TREATISE

ON

MINERALOGY.

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TREATISE

ON

MINERALOGY,

OR THE

NATURAL HISTORY OF THE MINERAL KINGDOM.

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PHYSIOGRAPHY.

§. 253. DEFINITION.

Physiography means the description of natural productions (§. 17.). It is intended to produce a distinct image of those objects which we distinguish from each other by means of the Characteristic, and denominate conformably to the rules laid down in the Nomenclature.

Physiography is not adapted to the purpose of distinguishing minerals. We cannot by its assistance find the place of a given mineral in the system; or, in other words, recognise it: for it is independent of that connexion among natural productions upon which systems are founded, and considers them singly, every one by itself. Physiography, therefore, cannot acquiesce in considering single characters or characteristic marks; but it must exhibit them all, if the image it produces is meant to be a complete and satisfactory one. Its difference from the Characteristic, founded upon these properties, is as obvious as the impossibility of substituting the one instead of the other. A description, therefore, is not a character (§. 242.); since the peculiarity of every character consists in its being composed of a smaller number of characteristic terms than may be observed in the objects characterized.

The descriptions presuppose nothing but Terminology. It is perfectly indifferent what nomenclature is made use of in Physiography, provided only the names and denominations to which the descriptions of the species refer, answer the purpose of keeping separate those objects, which really differ from each other. If that department of Natural History to which the Physiography belongs, possesses the advantage of a systematic nomenclature, this will be preferable in its application to any other, since it is the only one which deserves to be called scientific.

The Determinative and the Descriptive parts of Mineralogy have never been distinctly kept separate from each other, and this has been the reason why neither of them has yet attained that degree of perfection and utility of which it is susceptible, even in the present state of Mineralogy, and with our limited knowledge of the productions of the Mineral Kingdom. Every thing was expected from the Descriptive part of Natural History, while the Determinative part was entirely lost sight of; and thus Mineralogy has remained far behind her sister sciences, Zoology and Botany.

§. 254. OBJECTS OF PHYSIOGRAPHY.

The object to which Physiography refers, in the Natural History of the Mineral Kingdom, in as far as it produces a *mere* description, is the *Individual.*

Any description, containing the indication of all the properties, will suffice for determining a particular individual. In the Animal and Vegetable Kingdoms, homogeneous individuals (§. 220.) are in most cases at the same time identical (§. 214.), excepting their sexual differences; or at least the deviations occurring in their single characters may be considered as merely accidental. One individual therefore, or in the case of an existing difference in the sexes, two of them, will represent the whole species; and the description of these individuals may be received in the place of a description of the whole species. In the Mineral Kingdom, the homogeneous individuals in most cases so widely differ from each other, that a description of the one does not by any means apply to another; one, or a few of them, therefore, cannot represent the whole species, nor can their description be substituted instead of the description of the species. The description of all the varieties of a species does not produce a clear idea or representation of the species itself; because the species is not a *single* body, but the assemblage of all the homogeneous individuals or varieties (§. 220.). Thence we infer that the species in Mineralogy is not properly an object for a description; and the latter will not therefore allow of the same use in the Mineral Kingdom, to which it is adapted in the Animal and Vegetable Kingdoms.

In the Mineral Kingdom, only individuals (or compositions (§. 23.) of individuals), admit of being described, and this is effected by indicating all their natural-historical properties. In enumerating these, it is useful to keep to a certain determined, though in itself arbitrary order of succession, which, for the sake of perspicuity, should remain unaltered, if it has once been fixed upon. All prolixity should be carefully avoided, every superfluous word, every not perfectly determined expression, in short, every thing foreign to the purpose, should be rejected; and such terms employed as are explained in the Terminology. Many observations apply also to the present subject, which have been made to the same purpose in the introduction to the Characteristic.

Descriptions are required, whenever there occur new varieties of a species, the latter being either already known, or entirely new; they are also useful in such varieties as are distinguished by a particular application, or any remarkable property, or such as have been provided with particular names in the arts of life. In the latter, it is only necessary to indicate those properties, by which the variety in question differs from other varieties of the same species. It is very useful to give an *accurate* description of such individuals, as are subjected to a chemical analysis.

§. 255. GENERAL DESCRIPTION OF THE SPECIES.

In order to represent the natural-historical species in the Mineral Kingdom, it is necessary to construct a *Collective or General Description.*

The problem to be resolved in constructing a General Description is, to give a correct idea of all, or at least of the known varieties of a species in their proper connexion; it must therefore contain at once all the descriptions of these varieties, without its being itself in a strict sense a description at all. It is evident that the only means of arriving at this end, will be the employment of the series of characters.

The method of constructing a general description of a species is as follows. First, any suitable variety of the species is chosen, and described with all possible accuracy, the single characters succeeding each other agreeably to the order fixed upon, as above mentioned. The description will contain only single characters, consisting of a certain form, a certain colour, a certain kind of lustre, a certain degree of hardness or of specific gravity, &c., all of these being members of their respective series. If in the place of every one of these single characters, we substitute the complete series to which it belongs, the *Description of the Individual*, or of the variety, is transformed into the *Collective* or *General Description of the Species.*

The characters contained in the general description are expressed in series, produced either by immediate observation and interpolation, or by derivation (§. 79.). The characters in the descriptions of determined varieties consist of single members of these series. Evidently the collective description not only produces a complete idea of the species itself, but it also contains the individual description of every one of its single varieties; for, as to the latter, if we choose arbitrarily any single member from every one of the mentioned series, and join these members in the adopted order of succession, the result will be the description of a variety, belonging to the species.

The representation of the species as contained in the general description, is far more complete, than it could be obtained by immediate observation; for it unites all the varieties which may be produced by all possible combinations of the single properties (the members of different series). It would contain all the varieties possible in a species, if the series themselves were complete, which can be maintained only of those produced by derivation. Thus the considerations referring to the Mineral Kingdom become both fertile and interesting; because, by means of the general description, we obtain from every newly discovered variety, though it should differ from those already known, only in a single character, an almost endless number of new varieties, which may be produced by uniting the newly discovered property with every combination of the members of the other series, which the general description contains. The same process of reasoning is followed here, by which we obtain from a newly ascertained co-efficient, or from a number of derivation not known before, not merely a single form, but whole series of such forms.

The pure, or properly so called, general description, refers only to the individuals of the species, because it is only from these that we are entitled to derive characteristic marks, fit for being employed in Natural History (§. 192.). If the compound varieties are to be noticed, this must be done without mixing them up with the simple ones.

From the preceding observations, it appears that the general description pre-supposes the correct idea of the natural-historical species; but none besides of the general ideas developed in the Theory of the System (§. 17.).

The collective description explained here has no doubt been the fundamental idea of the descriptions introduced in Oryctognosy by the celebrated Werner. In these too series are made use of; and supposing the determination of the species to be correct, they might be employed in the place of the general descriptions of this work, if those series, upon which their completeness and utility more particularly depends, had been known at an earlier period, and the compound varieties properly separated from the simple ones.

The general description requires in particular, that the rules be strictly followed which have been mentioned in §. 244., in respect to the Characteristic.

§. 256. ARRANGEMENT OF THE GENERAL DESCRIPTION.

The general or collective descriptions require to be so arranged, as to facilitate their use as much as possible, and to produce, in fact, a complete general view of the species.

An example taken from one of the general descriptions contained in this Treatise, will be the best means to shew their arrangement in a greater detail; for which purpose, we select that of rhombohedral Lime-haloide, which is particularly well calculated for illustration, on account of the numerous varieties which this species comprehends.

In order to determine the series of crystallisation of a species in general, it is necessary to indicate its fundamental form with its dimensions expressed by numbers. The authority has been given in the forms of variable dimensions. Those which have been re-examined, or newly or more accurately determined, are likewise indicated by the addition of R. G. (Reflective Goniometer) or Ap. (approximation); the first expressing a higher degree of exactitude.

The angles or dimensions of every one of these which can possibly occur in the species, may be calculated from the fundamental form, agreeably to the rules laid down for the derivations of other simple forms. For the sake of greater convenience in calculating the angles of rhombohedral Lime-haloide, the value of a, the axis of the fundamental form, has been given; its horizontal projection being supposed $= 1$. The same is observed in forms of the Pyramidal system. In the fundamental forms belonging to the Prismatic system, the ratio of the axis and the two diagonals, $a : b : c$ has been given; in Hemi-prismatic forms the ratio of the four lines $a : b : c : d$, as explained in §. 98.

Yet a calculation would always be required, if we intended to find the angles of the simple forms from the given value of the axis, or from that of the mentioned ratios between the axis and the diagonals; and as it is useful and interesting to know what simple forms have already been observed, or which among these most commonly occur in the species; the derived forms have also been indicated, along with the measure of their angles, and expressed by means of their crystallographic signs. In respect to the indication of their angles, a general exception has been made in those limiting forms, in which a similar determination is not necessary, since their angles are the same wherever they occur, and have been given in their proper place, under the head of Terminology. An asterisk over the crystallographic sign of a simple form denotes, that it has been observed in nature, without any additional faces.

The peculiar mode in which the simple forms of a species join in combinations, is another very important subject in the general outline of that species; it is the *Character of Combinations* (§. 145., &c.). The simple forms of octahedral Fluor-haloide, those of hexahedral Iron-pyrites and of tetrahedral Copper-glance, belong to one and the same series of crystallisation, and yet every one of these species contains some simple forms not to be met with in the others, and which nevertheless impart a peculiar aspect to the combinations in which they enter, so that the crystallisations of the three species differ most essentially from each other. This difference is expressed in the Character of Combinations, which is *tessular* (§. 156.) in the Fluor-haloide, *semi-tessular of parallel faces* (§. 157.) in the Iron-pyrites, and *semi-tessular of inclined faces* (§. 157.) in the Copper-glance. In the rhombohedral system, the combinations are either rhombohedral or di-rhombohedral, or hemi-rhombohedral, &c. agreeably to §. 145., &c. The first of these applies to the species of rhombohedral Lime-haloide, and its Character of Combinations therefore is *rhombohedral.*

Next to this are indicated some of the most common or remarkable combinations occurring in the species, expressed by their crystallographic signs, and partly also illustrated by figures. It may be supposed here, that the use of the signs will be entirely familiar to those who have read the preceding part of the present work. Upon this supposition the few lines referring to the combinations will be more useful to the reader, than the descriptions of crystalline forms commonly to be met with in mineralogical books, which, though sometimes extended to several pages, yet seldom suffice for representing with any degree of accuracy, combinations of three or four simple forms, far less such as are still more complicated. These descriptions never can arrive at any thing like mathematical precision, whereas the crystallographic designation employed in this work admits of the most accurate calculations, and will answer every crystallographic question, which regards the designated compound form.

The phenomenon of cleavage being in the nearest relation to the crystalline forms, the next place in the collective description has been assigned to it. The forms of cleavage are likewise represented by means of their crystallographic signs; and as to the faces of cleavage, due attention has been paid to their degree of perfection, some of them being more easily observed, and on that account distinguished from others, which require a more minute examination, sometimes even the assistance of a very intense light (§. 162.). Thus in rhombohedral Lime-haloide the faces of cleavage obtained in the direction of the faces of the rhombohedron R, commonly present high degrees of perfection, while those in other directions, if ever they occur, generally appear less distinctly.

Fracture, as far as it is contained in the collective description itself, refers only to simple minerals. Although in itself rather insignificant, yet for the sake of completeness we cannot pass it by unnoticed. Several varieties of fracture, if mentioned in one and the same place, denote the limits, between which the varieties range, which occur in the species. Also in respect to fracture, it will be indicated, whether it be easily or difficultly obtained. Rhombohedral Lime-haloide so very readily yields to cleavage, that in most cases it is attended with considerable difficulty to perceive the faces of fracture, which are conchoidal.

The physical quality of the surface of crystals is far more important than fracture, since it is in close connexion with the crystalline forms themselves. Also these faces are expressed by crystallographic signs, because they cannot be indicated with greater brevity or precision. Several of the faces of crystallisation of rhombohedral Lime-haloide are very often found to be streaked; but these striæ, with a few trifling exceptions, have a constant direction, being almost in every instance parallel to the intersection of the striated faces with the faces of the rhombohedron R.

The characters depending upon the presence of light, contribute very much to enliven the image or representation of the species. The kinds of lustre must everywhere be mentioned; and if there should be found a difference as to its occurrence upon different faces, also the direction must be given, in which the different kinds of lustre may be observed. In rhombohedral Lime-haloide, the lustre is in general vitreous, only the faces of $R - \infty$ sometimes present pearly lustre. The latter kind of lustre sometimes also extends to compound varieties, whose faces of composition correspond to those of $R - \infty$, as in the well known example of Slate-spar. Of the degrees of lustre, it is sufficient to mention the limits.

The series of colours in particular might be very useful in enlivening the collective descriptions, if they could be expressed with the same conciseness as those of the crystalline forms. But in order to indicate the series, it is indispensible to mention all its single members; and I have therefore thought more convenient, for the sake both of precision and brevity, merely to give an outline of these series, by indicating their principal points, or some of their more peculiar properties. This mode of treating the subject does by no means injure the use of the series of colours, nor diminish their importance in the determination of the species. It is the white colour, which, in rhombohedral Lime-haloide, accidentally inclines to several others, none of their different shades possessing any degree of brightness. Colours produced by occasional admixtures of minerals foreign to the species, do not properly belong to the collective description ; because they are not members of the series of colours of the species described. Yet they are indicated by themselves, at least the common shades, in order to exclude them from those, with which they are not connected by transitions within the same series.

It is important to indicate correctly the colour of the powder, or the streak.

The indication of the limits will suffice for the degrees of transparency. In general, refraction is simple in all those species whose forms belong to the tessular system : it is double in all those of the other systems. There is but one optical axis in the rhombohedral and pyramidal systems, which coincides with the crystallographic principal axis. In the prismatic forms, there exist two optical axes, situated in planes which pass through the axis and one of the diagonals. The direction of these axes, in respect to the crystallographic axes and diagonals, in most cases has not been sufficiently ascertained. The characters of the minerals derived from their action upon light, will no doubt form an essential part in future of the general descriptions.

Lastly, the general descriptions contain the indication of the form of aggregation, of hardness, specific gravity, and other characteristic marks derived from, or respecting, the substance of minerals, as odour, taste, &c., which may be useful in the description of varieties ; all of them expressed with the brevity essential to the characters which compose the Characteristic. It is necessary to observe here, that the unity of comparison for the specific gravity of expansible fluids, is that of atmospheric air ; in the same way in which that for liquid or solid bodies is the specific gravity of distilled water. The specific gravities given without adding any authority, have been newly determined and reduced to a temperature of 15° centigr. (59° Fahrenh.).

A great number of the different varieties of certain species is produced by the composition of their individuals. The species of rhombohedral Lime-haloide is one of the most remarkable in this respect; and this has been the reason of its having been divided and subdivided into a great number of sub-species and kinds. If the collective description of the simple varieties has been drawn up with sufficient accuracy, it will not be difficult to join the compound varieties within a narrow compass which can be easily surveyed, and annexed to the former. This has been done in rhombohedral Lime-haloide. Among the compound varieties, the most remarkable are those in which the composition follows a certain rule, that is the twin-crystals. The general consideration of the twin-crystals (§. 179.) contains the principles of a method, according to which those belonging to any particular species may be indicated with precision and convenience, and provided with an appropriate designation. This method consists in expressing the form of the regularly joined individuals by means of their crystallographic signs, and in determining in the same way the axis of revolution and the face of composition. It will be still more general if we conceive, that not any particular observed crystalline variety, but indeed every simple or compound form belonging to the species, may belong to the individuals, which are joined in the regular composition.

It will be sufficient only to mention the imitative forms, in order to recal their properties to the memory, these being commonly so much alike in every instance, that they allow of a general explanation, which has been given in its proper place (§. 181, &c.). The condition of their surface, or of the faces of composition in their interior, the shape of the particles of composition, and the mode of that composition itself, may likewise be indicated. It is necessary to remark here that the occurrences of composition are not mentioned for the purpose of recognising or distinguishing the compound varieties of rhombohedral Lime-haloide from those of any other species, which in fact would in every respect be foreign to the purposes of a collective description; but that they are intended merely for producing a general survey of every thing relative to those compositions contained within the limits of the species.

The same applies also to amorphous compositions, or, as they are more commonly called, to the *massive* varieties. As to these, the most important properties to be mentioned here will be, the shape of the component particles, their size, mode of aggregation and fracture; for, according to these properties, the species of rhombohedral Lime-haloide has been divided into foliated, fibrous, and compact Limestone, together with their farther subdivisions; and likewise the oryctognostic species of Slate-spar, Anthracolite Chalk, Rockmilk, and others, have been formed under the same influence of composition, as will appear more evidently in the *Observations* annexed to the description of the present species. Thus we are capable of expressing in a few words, much that has been described with great prolixity in mineralogical works; while we enjoy the advantage of arriving at an idea of the subject, correct and general, and conformable to nature.

Also the pseudomorphoses need nothing more than to be mentioned. Even though their appearance be regular, they so little refer to the internal quality of the species, that their knowledge does not add to our general knowledge of the species.

The arrangement of all the other collective descriptions is the same as that explained in the preceding example, taken from rhombohedral Lime-haloide. If other properties should happen to occur than those mentioned here, these properties will likewise be inserted in a proper order, provided they contribute to our natural-historical knowledge of the species in question; whereas others mentioned in rhombohedral Lime-haloide, if they be wanting, will be passed over in silence. In general, some one or other of the natural-historical properties of the species may be rendered more prominent, the more it contributes to a clear and distinct image of the species; without, however, too much encroaching upon the uniformity of the collective descriptions, as far as this may be consistent with the qualities of the species described.

The collective descriptions of the species form one of the most important subjects of the Natural History of the Mineral Kingdom. Although they represent the mineral species by themselves, not paying any attention to their resemblance to others, yet they effect this in the minutest detail, and to the greatest possible completeness, and hence they contain *all the natural-historical information, properly so called*, relative to the mineral productions. *Character naturalis* (§. 242. 243.) *generum plantarum fundamentum est, quo destitutus nullus de genere rite judicabit; adeoque absolutum fundamentum cognitionis plantarum est et erit*. Linn. Phil. Bot. 189. This knowledge, however, is still very imperfect. For mineralogists have hitherto attached too much importance to composition and other subordinate subjects, whilst the study of what alone is capable of bringing the collective descriptions of mineral species nearer perfection, has comparatively been too much neglected. Hence the accurate investigation of the natural-historical properties of individuals, upon which this chiefly depends, cannot be too strongly recommended for the promotion of mineralogical science. I trust that in these inquiries the perusal of the present work will remove a great part of those difficulties, which have formerly originated from a too general want of crystallographic knowledge. Crystallographic information being now rendered more accessible, and its application shewn by a great number of examples; in short, the path being open which ought to be followed, we may justly expect, that, within a short period, the zeal and perseverance at present bestowed upon the study of Mineralogy, will greatly improve the collective descriptions of the mineral species.

§. 257. THE COLLECTIVE DESCRIPTIONS DO NOT DEPEND UPON THE SYSTEMS.

The collective descriptions are independent of the systems; they are applicable, therefore, in every system, even though the principles to which it is framed should not agree with those of Natural History.

The collective description represents the natural-historical species developed in its minutest details. The natural-historical species itself is the basis of every method, or in fact of every science, which refers to the productions of the Mineral Kingdom: it is the object, not the product of classification (§. 220. 223.). The collective description is therefore independent of the system, and may be applied in every one of them, natural or artificial, and drawn up conformably to the principles of Natural History, or to those of any other science. Thus the collective description, by means of its general applicability, is raised to a still higher degree of importance, since it becomes the link between Natural History and other sciences referring likewise to the productions of the Mineral Kingdom.

Having completed the collective descriptions, Natural History has fulfilled its duty, and the natural-historical species is now fit to be the subject of farther investigation in other sciences, in all of which it is the general classifiable unity, since it is not only distinguishable with the greatest facility from every one resembling it, but also clearly represented to the minutest details by the enumeration of its natural-historical properties. The acquirement of all other kinds of information referring to minerals is foreign to Natural History, although its foundation consists in the correct determination of that science. It is only by dividing and keeping separate the heterogeneous principles, that it will be possible to produce unity and connexion within the store of our knowledge, for by this means we shall not only avoid future disputes and contradictions, but also terminate those which have hitherto prevailed. Every thing being thus preserved in its proper place, one will regularly follow the other; and there will not exist that mixture of heterogeneous matter of information, which has been till now called Mineralogy, without, however, having a just title, according to its nature and principles, to be regarded as such. Every one therefore of those sciences, which have hitherto been but too frequently mixed up with one another, thus confined within their respective limits, will entirely become what it ought to be, and will not be prevented in future by foreign considerations, from approaching nearer perfection. It is of the greatest importance never to lose sight of the succession of such sciences as refer to one and the same object.

Every step taken upon the methodical path, leads us forwards; and every one is equally important, since it becomes possible only upon the supposition of the preceding one having been accomplished. It is Natural History which takes the lead in this process; and every scientific examination of a production of nature, must therefore begin with its natural-historical determination.

The following list contains some mineralogical works useful in a more detailed study of mineral species, and which have partly also been made use of in the physiographical department of the present Treatise:

A System of Mineralogy, in which minerals are arranged according to the Natural History method. By Robert Jameson. Third edition. Edinburgh, 1820.

Manual of Mineralogy: containing an account of simple Minerals; and also a description and arrangement of mountain rocks. By Robert Jameson. Edinburgh, 1821.

An Elementary Introduction to the Knowledge of Mineralogy, &c. By William Phillips. Third edition. London, 1823.

Handbuch der Mineralogie, von C. A. S. Hoffmann. Freiberg, 1811. Continued by A. Breithaupt.

Handbuch der Mineralogie, von J. F. L. Hausmann. Göttingen, 1813.

Vollständiges Handbuch der Oryktognosie, von H. Steffens. Halle, 1811.

Handbuch der Oryktognosie, von Karl Cæsar v. Leonhard. Heidelberg, 1821.

Cristallographie, &c. par M. de Romé de l'Isle. V. Vol. I. p. 17.

Traité de Minéralogie, par le C^{en}. Haüy. V. Vol. I. p. 17.

Tableau comparatif des resultats de la Cristallographie et de l'analyse chimique, relativement à la classification des minéraux, par M. l'Abbé Haüy. Paris, 1809.

Traité de Minéralogie, par M. l'Abbé Haüy. Seconde édition. Paris, 1822.

Numerous Memoirs in different Journals, by Messrs Haüy, Monteiro, Count Bournon, Soret, Weiss, Bernhardi, Fuchs, Dr Brewster, Phillips, Brooke, Lévy, and others.

For Synonymes and Literature in general,

T. Allan's Mineralogical Nomenclature, alphabetically arranged, &c. Edinburgh, 1819.

Systematische Uebersicht der Litteratur für Mineralogie, Berg-und Hütten-Kunde, vom Jahr 1800 bis mit 1820, von Dr Johann Carl Freiesleben, Kön. Sächs. Bergrath. Freyberg, 1822.

GENERAL DESCRIPTIONS

OF THE

SPECIES.

CLASS I.

GAS. WATER. ACID. SALT.

ORDER I. GAS.

GENUS I. HYDROGEN-GAS.

1. PURE HYDROGEN-GAS.

Pure Hydrogen Gas. JAMESON. Man. p. 1. Wasserstoffgas. HAUSMANN. I. S. 63.

Amorphous. Transparent. Expansible. Sp. Gr. = 0·0688. BERZ.* 0·0732. BIOT and ARAGO.† Odour peculiar.

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* Lärbok i Kemien, af J. J. BERZELIUS. Stockholm.

† Traité de Physique Expér. et Math. par M. BIOT. Paris.

OBSERVATIONS.

1. Hydrogen-gas, as it is found in nature, is generally in a state of combination. By the assistance of chemical processes, it may be obtained free from all odour. It burns with a feeble light in atmospheric air, and if mixed with it, produces a detonating gas. It imparts neither odour nor taste to water with which it has been kept in contact.

2. The pure Hydrogen-gas is developed from several kinds of rocks, limestone, beds of coal, &c.; also from pools and stagnant water in general; and it is met with under these circumstances in different countries all over the globe. It is one of the most common sources of the perpetual fires of the Pietra Mala, and other places in Italy, in the north of Asia, &c. and occurs in several mines.

2. EMPYREUMATIC HYDROGEN-GAS.

Empyreumatic or carburetted Hydrogen Gas. Jam. Man. p. 1. Kohlenwasserstoffgas. Hausm. I. S. 64.

Amorphous. Transparent. Expansible.
Sp. Gr. = 0·5707. Berz. Odour empyreumatic.

OBSERVATIONS.

1. The empyreumatic Hydrogen-gas consists of

Carbon	74·00.
Hydrogen	26·00, according to Berzelius.

It burns with a very faint blue flame, and imparts neither odour nor taste to water it has been in contact with.

2. It is developed from marshes and stagnant pools, and is also found in volcanic countries. It seems that the above mentioned species, which is said by Berzelius to burn with almost no flame at all, is different from the inflammable gas which occurs in coal mines, particularly those of Newcastle and Liege, since the latter burns with a bright flame. This gas is called *fire-damp* at Newcastle. There are continual streams of it issuing from the coal seams or the accompanying strata. It mixes readily with

atmospheric air, in which state it has been the cause of many melancholy accidents by sudden explosions.

3. SULPHUREOUS HYDROGEN-GAS.

Sulphuretted Hydrogen Gas. JAM. Man. p. 2. Schwefelwasserstoffgas. HAUSM. I. S. 63.

Amorphous. Transparent. Expansible.
Sp. Gr. = 1·181. BERZ. 1·1912. GAY-LUSSAC.
Odour of putrid eggs.

OBSERVATIONS.

1. The sulphureous Hydrogen-gas consists of
Hydrogen 5·824.
Sulphur 94·176. BERZELIUS.

It does not support combustion; it blackens most of the metals, and becomes fatal to animals if inhaled in any considerable quantity.

2. It is developed from sulphureous waters, both cold and warm, as at Nenndorf, in Westphalia, and at Baaden, near Vienna; also from swamps and marshes. In Italy both cold and warm, it is disengaged from the soil of the *Solfataras* and of the *Fumacchie*, sometimes mixed with other kinds of gas, of which several instances have been mentioned by M. VON PRZYSTANOWSKY, in his Memoir on the Origin of the Volcanoes in Italy. On the western bank of the Niagara river, a mile south of the Falls, it issues from the bank, which consists of a shelly limestone, including thin beds of coal and Iron-pyrites. Under similar circumstances, it occurs near Otsquaga Creek. A. EATON.

4. PHOSPHOROUS HYDROGEN-GAS.

Phosphuretted Hydrogen Gas. JAM. Man. p. 2. Phosphorwasserstoffgas. HAUSM. I. S. 64.

Amorphous. Transparent. Expansible.
Sp. Gr. = 0·9022. THOMSON. Odour of putrid fish.

OBSERVATIONS.

1. This gas is composed of phosphorus and hydrogen, the relative quantities of which have not yet been ascertained. Bubbles of this gas, passing through a liquid into atmospheric air, undergo a spontaneous combustion, and produce a smoke remarkable for its annular disposition. If allowed to remain for some time in contact with water, it imparts to it a disagreeable odour, and a bitter taste.

2. The phosphorous Hydrogen-gas, is the product of bogs and other humid places, which contain organic matter in a state of putrefaction. It has been considered as the cause of the *ignis fatuus* or jack o' lantern ; an opinion not very probable, if we compare the properties of the gas with the descriptions given of these luminous phenomena.

GENUS II. ATMOSPHERIC-GAS.

1. PURE ATMOSPHERIC-GAS.

Pure Atmospheric Air. JAM. Man. p. 2. Atmosphærische Luft. HAUSM. III. S. 762.

Amorphous. Transparent. Expansible.

Sp. Gr. = 1·0. It is nearly 800 times lighter than pure Atmospheric-water.

OBSERVATIONS.

1. Pure Atmospheric-gas consists of

Azote	78·999.
Oxygen	21·000.
Carbonic acid	0·001. BERZELIUS.

The proportion of azote and oxygen is constant, that of carbonic acid is variable ; being sometimes higher, sometimes lower than that mentioned above. Air filled in bottles at sea, at a considerable distance from the shore, has been found to contain no carbonic acid at all.

2. It constitutes the atmosphere, and surrounds the whole globe.

ORDER II. WATER.

GENUS I. ATMOSPHERIC-WATER.

1. PURE ATMOSPHERIC-WATER.

Pure Atmospheric Water. JAM. Man. p. 3. Weich-Wasser. Hart-Wasser. HAUSM. III. S. 766. 773.

Amorphous. Transparent. Liquid.
Sp. Gr. = 1·0. Without odour or taste.

OBSERVATIONS.

1. Pure Atmospheric-water consists of

Oxygen 88·94.
Hydrogen 11·06. BERZELIUS.

In its natural state, it generally contains several earthy substances, salts, or acids, in a state of solution, which sometimes exercise a considerable influence upon its taste, odour, and specific gravity. Thus are formed the different kinds of hard water, of acidulous and bitter waters, and sea-water, which by some naturalists have been considered as particular species. If the temperature be sufficiently high or low, its form of aggregation is changed; and instead of water, there appears steam or ice. The crystals of ice or snow, of which a great number are described and figured by Captain Scoresby, are commonly said to belong to the rhombohedral system. But the figures of the crystals of snow, being commonly like that of a star with six radii, very nearly resemble the regular compositions of di-prismatic Lead-baryte, Fig. 38., and of other minerals belonging to the prismatic system. Dr BREWSTER has found, on the other hand, that ice exhibits in polarised light most distinctly the single system of coloured rings, depending upon the existence of a single axis of double refraction. It will therefore be prudent to leave the question still undecided, to which system of crystallisation these forms belong, which will depend upon future investigations of their angles. The grains of hail are compound, like other products of a similar formation. Those which fall during the changeable season of spring have the form of spheric sections, consisting of thin prisms, radiating from the centre, which prisms are columnar particles of composition, and commonly opake. The hail formed during heavy thunder-storms, in general affects the shape of irregular, flattish globules; it is likewise compound, but often perfectly transparent, and including air bubbles.

2. The pure Atmospheric-water occurs in the shape of dew, mist, rain, snow, hail, ice, &c.; also in springs, rivers, lakes, &c. In many instances it is found with admixtures of saline solutions, particularly in the sea. In the one or the other form, it is spread all over the globe.

ORDER III. ACID.

GENUS I. CARBONIC-ACID.

1. GASEOUS CARBONIC-ACID.

Aëriform Carbonic Acid. JAM. Man. p. 4. Kohlensäure. HAUSM. III. S. 792.

Amorphous. Transparent. Expansible. Sp. Gr. = 1·51961. BIOT and ARAGO. Taste slightly acidulous, pungent.

OBSERVATIONS.

1. The gaseous Carbonic-acid consists of

Carbon 27·40.
Oxygen 72·60. BERZELIUS.

It suffocates animals, and extinguishes fire. It reddens the blue tincture of litmus; but the original colour very soon returns. It produces a copious precipitate in a solution of quicklime in water; and is itself absorbed by water, to which it communicates its acidulous taste.

2. This acid is found most commonly in the neighbourhood of, or stagnating upon, acidulous springs; also in several marshes, and in the solfataras. In various circumstances it is formed upon the surface of the earth. It occurs in several excavations, both natural and artificial, as in the *grotta del cane* near Naples; and in a cave in the Büdös hegy, a porphyry mountain in Transylvania; besides also in many mines, where in some places this dangerous gas is known by the name of Schwaden or Swath. The gaseous Carbonic-acid, obtained by art, is employed for various purposes.

GENUS II. MURIATIC-ACID.

1. GASEOUS MURIATIC-ACID.

Aëriform Muriatic Acid. JAM. Man. p. 4. Salzsäure. HAUSM. III. S. 801.

Amorphous. Transparent. Expansible.
Sp. Gr. = 1·278 BERZ. 1·274 BIOT and ARAGO.
Odour pungent. Taste strongly acid.

OBSERVATIONS.

1. The gaseous Muriatic-acid consists of

Muriatic acid	75·31.
Water	24·69. BERZELIUS.

It is unfit for respiration, suffocates animals, and extinguishes fire. The blue colour of an infusion of litmus is changed by it into a durable red one.

2. It occurs in the vicinity of active volcanoes, near Mount Etna and Vesuvius; it is also said to be produced by stagnant waters in salt-mines.

GENUS II. SULPHURIC-ACID.

1. GASEOUS SULPHURIC-ACID.

Aëriform Sulphuric Acid. JAM. Man. p. 4. Schweflichte Säure. HAUSM. III. S. 797.

Amorphous. Transparent. Expansible.
Sp. Gr. = 2·247. Berz. 2·1204. Gay-Lussac and Thenard. Odour pungent and acid, like that of burning sulphur.

OBSERVATIONS.

1. The gaseous Sulphuric-acid consists of
Sulphur 50·144.
Oxygen 49·856. Berzelius.

At the common temperature of our atmosphere it is permanently elastic; but it may be converted into a liquid substance, by exposing it to either frost or pressure. It is readily absorbed by water.

2. This acid rushes out from active volcanoes, and is found in considerable quantities, near Mount Etna, Vesuvius, &c. It occurs likewise, along with gaseous Carbonic-acid, in a cave which is situated in the Büdös hegy, a porphyry hill in Transylvania, on the frontiers of Moldavia. At the foot of the mountain there are numerous acidulous springs, which develope a considerable quantity of gaseous Carbonic-acid. The walls of the cave described above, are covered with a crust of prismatic Sulphur.

2. LIQUID SULPHURIC-ACID.

Liquid Sulphuric Acid. Jam. Man. p. 4. Schwefelsäure. Hausm. III. S. 799. Acide sulfurique. Haüy. Tabl. comp. p. 1. Traité de Min. 2de Ed. Tom. I. p. 295.

Amorphous. Transparent, in different degrees. Liquid.
Sp. Gr. = 1·857. Berz. Taste strongly acid and burning.

OBSERVATIONS.

The anhydrous Sulphuric acid is solid, and consists of
Sulphur 40·14.
Oxygen 59·86. Berzelius.

The liquid Sulphuric-acid contains at least 18·5 per cent. of water. If it contains 37 per cent. it possesses the property of crystallising at a temperature of 4°—5° centigr., about 40° Fahr. The crystalline forms quoted are six-sided prisms terminated by six-sided pyramids, of which as yet neither the system nor the angles have been determined.

2. The liquid Sulphuric-acid occurs in the neighbourhood of several volcanoes, as Mount Etna, and in great quantities in the island of Java, &c.; it is found besides in caves in several places in Italy, and at Aix in Savoy. Sulphuric-acid is also formed by the decomposition of several species of the order Pyrites.

GENUS IV. BORACIC-ACID.

1. PRISMATIC BORACIC-ACID.

Sassoline or Native Boracic Acid. JAM. Syst. Vol. III. p. 48. Scaly Boracic Acid. Man. p. 5. Sassolin. HAUSM. III. S. 803. Boraxsäure. LEONH. S. 113. Acide boracique. HAÜY. Tabl. comp. p. 2. Traité, 2de Ed. T. I. p. 297.

Fundamental form. Scalene four-sided pyramid. Vol. I. Fig. 9. Determinable forms unknown.

Lustre pearly. Colour greyish- and yellowish-white. Streak white. Feebly translucent.

Sp. Gr. = 1·480. BERZ. Taste acidulous, afterwards bitter and cooling, lastly sweetish.

Compound Varieties. Loose scaly particles, crystalline grains, sometimes aggregated in the form of crusts.

OBSERVATIONS.

1. The prismatic form of the six-sided tabular crystals

of this substance has been inferred from Dr Brewster's optical observations.

2. According to Professor Stromeyer, the prismatic Boracic-acid from Volcano, one of the Lipari islands, is perfectly pure Boracic Acid, with an accidental admixture of sulphur. If pure, it consists of

Boron 25·83.
Oxygen 74·17. Berzelius.

The crystallised variety contains 45 per cent. of water. It is fusible at the flame of a candle, and yields a glassy globule, which acquires resinous electricity by friction, even without being isolated.

3. It is deposited from the hot springs near Sasso, and from the *lagoni* in Tuscany. Another locality is Volcano, one of the Lipari Islands.

Genus V. ARSENIC-ACID.

1. OCTAHEDRAL ARSENIC-ACID.

Oxide of Arsenic. Jam. System. Vol. III. p. 552. Octahedral Arsenic Acid. Man. p. 5. Arsenikblüthe. Hausm. III. S. 805. Arsenikblüthe. Leonh. S. 170. Arsenic oxydé. Haüy. Traité, T. IV. p. 225. Tabl. comp. p. 108. Traité, 2de. Ed. T. IV. p. 241.

Fundamental form. Hexahedron, Vol. I. Fig. 1.

Simple forms. $\overset{*}{O}$, Vol. I. Fig. 2., commonly elongated in one or another direction.

Cleavage octahedron, perfect. Fracture conchoidal.

Colour white, often inclining to yellow. Streak white. Lustre vitreous, inclining to adamantine. Semi-transparent ... opake.

Sp. Gr. = 3·698. Roger and Dumas. Taste sweetish astringent.

Compound Varieties. Reniform, botryoidal, stalactitic; thin crusts: particles of composition, if columnar, and very thin, commonly of a pearly lustre. Massive. Pulverulent.

OBSERVATIONS.

1. The octahedral Arsenic-acid consists of

Arsenic 75·82.
Oxygen 24·18. BERZELIUS.

If exposed to a high degree of temperature, it is entirely volatilised; upon ignited charcoal it emits a strong garlick smell. Its white smoke condenses itself again upon cold bodies. It is soluble in water. The poisonous qualities of this substance are well known.

2. The repositories of the octahedral Arsenic-acid are the mineral veins, where it probably owes its existence to the decomposition of other minerals. It is chiefly accompanied by native Arsenic, hemi-prismatic Sulphur, rhombohedral Ruby-blende, hexahedral Lead-glance, &c., and has been found at Andreasberg in the Hartz, at Joachimsthal in Bohemia, at Bieber in the principality of Hanau, &c.

ORDER IV. SALT.

GENUS I. NATRON-SALT.

1. HEMI-PRISMATIC NATRON-SALT.

Prismatic Natron. JAM. Syst. Vol. III. p. 39. Man. p. 5. Natron. Carbonate of Soda. PHILLIPS, p. 190. Natürlich Mineral-Alkali. WERNER. Hoffmann, Handbuch. Th. III. 1. Abth. S. 212. Soda. Trona. HAUSM. III. S. 832. 833. Kohlensaures Natron. LEONH. S. 614. Soude carbonatée. HAÜY. Traité, T. II. p. 373. Tabl. comp. p. 21. Traité, 2de. Ed. T. II. p. 207.

Fundamental form. Scalene four-sided pyramid. $P = \left\{\begin{matrix} 79° 41' \\ 77° 14' \end{matrix}\right\}$, 154° 31', 115° 22'. Inclination $= 3° 0'$, in the plane of the long diagonal. Vol. I. Fig. 41. R. G.

$$a : b : c : d = 19{\cdot}10 : 34{\cdot}72 : 13{\cdot}66 : 1.$$

Simple forms. $\frac{P}{2}$ $(P) = 79° 41'$; $(\breve{P}r + \infty)^3$ $(M) = 76° 28'$; $\pm\frac{\breve{P}r}{2} = \left\{\begin{matrix}58° 52'\\63° 28'\end{matrix}\right\}$; $\bar{P}r - 1 = 110° 5'$; $\breve{P}r + \infty$; $\bar{P}r + \infty$ (l).

Character of Combinations. Hemi-prismatic. Inclination of $P - \infty$ to $\breve{P}r + \infty = 93° 0'$.

Combinations. 1. $\frac{P}{2}$. $(\breve{P}r + \infty)^3$.

2. $\frac{P}{2}$. $(\breve{P}r + \infty)^3$. $\bar{P}r + \infty$. Fig. 45.

3. $\frac{P}{2}$. $\bar{P}r - 1$. $-\frac{\breve{P}r}{2}$. $(\breve{P}r + \infty)^3$. $\bar{P}r + \infty$.

4. $\frac{\breve{P}r}{2}$. $\frac{P}{2}$. $(\breve{P}r + \infty)^3$. $\breve{P}r + \infty$. $\bar{P}r + \infty$.

Cleavage. $\frac{\breve{P}r}{2}$, distinct; $\bar{P}r + \infty$ imperfect; traces of $(\breve{P}r + \infty)^3$. Fracture conchoidal. Surface smooth and even.

Lustre vitreous. Colour white, the grey and yellow tints are owing to foreign admixtures. Streak white. Semi-transparent.

Sectile. Hardness $= 1{\cdot}0 \ldots 1{\cdot}5$. Sp. Gr. $= 1{\cdot}423$. Taste pungent, alcaline.

Compound Varieties. Several imitative shapes: composition columnar. Massive: composition granular. Commonly occurring in the state of powder.

OBSERVATIONS.

1. The native carbonate of soda, found in the province of Sukena, in Africa, consists, according to **Klaproth**, of

Soda	37·00.
Carbonic Acid	38·00.
Sulphate of Soda	2·50.
Water	22·50.

Its composition differs considerably from that of the crystallised varieties, to which the above description refers, the composition of these being expressed, according to **Berzelius**, by $\ddot{\mathrm{Na}}\,\ddot{\mathrm{C}}^2 + 20\,\mathrm{Aq} = 21{\cdot}77$ of Soda, 15·33. of Carbonic acid, and 62·90 of Water. It is likely, therefore, to belong to another, perhaps to the following species. It is very soluble in water, effervesces with acids, and melts easily before the blowpipe. Blue vegetable colours are changed by it into green.

2. This salt loses its water, on being exposed to a dry atmosphere, and is therefore commonly met with in a state of efflorescent powder on the surface of the earth, on the shores of lakes, or in natural caverns. It is held in solution by certain mineral waters. According to **Bertholet**, it is formed in part by a decomposition of hexahedral Rock-salt, by carbonate of lime.

3. It occurs in considerable quantities in the plains of Debreczin, in Hungary; also in Bohemia, Italy, and several other European countries, but principally in the soda lakes of Egypt, and in some parts of Asia and America.

4. Its chief employment is in the manufactures of soap. It enters also the composition of glass, and is used in dyeing, washing, bleaching, &c. both in its natural state, and purified by the assistance of chemical processes.

2. PRISMATIC NATRON-SALT.

Synonymes as above.

Fundamental form. Scalene four-sided pyramid. P = 141° 48′, 52° 9′, 145° 52′. Vol. I. Fig. 9. Ap.

$$a : b : c = 1 : \sqrt{0{\cdot}806} : \sqrt{0{\cdot}107}.$$

Simple forms. $P - \infty$; P (P); $(\breve{P}r + \infty)^5$ (d) $= 107° 50'$; $\breve{P}r - 1 = 121° 46'$; $\breve{P}r$ (o) $= 83° 50'$; $\breve{P}r + \infty$ (p).

Char of Comb. Prismatic.

Combinations. 1. $P - \infty$. $(\breve{P}r + \infty)^5$. $\breve{P}r + \infty$.
2. $\breve{P}r$. $(\breve{P}r + \infty)^3$. $\breve{P}r + \infty$. Similar to Fig. 9.
3. $\breve{P}r$. P. $(\breve{P}r + \infty)^3$. $\breve{P}r + \infty$. Fig. 16.
4. $P - \infty$. $\breve{P}r - 1$. $\breve{P}r$. P. $(\breve{P}r + \infty)^3$. $\breve{P}r + \infty$.

Cleavage, traces of $\breve{P}r + \infty$, interrupted by conchoidal fracture. Imperfect. Fracture conchoidal. Surface generally smooth; $P - \infty$ streaked, parallel to its edges of combination with $\breve{P}r$.

Lustre vitreous, more bright upon $\breve{P}r + \infty$; the faces $\breve{P}r - 1$ and $\breve{P}r$ being sometimes dull. Colour white, sometimes yellowish. Streak white. Transparent ... semi-transparent.

Sectile. Hardness $= 1{\cdot}5$. Sp. Gr. $= 1{\cdot}562$. Taste pungent, alcaline.

OBSERVATIONS.

1. The difference existing between this and the preceding species has hitherto remained unnoticed, although it seems that both of them are met with in nature. They may easily be obtained by the assistance of art, as have been the crystals of both species described above. If a perfectly saturated solution of carbonate of soda be exposed to a further evaporation at a temperature of about 25°—40° centigr., about 77°—104° Fah., or very slowly cooled, beautiful crystals of the prismatic species will be formed, whilst a less saturated solution will produce the hemi-prismatic species at a lower temperature, or if cooled more rapidly.

2. The relative chemical proportions of this salt have not

yet been ascertained, if perhaps the above analysis by KLAPROTH does not belong to the present species. It seems to differ from the hemi-prismatic Natron-salt, chiefly by its containing a smaller quantity of water. It is, like the former, subject to decomposition, by which it loses its water, and is reduced to a powder; yet this effect does not take place so easily and so quickly, as in the hemi-prismatic species. If they are both contained in the carbonate of soda of commerce, the crystals of prismatic Natron-salt are very often found to be quite fresh in the drusy cavities, while those of the hemi-prismatic, are already entirely decomposed.

GENUS II. GLAUBER-SALT.

1. PRISMATIC GLAUBER-SALT.

Prismatic Glauber Salt. JAM. Syst. Vol. III. p. 31. Man. p. 7. Glauber Salt. Sulphate of Soda. PHIL. p. 191. Natürlich Glaubersalz. WERN. Hoffm. H. B. Th. III. 1. S. 245. Glaubersalz. HAUSM. III. S. 835. Schwefelsaures Natron. LEONH. S. 617. Soude sulfatée. HAÜY. Tabl. comp. p. 19. Traité, 2de. Ed. T. II. p. 189.
HAIDINGER. Edinb. Phil. Journ. No. XX. p. 305.

Fundamental form. Scalene four-sided pyramid. $P = \left\{\begin{matrix} 93^\circ\ 12' \\ 81^\circ\ 10' \end{matrix}\right\}$; 140° 23′; 105° 51′. Inclination = 14° 41′ in the plane of the long diagonal. Vol. I. Fig. 41. R. G.

$$a : b : c : d = 3{\cdot}816 : 7{\cdot}005 : 3{\cdot}188 : 1.$$

Simple forms. $P - \infty\,(l)$; $\pm\frac{P}{2}\left\{\begin{matrix} n \\ z \end{matrix}\right\} = \left\{\begin{matrix} 93^\circ\ 12' \\ 81^\circ\ 10' \end{matrix}\right\}$; $-\frac{(\check{P})^3}{2}\,(d)$; $-\frac{(\bar{P}r)^3}{2}\,(v)$; $(\check{P}r + \infty)^3\,(o) = 86^\circ 31'$;

$\pm\frac{\breve{P}r}{2}\left\{\begin{matrix} r \\ T \end{matrix}\right\} = \left\{\begin{matrix} 49^\circ 50' \\ 72^\circ 15' \end{matrix}\right\}$; $-\frac{\breve{P}r+1}{2}\,(w) = 47^\circ 56'$;
$\breve{P}r + \infty\,(M)$; $\breve{P}r - 1\,(y) = 118^\circ 12'$; $\bar{P}r + \infty\,(P)$.

Char. of Comb. Hemi-prismatic. Inclination of
$P - \infty$ to $\breve{P}r + \infty = 104^\circ 41'$.

Combinations. 1. $-\frac{\breve{P}r}{2}.\ -\frac{P}{2}.(\breve{P}r+\infty)^5.\breve{P}r+\infty$.

2. $\frac{P}{2}.\ -\frac{\breve{P}r}{2}.\ -\frac{P}{2}.\ (\breve{P}r+\infty)^5.\breve{P}r+\infty$. Fig. 55.

3. $\frac{P}{2}.\ -\frac{\breve{P}r}{2}.\ -\frac{P}{2}.\ -\frac{\breve{P}r+1}{2}.\ (\breve{P}r+\infty)^5$.
$\breve{P}r+\infty.\ \bar{P}r+\infty$.

4. $P-\infty.\ \frac{\breve{P}r}{2}.\ \frac{P}{2}.\ \bar{P}r-1.\ -\frac{\breve{P}r}{2}.\ -\frac{P}{2}$.
$-\frac{(\bar{P}r)^3}{2}.\ -\frac{\breve{P}r+1}{2}.\ -\frac{(\breve{P})^3}{2}.\ (\breve{P}r+\infty)^5$.
$\breve{P}r+\infty.\ \bar{P}r+\infty$. Fig. 56.

Cleavage. $\breve{P}r+\infty$, highly perfect, and easily obtained; traces of $-\frac{\breve{P}r}{2}$ and of $\bar{P}r+\infty$. Fracture conchoidal, perfect. Surface smooth and even, alike in all the forms.

Lustre vitreous, bright. Colour white. Streak white. Transparency perfect.

Sectile. Hardness = 1·5 … 2·0. Sp. Gr. = 1·481. Taste cool, then saline and bitter, feeble.

Compound Varieties. Twin-crystals : face of composition parallel to $\bar{P}r+\infty$; axis of revolution perpendicular to $\breve{P}r+\infty$. Rare. Several imitative shapes. Efflorescent. Mealy crusts.

OBSERVATIONS.

1. The crystals obtained while the solution of sulphate of soda is cooling, are in most cases lengthened in the direction of the edges between *M* and *T*, as in Fig. 55.; and implanted in the place of the face *P*. Those which are formed during a slow evaporation are solitary, and limited by a greater number of faces, as in the crystal represented in Fig. 56.

2. The chemical formula of prismatic Glauber-salt is $\ddot{\mathrm{Na}}\,\dddot{\mathrm{S}}^{2} + 20\,\mathrm{Aq.}$ = 19·39 of Soda, 24·85 Sulphuric Acid, and 55·76 Water. It is easily soluble in water, but decomposes readily on being exposed to the air, and falls into powder. It is thus found in nature; a variety from Egra, in Bohemia, has yielded to Reuss,

$$\left.\begin{array}{l}\text{Sulphate}\\ \text{Carbonate}\\ \text{Muriate}\end{array}\right\}\text{of Soda}\left\{\begin{array}{l}67{\cdot}024.\\ 16{\cdot}333.\\ 11{\cdot}000.\end{array}\right.$$

Muriate of Lime 5·643.

The progress of decomposition of this species is very peculiar; it takes its rise from single points, which enlarge and extend in several directions, while the rest of the crystal remains in its original state: so that the whole takes the appearance of worm-eaten wood.

It is possible also to obtain crystals of the *anhydrous* Glauber-salt, if a solution of sulphate of soda be evaporated at a temperature above 33° centigr., above 106° Fahr. The crystals are prismatic, of the form $P.\ P + \infty.\ \breve{P}r + \infty$, similar to Fig. 6.; more commonly they shew only the pyramid P, Vol. I. Fig. 9., whose angles have not yet been ascertained. They are easily cleavable in the direction of $\breve{P}r + \infty$. Their hardness is = 2·5, their specific gravity = 2·462. They are white and transparent, but become very soon opake, if exposed to a higher temperature.

3. The prismatic Glauber-salt is found in nature accompanying hexahedral Rock-salt and prismatic Epsom-salt, or as an efflorescence upon the soil and several rocks, also on the shores of salt lakes, and in some mineral springs.

4. It occurs in the neighbourhood of Aussee, Ischel, and Hallstadt in Austria, at Hallein in Salzburg, in Hungary, in Switzerland, also in Italy and Spain.

5. It is employed in medicine, and in manufacturing glass.

GENUS III. NITRE-SALT.

1. PRISMATIC NITRE-SALT.

Prismatic Nitre. JAM. Syst. Vol. III. p. 35. Man. p. 8. Nitre. Nitrate of Potash. PHILLIPS, p. 189. Natürlicher Salpeter. WERN. Hoffm. H. B. Th. III. 1. S. 216. Salpeter. HAUSM. III. S. 849. Salpeter. LEONH. S. 629. Potasse nitratée. HAÜY. Traité, T. II. p. 346. Tabl. comp. p. 19. Traité, 2de. Ed. T. II. p. 177.

Fundamental form. Scalene four-sided pyramid. P = 132° 22′; 91° 15′; 107° 43′. Vol. I. Fig. 9. HAÜY.

$$a : b : c = 1 : \sqrt{2\cdot1333} : \sqrt{0\cdot7111}.$$

Simple forms. P — ∞ (*o*); P — 1 (*z*); P (*y*); P + 1 (*t*); P + ∞ (*M*) = 120°; P̌r (*x*) = 111° 12′; P̌r + 1 (*P*) = 72° 17′; P̌r + 2 (*s*) = 40° 7′; P̌r + ∞ (*h*); P̄r + ∞ (*l*).

Char. of Comb. Prismatic.

Combinations. 1. P̌r + 1. P + ∞. P̌r + ∞. Fig. 9.
2. P. P̌r + 1. P + ∞. P̌r + ∞.
3. P — ∞. P̌r + 1. P + ∞. P̌r + ∞.
4. P̌r. P̌ + 1. P̌r + 2. P + ∞. P̌r + ∞. Fig. 23.

Cleavage, P + ∞ and P̌r + ∞. Imperfect, the latter rather more easily observed than the former.

Fracture conchoidal. Surface, P + ∞ and P̌r + ∞ striated, both horizontally and vertically, particularly in irregular crystals.

Lustre vitreous. Colour white. Streak white. Transparent ... semi-transparent. Sectile. Hardness = 2·0. Sp. Gr. = 1·9369. HASSENFRATZ. Taste saline and cool.

Compound Varieties. Twin-crystals, very frequent, compound parallel to one or both the faces of $P + \infty$, variously repeated, similar to Fig. 39. In crusts and flakes: composition sometimes columnar.

OBSERVATIONS.

1. The prismatic Nitre-salt, as it is found at the Pulo di Molfetta, in Apulia, consists, according to KLAPROTH, of

Nitrate of Potash		42·55.
Sulphate	of Lime	25·45.
Muriate		0·20.
Carbonate		30·40.

The composition of the crystals is expressed by $\ddot{K}\,\overset{::}{N}^2$ = 55·28 of Potash and 44·72 Nitric acid. It dissolves very easily in water, is not altered on being exposed to air, and detonates with combustible substances.

2. More commonly this salt occurs in thin crusts on the surface of the earth, sometimes upon limestone, chalk, or calcareous tufa; also in caves contained in limestone, and mixed up with, or in small veins traversing, sandstone.

3. Spain, Italy, and Hungary, afford considerable quantities of this salt. In still greater proportions, and in a high state of purity, it is met with in India, and in several caverns in limestone, and in the sandstone of the United States of North America.

4. Its chief employment is in the composition of gunpowder. Besides this, it is used in medicine, for obtaining nitric acid, and for several other purposes. In some countries, as in the East Indies, in Spain, and in Hungary, it is collected for use; the greater part of that, which

is an object of commerce, is extracted from heaps, gathered together for that purpose.

GENUS IV. ROCK-SALT.

1. HEXAHEDRAL ROCK-SALT.

Hexahedral Rock-Salt. JAM. Syst. Vol. III. p. 1. Man. p. 9. Common Salt. PHILL. p. 193. Natürlich Kochsalz. WERN. Hoffm. H. B. Th. III. 1. S. 222. Steinsalz. HAUSM. III. S. 843. Steinsalz. LEONH. S. 619. Soude muriatée. HAÜY. Traité, T. II. p. 356. Tabl. comp. p. 20. Traité, 2de. Ed. T. II. p. 191.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. $\overset{*}{H}$ (P); $\overset{*}{O}$ (o) Vol. I. Fig. 2.; D. Vol. I. Fig. 31.; A_2. Vol. I. Fig. 32.

Character of Combinations. Tessular.

Combinations. 1. H. O. Vol. I. Fig. 3. and 4.
2. H. A_2. Fig. 152.
3. H. D. A_2.
4. H. O. A_2.

Cleavage, hexahedron, perfect. Dodecahedron, often distinct, though generally only a few faces. Fracture conchoidal. Surface generally smooth; the faces of the icositetrahedron sometimes rough.

Lustre vitreous, somewhat inclining to resinous. Colour, generally white, passing into yellow, flesh-red and ash-grey. Sometimes beautifully violet-, berlin-, or azure-blue. Streak white. If scratched with the nail it does not yield any powder, but receives an impression, and becomes a little shining. Transparent ... translucent.

Rather brittle. Hardness = 2·0. Sp. Gr. = 2·257, a yellowish-white transparent variety. Taste saline.

Compound Varieties. Dentiform and some other imitative shapes, rare. Commonly massive. Composition* granular or columnar, the latter in most cases parallel, sometimes curved. Size of the component individuals various. Faces of composition rough.

OBSERVATIONS.

1. The species of hexahedral Rock-salt has formerly been divided into different sub-species and kinds. The principles, according to which this sub-division has been effected, are the geognostic relations and the mechanical composition of its varieties, and therefore not founded upon Natural History. Thus the varieties occurring in beds, have been called *Rock-salt;* such as are formed at the bottom of salt lakes, or on their shores, *Sea-salt;* and the former again have been divided into *foliated* and *fibrous Rock-salt*, according to their granular or columnar mode of composition.

2. The hexahedral Rock-salt consists of

Muriate of Soda	983·25.	
Sulphate of Lime	6·50.	
Muriate of Magnesia	0·19.	
Muriate of Lime	0·06.	
Undissolved Matter	10·00.	HENRY.

The composition of the Muriate of Soda is expressed by $\ddot{N}a\ \ddot{M}^{3}$ = 53·29 of Soda, and 46·71 Muriatic acid. It is very easily soluble in water, remains unaltered if exposed to the

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* A remarkable kind of composition on a large scale has been long ago known to occur in the Rock-salt of Cheshire. Concentric layers of this substance, of different colours and purity, alternate with each other, and produce globular masses of a diameter of several yards. Several of these globular masses are again enveloped in concentric layers, common to them all, in a manner exactly analogous to the composition observable on a small scale in Pearlstone, a variety of empyrodox Quartz.

dry atmosphere, and decrepitates upon glowing charcoal, or before the blowpipe. It crystallises, both from solutions in water, and from fusion. It undergoes a remarkable change if exposed to a moist atmosphere, from which it attracts a portion of water. The dissolution of a mass of a hexahedral shape begins regularly at its edges, and transforms this first into a combination of the hexahedron and the hexahedral trigonal-icositetrahedron, Fig. 152., and then into a simple form of that kind, without any additional faces, Vol. I. Fig. 32. In the latter form, the mass of the salt diminishes in size, till at last it is entirely dissolved.

3. The hexahedral Rock-salt occurs chiefly in beds, some of which are of considerable dimensions, though commonly of a rather irregular form, and is met with in secondary, according to some geologists also in transition rocks, accompanied by both the species of Gypsum-haloide, principally the prismatoidal one, by several compound varieties of rhombohedral Lime-haloide, associated with sandstone, clay, &c. It is likewise found at the bottom, and in the vicinity of salt lakes, in the waters of which it is dissolved. It is contained in the waters of salt springs, of several mineral wells, and of the sea, though in variable quantities. It occurs upon certain varieties of lava, and in some volcanic lakes.

4. Hexahedral Rock-salt is found in considerable quantity in Poland, Hungary, Transylvania, Moldavia, and Valachia, in Stiria, Upper Austria, Salzburg, the Tyrol, Bavaria, Würtemberg, and Switzerland ; also in England, in Spain, and in many other countries in and out of Europe. In several of these, and in some others, where this salt has never been found in a solid state, there occur nevertheless a number of salt-springs, from which it may be obtained by means ef evaporation. The sea-salt in particular is found in the Crimea, in the deserts at the Caspian Sea, in Egypt, and in several places in Southern Africa and America.

5. The employment of hexahedral Rock-salt for culinary purposes, in different arts and manufactures, &c. is too

well known to be mentioned here more at large. It shall only be remarked, that for the greater part it is not used in the state in which it is found in nature, but in that in which it is obtained from evaporating its solutions.

GENUS V. AMMONIAC-SALT.

1. OCTAHEDRAL AMMONIAC-SALT.

Octahedral Sal Ammoniac. JAM. Syst. Vol. III. p. 11. Man. p. 11. Muriate of Ammonia. PHILL. p. 194. Natürlicher Salmiak. WERN. Hoff. H. B. Th. III. 1. S. 219. Salmiak. HAUSM. III. S. 853. Salmiak. LEONH. S. 631. Ammoniaque muriatée. HAÜY. Traité, T. II. p. 360. Tabl. comp. p. 22. Traité, 2de Ed. T. II. p. 221.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. $\overset{*}{H}$; $\overset{*}{O}$ (*P*), Vol. I. Fig. 2.; D, Vol. I. Fig. 31.; $\overset{*}{C}_1$ (*z*), Vol. I. Fig. 34.

Char. of Comb. Tessular.

Combinations. 1. H. O. Vol. I. Fig. 3. and 4.

Cleavage, octahedron. Fracture conchoidal. Surface smooth.

Lustre vitreous. Colour generally white, often inclining to yellow or grey. Sometimes it is stained green, yellow, or black. Transparent ... translucent.

Very sectile. Hardness = 1·5 ... 2·0. Sp. Gr. = 1·528. Taste acute and pungent.

Compound Varieties. Stalactitic, botryoidal, globular, reniform shapes, also in crusts: composition columnar. Massive: composition impalpable. Fracture conchoidal. Sometimes in a state of mealy efflorescence.

OBSERVATIONS.

1. The octahedral Ammoniac-salt from Mount Vesuvius consists of

Muriate of Ammonia	99·5.
Muriate of Soda	0·5.

KLAPROTH.

In its pure state it is $\dot{N}H^{6}\ddot{M}^{2} + Aq = 32{\cdot}06$ of Ammonia, 51·16 Muriatic acid, and 16·78 Water. It is perfectly volatile at a higher temperature, dissolves readily in water, but does not attract moisture from the atmosphere. It emits a pungent smell of ammonia, if rubbed wet with quicklime. If a saturated solution of this salt be brought into a lower temperature, its surface will very soon be covered with feathery masses of aggregated crystals, which sink to the bottom, when they have attained a certain weight. The movement thus produced in the fluid gives rise to the formation of numerous small crystals, terminated on all sides, which appear to consist of three needles perpendicular to each other, or as it were the pyramidal axes of the octahedron, whenever they become large enough to be visible by the assistance of a microscope. In the beginning they are quite steady in the fluid, but they sink when they increase in weight, during which their size also continually increases. The continuation of this process, and the more rapid cooling of the outer parts of the fluid, produce a regular movement within the latter, since the colder particles sink, while the warmer rise in its centre, and carry along with them part of the crystals already formed. This movement again accelerates the formation of the crystals, the fluid appears now quite troubled, and does not become clear again, till whatever had been dissolved in the fluid above its capacity at that temperature, has fallen to the bottom of the vessel in the shape of highly delicate flakes of snow. MONGE seems to be the first who described this phenomenon. Crystals of considerable size are obtained by sublimation.

It must be observed here, that the tessular form of the crystals of this substance is given upon the authority of

HAÜY and others. The shape which the small crystals assume when forming in the fluid, seems rather to indicate the pyramidal system, particularly if compared to the figure given by Mr PHILLIPS, which represents the icositetrahedron C_1, having only four of its unequiangular solid angles replaced by additional faces, so that those faces by themselves would produce a rectangular four-sided prism.

2. The octahedral Ammoniac-salt occurs in cracks and fissures in the immediate vicinity of active volcanoes, and is a product of sublimation. Thus it is also found near burning coal-seams. It has been said to occur in slaty clay along with prismatic Sulphur.

3. Its best known localities are Mount Etna and Vesuvius, the Solfataras, the Lipari islands, England, particularly the neighbourhood of Newcastle, Scotland, Iceland, the neighbourhood of Liege, the Bucharian Tartary, &c. It is often produced by immediate composition of its constituent parts, or by various chemical processes. A considerable quantity is produced in Egypt by the combustion of the dung of camels.

4. This salt, as it occurs in nature, will probably be of very little use, on account of its scarcity. That obtained by the assistance of art is employed in dyeing, in medicine, and in several operations of metallurgy.

GENUS VI. VITRIOL-SALT.

1. HEMI-PRISMATIC VITRIOL-SALT.

Rhomboidal Vitriol or Green Vitriol. JAM. Syst. Vol. III. p. 17. Hemi-prismatic Vitriol or Green Vitriol. Man. p. 13. Sulphate of Iron. PHILL. p. 240. Natürlicher Vitriol. WERN. Hoffm. H. B. Th. III. 1. S. 235. Eisenvitriol. HAUSM. III. S. 1058. Eisen-Vitriol. LEONH. S. 355. Fer sulfaté. HAÜY. Traité, T. IV. p. 122. Tabl. comp. p. 100. Traité, 2de Ed. T. IV. p. 140.

Fundamental form. Scalene four-sided pyramid.

$\mathrm{P} = \left\{ \begin{matrix} 101^\circ\ 35' \\ 87^\circ\ 41' \end{matrix} \right\}$; 108° 6′; 126° 58′. Inclination of the axis = 14° 20′ in the plane of the long diagonal. Vol. I. Fig. 41. R. G.

$$a : b : c : d = 3{\cdot}920 : 3{\cdot}090 : 2{\cdot}629 : 1.$$

Simple forms. $\mathrm{P} - \infty\ (b)$; $\frac{\mathrm{P}}{2}\ (P) = 101^\circ\ 35'$; $\mathrm{P} + \infty\ (f) = 82^\circ\ 21'$; $-\frac{(\bar{\mathrm{P}}\mathrm{r})^3}{2}$; $\frac{\frac{4}{3}\,\breve{\mathrm{P}}\mathrm{r} - 2}{2}\ (g) = 69^\circ\ 6'$; $\pm\frac{\breve{\mathrm{P}}\mathrm{r}}{2} \left\{ \begin{matrix} v \\ t \end{matrix} \right\} = \left\{ \begin{matrix} 46^\circ & 13' \\ 28^\circ & 4' \end{matrix} \right\}$; $\breve{\mathrm{P}}\mathrm{r} + \infty$; $\bar{\mathrm{P}}\mathrm{r}\ (o) = 69^\circ\ 17'$; $\bar{\mathrm{P}}\mathrm{r} + \infty\ (u)$.

Char. of Comb. Hemi-prismatic. Inclination of $\mathrm{P} - \infty$ to $\breve{\mathrm{P}}\mathrm{r} + \infty = 104^\circ\ 20'$; of $\mathrm{P} - \infty$ to $\mathrm{P} + \infty = 99^\circ\ 23'$.

Combinations. 1. $\mathrm{P} - \infty.\ \mathrm{P} + \infty.$ Sim. Fig. 44.

2. $\mathrm{P} - \infty.\quad -\frac{\breve{\mathrm{P}}\mathrm{r}}{2}.\quad \mathrm{P} + \infty.$

3. $\mathrm{P} - \infty.\ -\frac{\breve{\mathrm{P}}\mathrm{r}}{2}.\ \bar{\mathrm{P}}\mathrm{r}.\ \mathrm{P} + \infty.\ \breve{\mathrm{P}}\mathrm{r} + \infty.\ \bar{\mathrm{P}}\mathrm{r} + \infty.$

4. $\mathrm{P} - \infty.\ \frac{\frac{4}{3}\,\breve{\mathrm{P}}\mathrm{r} - 2}{2}.\ \frac{\breve{\mathrm{P}}\mathrm{r}}{2}.\ \frac{\mathrm{P}}{2}.\ \bar{\mathrm{P}}\mathrm{r}.\ -\frac{\breve{\mathrm{P}}\mathrm{r}}{2}.$
$\mathrm{P} + \infty.\ \bar{\mathrm{P}}\mathrm{r} + \infty.$ Fig. 52.

Cleavage. $\mathrm{P} - \infty$, perfect; $\mathrm{P} + \infty$, distinct, though less perfect than $\mathrm{P} - \infty$; sometimes traces of $-\frac{\breve{\mathrm{P}}\mathrm{r}}{2}$. Fracture conchoidal. Surface generally smooth; nearly the same in all the forms.

Lustre vitreous. Colour, several shades of green, passing into white. Streak white. Semi-transparent ... translucent. A faint blueish opalescence sometimes observable parallel to the faces of $\bar{P}r + \infty$.

Rather brittle. Hardness = 2·0. Sp. Gr. = 1·832, of a variety containing about 0·1 of sulphate of copper. Taste sweetish-astringent and metallic.

Compound Varieties. Stalactitic, botryoidal, reniform: composition columnar; if the particles become very thin, the lustre approaches to pearly. Massive: composition granular. Pulverulent.

OBSERVATIONS.

1. The present species consists of

Oxide of Iron 25·7.
Sulphuric Acid 28·9.
Water 45·4. BERZELIUS.

It is $\ddot{Fe}\,\dddot{S}^2 + 12\,Aq$ = 26·19 Oxide of Iron : 29·89 Sulphuric Acid : 43·92 Water, according to MITSCHERLICH. It is easily soluble in water, and the solution becomes black on being mixed with tincture of galls. If exposed to the open air, it soon becomes covered with a yellow powder, which is Persulphate of Iron. Before the blowpipe it becomes magnetic, and colours glass of borax green.

2. In most cases the hemi-prismatic Vitriol-salt is produced by the decomposition of other minerals, particularly of hexahedral and prismatic Iron-pyrites; and it is therefore commonly found in such places in which artificial heaps constructed for that purpose, mines or other circumstances, have given occasion to its formation. It is also found dissolved in the waters of several mines.

3. It occurs in the Rammelsberg near Goslar in the Hartz, at Schwarzenberg in Saxony, in several mines at Schemnitz in Hungary; also in Sweden, in Spain, &c.; in different coal-mines in England; at Hurlet in Renfrewshire in Scotland, and other places.

4. Both the natural and the artificial hemi-prismatic Vi-

triol-salt, are used in dyeing, in making ink and Prussian blue, and also for producing sulphuric acid. The residue from the distillation, being red oxide of iron, is employed as a colour, and for polishing steel.

2. TETARTO-PRISMATIC VITRIOL-SALT.

Prismatic Vitriol, or Blue Vitriol. JAM. Syst. Vol. III. p. 19. Man. p. 14. Sulphate of Copper. PHILL. p. 313. Natürlicher Vitriol. WERN. Hoffm. H. B. Th. III. 1. S. 235. Kupfervitriol. HAUSM. III. S. 1054. Kupfer-Vitriol. LEONH. S. 271. Cuivre sulfaté. HAÜY. Traité, T. III. p. 580. Tabl. comp. p. 92. Traité, 2de Ed. T. III. p. 523.

Fundamental form. Scalene four-sided pyramid of unknown dimensions. Inclination of the axis in the planes of both diagonals. Vol. I. Fig. 42.

Simple forms, not determined.

Char. of Comb. Tetarto-prismatic.

Cleavage, very imperfect in the direction of the faces *T* and *M*, Fig. 83., the latter rather more distinct. Fracture conchoidal. Surface: the faces *n* commonly deeply striated, parallel to their edges of combination with *M* and *T*, which faces are also sometimes striated, though not so generally as *n*.

Lustre vitreous. Colour, sky-blue, in different shades, commonly deep. Streak white. Semi-transparent ... translucent.

Rather brittle. Hardness = 2·5. Sp. Gr. = 2·213. Taste astringent and metallic.

OBSERVATIONS.

1. The theory of the forms in which the inclination of the axis takes place at the same time in the planes of both diagonals, has not as yet been perfectly developed. In

the present place it seems to be the best, to describe one of the varieties most generally occurring, together with the angles as given by HAÜY, in order to enable the student to compare this crystal with others he should meet with in nature.

This variety is represented Fig. 83. The incidence

of P to M is $= 109° 32'$;
of P to T $= 128° 27'$;
of M to T $= 149° 2'$;
of n to T $= 149° 42'$;
of n to M $= 154° 20'$;
of r to $M = 126° 11'$;
of r to $T = 109° 47'$;
of u to $P = 126° 11'$;
of u to $M = 124° 17'$.

2. The tetarto-prismatic Vitriol-salt consists of

Oxide of Copper 32·13.
Sulphuric Acid 31·57.
Water 36·30. BERZELIUS.

It is $\ddot{\text{Cu}}\,\dddot{\text{S}}^{2} + 10\ \text{Aq} = 29{\cdot}9$ Oxide of Copper : 32·3 Sulphuric Acid : 37·8 Water, according to MITSCHERLICH. Very often sulphate of copper is contained in different proportions in the crystals of hemi-prismatic Vitriol-salt; the forms of the latter nevertheless are not affected by this admixture, except that they more commonly present the simple varieties, as, for instance, that of Fig. 44. It is easily soluble in water, and gives a blue solution. A polished surface of iron is covered with a film of metallic copper, if dipped into this solution.

3. This salt, like the preceding one, owes its existence to the decomposition of other minerals, particularly of pyramidal Copper-pyrites, and is often produced by various chemical processes. It is found dissolved in several waters, partly issuing from mines, and which have received the name of waters of *Cementation.*

4. Its chief localities are the Rammelsberg near Goslar, Neusohl in Hungary, Anglesea in England, Wicklow in Ireland, Fahlun in Sweden, the isle of Cyprus, &c.

5. As it occurs in nature, it requires first to be purified, before it can be employed in the arts, where it is used in dyeing, in printing of cotton and linen, &c. The oxide of copper, separated from its acid, is likewise used in painting.

6. The salt which goes by the name of Blue Vitriol from Goslar, though it contains sulphate of copper, is not tetarto-prismatic Vitriol-salt, since its forms are not tetarto-prismatic, but hemi-prismatic, and similar to those of the hemi-prismatic Vitriol-salt. Its colour is sky-blue, but considerably paler than that of tetarto-prismatic Vitriol-salt. Besides sulphate of copper, it also contains sulphate of zinc, and is probably one of the salts expressed by the general formula $\ddot{R}\ \dddot{S}^2 + 12$ Aq. of Mitscherlich, upon which supposition it would consist of 14·95 Oxide of Copper, 13·83 Oxide of Zinc, 29·94 Sulphuric Acid, and 41·28 Water.

3. PRISMATIC VITRIOL-SALT.

Pyramidal Vitriol or White Vitriol. Jam. Syst. Vol. III. p. 21. Man. p. 75. Sulphate of Zinc. Phill. p. 356. Natürlicher Vitriol. Wern. Hoffm. H. B. Th. III. 1. S. 235. Zink-Vitriol. Hausm. III. S. 1118. Zink-Vitriol. Leonh. S. 314. Zinc sulfaté. Haüy. Traité, T. IV. p. 180. Tabl. comp. p. 104. Traité, 2de Ed. T. IV. p. 198.

Fundamental form. Scalene four-sided pyramid. $P = 127°27'$; $126°45'$; $78°5'$. Vol. I. Fig. 9. R. G.

$a : b : c = 1 : \surd 3·0407 : \surd 3·0037$.

Simple forms. $P\ (l)$; $P + \infty\ (M) = 90°\ 42'$; $(\breve{P}r)^3$; $(\breve{P}r + \infty)^3 = 53°\ 25'$; $\breve{P}r = 120°\ 20'$; $\breve{P}r + \infty\ (o)$; $\bar{P}r = 120°\ 3'$; $\bar{P}r + \infty$.

Char. of Comb. Hemi-prismatic, of inclined faces.

Combinations. 1. P. $P + \infty$.

2. P. $P + \infty$. $\breve{P}r + \infty$. Sim. Fig. 6.

3. $\bar{P}r$. P. $P + \infty$. $\breve{P}r + \infty$.

4. $\breve{P}r$. $\bar{P}r$. P. $(\breve{P}r)^3$. $P + \infty$. $(\breve{P}r + \infty)^3$. $\breve{P}r + \infty$.

Cleavage. $\breve{P}r + \infty$, highly perfect; $\bar{P}r$, less distinct. Traces of $P + \infty$. Fracture conchoidal.

Surface. $P + \infty$ sometimes, $\breve{P}r + \infty$ almost always, vertically streaked. The rest of the faces smooth and even.

Lustre vitreous. Colour white, sometimes inclining to peachblossom-red, and violet-blue, pale. Streak white. Transparent ... translucent.

Brittle. Hardness = 2·0 ... 2·5. Sp. Gr. = 2·036. Taste astringent, nauseous and metallic.

Compound Varieties. Reniform, botryoidal, stalactitic; composition columnar, if the particles be very delicate, the lustre becomes pearly. Massive: composition granular passing into impalpable.

OBSERVATIONS.

The prismatic Vitriol-salt from the Rammelsberg, near Goslar, consists of

Oxide of *Zinc*	27·5.	
Oxide of Manganese	0·5.	
Sulphuric Acid	20·0.	
Water	50·0.	KLAPROTH.

According to MITSCHERLICH its chemical formula is $\ddot{Z}n\,\dddot{S}^2 + 14\,Aq$, corresponding to 27·67 Oxide of *Zinc*, 27·57 Sulphuric Acid, and 44·76 Water. It is very easily soluble in water; before the blowpipe it froths, and covers the charcoal with a white coating.

2. It seems that the decomposition of dodecahedral Garnet-blende gives rise to the formation of the present species, though in general that species be not very subject to be decomposed by the action of the atmosphere. Its occurrence in nature corresponds to the mode of its formation.

3. It is found in the Rammelsberg near Goslar in the Hartz, at Schemnitz in Hungary, at Fahlun in Sweden, at Holywell in Flintshire, and it is said also in Cornwall.

4. It occurs but sparingly in nature, but is often produced artificially by chemical processes. It is employed in medicine, but its principal use is in dyeing.

GENUS VII. EPSOM-SALT.

1. PRISMATIC EPSOM-SALT.

Prismatic Epsom-Salt. JAM. Syst. Vol. III. p. 24. Man. p. 16. Sulphate of Magnesia. PHILLIPS, p. 180. Natürlich Bitter-Salz. WERN. Hoffm. H. B. Vol. III. 1. S. 243. Bittersalz. HAUSM. III. S. 818. Bittersalz. LEONH. S. 507. Magnésie sulfatée. HAÜY. Traité, T. II. p. 331. Tabl. comp. p. 15. Traité, 2de Ed. T. II. p. 51.

Fundamental form. Scalene four-sided pyramid. $P = 127^\circ\ 22'$; $126^\circ\ 48'$; $78^\circ\ 7'$. Vol. I. Fig. 9. R. G.

$$a : b : c = 1 : \sqrt{3{\cdot}0635} : \sqrt{3{\cdot}0066}.$$

Simple forms. $P\ (l)$; $P + \infty\ (M) = 90^\circ\ 38'$; $(\breve{P}r + \infty)^3 = 53^\circ 36'$; $\breve{P}r = 120^\circ 34'$; $\breve{P}r + \infty\,(o)$; $\bar{P}r = 120^\circ\ 3'$.

Char. of Comb. Hemi-prismatic, of inclined faces.

Combinations. 1. P. $P + \infty$.

2. P. $P + \infty$. $\breve{P}r + \infty$. Fig. 6.

3. $\breve{P}r$. $\bar{P}r$. P. $P + \infty$. $\breve{P}r + \infty$.

4. $\bar{P}r$. P. $P + \infty$. $(\breve{P}r + \infty)^3$. $\breve{P}r + \infty$.

Cleavage, $\breve{P}r + \infty$ highly perfect; $\bar{P}r$, less distinct; traces of $P + \infty$. Fracture conchoidal. Surface. $P + \infty$ sometimes, $\breve{P}r + \infty$ almost always vertically streaked. The rest of the faces smooth and even.

Lustre vitreous. Colour white. Streak white. Transparent ... translucent.

Rather brittle. Hardness = 2·0 ... 2·5. Sp. Gr. = 1·751. Taste saline and bitter.

Compound Varieties. Botryoidal, reniform, and in the shape of crusts: composition columnar, if the particles are very delicate, the lustre becomes pearly. Pulverulent.

OBSERVATIONS.

1. In the combinations occurring among the crystals of this species, some of the faces of the pyramid P (*l*) are very often irregularly enlarged at the expence of others. Since this enlargement sometimes takes place in the alternating faces of the pyramid, it has been supposed by several crystallographers, and among others by Messrs **Haüy** and **Weiss**, to follow a certain constant rule. Considering the vertical prism as rectangular, and completing what otherwise might have been wanting in the forms, they have thus represented the series of crystallisation of prismatic Epsom-salt as being hemi-pyramidal with inclined faces, a supposition rendered sufficiently improbable, as far as regards the pyramidal system, if we only attend to the position of the single perfect face of cleavage. Professor **Mitscherlich**, however, has lately observed, that of some secondary faces, as *s*, *s*, and *t*, *t*, which belong to $(\bar{P}r)^3$ and $(\breve{P}r)^3$, only the alternating ones appear in the combinations, as represented in Fig. 168.; and according to this observation, the Character of Combinations has been stated above as hemi-prismatic with inclined faces.*

2. According to **Vogel**, the prismatic Epsom-salt consists in its natural state of

Water	48·0.
Sulphuric Acid	33·0.
Magnesia	18·0.

It is $\ddot{\mathrm{Mg}}\,\dddot{\mathrm{S}}^{2}$ + 14 Aq, or 16·6 Magnesia, 32·2 Sulphuric acid, and 51·2 Water, according to **Mitscherlich**. It dissolves very easily in water, deliquesces before the

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* Professor Mitscherlich has kindly communicated to me this interesting fact, which he has likewise observed in prismatic Vitriol-salt, and in the crystals of sulphate of nickel. H.

blowpipe, but is difficultly fusible, if its water of crystallisation has been driven off.

3. It effloresces from several rocks, both in their original repository, and in artificial walls, and then it is a product of their decomposition. It forms the principal ingredient of certain mineral waters.

4. It occurs in Freiberg and in its neighbourhood efflorescent upon gneiss, in several places of the Hartz, in Scotland, in Berchtesgaden, in Salzburg, at Idria in Carniola, from whence it has been described under the name of *Halotrichum*, or Hair-salt, in Bohemia, in Hungary, &c.

5. After having been purified, it is employed in medicine, as also for the production of magnesia.

GENUS VIII. ALUM-SALT.

1. OCTAHEDRAL ALUM-SALT.

Octahedral Alum. JAM. Syst. Vol. III. p. 27. Man. p. 17. Alum. PHILL. p. 196. Alaun. Hoffm. H. B. Th. IV. 2. S. 169. Alaun. HAUSM. III. S. 813. Alaun. LEONH. S. 625. Alumine sulfatée alcaline. HAÜY. Traité, T. II. p. 387. Tabl. comp. p. 22. Alumine sulfatée. Traité, 2de. Ed. T. II. p. 114.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. $\overset{*}{H}$ (*r*); $\overset{*}{O}$ (P) Vol. I. Fig. 2.; D (*o*) Vol. I. Fig. 31.; B Vol. I. Fig. 33.; C_1 Vol. I. Fig. 34.

Char. of Comb. Semi-tessular with parallel faces.

Combinations. 1. H.O. Vol. I. Fig. 3. and 4.
2. H. O. D.
3. H. O. D. B. C_1.

Cleavage, octahedron, imperfect. Fracture conchoidal. Surface smooth. The faces of the dodecahedron sometimes faintly streaked, parallel to its edges of combination with the octahedron.

Lustre vitreous. Colour white. Streak white. Transparent ... translucent.

Not very brittle. Hardness = 2·0 ... 2·5. Spec. Grav. = 1·753, of a transparent variety. Taste sweetish astringent.

Compound Varieties. Twin-crystals: face of composition parallel, axis of revolution perpendicular to one of the faces of the octahedron. Stalactitic and other imitative forms: composition columnar, if they are very delicate the lustre becomes pearly. Massive: composition either columnar or granular, often impalpable. Mealy efflorescence.

OBSERVATIONS.

1. The Character of Combinations is given on the authority of Count **Bournon** and M. **Beudant**. According to **Beudant**, certain combinations obtained by dissolving Alum in muriatic-acid, and allowing it to crystallise, contain the faces of a pentagonal dodecahedron, which is the half of a hexahedral trigonal-icositetrahedron. Count **Bournon** likewise quotes this variety as having been obtained by himself.

2. **Klaproth** having analyzed a variety from Freienwalde in Silesia, called natural alum, but which probably does not belong to this species, obtained the following result:

Alumina	15·25.
Potash	0·25.
Oxide of Iron	7·50.
Sulphuric Acid and Water	77·00.

The crystallized varieties to which the above description refers, are $\ddot{K}\,\dddot{S}^2 + 2\,\dddot{Al}\,\dddot{S}^2 + 48\,Aq$, or 9·94 Potash, 10·82 Alumine, 33·77 Sulphuric acid, and 45·47 Water. It is pretty easily soluble in water, melts before the blowpipe in its water of crystallisation, and is converted into a spongiform mass.

3. The octahedral Alum-salt commonly appears in a state of efflorescence upon several minerals, which contain alumina, as upon rhombohedral Alum-haloide, alum-slate, alum-earth, &c.: but it occurs also in a solid shape accompanying brown-coal, and is contained in the waters of certain mineral wells.

4. It is found in several parts of Italy. At Tschermig near Kommothau in Bohemia, it forms thin layers between the strata of brown-coal. It is likewise met with at Freienwalde in Silesia, in England and Scotland, in Norway, Sweden, &c.

5. The salt as produced by nature requires first to be purified, in order to be applicable in the arts. A great quantity is obtained by the assistance of chemical processes. Its uses are various, in dyeing, in manufacturing leather and paper, for preventing putrefaction, &c.

GENUS IX. BORAX-SALT.

1. PRISMATIC BORAX-SALT.

Prismatic Borax. JAM. Syst. Vol. III. p. 45. Man. p. 18. Borate of Soda. PHILL. p. 192. Tinkal. HAUSM. III. S. 841. Boraxsaures Natron. LEONH. S. 623. Soude boratée. HAÜY. Traité, T. II. p. 366. Tabl. comp. p. 20. Traité, 2de Ed. T. II. p. 200.

Fundamental form. Scalene four-sided pyramid. P = 152° 9′, 120° 23′, 67° 3′. Inclination = 0° 0′, in the plane of the long diagonal. Vol. I. Fig. 41. HAÜY.

$$a : b : c : d = 1 : \sqrt{12} : \sqrt{2{\cdot}8125} : 0.$$

Simple forms. $\frac{P}{2}\,(o) = 120^\circ\ 23'$; $\frac{(\check{P}r)^5}{2}\,(z)$;

$(\breve{P}r + \infty)^3\ (r) = 88^\circ\ 9'$; $-\frac{\breve{P}r}{2}\ (P) = 73^\circ\ 54'$

$\breve{P}r + \infty\ (M)$; $\bar{P}r + \infty\ (T)$.

Char. of Comb. Hemi-prismatic.

Combinations. 1. $-\frac{\breve{P}r}{2}$. $(\breve{P}r + \infty)^3$. $\breve{P}r + \infty$.

2. $-\frac{\breve{P}r}{2}$. $(\breve{P}r + \infty)^3$. $\breve{P}r + \infty$. $\bar{P}r + \infty$.

3. $\frac{P}{2}$. $-\frac{\breve{P}r}{2}$. $\breve{P}r + \infty$. $\bar{P}r + \infty$.

4. $\frac{\breve{P}}{2}$. $\frac{(\breve{P}r)^5}{2}$. $-\frac{\breve{P}r}{2}$. $(\breve{P}r + \infty)^3$. $\breve{P}r + \infty$. $\bar{P}r + \infty$. Fig. 51.

Cleavage. $\breve{P}r + \infty$, perfect; less distinct $(\breve{P}r + \infty)^3$; traces of $\bar{P}r + \infty$. Fracture conchoidal. Surface of $\frac{P}{2}$, $\frac{(\breve{P}r)^5}{2}$ and $(\breve{P}r + \infty)^3$ streaked parallel to the edges of combination with $-\frac{\breve{P}r}{2}$. The rest of the faces smooth.

Lustre resinous. Colour white, inclining to grey and green. Streak white. Transparent . . . translucent.

Rather brittle. Hardness = 2·0...2·5. Sp. Gr. = 1·716. Taste sweetish alcaline, feeble.

OBSERVATIONS.

1. The natural borax consists, according to **Klaproth**, of

Soda	14·5.
Boracic-Acid	37·0.
Water	47·0.

This composition corresponds to the formula $\dot{N}a\,\ddot{B}^{8} + 24$ Aq. The preceding general description, however, refers to the artificial salt, which is expressed by $\dot{N}a\,\ddot{B}^{2} + 10$ Aq, and consists of 31·97 Soda, 22·06 Boracic acid, and 45·97 water. It is soluble in water; the solution changes the blue colour of litmus into green. It intumesces before the blowpipe, and then melts into a transparent globule.

2. The natural salt, the natural-historical properties of which are as yet unknown, occurs in different districts of Persia and Thibet, where it is found on the surface of the soil, in the vicinity, and sometimes at the bottom, of several lakes, and in a state of solution in the waters of mineral wells. It is said also to have been met with in Ceylon, and in considerable quantity in Potosi.

3. The natural salt is employed in manufacturing the artificial one by the addition of a greater quantity of soda. The artificial salt is made use of as a flux, in the production of imitation gems, and in the process of soldering.

GENUS X. BRITHYNE*-SALT.

1. PRISMATIC BRITHYNE-SALT.

Glauberite. JAM. Syst. II. p. 613. Prismatic Glauberite. Man. p. 19. Glauberite. PHILL. 198. Glauberit. HAUSM. III. S. 839. Brongniartin. LEONH. S. 618. Glaubérite. HAÜY. Tabl. comp. p. 23. Traité, 2de Ed. T. II. p. 215.

Fundamental form. Scalene four-sided pyramid. $P = \left\{\begin{matrix}120^\circ\ 12'\\ 102^\circ\ 21'\end{matrix}\right\}$, 128° 0′; 90° 0′. Inclination = 22° 49′ in the plane of the long diagonal. Vol. I. Fig. 41. HAÜY.

$$a : b : c : d = 2{\cdot}3717 : 4 : 3{\cdot}0984 : 1.$$

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[*] From βριθὺς dense (heavy).

Simple forms. $P - \infty\ (P)$; $\pm \frac{P}{2} \begin{Bmatrix} f \\ n \end{Bmatrix} = \begin{Bmatrix} 120^{\circ}\ 12' \\ 102^{\circ}\ 21' \end{Bmatrix}$; $-\frac{(\breve{P}r)^{3}}{2}\ (e)$; $P + \infty\ (M) = 80^{\circ}\ 6'$; $-\frac{\breve{P}r}{2}(t) = 74^{\circ}\ 29'$; $\breve{P}r + \infty\ (s)$.

Char. of Comb. Hemi-prismatic. Inclination of $P - \infty$ to $\breve{P}r + \infty = 112^{\circ}\ 49'$; to $\frac{P}{2} = 142^{\circ}\ 14'$; to $P + \infty = 104^{\circ}\ 24'$.

Combinations. 1. $P - \infty.\ \frac{P}{2}.$ Fig. 59.

2. $P - \infty.\ \frac{P}{2}.\ P + \infty.$

3. $P - \infty.\ \frac{P}{2}.\ P + \infty.\ \breve{P}r + \infty.$

4. $P - \infty.\ \frac{P}{2}.\ -\frac{\breve{P}r}{2}.\ -\frac{P}{2}\ -\frac{(\breve{P}r)^{3}}{2}.\ P + \infty.\ \breve{P}r + \infty.$ Fig. 60.

Cleavage. $P - \infty$, perfect; traces of $P + \infty$, interrupted by conchoidal fracture. Fracture conchoidal. Surface; $P - \infty$ and still more so, $\frac{P}{2}$ streaked parallel to their common edges of combination. $P + \infty$ partly uneven, but smooth and shining.

Lustre vitreous. Colour yellowish or greyish-white. Streak white. Semi-transparent ... translucent.

Brittle. Hardness = 2·5 ... 3·0. Sp. Gr.

= 2·807, of a solitary crystal. Taste saline and astringent, feeble.

OBSERVATIONS.

1. According to measurements with the reflective goniometer by Mr **Phillips**, the angle of P given above as = 120° 12′ is equal to 116° 20′, that of $P + \infty$ equal to 83° 20′, and the incidence of $P - \infty$ upon $P + \infty = 104° 15′$.

2. The prismatic Brithyne-salt consists, according to **Brongniart**, of

Sulphate of Lime	49·0.
Sulphate of Soda	51·0.

Its chemical composition is expressed by $\ddot{Na}\,\dddot{S}^2 + \ddot{Ca}\,\dddot{S}^2$, and it consists accordingly of 22·35 Soda, 20·35 Lime, and 57·39 Sulphuric acid; that is to say, of one atom of anhydrous sulphate of lime, and one atom of anhydrous sulphate of soda. The forms of both these substances are prismatic, those of the prismatic Brithyne-salt are hemi-prismatic. Hence it is not one of those cases, in which one of the substances contained in the mixture impresses its form upon the whole, as is the case in hemi-prismatic Vitriol-salt, which may contain sulphate of copper without change of form. Also the determined proportions in the constituent parts of the Brithyne-salt agree with this observation. If immersed in water, it loses its transparency, and is partly dissolved. The same happens if exposed to a moist atmosphere. Before the blowpipe it decrepitates and melts into a white enamel.

3. It occurs in imbedded crystals in hexahedral Rock-salt, at Villarubia near Ocaña in New Castile. Another locality is Aussee in Upper Austria. The combinations described above have been observed in the Spanish variety.

CLASS II.

HALOIDE. BARYTE. KERATE. MALACHITE. MICA.
SPAR. GEM. ORE. METAL. PYRITES.
GLANCE. BLENDE. SULPHUR.

ORDER I. HALOIDE.

GENUS I. GYPSUM-HALOIDE.

1. PRISMATOIDAL GYPSUM-HALOIDE.

Axifrangible Gypsum. JAM. Syst. Vol. II. p. 615. Prismatoidal Gypsum. Man. p. 20. Gypsum. Sulphate of Lime. PHILL. p. 174. Gips. Fraueneis. WERN. Hoffm. H. B. III. 1. S. 105. 116. Gyps. Stinkgyps. HAUSM. III. S. 887. 893. Wasserhaltiger schwefelsaurer Kalk. LEONH. S. 549. Chaux sulfatée. HAÜY. Traité, T. II. p. 266. Tabl. comp. p. 9. Traité, 2de Ed. T. I. p. 527.
WEISS. Schriften der Acad. der Wiss. zu Berlin für 1820, u. 21. SORET. Ann. des Min. II. 435. III. 487.

Fundamental form. Scalene four-sided pyramid. $P = \left\{\begin{matrix}143° \ 52'\\138° \ 54'\end{matrix}\right\}$, 123° 36′, 70° 23′. Inclination $= 9° \ 11'$ in the plane of the short diagonal. $\pm\frac{\bar{P}r}{2}\left\{\begin{matrix}\text{unk.}\\ \text{T}\end{matrix}\right\} = \left\{\begin{matrix}53° \ 8'\\66° \ 52'\end{matrix}\right\}$. Vol. I. Fig. 41. HAÜY.

$a : b : c : d : = 6{\cdot}2 : 10{\cdot}8 : 15{\cdot}4 : 1.$

Simple forms. $\pm\frac{P}{2}\left\{\begin{matrix}n\\l\end{matrix}\right\} = \left\{\begin{matrix}143° \ 52'\\138° \ 54'\end{matrix}\right\}$; $P + \infty$

$(f) = 110^\circ\,37'$; $-\dfrac{(\breve{P}r)^3}{2}$ $(x$, *Soret*$) = 106^\circ\,16'$; $(\breve{P}r + \infty)^3$ $(h$, *Sor.*$) = 71^\circ\,41'$; $-\dfrac{(\breve{P})^3}{2}$ $(s$, *Sor.*$) = 83^\circ\,18'$; $(\breve{P} + \infty)^3$ $(k$, *Sor.*$) = 51^\circ\,26'$; $\breve{P}r$ $(n$, *Sor.*$) = 136^\circ\,8'$; $\breve{P}r + \infty$ (P); $-\dfrac{\frac{4}{3}\bar{P}r - 2}{2}$ $(o$, *Sor.*$) = 88^\circ\,1'$; $\bar{P}r + \infty$ (M).

Char. of Comb. Hemi-prismatic. Inclination of $P - \infty$ to $\bar{P}r + \infty = 99^\circ\,11'$.

Combinations. 1. $\dfrac{P}{2}$. $P + \infty$. $\breve{P}r + \infty$. Fig. 57. Shotoverhill near Oxford.

2. $\dfrac{P}{2}$. $-\dfrac{P}{2}$. $P + \infty$. $\breve{P}r + \infty$. Kommothau, Bohemia.

3. $\dfrac{P}{2}$. $-\dfrac{\frac{4}{3}\bar{P}r - 2}{2}$. $P + \infty$. $\breve{P}r + \infty$. Shotoverhill.

4. $\dfrac{P}{2}$. $-\dfrac{\frac{4}{3}\bar{P}r^2 - 2}{2}$. $P + \infty$. $(\breve{P}r + \infty)^3$. $\breve{P}r + \infty$. Fig. 58. Bex, Switzerland.

Cleavage. $\breve{P}r + \infty$, highly perfect and easily obtained; $-\dfrac{\bar{P}r}{2}$, and $\bar{P}r + \infty$ imperfect, the latter of these being of a conchoidal appearance, while the former is difficultly obtained, on account of the flexibility of the mineral in that direction, and often of a fibrous aspect. Traces of $-\dfrac{P}{2}$. Fracture scarcely perceptible.

Surface. $P + \infty$ and $\breve{P}r + \infty$ streaked parallel to their common intersections. The faces of $-\frac{\frac{4}{3}\bar{P}r-2}{2}$ and $+\frac{P}{2}$ commonly rounded, which gives rise to the well known lenticular shapes, if in combinations like 3, the faces of $P+\infty$ and $\breve{P}r+\infty$ disappear.

Lustre vitreous. $\breve{P}r+\infty$ possesses a pearly lustre, more or less distinct, both upon faces of cleavage and faces of crystallisation.

Colour, generally white, sometimes inclining and passing into smalt-blue, flesh-red, ochre-yellow, honey-yellow, and several shades of grey. Impure varieties assume dark-grey, brick-red and brownish-red tinges. Streak white. Transparent ... translucent.

Sectile. Thin laminæ are flexible in the direction of those edges which arise from the intersection of $\breve{P}r+\infty$, with $-\frac{\frac{4}{3}\bar{P}r-2}{2}$, and $-\frac{\bar{P}r}{2}$.

Hardness = 1·5 ... 2·0. The lowest degrees upon $\breve{P}r+\infty$, the highest degrees in the direction of $P-\infty$, in which the crystals very often are rounded. Sp. Gr. = 2·310, a perfectly transparent crystal from Oxford.

Compound Varieties. Twin-crystals. 1. Axis of revolution perpendicular, face of composition parallel to $\bar{P}r+\infty$. (Hence forms like the *Chaux sulfatée prominule* of HAÜY). 2. Axis of revolution perpendicular to $\bar{P}r+\infty$; face of composition parallel to $\breve{P}r+\infty$. 3. Axis of revolution perpendicular, face of composition parallel to $+\frac{\text{Pr}}{2}$. (According to this law are formed the arrow-shaped twins, consisting of lenticular crystals). Globular masses, generally formed of discernible individuals. Dentiform. Massive: composition granular, passing into impalpable, sometimes scaly; also columnar, often as thin as hair, long and generally straight and parallel. Sometimes without cohesion of the single particles in the state of powder.

OBSERVATIONS.

1. The forms, as given above, depend upon the determinations of HAÜY, and the subsequent labours of Mr SORET on the crystallisations of this substance, attention being given to the inclination of the axis. The connexion among them appears more simple and conformable to nature, than in any of the representations that have hitherto been given of the same subject; yet the more accurate determinations of the angles by means of the reflective goniometer have not yet been introduced; and according to these, it will be necessary in future to correct the angles. According to PHILLIPS, the angle of $P + \infty$ is $= 111° 20'$.

Within the species of prismatic Gypsum-haloide, two species, *Fraueneis* or *Selenite*, and *Gypsum*, used to be formerly distinguished, without, however, allowing determined limits to be indicated between them, and which on that account, though not from reasons of Natural History, have been again united by most mineralogists. Such varieties as are pure, transparent, and, in short, most perfectly formed, were comprehended within the first, less perfectly formed varieties within the second of the above-mentioned species. The latter, or Gypsum, was divided into several sub-species, comprehending almost exclusively compound varieties pretty easily distinguishable from each other, as their division depends upon the size of the grain or composition in general. Thus *foliated* Gypsum consists of discernible granular particles, *compact* Gypsum of impalpable particles of composition; *scaly foliated* Gypsum consists of minute scaly particles, *earthy* Gypsum of a mealy powder. Very thin columnar composition produces *fibrous* Gypsum.

2. Prismatoidal Gypsum-haloide consists of

Lime	33·0.	
Sulphuric Acid	44·8.	
Water	21·0.	**Bucholz.**

It is represented by $\ddot{\text{Ca}}\,\dddot{\text{S}}^{2} + 4\,\text{Aq}$, which corresponds to 32·91 of Lime, 46·31 Sulphuric acid, and 20·78 Water. The analysis refers to a variety of Fraueneis; but most of the rest very nearly agree with it. Before the blowpipe it exfoliates, and melts, though with difficulty, into a white enamel, which after a short time falls into powder. In a lower degree of heat it loses its water and becomes friable, so as to be easily reduced to an impalpable powder. If mixed with water, this powder becomes warm, and soon hardens into a solid mass.

3. Compound varieties of this species form beds in secondary mountains, more sparingly in the older classes of rocks; they generally possess a considerable thickness, though they are of a very limited extent in length and breadth. It is less frequently met with in veins and beds, accompanying minerals of the orders Glance, Blende, Pyrites, sometimes hexahedral Gold, &c. In its more peculiar repositories, it is accompanied by compound varieties of rhombohedral Lime-haloide, hexahedral Rock-salt, by different kinds of sandstone and clay in alternating layers, in the latter of which it also occurs in imbedded masses or crystalline groupes. Very often brine springs issue from the rocks in its vicinity. In some places it is associated with prismatic Sulphur and prismatoidal Hal-baryte. Simple varieties are chiefly found in salt-works, also in abandoned mines and old heaps, where they must be considered as products of more recent formation. Of the organic re-

mains found in gypsum, those of extinct species of terrestrial quadrupeds in the Montmartre near Paris, are the most remarkable.

4. The prismatoidal Gypsum-haloide occurs in a great many countries. It is found in various modifications, both crystallised and massive, in different parts of Germany, particularly in Mansfeld, Thuringia, Bavaria, Franconia, Suabia, in the neighbourhood of Lüneburg, in Switzerland, in the Tyrol, in Stiria and Austria; also in Poland, Hungary, and Transylvania; in England, France, Spain, &c. Beautiful crystals are met with near Oxford, at Bex in Switzerland, at Hall in the Tyrol, in several places in Upper Austria, Stiria, Salzburg, and Sicily, &c.; large lenticular crystals, generally twins, and the scaly varieties, are known from Montmartre near Paris; the earthy ones from Saxony and Thuringia.

5. This species is variously employed in manufacturing artificial marble, stucco work, mortar, &c.; also for making casts of statues, medals, &c. It is added to the mass of certain kinds of porcelain and glass. In sculpture it is used under the name of Alabaster. It is also used in agriculture, for improving the soil, both calcined and in its natural state; it forms the paste of coloured drawing pencils; it is employed in polishing, &c.

2. PRISMATIC GYPSUM-HALOIDE.

Prismatic Gypsum, or Anhydrite. JAM. Syst. Vol. II. p. 605. Man. p. 25. Anhydrous Gypsum. Anhydrite. PHILL. 172. Muriazit. WERN. Hoffm. H. B. III. 1. S. 123. Karstenit. HAUSM. III. S. 881. Wasserfreier schwefelsaurer Kalk. LEONH. S. 546. Chaux sulfatée anhydre. HAÜY. Traité, T. IV. p. 348. Chaux anhydro-sulfatée. Tabl. comp. p. 10. Traité, 2de Ed. T. I. p. 562.

BOURNON on Bardiglione. Trans. of the Geol. Soc. Vol. I. p. 355.

Fundamental form. Scalene four-sided pyramid. P = 121° 32′, 108° 35′, 99° 7′. Vol. I. Fig. 9. HAÜY.

$$a : b : c = 1 : \sqrt{1\cdot7647} : \sqrt{1\cdot2353}.$$

Simple forms. $P - \infty\ (P)$; $P\ (o)$; $(\bar{P}r)^3\ (n)$; $(\bar{P})^3\ (f)$; $P + \infty\ (r) = 100°\,10'$; $\breve{P}r + \infty\ (T)$; $\bar{P}r + \infty\ (M)$.

Char. of Comb. Prismatic.

Combinations. 1. $P - \infty.\ \breve{P}r + \infty.\ \bar{P}r + \infty.$ Aussee, Stiria.

2. $P - \infty.\ P + \infty.\ \breve{P}r + \infty.\ \bar{P}r + \infty.$ Hall, Tyrol. HAÜY.

3. $P - \infty.\ P.\ (\bar{P}r)^5.\ (\bar{P})^5.\ \breve{P}r + \infty.\ \bar{P}r + \infty.$ Fig. 26. Aussee, Stiria.

Cleavage. $\breve{P}r + \infty$ and $\bar{P}r + \infty$ highly perfect; $P - \infty$ less distinct, yet easily obtained. Fissures in the interior partly iridescent parallel to $\breve{P}r = 106°\,3'$. Fracture imperfect conchoidal, uneven. Surface, $\breve{P}r + \infty$ and $\bar{P}r + \infty$ smooth; $P - \infty$ rough.

Lustre vitreous, inclining a little to pearly upon the most distinct faces of cleavage. Colour generally white; commonly it inclines to flesh-red, violet- and smalt-blue or ash-grey. Streak greyish-white. Transparent, not perfectly, passing into translucent.

Brittle. Hardness $= 3\cdot0 \ldots 3\cdot5$. Sp. Gr. $= 2\cdot899$ a greyish-white cleavable variety from Hall in the Tyrol.

Compound Varieties. Contorted: composition columnar in thin fibres, parallel, and variously bent. Massive: composition granular, of different sizes, sometimes impalpable, and then the fracture is splintery: in other massive varieties the composition is columnar, commonly thin and parallel. Faces of composition rough.

OBSERVATIONS.

1. The species *Muriacite* of the Wernerian System is subdivided into five different kinds, pretty easily distinguishable, but not provided with the best nomenclature. Thus the *Cubic Muriacite*, also called Cube-spar, comprehends simple varieties, and easily cleavable compound ones, in which the individuals possess a considerable size. The name of *Anhydrite* has been given to varieties of a smaller granular composition, and that of *Gekrösstein* or *pierre de trippes* to the contorted compositions consisting of thin columnar individuals. *Compact* and *fibrous Muriacite* were the denominations of compound varieties of very small individuals, the one granular and impalpable, the other columnar. The *Vulpinite* of Italy, so named from its locality, is composed of granular individuals, a little longer in one direction, of a greyish-white or grey colour, and very much resembling a coarse grained primitive marble.

2. A cleavable variety from Hall in the Tyrol has been found to consist of

Sulphuric Acid	55·00.	
Lime	41·75.	
Muriate of Soda	1·00.	KLAPROTH.

Except the muriate of soda, the rest of the varieties have presented nearly the same proportions. The Vulpinite contains a little silica, probably from imbedded crystals of rhombohedral Quartz. The chemical formula for the pure mixture of this mineral is $\ddot{\mathrm{Ca}}\,\dddot{\mathrm{S}}^{2}$, which gives 41·53 of lime, and 58·47 of sulphuric acid. It does not exfoliate before the blowpipe, but is covered with a white friable enamel.

By a peculiar process, the prismatic Gypsum-haloide attracts water, loses its transparency, a portion both of its hardness and specific gravity, and approaches in some of these properties to the preceding species, which generally occurs along with it, particularly in small crystals lining the fissures which traverse the mass in all directions. Cleavage yet enables us to distinguish this decomposed substance, which has been called *Chaux sulfatée épigène* by HAÜY, from the real and determinable varieties of prismatoidal Gypsum-haloide. The change is here exactly the reverse of what happens in the decomposition of hemi-prismatic Natron-salt, and of prismatic Glauber-salt, &c., which lose their water, instead of attracting a portion of it, like the prismatic Gypsum-haloide.

3. The repositories of the preceding species are in general at the same time those of the present one, by which it is commonly accompanied; yet it does not form beds by itself. It is also found along with metallic minerals, as at Bleiberg in Carinthia, with hexahedral Lead-glance, and occurs in globular masses of various sizes in the beds of clay, which accompany prismatoidal Gypsum-haloide and hexahedral Rock-salt.

4. Splendid geodes of large and well defined crystals (Fig. 26.) of this species have been found at Aussee in Stiria, other crystallised varieties at Hall in the Tyrol, at Hallein in Salzburg, in Switzerland, &c.; accompanied by large grained cleavable masses. The blue Anhydrite is found at Sulz on the Neckar, and at Bleiberg in Carinthia. Columnar varieties occur at Ischel and Berchtesgaden; compact ones, besides these localities, also in the Hartz, in Mansfeld, &c.; the contorted varieties are found at Wieliczka and Bochnia in Poland. The decomposed prismatic Gypsum-haloide occurs in considerable masses at Aussee in Stiria, at Bex in Switzerland, and other places.

5. The blue varieties, in which the granular particles of composition cohere more firmly than in others, are cut and polished for various ornamental purposes, as also in Italy the Vulpinite, which has been called *Marmo bardiglio di Bergamo.*

GENUS II. CRYONE-HALOIDE.

1. PRISMATIC CRYONE-HALOIDE.

Prismatic Cryolite. JAM. Syst. Vol. II. p. 601. Man. p. 28. Cryolite. PHILL. p. 197. Kryolith. WERN. Hoffm. H. B. III. 1. S. 204. Kryolith. HAUSM. III. S. 846. Kryolith. LEONH. S. 624. Alumine fluatée alcaline. HAÜY. Traité, T. II. p. 398. Tabl. comp. p. 23. Traité, 2de Ed. T. II. p. 157.

Fundamental form. Scalene four-sided pyramid of unknown dimensions. Vol. I. Fig. 9. Simple forms and combinations unknown.

Cleavage. $P - \infty$ perfect. $\breve{P}r + \infty$ and $\bar{P}r + \infty$ less perfect or coherent. Traces of P. Fracture imperfect conchoidal, uneven.

Lustre vitreous, a little inclining to pearly upon the faces of $P - \infty$. Colour white, sometimes verging upon red or yellowish-brown. Streak white. Semi-transparent ... translucent. On account of its low refractive power, it appears more transparent when immersed in water.

Brittle. Hardness = 2·5...3·0. Sp. Gr. = 2·963 of a white variety.

Compound Varieties. Massive: composition granular, the individuals being of considerable size.

OBSERVATIONS.

1. The prismatic Cryone-haloide consists of

Alumine	21·0	24·0.
Soda	32·0	36·0.
Fluoric Acid and Water	47·0	40·0.
	KLAPROTH.	VAUQUELIN.

It is considered by BERZELIUS to be the compound $3\,\dot{N}a\,\ddot{F} + \dddot{A}l^2\,\ddot{F}^3$. It is very easily fusible, even at the flame of a candle. Before the blowpipe it is first perfectly liquefied, but soon becomes hard again, and assumes at last a slaggy appearance. It is insoluble in water, though it appears in it of a higher degree of transparency, and, according to Mr **ALLAN**, more easily admits of cleavage, after having been kept in it for some time.

2. It occurs in Arksut-fiord, West Greenland, in two small layers in gneiss, one of which contains only the white varieties, whereas the other contains the coloured ones accompanied by hexahedral Lead-glance, several species of Pyrites, rhombohedral Quartz, and imbedded crystals of brachytypous Parachrose-baryte, and prismatic Feld-spar.

GENUS III. ALUM-HALOIDE.

1. RHOMBOHEDRAL ALUM-HALOIDE.

Rhomboidal Alumstone. **JAM.** Syst. Vol. II. p. 599. Man. p. 29. Alum-stone. **PHILL.** p. 196. Alaunstein. **WERN.** Hoffm. H. B. II. 2. S. 78. Alaunstein. **HAUSM.** II. S. 465. Alaunstein. **LEONH.** S. 628. Lave altérée alunifère. **HAÜY.** Traité, T. IV. p. 504. Alumine sous-sulfatée alcaline. Traité, 2de Ed. T. II. p. 128.
CORDIER. Ann. de Chim. Vol. IX. p. 71.

Fundamental form. Rhombohedron. $R = 92° 50'$. Vol. I. Fig. 7. **PHILLIPS.**

$$a = \sqrt{3 \cdot 892}.$$

Simple forms. $R - \infty$ (*o*); R (*R*). Char. of Comb. Rhombohedral. Combination. 1. $R - \infty$. R. Fig. 111.

Cleavage. $R - \infty$ rather perfect. Traces of R. Surface, smooth and even. The faces of R sometimes streaked parallel to their edges of combination with $R - \infty$.

Lustre vitreous, inclining to pearly upon the more distinct faces of cleavage. Colour white, sometimes reddish or greyish. Streak white. Transparent ... translucent.

Brittle. Hardness = 5·0. Sp. Gr. = 2·694 of a crystallised variety from Tolfa.

Compound Varieties. Massive: composition small granular, often impalpable; fracture uneven, flat conchoidal, splintery, sometimes earthy. In the interior of the massive varieties, there are cavities lined with crystals.

OBSERVATIONS.

1. This species consists, according to Cordier, who analysed a variety from Tolfa, of

Sulphuric Acid	35·495.
Alumina	39·654.
Potash	10·021.
Water and loss	14·350;

with a trace of oxide of iron. Upon charcoal before the blowpipe it does not melt by itself, nor with soda, but is fusible into a colourless globule with borax. Reduced to powder, it is soluble in sulphuric acid.

2. Rhombohedral Alum-haloide is found at Tolfa near Civita Vecchia, in the vicinity of Rome; also in Tuscany, in the kingdom of Naples, and in the county of Beregh in Hungary, also in the neighbourhood of several active volcanoes. It seems to form beds in these places. According to Przystanowsky, the beds of rhombohedral Alum-haloide in Italy occur in Quartz, which is here and there mixed with clay. According to others it is found in veins and geodes of a particular kind of rock, which has been called the *Alum-rock*, and which probably consists of compact varieties of the same species.

3. It is used in the manufacture of alum; and the su-

perior quality of that produced at Tolfa is ascribed to the employment of this mineral.

GENUS IV. FLUOR-HALOIDE.

1. OCTAHEDRAL FLUOR-HALOIDE.

Octahedral Fluor. JAM. Syst. Vol. II. p. 587. Man. p. 29. Fluor. Fluate of Lime. PHILL. p. 168. Fluss. WERN. Hoffm. H. B. III. 1. S. 94. Fluss. HAUSM. III. S. 876. Flusssaurer Kalk. LEONH. S. 561. Chaux fluatée. HAÜY. Traité, T. II. p. 247. Tabl. comp. p. 8. Traité, 2de Ed. T. I. p. 505.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. $\overset{*}{H}$ (*i*), Alstonmoor; $\overset{*}{O}$ (*P*) Vol. I. Fig. 2., Moldawa, Bannat; $\overset{*}{D}$ (*s*), Vol. I. Fig. 31., Ehrenfriedersdorf, Saxony. A_2 (*z*), Vol. I. Fig. 32.; $\overset{*}{A}_3$ (*x*), Cornwall; B, Vol. I. Fig. 33. C_1, Vol. I. Fig. 34.; $\overset{*}{C}_2$ (*u*), Zinnwald, Saxony; T_3 (*n*) Vol. I. Fig. 35.

Char. of. Comb. Tessular.

Combinations. 1. H. O. Vol. I. Fig. 3. and 4. St. Gallen, Stiria.

2. H. D. Fig. 151. Falkenstein, Tyrol.
3. H. A_3. Fig. 148. St Agnes, Cornwall.
4. H. C_2. Fig. 149. Zinnwald, Saxony.
5. H. T_3. Matlock, Derbyshire.
6. O. A_2. Altenberg, Saxony.
7. H. O. D. Schwarzenberg, Saxony.
8. H. D. C_2. Falkenstein, Tyrol.

Cleavage. Octahedron, perfect and easily obtained. Dodecahedron and hexahedron sometimes distinct in the green varieties from Alstonmoor, the first also in a dark violet blue variety from St. Gallen in Stiria, the second in the yellow hexahedral varieties from Saxony. Fracture conchoidal, more or less perfect.

Surface. The hexahedron generally smooth. Octahedron often rough and drusy. Dodecahedron various, being sometimes smooth, at other times rough or drusy. Hexahedral trigonal-icositetrahedrons commonly streaked parallel to their edges of combination with the dodecahedron. Sometimes the faces of the hexahedron and the tetraconta-octahedrons are curved.

Lustre vitreous.

Colour white, though not very common, and seldom pure. Generally wine-yellow or violet-blue. Among its brightest colours are emerald- and pistachio-green, sky-blue, rose-red, and crimson-red. Very dark blue colours, bordering upon black, probably owing to foreign admixtures. Frequently different shades of colours are disposed in coats parallel to the faces of the hexahedron, or symmetrically distributed along the edges or solid angles of crystals.

Streak white. It is sometimes slightly tinged, if the colours be very deep.

Translucent ... transparent. Sometimes different colours appear by reflected and by transmitted light.

Brittle. Hardness = 4·0. Sp. Gr. = 3·140, violet-blue crystals from St. Gallen in Stiria.

Compound Varieties. Twin-crystals. Axis of revolution perpendicular, face of composition parallel to one of the faces of the octahedron; the individuals, having one of their axes parallel, are continued beyond the face of composition, and particles of the one are observed formed upon the faces of the other. Fig. 128. Implanted globular shapes, rare: surface drusy, composition columnar. Massive: composition granular, the individuals being of various sizes; if the composition be impalpable, the fracture becomes flat conchoidal and splintery, the surface of fracture being scarcely glimmering. Massive varieties are also sometimes compound of columnar particles, generally of considerable size, seldom thin or diverging, but very often forming a second curved lamellar composition. The faces of composition are sometimes irregularly streaked, more generally uneven and rough.

OBSERVATIONS.

1. Fluor has been divided into *foliated* and *compact* Fluor, of which the first is more generally called Fluor-spar. This division comprehends the simple varieties, and such compound ones as consist of individuals, whose cleavage can still be ascertained. The other includes those in which the individuals are too small to allow cleavage to be observed. This division is not erroneous, but it is useless. A third sub-species has been added to the former two, which comprehends the *earthy* Fluor, or the friable varieties of the species, in which the individuals have lost their connexion, probably by decomposition.

2. Octahedral Fluor-haloide consists of

Lime	67.75.
Fluoric Acid	32·25. KLAPROTH.

According to BERZELIUS it is expressed by $\ddot{C}a\ \ddot{F}$, and composed of 72·14 of Lime, and 27·86 of Fluoric acid. Before the blowpipe it decrepitates, and becomes phosphorescent, but loses its colour, and melts at last into a rather opake globule. It phosphoresces likewise, if thrown upon ignited charcoal or heated iron. Several varieties, which exhibit this phenomenon in particularly bright green colours, have been called Chlorophane or Pyro-smaragdus. If exposed to a too high degree of temperature, they lose the property of again shewing this phenomenon. Sulphuric acid decomposes the powder of the mineral; fluoric acid is disengaged in a gaseous state, and corrodes glass. Several varieties, particularly the sky-blue ones, lose their colour, on being exposed to light.

3. This species does not enter as a regular constituent into the composition of rocks. It is not very frequently found in beds; this, however, seems to be the case at Alstonmoor and Castleton; some varieties occur in beds of octahedral Iron-ore, pyramidal Copper-pyrites, &c. More generally it is found in veins, with various minerals, in ancient and more modern rocks. Very seldom it is associated with petrifactions, as the blue varieties of Derbyshire with entrochites.

4. Octahedral Fluor-haloide is common in some countries, while in others it is very rare. Among the first we notice Saxony, some districts of the Hartz, and England, among the last Scotland, Hungary, Transylvania, &c. Most beautiful and interesting crystallized varieties are found at Beeralston in Devonshire, at St Agnes and other places in Cornwall, and at Zinnwald in Bohemia; also some rare colours, as for instance the sky-blue ones. Large crystals, generally twins of the hexahedron, of beautiful green and blue colours, occur at Alston in Cumberland, which frequently contain water. Beautiful dark blue perfect crystals, of the form Fig. 148., have been found, in small geodes, along with rhombohedral Quartz, near Gourock in Renfrewshire. They here occur in porphy-

ritic greenstone. Well defined octahedrons of an apple-green colour at Moldawa, in the Bannat of Temeswar. Rose-red octahedrons are met with near Chamouni in Savoy, associated with tabular crystals of rhombohedral Lime-haloide; emerald-green octahedrons have been brought from America. The Saxon varieties are generally of a hexahedral form, and violet-blue or wine-yellow colours; yet there occur some of other forms and colours, both in Saxony and the adjacent districts of Bohemia. The compound uncleavable varieties (compact fluor) are chiefly known from Strassberg and Stollberg in the Hartz, Cornwall, and Sweden. The friable ones (earthy fluor) are found in Saxony, England, and Norway. Several parts of Germany, France, Siberia, America, &c. produce likewise varieties of this species.

5. Octahedral Fluor-haloide, particularly those varieties which consist of columnar particles of composition, are cut and polished for various ornamental purposes. In Derbyshire they are turned into vases, for which, however, they require first to be prepared by certain processes, which increase their tenacity. In former times, those of fine colours used to be cut and worn as gems, and were designated by the same names. A more important employment is that of fluxing several ores, from which the name of *Fluor* has been derived. The fluoric acid, disengaged from it by means of sulphuric acid, has been used for corroding and etching upon glass.

2. RHOMBOHEDRAL FLUOR-HALOIDE.

Rhombohedral Apatite. Jam. Syst. Vol. II. p. 575. Man. p. 32. Apatite. Phosphate of Lime. Phill. p. 167. Apatit. Spargelstein. Phosphorit. Wern. Hoffm. H. B. III. 1. S. 84. 89. 92. Apatit. Phosphorit. Hausm. III. S. 869. 872. Phosphorsaurer Kalk. Leonh. S. 557. Chaux phosphatée. Haüy, Traité, T. II. p. 234. Tabl. comp. p. 7. Traité, 2de Ed. T. I. p. 487. Haidinger. Edin. Phil. Journ. No. XIX. p. 140.

Fundamental form. Rhombohedron. $R = 88° 41'$. Vol. I. Fig. 7. R. G.

$$a = \sqrt{4{\cdot}8245}.$$

Simple forms. $R - \infty$ (*P*); $R - 1$ (*a*); R (*s*); $R + 1$; $R + \infty$ (*e*); $P - 1$ (*r*) = 157° 33′, 45° 49′; P (*x*) = 142° 20′, 80° 25′; $P + 1$ (*z*) = 129° 1′, 118° 48′; $P + \infty$ (*M*); $(P)^{\frac{5}{3}}$ (*u*); $(P - 1)^{\frac{7}{3}}$; $(P)^{\frac{7}{3}}$ (*b*); $(P + \infty)^{\frac{5}{3}}$ (*c*) = 158° 12′ 48″, 141° 47′ 12″; $(P + \infty)^{3}$ (*f*) = 141° 47′ 12″, 158° 12′ 48″.

Char. of Comb. $R + n$ dirhombohedral. $(P + n')^{m}$, hemi-dirhombohedral with parallel faces. 2 (R) = 131° 14′, 111° 20′.

Combinations. 1. $R - \infty$. $P + \infty$. Greiner, Salzburg.

2. P. $P + \infty$. Cabo de Gata, Spain.

3. $P - 1$. 2 (R). $P + \infty$. Ehrenfriedersdorf, Saxony.

4. $R - \infty$. $P - 1$. $P + \infty$. Fig. 110. Ehrenfriedersdorf, Saxony.

5. $R - \infty$. $2\,(R - 1)$. P. 2 (R). $P + 1$. $\frac{1}{r}\,\frac{2\left((P)^{\frac{5}{3}}\right)}{2}$. $\frac{1}{r}\,\frac{(P + \infty)^{\frac{5}{3}}}{2}$. $R + \infty$. $P + \infty$. Fig. 148. St. Gotthard.

6. $R - \infty$. $P - 1$. $2\,(R - 1)$. P. 2 (R). $P + 1$. $\frac{1}{r}\,\frac{2\left((P)^{\frac{5}{3}}\right)}{2}$. $\frac{1}{r}\,\frac{2\left((P)^{\frac{7}{3}}\right)}{2}$. $R + \infty$. $P + \infty$. Fig. 149. St. Gotthard.

Cleavage. $R - \infty$ and $P + \infty$, not perfect, the latter generally more easily obtained. The asparagus-green varieties from Salzburg, imbedded in talc, shew very smooth faces of cleavage, particularly in the direction of $P + \infty$, which, however, are interrupted by conchoidal fracture. Fracture conchoidal, more or less perfect, uneven.

Surface, the dirhombohedrons and pyramids generally very smooth. $P - 1$, sometimes rough, though even, sometimes horizontally streaked. $R - \infty$ frequently a little curved or uneven. The vertical prisms often deeply striated in a longitudinal direction. Sometimes all the edges are rounded.

Lustre vitreous, inclining to resinous. Colour white, though not general. Frequently violet-blue, mountain-green, or asparagus-green; also yellow, grey, red, and brown colours, none of them bright. Transparent, but generally translucent. A blueish opalescence appears upon the faces parallel to the principal axis in some crystals, particularly the white varieties.

Brittle. Hardness = 5·0. Sp. Gr. = 3·225, asparagus-green crystals from Spain; = 3·180, from Salzburg.

Compound Varieties. Implanted globular and reniform shapes: composition imperfect columnar, faces of composition rough. Massive: composition granular, individuals of different size, not impalpable, faces of composition uneven or rough.

OBSERVATIONS.

1. The most remarkable feature in the series of crystallisation of rhombohedral Fluor-haloide is the mode in which the scalene six-sided pyramids enter into combinations with other forms. It is the mode called hemi-rhombohedral parallel with faces (Vol. I. §. 147.), and is not as yet known with the same peculiarities in any other species. If sufficiently enlarged, the faces marked *u*, *u* &c., and *b*, *b* &c., Fig. 148. and 149. will produce forms which by themselves appear as isosceles six-sided pyramids if we give no attention to their connexion with other simple forms of the species. In LEONHARD's Mineralogy, mention is made of this peculiarity, but it is said to be unsymmetrical, and like the *Quartz plagièdre* of HAÜY, from which, however, it is distinguished by having the oblique faces disposed on one end to the right, on the other to the left of the faces of 2 (R), while in Quartz they are disposed on both ends of the crystals, equally, either to the right or to the left of the same faces. The twelve-sided prisms $(P+\infty)^{\frac{5}{3}}$ and $(P+\infty)^3$, though derived according to different numbers of derivation, yet possess the same transverse sections, with that difference only that the obtuse edges of the one have the situation of the acute edges of the other. These prisms also produce hemi-dirhombohedral combinations with other forms, so that if we find the alternating faces of $(P+\infty)^{\frac{5}{3}}$ contiguous to the left side of the faces of 2 (R), the right ones of $(P+\infty)^3$ will appear. The product of a combination of $R+\infty$, $P+\infty$, $\frac{l}{r}\frac{(P+\infty)^{\frac{5}{3}}}{2}$ and $\frac{r}{l}\frac{(P+\infty)^3}{2}$ is limited parallel to the axis by four times six faces of the same kind, including angles with each other of alternately 160° 53′ 38″ and 169° 6′ 24″, so that, proceeding from right to left, the edge of combination between $\frac{(P+\infty)^3}{2}$ and $R+\infty$ is equal to that between $\frac{(P+\infty)^{\frac{5}{3}}}{2}$ and $P+\infty$, and so all round.

As has been shewn in Vol. I. §. 115., this equality of the angle is a general relation in the rhombohedral system, where, from the formula $m = \frac{3m' + 1}{3(m' - 1)}$ it appears that $m = 3$ gives $m' = \frac{5}{3}$, that $m = 2$ gives $m' = \frac{7}{3}$, &c. It is deserving of notice, that if T_1, the first variety of tetraconta-octahedrons (Vol. I. §. 77.), be placed in an upright position, so as to have one of the rhombohedral axes vertical, and the hexahedron be supposed $= R$, as the fundamental form of the series; the vertical faces will be expressed by the sign $(P + \infty)^{\frac{5}{3}}$. The inclined faces would be, upon the same supposition, $P - 1$. $(P - 1)^2$. $(P - 1)^5$.

2. The varieties of the present species, by no means less distinct than those of the preceding one, decidedly separate from others and connected among themselves, have been considered by some mineralogists as forming two or even three different species, and farther subdivided into several sub-species or kinds. The distinctive marks between them, however, are so slight, that they cannot be indicated with precision, nor usefully employed in an actual distinction. It would be superfluous, therefore, to attempt their explanation. The varieties of Apatite, Asparagus-stone, and Phosphorite, are so intimately connected, that they pass insensibly into each other; and thus demonstrate that in fact they form but one and the same species, which is an immediate consequence of the transitions, and in the present species was first ascertained by the Abbé HAÜY.

3. Rhombohedral Fluor-haloide consists of

Lime 55·0.
Phosphoric Acid 45·0. KLAPROTH.

It is $\ddot{Ca}^3 \overset{:\cdot:}{P}^2$, according to which formula the proportion of lime to that of phosphoric acid will be as 54·48 : 45·52. It is slowly soluble in nitric acid, and without effervescence. Some varieties are phosphorescent upon ignited charcoal and before the blowpipe, others even when rubbed with hard bodies. In a very strong heat of the blowpipe, the edges and solid angles are rounded off, but it does not melt without addition. With salt of phosphorus it forms a clear globule. A phosphate of lime has been artificially obtained in lamellar masses of a greyish colour, by the younger SAUSSURE, upon exposing a mixture of phosphoric acid and sulphate of lime to a high temperature. These lamellar masses shewed by heat opposite kinds of electricity on opposite ends, a property which HAÜY in vain tried to discover in the natural crystals of rhombohedral Fluor-haloide.

4. There are examples, though few, of this species entering as an occasional admixture into the composition of rocks. Thus the granite of the neighbourhood of Rio Janeiro, and the green prismatic Talc-mica, called common Talc of Salzburg, contain varieties of it. More frequently it appears in beds and veins consisting chiefly of ores of iron and tin, particularly in the latter, associated with pyramidal Tin-ore, prismatic Scheelium-ore, prismatic Topaz, several species of Pyrites and Haloides, &c. In another kind of veins, consisting of crystallised varieties of those species of which the rocks themselves are composed, it is accompanied by rhombohedral Quartz, and several species of the genera Feld-spar and Talc-mica. The crystallised varieties from Spain, called Asparagus-stone, occur along with rhombohedral Iron-ore and compact rhombohedral Lime-haloide; the compound varieties, or Phosphorite, of the same country, form particular beds.

5. Ehrenfriedersdorf in Saxony, Schlackenwald in Bohemia, the Greiner mountain in Salzburg, Cabo de Gata in Spain, Arendal in Norway, Devonshire and Cornwall in England, afford some of the most generally known localities of fine varieties of rhombohedral Fluor-haloide. Very beautiful crystals of this substance have lately been discovered at Carrock in Cumberland, associated with the different species, which usually occur in veins and beds of Tin-ore. From St Gothard in Switzerland, and Heiligenbluter Tauern in Salzburg, remarkable white, transparent crystals have been brought. Other varieties occur in

France, Italy, America, &c.; the Phosphorite is known from Estremadura in Spain, and Schlackenwald in Bohemia.

GENUS. V. LIME-HALOIDE.

1. PRISMATIC LIME-HALOIDE.

Prismatic Limestone or Arragonite. JAM. Syst. Vol. II. p. 568. Man. p. 34. Arragonite. PHILL. p. 161. Eisenblüthe (Var. of Fasriger Kalksinter). Arragon. WERN. Hoffm. H. B. III. 1. S. 32. 77. Arragonit. HAUSM. III. S. 972. Arragon. LEONH. S. 584. Arragonite. HAÜY. Traité, T. IV. p. 337. Tabl. comp. p. 6. Traité, 2de Ed. T. p. 432.

Fundamental form. Scalene four-sided pyramid. $P = 112° 39'$, $93° 33'$, $123° 34'$. Vol. I. Fig. 9. AP.

$$a : b : c = 1 : \sqrt{0{\cdot}736} : \sqrt{0.476}.$$

Simple forms. $P - \infty$ (s); $P - 1 = 129° 11'$, $116° 1'$, $85° 58'$; P (r); $(\breve{P}r - 1)^3 = 92° 56'$, $129° 40'$, $108° 5'$; $(\breve{P}r + \infty)^3 (M) = 63° 44'$; $\bar{P}r - 2\ (x) = 140° 10'$; $\bar{P}r - 1\ (P) = 108° 8'$; $\frac{3}{4}\bar{P}r = 85° 13'$; $\frac{3}{4}\bar{P}r + 1 = 49° 24'$; $\frac{5}{4}\bar{P}r + 1 = 30° 51'$; $\bar{P}r + \infty$; $\breve{P}r = 80° 52'$; $\breve{P}r + \infty$.

Char. of Comb. Prismatic.

Combinations. 1. $P - \infty$. $(\breve{P}r + \infty)^3$. $\bar{P}r + \infty$. Arragon.

2. $\bar{P}r - 1$. $(\breve{P}r + \infty)^3$. $\bar{P}r + \infty$. Sim. Fig. 9. Leogang, Salzburg.

3. $\bar{P}r - 2$. $\bar{P}r - 1$. $\frac{3}{4}\bar{P}r$. $(\breve{P}r + \infty)^3$. $\bar{P}r + \infty$. Sim. Fig. 23. Bilin, Bohemia.

4. $\bar{P}r - 2$. $\bar{P}r - 1$. P. $(\breve{P}r + \infty)^3$. $\bar{P}r + \infty$. The individuals in Fig. 39. Bilin, Bohemia.

Cleavage, $\bar{P}r - 1$ and $(\breve{P}r + \infty)^3$; with greater facility and perfection $\bar{P}r + \infty$. Fracture, conchoidal, uneven. Surface, generally smooth, $P - 1$, and $(\breve{P}r - 1)^3$ rough. $(\breve{P}r + \infty)^3$ and $\bar{P}r + \infty$ often a little uneven, $\breve{P}r$ uneven. The curvature of the faces parallel to the axis very often produces acicular crystals, variously aggregated.

Lustre vitreous, inclining to resinous upon faces of fracture. Colour white, prevalent; sometimes passing into grey, yellow, mountain-green and violet-blue. Some of the green colours probably owing to foreign admixtures. Streak greyish-white. Transparent, translucent.

Brittle. Hardness = 3·5...4·0. Sp. Gr. = 2·931, the transparent crystals from Bohemia.

Compound Varieties. Twin-crystals. 1. Axis of revolution perpendicular, face of composition parallel to one of the faces of $(\breve{P}r + \infty)^3$, Fig. 39.; 2. Axis of revolution parallel, face of composition perpendicular upon one of the lateral edges of $(\breve{P}r + n)^3$. These two kinds of regular composition are, the one as it were the complement of the other, since twin-crystals, in which the substance of the individuals is continued beyond the face of composition, as is very frequent in the present species, may be explained upon either supposition, at least if we pay no attention to the internal structure of the crystals. The composition is very often repeated in parallel laminæ. Thus masses are formed consisting of alternating layers of the two individuals.

Globular, reniform, coralloidal shapes: surface drusy, composition columnar, the individuals being often very delicate, but also occurring of various dimensions, faces of composition irregularly streaked. Massive: composition columnar, either parallel, or divergent, or irregular, and of different sizes of individuals.

OBSERVATIONS.

1. Although several varieties of the present species had long ago been separated from the rest of the Lime-haloides, and more particularly from the rhombohedral one, and erected into a particular species, under the name of *Arragonite;* yet there are still some, which to this moment we find united with it in several mineralogical systems. The determination of a species is not attended with the slightest difficulty, as long as it is possible to obtain correct information of the form or regular structure of a mineral, of its hardness and specific gravity. In fact, those varieties which have not hitherto been united with the species of prismatic Lime-haloide, are so much compound, that the above mentioned properties can only be observed with great difficulty, or not at all. The component individuals of *Flosferri*, particularly that of Eisenerz in Stiria, are so minute, that their form and structure is withdrawn from the eye. At Hüttenberg and in other localities of Carinthia, also at Torotzko in Transylvania, there are varieties of the same mineral, similarly compound, in which, however, the size of the individuals is considerable enough to allow the regular forms and cleavage to be ascertained, and above all, to be sufficiently distinguished from those of rhombohedral Lime-haloide. In the same way, as in the preceding example, it is necessary to proceed in every similar

case; and no doubt can remain, that the determination of Haüy, who first united the *Flosferri* with his *Arragonite*, is perfectly correct and conformable to nature *.

2. With regard to the chemical relations, the species of prismatic Lime-haloide is particularly remarkable. For a long time the most accurate analytical chemists were not capable of finding the smallest difference in the mixture of prismatic and of rhombohedral Lime-haloide. Professor Stromeyer succeeded in discovering in several varieties of the former, a small proportion of carbonate of strontites and water. According to the very exact analyses of this chemist, the varieties of prismatic Lime-haloide consist of

Carbonate of Lime	95·2965...99·2922.
Carbonate of Strontites	0·5090... 4·1043.
Water	0·1544... 0·5992.

The carbonate of strontites does not exist in constant proportions, and has not been found at all in the coralloidal varieties. For this reason several mineralogists still consider the varieties of Flosferri as different from the species of prismatic Lime-haloide. Thin fragments of transparent crystals decrepitate in the flame of a candle; other varieties lose their transparency, and become friable. It phosphoresces upon red-hot iron, and is soluble in nitric and muriatic acid, during which process the carbonic acid is disengaged.

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* In every variety of this species, which consists of columnar particles of composition, traces of cleavage in longitudinal directions are observable, and produce that characteristic silky lustre, which appears in *Satin-spar*; while in every variety of the rhombohedral species, traces of the inclined faces of cleavage remain, though the component individuals be ever so small. There are varieties in which the two species are joined longitudinally in similar compositions. Still more frequently the two species alternate in layers perpendicular to the direction of the fibres, in which case those of prismatic Lime-haloide generally possess lower degrees of transparency than those of the rhombohedral species. H.

3. Imbedded crystals, generally twins, or consisting of a greater number of individuals, are found in compound varieties of prismatoidal Gypsum-haloide, mixed and coloured with oxide of iron, accompanied with crystals of rhombohedral Quartz, which have likewise suffered a similar admixture. Other varieties occur in the cavities of basalt and other trap rocks, also in irregular beds and veins. It is found in beds of iron-ores, in those coralloidal varieties, which have been called *Flosferri;* also massive and crystallised. The first, though they occur in cavities or open fissures, are not products of a *stalactitic* formation. The most beautiful crystals, well defined and transparent, occur near Bilin in Bohemia, in a vein traversing basalt, and filled with a massive variety of the same species, consisting of large columnar particles of composition. It is often found in various repositories, along with several species of the orders Glance, Pyrites, Malachite, &c. to the latter of which it sometimes owes its blueish or greenish colour. It likewise occurs in several kinds of lavas.

4. The varieties imbedded in prismatoidal Gypsum-haloide, have been found in the kingdom of Arragon in Spain, from which the names of Arragone, Arragonite, have been derived. It occurs with ores of iron in Stiria, Carinthia, Hungary, Transylvania, and other countries, in cavities of traprocks in Bohemia, Thuringia, Hessia, on the Rhine, in Baaden, France, Scotland, Iceland, &c. In metallic veins or beds it is met with at Schwatz in the Tyrol, Iglo in Hungary, Leadhills in Scotland, in Siberia, and other places.

2. RHOMBOHEDRAL LIME-HALOIDE.

Limestone (with the exception of Aphrite). JAM. Syst. Vol. II. p. 481. Rhomboidal Limestone. Man. p. 36. Carbonate of Lime. PHILL. p. 147. Bergmilch. Kreide. Kalkstein. Kalktuff. Schieferspath. Stinkstein. Mergel. Anthrakolith. Bituminöser Mergelschiefer. WERN. Hoffm. H. B. III. 1. S. 2. 4. 7. 40. 46. 63. 67. 72. Duttenstein. Letztes Mineral-System, S. 11. 44.

Kalk (with the exception of Schuppiger Aphrit). Saugkalk. Mergel. Stinkmergel. Stinkkalk. Anthrakonit. Hausm. III. S. 900. 924. 927. 932. 934. 941. Kohlensaurer Kalk and the Schieferspath of the second appendix. Leonh. S. 566. Chaux carbonatée (with exception of Ch. c. aluminifère, ferrifère, magnésifère). Haüy. Traité, T. II. p. 127. Id. (with the same exceptions, and moreover Ch. c. manganésifère rose, ferro-manganésifère). Tabl. comp. p. 2. Id. Traité, 2de Ed. T. I. p. 298.
Monteiro. Journ. des Mines. T. XXXIV. p. 161. Ann. des Mines. T. V. p. 3. Bournon. Traité complet, &c.

Fundamental form. Rhombohedron. $R = 105° 5'$. Vol. I. Fig. 7. R. G.

$$a = \sqrt{2{\cdot}1895}.$$

Simple forms. $R - \infty$ (o); $\overset{*}{R} - 1$ (g) $= 134° 57'$, Alston, Cumberland; $\overset{*}{R}$ (P), Val di Brosso, Piedmont; $\overset{*}{R} + 1$ (f) $= 78° 51'$, Hüttenberg, Carinthia; $\overset{*}{R} + 2$ (m) $= 65° 50'$, Leogang, Salzburg; $R + 3 = 61° 33'$; $\frac{5}{4}\overset{*}{R} = 95° 28'$, Faroe; $R + \infty$ (c); $P = 144° 33', 59° 20'$; $P + \infty$ (u); $(P - 2)^3$ (t) $= 138° 5', 159° 24', 64° 54'$; $(P)^2$ (λ *Mont.*) $= 102° 11', 155° 50', 113° 45'$; $(\overset{*}{P})^3$ (r) $= 104° 38', 144° 24', 132° 58'$, Derbyshire; $(P)^5$ (y) $= 109° 1', 134° 28', 150° 44'$; $(\overset{*}{P})^7$ (ς *Mont.*) $= 111° 39', 130° 10', 158° 53'$, Andreasberg; $(\overset{*}{P})^{11} = 114° 24', 126° 26', 166° 28'$, Faroe; $(P + 1)^{\frac{5}{3}} = 88° 18', 159° 20', 127° 29'$; $(P + 1)^2$ (x) $= 92° 9', 153° 16', 135° 19'$; $(P + 1)^3 = 99° 58', 142° 30', 149° 21'$.

Char. of Comb. Rhombohedral.

Combinations. 1. $R-\infty$. $R-1$. Sim. Fig. 109. Himmelsfürst mine, Saxony.

2. $R-\infty$. $R+2$. Fig. 111. HAÜY.

3. $R-\infty$. $R+\infty$. Fig. 132. 133. Andreasberg, Hartz.

4. $R-1$. $R+\infty$. Sim. Fig. 114. Schemnitz, Hungary.

5. $R-1$. $P+\infty$. Sim. Fig. 118. Dufton, Lancashire.

6. $(P-2)^3$. $(P)^3$. Fig. 129. Derbyshire.

7. R. $R+\infty$. Fig. 114. Andreasberg, Hartz.

8. $R-\infty$. R. $R+2$. Fig. 115. Leogang, Salzburg.

9. $R-\infty$. $R+\infty$. $P+\infty$. Strontian, Argyllshire.

10. $R-1$. $(P)^2$. $R+\infty$. MONT.

11. $R-1$. $(P)^5$. $R+\infty$. Derbyshire.

12. $(P-2)^3$. $(P)^3$. $R+\infty$. Derbyshire.

13. R. $(P+1)^{\frac{5}{3}}$. $R+\infty$. Alston, Cumberland.

14. R. $(P)^3$. $R+2$. $(P)^5$. $R+\infty$. Fig. 116. Derbyshire.

15. $R-1$. $(P-2)^3$. R. $\frac{5}{4}R$. $R+1$. $(P)^3$. $R+\infty$. Vol. I. Fig. 59. Derbyshire.

16. $R-1$. $(P-2)^3$. R. $R+1$. $(P+1)^2$. $R+2$. $(P)^5$. $(P+1)^3$. $R+3$. Mariatrost, near Gratz, Stiria.

Cleavage. R, very easily obtained, even and often highly perfect. Of the forms $R-\infty$, $R-1$, $R+\infty$, $P+\infty$ and $(P)^3$ faint traces are sometimes observable in a strong light. Curved faces of cleavage commonly originate in composition. Fracture perfect conchoidal, difficult to be obtained.

Surface generally even, only certain rhombohedrons and pyramids curved. R — ∞ commonly rough; R — 1 striated parallel to its own inclined diagonals, or to the edges of combination with R; R + ∞ smooth. P and P + ∞ streaked parallel to their edges of combination with R; so are likewise the scalene six-sided pyramids belonging to R, and above all $(P)^5$.

Lustre vitreous. The lustre of P — ∞, particularly as a face of composition inclining to pearly. Colour, white, prevalent. Also different shades of grey, red, green, yellow; all of them pale. Dark brown and black colours, owing to foreign admixtures. Streak greyish-white. Transparent ... translucent. Double refraction very considerable, and easily observed.

Brittle. Hardness = 3·0. Sp. Gr. = 2·721, a transparent crystal of the form var. 13.

Compound Varieties. Twin-crystals. 1. Axis of revolution perpendicular, face of composition parallel to R — ∞, as in Fig. 129. and 135.*, parallel to R — 1, as in Fig. 130. and Fig. 133., parallel to R, as in Fig. 132., or parallel to R + ∞, as in Fig.

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* This figure represents a crystal from Alstonmoor, in the collection of Mr ALLAN, in which the substance of the individuals is continued beyond the face of composition. H.

134. 2. Axis of revolution parallel, face of composition perpendicular to a terminal edge of R. The regular composition in faces parallel to R — 1, Fig. 130., takes place also in massive varieties, and then more or less thick laminæ of the two individuals alternate with each other, as in Fig. 131. The frequent occurrence of those well known striæ upon the faces of cleavage, parallel to the horizontal diagonal of the rhombs, depends upon this mode of regular composition. The faces of composition, also those in the direction of R — ∞, used formerly to be considered as faces of cleavage.

Implanted globules; stalactitic, botryoidal, fruticose shapes: surface uneven, drusy, rough or smooth, composition columnar, more or less distinct, straight, diverging, and of various sizes. Stalactitic and botryoidal varieties are often composed a second time of curved lamellar particles, conformably to the surface of the imitative shape, the faces of composition being uneven and rough, or irregularly streaked in a longitudinal direction. Massive: 1. Composition columnar, the individuals being straight, parallel, or diverging, very often of remarkable delicacy. In a second composition, globular masses are produced, consisting of curved lamellar particles, the faces of composition between the latter often being smooth. These globules are again joined in a third composition, producing granular masses, between which the faces of composition are uneven and rough. 2. Composition granular, the individuals being of various sizes, and even impalpable; faces of composition irregularly streaked, uneven, and rough. The individuals cohere more or less firmly. If the composition be impalpable, fracture becomes splintery, uneven, flat conchoidal, or even; on a large scale it is sometimes slaty. The fracture is earthy in those varieties in which the individuals cohere but slightly. 3. Composition lamellar; the individuals more or less thin, and often bent; face of composition sometimes rough, and possessing a pearly lustre. Globules formed in cavities; plates, of various kinds of composition.

OBSERVATIONS.

1. The species of rhombohedral Lime-haloide is not yet determined with perfect purity and correctness by all mineralogists. Even in the system of Abbé HAÜY, it includes, though only as an appendix, substances which do not belong to the species. Pearl-spar, Dolomite, Rhomb-spar, have long ago been separated from the species of rhombohedral Lime-haloide; and this separation is fully confirmed by the examination of the angles, the degrees of hardness and of specific gravity, which has produced the assumption of the three following species. It cannot yet be maintained, that the number of those species of the present genus, whose forms belong to the rhombohedral system, is thus exhausted; on the contrary, it is highly probable, that there exist several others, the determination of which has hitherto been impossible, on account of the want of an exact natural-historical examination. The same takes place in other genera. Differences in the admeasurement of forms, in hardness, specific gravity, &c., if they be constant and not connected by transitions, necessarily produce different species. Yet

they require most accurate examination; and this, on the other hand, must serve as a proof that the measures of the angles within a correctly determined natural-historical species, are in fact invariable.

The distinction of several species within that of rhombohedral Lime-haloide, and the division of them into several sub-species and kinds, as it used to be in the older Mineralogy, depends chiefly upon the mode of composition, and upon admixtures and impurities, with which the individuals have been affected in their formation. Of these, *Limestone*, if we except Flosferri (p. 83.), represents the greater part of the pure varieties of the species. The simple varieties, and such compound ones in which the individuals are of considerable size, and easily cleavable, have been called *Calcareous spar*, compound varieties of granular still discernible individuals, are *granular Limestone*, both comprehended under the head of *foliated Limestone*. If the granular composition disappear, *compact Limestone* is formed, under which denomination also the *Oolite* or *Roestone* was exhibited. The roundish grains, however, of the latter, consist of columnar individuals, disposed like the radii of a sphere, and frequently shewing distinct traces of cleavage. *Common fibrous Limestone* is produced by columnar composition in massive varieties, the *fibrous Calcsinter* by the same, but appearing in various imitative shapes. The latter must be carefully distinguished from similar formations of prismatic Lime-haloide. *Pea-stone* or *Pisolite* consists of diverging columnar individuals, collected into curved lamellar ones, forming globular masses, which are again agglutinated by a calcareous cement. Each of the globules generally contains a fragment, sometimes of considerable size, of some heterogeneous matter, as quartz, granite, &c. Compact limestone passes into *Chalk*, if the individuals are more loosely connected with each other, so that the whole assumes an earthy appearance; and *Rock-milk* or *Agaric mineral* is formed, if the mass contains so many interstices, that it seems to possess but a small degree of specific gravity. *Calcareous tufa*, a recent deposit formed on the surface of the earth, is often cleavable, and then possesses all the properties of calcareous spar. *Slate-spar* is produced by a lamellar composition in massive varieties in the direction of the face of $R - \infty$, contained in thin parallel layers. The face of composition, like that of $R - \infty$ in crystallised individuals, often possesses pearly lustre. The single laminæ of slate-spar are cleavable into rhombohedrons, like every other simple variety of the species. There is no transition from slate-spar into Aphrite. *Swinestone*, *Anthracolite*, *Marl*, *Duttenstein*, and *bituminous Marlslate*, are impure and mixed varieties, partly of calcareous spar, partly of compact limestone.

The pure varieties of rhombohedral Lime-haloide consist, according to the analyses of several of the first chemists, of

Lime	56·0...57·0.
Carbonic Acid	43·0...44·0.

Their chemical formula is $\ddot{\mathrm{C}}\mathrm{a}\ \dddot{\mathrm{C}}^{2}$, which requires 56·39 of lime, and 43·61 of carbonic acid. Very often the varieties contain a small proportion of oxide of iron, silica, magnesia alumina, carbon or bitumen. Rhombohedral Lime-haloide, if pure, is entirely soluble in nitric acid, during which a brisk effervescence takes place. In common fire it is infusible, but loses its carbonic acid, and becomes burnt, or quick lime.

3. Rhombohedral Lime-haloide rarely enters into the composition of rocks. In most cases, the more considerable masses of it form particular beds in other rocks, or constitute rocks themselves: the latter consist chiefly, though not exclusively, of compact limestone; the former of granular limestone. The simple varieties occur in drusy cavities, more frequently in veins than in beds, accompanied with the varieties of different species. There are also compound varieties found in these repositories; columnar compositions have been observed to form veins by themselves, and a great number of varieties are met

with in the cavities of several rocks. Slate-spar is generally a product of beds of granular limestone; calcareous tufa and rock-milk, being of a sintery formation, occur upon the surface and in fissures of limestone rocks, and rock-milk in particular is generally a very pure carbonate of lime. Stalactitic and pisiform varieties are produced by calcareous springs and other waters. The original repository of Anthracolite is unknown, it having as yet been found only in large boulders. A variety of very similar composition, though consisting of smaller individuals, forms a coat round limestone nodules in the lias of Lyme in Dorsetshire; the axis of the individuals is perpendicular to the surface. The mixed or impure varieties occur in particular strata, between those of compound varieties of other species. The rhombohedral Lime-haloide very often occurs in petrifactions, imbedded in compact varieties of the same species. Among these we notice the variety called Lumachella, which is of a dark grey colour, and contains beautifully iridescent shells in a high state of preservation.*

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* In various petrifactions, the disposition of the crystalline particles of the present species is very curious. Thus every one of the spines of echini consists of a single individual, perfectly cleavable, and the axis of which is parallel to the axis of the spine. But, what is still more remarkable, the spines of these animals possess the same property even in recent specimens of the latter, and it appears that the carbonate of lime crystallises as rhombohedral Lime-haloide upon the body of those animals. The process of petrifaction seems to require nothing else but the replacement of the animal matter in the pores of these spines by calcareous particles, which will arrange themselves according to the attraction of the crystalline particles which already exist. The shell of the echini itself consists of several individuals; and the inside of each of the five ambulacra is often lined with two rows of crystals, disposed like those individuals, which constitute the shell. The encrinites are likewise composed of cleavable varieties of calcareous spar. The arrangement of the individuals in a

4. Rhombohedral Lime-haloide is a species widely diffused in nature, and several of its compound varieties have a considerable share in the constitution of mountains in many countries. So they appear in Switzerland, Italy, Carniola, Carinthia, Salzburg, Stiria, Austria, Bavaria, Suabia, &c. The earthy varieties of chalk occur in the low lands, or on the sea-shores of England, France, Denmark, Poland, &c. Beds of granular limestone occur in gneiss, mica-slate, clay-slate, &c.; beds of compact limestone likewise in the greywacke formation of the Hartz and other districts, also associated with sandstone, &c. Of crystallised varieties there are some, both simple and compound, which are more frequently found in some countries than in others. The most remarkable of them occur in Derbyshire and Cumberland, in the mining districts of Saxony and Bohemia, in the Hartz, in Carinthia, Stiria, Hungary, France, and other countries. Iceland is the locality of the purest and most transparent varieties, seldom crystallised in the shape of regular six-sided prisms, and which have by preference been called the *doubly refracting spar*. The crystallised sandstone of Fontainebleau, in France, *(Chaux carbonatée quartzifère. H.)*, is a variety of rhombohedral Lime-haloide, mechanically mixed with sand. If crystallised, it assumes the form of the acute rhombohedron $R + 1$. Slate-spar occurs in Saxony, Norway, and Cornwall; Pisolite near Laybach in Carniola, and at Carlsbad in Bohemia; Anthracolite in Salzburg, &c. Most of the other varieties are so common, that it would be useless to enter here into greater detail. According to the observations of Sir JAMES HALL, Mr BUCHOLZ, and others, carbonate of lime may be converted by the application of a

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columnar composition round a central axis in the belemnite seems to depend upon a similar disposition of calcareous matter in the living animal, similar perhaps to the fibrous structure in the bone of sepia, perpendicular to the layers of which it consists. H.

high degree of heat, into a cleavable mass of rhombohedral Lime-haloide, resembling saline marble. It is daily forming in the stalactites of limestone caves and in mines, where it has been observed in the Hartz, to cover the steps of old ladders. A remarkable instance of its deposition in a bottle of Saratoga water, has been mentioned in the Edin. Phil. Journ. Vol. VIII. p. 402.

5. Several varieties of the present species are usefully employed for various purposes, partly depending upon their mechanical, partly upon their chemical composition. Those used in sculpture, and in ornamental architecture, are called *Marble*, several varieties of which are celebrated, and their localities well known. The different kinds of marble have been distinguished and denominated, and are prized, according to pureness, colour, delineation, translucency, size of the component individuals, and of the blocks which may be obtained free from fissures and blemishes; also according to the degree of polish they receive, &c. The more common or coarse varieties are used for the common purposes of building, also for paving streets. A peculiar variety of very fine grained compact limestone is used for plates in lithography. The best sort is found near Pappenheim and Sohlenhofen in Bavaria. Quicklime mixed with sand, forms mortar; it is also used as manure, and in several manufactures, as in the process of tanning, &c. Carbonic acid for chemical purposes is often obtained from chalk. Chalk, and in Switzerland also Rock-milk, are well known materials for writing and whitewashing. The present species is a valuable addition in several processes of melting ores, and in producing certain kinds of glass; it is particularly useful in melting iron-ores.

3. MACROTYPOUS * LIME-HALOIDE.

Dolomite (in part). JAM. Syst. Vol. II. p. 462. Macro-

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

typous Lime-stone. Man. p. 55. Bitter-spar. Pearl-spar. Dolomite. Magnesian Limestone. Phill. p. 163. 165. 166. Braunspath. Dolomit. Rautenspath (in part). Wern. Hoffm. H. B. III. 1 S. 48. 57. 60. Braunkalk. Bitterkalk. Hausm. III. S. 947. 960. Bitterkalk (in part). Dolomit. Braunkalk. Leonh. S. 579, &c. Chaux carbonatée aluminifère. Ch. c. ferrifère perlée. Ch. c. magnésifère (in part). Haüy. Traité, T. II. p. 173. 175. 187. Ch. c. ferro-manganésifère (in part). Tabl. comp. p. 5. Ch. c. ferrifère, manganésifère rose, ferro-manganésifère, magnésifère. Traité, 2de Ed. T. I. p. 418. 420. 421. 427.

Fundamental form. Rhombohedron. $R = 106^\circ\ 15'$. Vol. I. Fig. 7. R. G.

$$a = \sqrt{2{\cdot}0779}.$$

Simple forms $R - \infty\ (o)$; $R - 1\ (g) = 135^\circ\ 57'$; $\overset{*}{R}\ (P)$, Zillerthal, Salzburg. $\overset{*}{R} + 1\ (f) = 79^\circ\ 36'$, Gotha, Saxony. $\overset{*}{R} + 2\ (m) = 66^\circ\ 7'$, Hall, Tyrol; $P + \infty\ (u)$; $(P)^3\ (r) = 104^\circ\ 56',\ 144^\circ\ 32',\ 132^\circ\ 5'$.

Char. of Comb. Rhombohedral.[*]

Combinations. 1. $R. - \infty.$ $R + 2.$ Fig. 113. Hall.

2. $R - 1.$ R. Miemo, Tuscany.

3. $R - \infty.$ R. $R + 2.$ Fig. 115. Hall.

4. $R - \infty.$ R. $R + 1.$ $(P)^3.$ $P + \infty.$ Miemo.

Cleavage. R, perfect. Traces of $R - 1$. Fracture conchoidal. Surface. $R - \infty$ deeply streaked, parallel to the edges of combination

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[*] According to a recent observation of Mr Levy, the scalene pyramids enter into the combination only with half the number of their faces, pairs of them being parallel to each other. H.

with R. The rest of the faces generally smooth, and of nearly the same physical quality.

Lustre vitreous, inclining to pearly in several varieties. Colour white, seldom pure, generally inclining to red or green. Various shades of red, among which is a fine rose-red. Also green, brown, grey, black, very often owing to foreign admixtures. Streak, greyish-white. Semi-transparent ... translucent.

Brittle. Hardness = 3·5...4·0. Sp. Gr. = 2·884, a greenish-white cleavable variety from Miemo.

Compound Varieties. Twin-crystals; axis of revolution perpendicular, face of composition parallel to one of the faces of R + ∞. Fig. 134., from Piedmont. Sometimes variously repeated. Implanted globules; botryoidal, fruticose, and other imitative shapes: surface drusy and rough, composition columnar. Massive: composition granular, of various sizes of individuals, generally easily distinguishable, and often but slightly cohering. The composition is often columnar, also of different sizes of individuals. These compositions are again variously compound, as the granular composition in a coarser kind of granular composition, of which the component particles may be easily separated, and present an uneven surface. It occurs often in crystalline coatings upon other crystals, impressions, &c.

OBSERVATIONS.

1. It is difficult to find out in mineralogical works the

synonymy of the present species with any degree of certainty, since in these the determination of the species does not always rest upon sure characters, but very often upon such uncertain ones as colour, composition, lustre, &c., and upon the chemical mixture, which in the present species does not seem to have yet been brought to sufficient clearness. The massive varieties, of granular composition, sometimes but slightly coherent, and of white colours, have been called *Dolomite*. *Rhomb-spar* and *Bitterspar*, are the names of crystallised or large grained and easily cleavable varieties, chiefly of greenish colours. These, however, include in the older systems the varieties of brachytypous Lime-haloide, though different from them not only in the admeasurement of their angles, but also in hardness and specific gravity. *Brown-spar*, with its subdivisions, the *foliated* and *fibrous* brown-spar, comprehends those varieties, in which the lustre approaches somewhat more to pearly, and whose colours incline to red or brown. Yet prismatic Lime-haloide in the latter, and macrotypous Parachrose-baryte, or even rhombohedral Lime-haloide in the former, have often been described as brown-spar, and are frequently confounded with each other in collections. In most cases specific gravity will be found a decisive and convenient character, for distinguishing these different species.

2. It is equally difficult to judge properly of the chemical composition of the present species. It contains carbonate of lime and carbonate of magnesia, but the relative quantity of the two seems not to be exactly the same in all varieties. From several analyses by KLAPROTH, this proportion is nearly as 54·18 : 45·82, upon which supposition the composition will be expressed by $\ddot{\mathrm{C}}\mathrm{a}\,\ddot{\mathrm{C}}^2 + \ddot{\mathrm{M}}\mathrm{g}\,\ddot{\mathrm{C}}^2$, being one atom of each, which corresponds to 30·56 of lime, 22·18 magnesia, and 47.26 carbonic-acid. Several analyses of brown-spar give very similar results, others deviate more or less from them. In general Brown-spar seems to contain more oxide of iron and manganese than either Dolomite or Rhomb-spar. The varieties of the present species

are soluble in acids, but more slowly than the preceding species, and they produce a much slighter effervescence. Before the blowpipe some of them assume a darker colour and a higher degree of hardness.

3. The different varieties of macrotypous Lime-haloide are likewise different in respect to their localities; and this, in fact, seems to have had some influence in the older determinations of the species. Dolomite constitutes beds in other rocks, and belongs therefore itself to the class of rocks. Rhomb-spar occurs in imbedded crystals and compound masses in several kinds of rocks, particularly in common talc, which is a variety of prismatic Talc-mica: less frequently in compact varieties of prismatic Gypsum-haloide that are mixed with clay. Brown-spar is principally found in metalliferous and other veins, where it is accompanied by several species of Glance, Blende, Pyrites, &c. and assumes various imitative shapes.

4. Dolomite occurs in St Gotthard, in the Appenines, in Carinthia; Rhomb-spar in various districts of Salzburg, the Tyrol, and Switzerland, at Miemo in Tuscany, from which the name of *Miemite* has been derived; and in many other countries; beautiful crystals at Traversella in Piedmont. Brown-spar is very frequent at Schemnitz in Hungary, Kapnik in Transylvania, Freiberg and other places in Saxony, at Clausthal in the Hartz, in Norway and Sweden, at Alstonmoor in Cumberland, in the greywacke-quarries of the same country, in Derbyshire, Beeralston and other places in Devonshire, &c. It is as difficult to form a decided opinion on the geological and geographical distribution, as on the chemical composition of any species, if the varieties of other species have not been distinguished from it with a sufficient degree of accuracy.

5. Several varieties of Dolomite, among which the Parian marble seems to be according to the specific gravity quoted, are used in sculpture; they are said to be particularly durable.

4. BRACHYTYPOUS* LIME-HALOIDE.

Dolomite (in part). Jam. Syst. Vol. II. p. 462. Brachytypous Limestone or Rhomb-spar. Man. p. 60. Bitter-spar (in part). Carbonate of Magnesia and Iron. Phill. p. 163. 378. Rautenspath (in part). Wern. Hoffm. H. B. III. I. S. 60. Bitterkalk (in part). Hausm. III. S. 950. Bitterkalk (in part). Leonh. S. 579. Chaux carbonatée magnésifère (in part). Haüy. Traité, T. II. p. 187. Tabl. comp. p. 5. Traité, 2de Ed. T. I. p. 428.

Fundamental form. Rhombohedron. R = 107° 22′. Vol. I. Fig. 7. R. G.

$$a = \sqrt{1{\cdot}9766}.$$

Simple form. $\overset{*}{R}$ (*P*), Zillerthal, Salzburg. Combinations unknown.

Cleavage. R, highly perfect. Very often conchoidal fracture in the direction of R — 1. Fracture conchoidal. Surface, even, rather rough.

Lustre vitreous, sometimes inclining to pearly upon faces of cleavage. Colour, white or grey, generally inclining to yellow; also yellow and brown. Streak greyish-white. Transparent ... translucent.

Brittle. Hardness = 4·0...4·5.

Sp. Gr. = $\left\{\begin{array}{l}3{\cdot}001 \text{ a clove brown}\\ 3{\cdot}112 \text{ a pale yellow}\end{array}\right\}$ variety

Compound Varieties. Massive: composition granular, individuals strongly coherent; face of composition uneven and rough.

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* From βραχὺς short, and τύπος.

OBSERVATIONS.

1. The correctness of the natural-historical determination of the present species is put beyond a doubt by the properties which it presents, particularly those contained in the character of the species. It has been for the first time distinguished from others in the *Characteristic of the Natural History System*, and more particularly from the varieties of Rhomb-spar with which it was formerly confounded. It has since been noticed by several mineralogists. Perhaps there are among the number of minerals, at present called Dolomite, Rhomb-spar, Miemite, Gurhofian, Bitter-spar, Brown-spar, Pearl-spar, &c., still contained the varieties of other species, like the following one, of which this is evident from the measures of its angles, specific gravity, hardness, and other characters. The establishment of macrotypous, brachytypous, and paratomous Lime-haloide, as particular species (besides those which belong to the following order), must therefore be considered only as a first attempt towards a more correct determination of these species, the continuation and developement of which will not only spread more light upon the natural-historical genus in general, but also more particularly upon the chemical constitution of these species.

2. The present species contains carbonate of iron, and carbonate of magnesia. These two ingredients were found in it by Professor STROMEYER. According to Mr BROOKE, they are to each other in the proportion of about 1·315 : 8·685 without a trace of lime.

3. The varieties of this species have always been found accompanying those called Rhomb-spar, of the preceding one; and the varieties of both of them are often mixed with each other, as is the case in the Rothen Kopf and Greiner mountains in the Zillerthal.

4. It occurs in various places in Salzburg, the Tyrol, and Switzerland, and has lately been discovered in very similar varieties, associated with the preceding species in Unst, one of the Shetland isles.

5. PARATOMOUS* LIME-HALOIDE.

Rohwand, rohe Wand, Rosszahn, Wandstein of the Stirian and Carinthian miners.

Fundamental form. Rhombohedron. R = 106° 12′. Vol. I. Fig. 7. R. G.

$a = \sqrt{2{\cdot}0825}$.

Simple forms. $R - \infty$ (*o*); $R - 1$ (*g*) = 135° 54′; $\overset{*}{R}$ (*P*), Golrath, Stiria.

Char. of Comb. Rhombohedral.

Combinations. 1. $R - \infty$. R. Sim. Fig. 111. Salzburg. 2. $R - 1$. R. Gastein, Salzburg.

Cleavage. R, perfect. Fracture uneven. Surface; $R - \infty$ rough; $R - 1$ deeply striated parallel to the edges of combination with R.

Lustre vitreous, slightly inclining to pearly. Colour, white, with various tints of grey, red, and brown. Streak white. Translucent, often very faintly.

Brittle. Hardness = 3·5...4·0. Sp. Gr. = 3·080, a white cleavable variety.

Compound Varieties. Twin-crystals. 1. Axis of revolution perpendicular, face of composition parallel to one of the faces of $R + \infty$. Fig. 134; this is also found in massive varieties (Golrath, Stiria). 2. Axis of revolution perpendicular, face of composition parallel to a face of $R - 1$, generally

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* From παρὰ about, and τέμνω I cleave; cleavable parallel to the faces of the fundamental form.

contained in parallel layers, and forming the striæ of the rhombohedron R, obtained by cleavage, in the direction of the horizontal diagonals. Fig. 131. Massive: composition granular, individuals in most cases easily discernible; often mixed with rhombohedral Lime-haloide. Faces of composition uneven and rough.

OBSERVATIONS.

1. The chemical constituents of this species are as yet unknown, at least as to their relative quantities. It contains, besides carbonate of lime, also carbonate of iron. It becomes black before the blowpipe, and acts upon the magnetic needle. In nitric acid it is soluble with a brisk effervescence. The colour is darkened on the surface, by being exposed to the air.

2. This species occurs in the Rathhausberg in Salzburg, upon beds in mica-slate, in many places upon the beds of brachytypous Parachrose-baryte, extending from Stiria all along the chain of the Alps, as in the Golrath, and at Eisenerz in Stiria, in Salzburg, &c. The compound Stirian varieties from the Raiding mountain near Vordernberg, and the Rothsol on the Veitschalpe, belong to a more recent class of rocks.

3. It forms an excellent addition in the process of melting iron-ores.

ORDER II. BARYTE.

GENUS I. PARACHROSE*-BARYTE.

1. BRACHYTYPOUS PARACHROSE-BARYTE.

Sparry Iron. JAM. Syst. Vol. II. p. 451. Rhomboidal

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[*] From παράχρωσις, change of colour.

Sparry Iron. Man. p. 61. Spathose Iron. Carbonate of Iron. Brown Spar. Phill. p. 236. Spatheisenstein. Wern. Hoffm. H. B. III. 2. S. 262. Eisenkalk. Sphärosiderit. Hausm. III. S. 951. 1070. Kohlensaures Eisen. Leonh. S. 360. Chaux carbonatée ferrifère. Haüy. Traité, T. II. p. 175. Fer oxidé-carbonaté. Tabl. comp. p. 99. Traité, 2de Ed. T. IV. p. 113.

Fundamental form. Rhombohedron. $R = 107° 0'$. Vol. I. Fig. 7. R. G.

$$a = \sqrt{2{\cdot}0093}.$$

Simple forms. $R - \infty$ (o); $R - 1$ (g) $= 136° 34'$, $\overset{*}{R}$ (P) Pfaffenberg, Hartz. $\overset{*}{R} + 1$ (f) $= 80° 5'$, Tavystock, Devonshire; $\frac{5}{4}\overset{*}{R} + 2$ (s) $= 67° 52'$, Wheal Maudlin, Cornwall; $R + \infty$ (c); $P + \infty$ (u).

Char of Comb. Rhombohedral.

Combinations. 1. $R - \infty$. R. Sim. Fig. 111. Przibram, Bohemia.

2. $R - 1$. R. Rathhausberg, Salzburg.

3. R. $R + \infty$. Sim. Fig. 114, the faces c very small. Przibram.

4. R. $P + \infty$. Sim. Fig. 118. Cornwall.

5. $R - \infty$. R. $\frac{5}{4}R + 2$. Cornwall.

Cleavage. R, perfect. Seldom traces of $R - 1$. Fracture imperfect conchoidal.

Surface. $R - \infty$ generally rough; R often rounded, which terminates in the saddle shaped lens. Vol. I. Fig. 79.; $R - 1$ streaked parallel to the edges of combination with R; $R + \infty$ smooth, $P + \infty$ rough, $\frac{5}{4}R + 2$ often uneven and rounded. The common lens is produced by continued striæ between R — 1 and R.

Lustre, vitreous inclining to pearly. Colour various shades of yellowish-grey, passing into ash- and greenish-grey, also into several kinds of yellow, white, and red. Streak white. Translucent, in different degrees.

Brittle. Hardness = 3·5...4·5. Sp. Gr. = 3·829, a crystallised variety from Pfaffenberg in Anhalt.

Compound Varieties. Striæ upon the faces of R, in the direction of the horizontal diagonals, and faces of composition parallel to R — 1, as in the preceding species, shew that there is also here regular composition according to the same law. Botryoidal and globular shapes: composition columnar; surface drusy. Massive: composition granular, passing into impalpable.

OBSERVATIONS.

1. The massive varieties of the present species are often regularly compound in the direction of the faces of R — 1, as in Fig. 131. It is sometimes possible to obtain from them by fracture, the form of R — 1, bounded on all sides by faces of composition, without presenting a single real face of cleavage. There is no distinct cleavage parallel to the faces of R — 1. The saddle-shaped lenses are in part composed of several individuals nearly in parallel position, but the axes of which are slightly diverging. Also the curvature of faces of cleavage often originates in composition. Vol. I. Fig. 80.

Different opinions prevail among mineralogists in regard to the determination and classification of the present species. In the Wernerian system it forms an undivided species in his Iron-genus. It was formerly united by

HAÜY with the species of rhombohedral Lime-haloide, but is now exhibited as an appendix to *Fer oxydé*, the prismatic Iron-ore of the system followed in the present work. Some varieties, containing from 0·005 to 0·025 of carbonate of lime, are considered by Professor HAUSMANN in connexion with rhombohedral Lime-haloide, while others, without that admixture, form a particular substance, *Sphærosiderite*, which name refers to the botryoidal and globular shapes, and the curved faces of cleavage. An accurate examination of all the physical properties shews the difficulties connected with the one and the other of these methods of considering the matter, and points out the way, upon which we arrive with perfect security at a correct determination of all the varieties which the species contains. Decomposed varieties of the present species have been considered as belonging to prismatic Iron-ore. This, however, is contrary to the principles of Natural History.

2. Two varieties of this species, 1. the Sphærosiderite, and 2. a cleavable variety from Neudorf in the Hartz, have yielded to KLAPROTH,

Protoxide of Iron	1., 63·75	2., 57·50.
Carbonic Acid	34·00	36·00.
Oxide of Manganese	0·75	3·30.
Lime	0·00	1·25.
Magnesia	0·52	0·00.

The chemical formula of brachytypous Parachrose-baryte is $\ddot{\mathrm{F}}\mathrm{e}\,\ddot{\mathrm{C}}^{2}$, which expresses the ratio of protoxide of iron to carbonic acid = 61·47 : 38·53. Before the blowpipe it becomes black, and acts upon the magnetic needle, but does not melt. It colours glass of borax green. It is difficultly soluble, and effervesces but little in nitric acid, particularly if not reduced to powder. On being exposed to the air it is gradually decomposed; first the colour of the surface becomes brown or black, from which change of colour the name of the genus has been derived; afterwards also the streak is changed into red or brown, hardness and specific gravity are diminished, and even the chemical constitution is altered, the whole being converted into hydrate of iron.

3. Frequently the present species is found along with compound varieties of rhombohedral Lime-haloide, upon beds in gneiss, mica slate, clay slate, and newer rocks; sometimes with prismatic and rhombohedral Iron-ore, prismatic Hal-baryte, and other species. It likewise occurs in metalliferous veins, accompanied by hexahedral Lead-glance, tetrahedral Copper-glance, hexahedral Iron-pyrites, pyramidal Copper-pyrites, &c., and is not uncommon in that class of veins in primitive mountains, in which the mass of the vein consists chiefly of the constituent parts of the rocks themselves. It is more rarely met with in the cavities of trap rocks.

4. The beds upon which the varieties of the present species are found in immense quantities in Stiria, Carinthia, and the bordering countries, form coherent tracts which extend along the chain of the Alps on one side into Austria, and on the other into Salzburg, &c. The celebrated Erzberg near Eisenerz, is situated in one of them. In similar relations it seems to occur in Schmalkalden, Siegen, &c. In Anhalt large masses of this species occur in veins of very considerable size, traversing greywacke, and in this rock it seems also to occur in various other places of the Hartz, and in many other countries. At Freiberg it is found in silver veins. In the high mountains of Salzburg it is met with in minute crystals in narrow veins, along with rhombohedral Quartz, prismatic Talc-mica, &c. It is also found with Tin-ore, as at Ehrenfriedersdorf in Saxony, Wheal Maudlin, St Just, and other places in Cornwall. Brachytypous Parachrose-baryte is besides found in more or less considerable masses in Bohemia, Bayreuth, Würtemberg, Switzerland, France, Spain, and in many other countries.

5. In many of the above mentioned countries, particularly in Stiria and Carinthia, considerable quantities of cast and wrought iron are obtained from the species, but particularly steel, for the production of which it is highly valuable.

2. MACROTYPOUS PARACHROSE-BARYTE.

Rhomboidal Red Manganese. JAM. Syst. Vol. II. p. 445. Man. p. 63. Carbonate of Manganese. PHILL. p. 246. Rother Braunstein. Braunspath (zum Theil). WERN. Hoffm. H. B. IV. S. 158. Rhodochrosit. HAUSM. III. S. 1081. Kohlensaures Mangan. LEONH. S. 381. Manganèse oxidé rose silicifère amorphe. HAÜY. Traité, T. IV. p. 248. Manganèse oxidé carbonaté. Tabl. comp. p. 111. Manganèse carbonaté. Traité, 2de Ed. T. IV. p. 272.

Fundamental form. Rhombohedron. R = 106° 51′. Vol. I. Fig. 7. R. G.

$$a = \sqrt{2{\cdot}0229}.$$

Simple forms. R — 1 (g) = 136° 25′; $\dot{\text{R}}$ (P), Kapnik, Transylvania.

Char. of Comb. Rhombohedral.

Combinations. 1. R — 1. R. Freiberg, Saxony.

Cleavage, R. Faint traces parallel to R — 1. Fracture uneven, imperfect conchoidal. Surface; R — 1 deeply streaked parallel to the edges of combination with R. This produces lenticular crystals. R sometimes smooth, but more generally curved, so as to give rise to saddle-shaped lenses. Vol. I. Fig. 79.

Lustre vitreous inclining to pearly. Colour, various shades of rose-red, partly inclining to brown. Streak white. Translucent, in different degrees.

Brittle. Hardness = 3·5. Sp. Gr. = 3·592, the crystallised variety from Kapnik.

Compound Varieties. Globular and botryoidal shapes: surface sometimes smooth, at other times rough; composition columnar, often indistinct.

Massive: composition granular, sometimes small and even impalpable, sometimes it is columnar.

OBSERVATIONS.

1. The varieties of the present species have often been confounded with other minerals, one of which, too imperfectly known to be yet received in the system, is enumerated in the Appendix. Though these species will not in future be confounded if we attend to their characters, yet they bear to each other a strong degree of resemblance, which extends likewise to some of the following species. The genus Parachrose-baryte joins to that of Lime-haloide, and explains, by the great similarity of the species contained in both these genera, the differences in the opinions which have prevailed among mineralogists in spite of the marked distinction among their characteristic properties.

2. A variety of the present species has been found by Du Menil to consist of

Oxide of Manganese	54·60.
Carbonic Acid	33·75.
Oxide of Iron	1·87.
Silica	4·37.
Lime	2·50.

In its pure state it is represented by $\ddot{Mn}\,\ddot{C}^2$, which expresses 62·35 oxide of manganese, and 37·65 carbonic acid. It effervesces rather briskly in nitric acid; before the blow-pipe its colour is changed into grey, brown, and black, and it decrepitates strongly, but is infusible without addition. It is easily soluble in glass of borax, which becomes violet-blue. If exposed to the air, its natural colour is changed into brown. Many bright rose-red varieties become paler on being exposed in a similar manner.

3. The varieties of the present species occur generally in metalliferous veins, with various ores of silver and lead, also with Copper-pyrites and Iron-pyrites, rhombohedral Quartz, &c. They have likewise been found in beds in

transition mountains, with other minerals containing manganese.

4. It is frequently found in several of the Saxon mines, particularly in the neighbourhood of Freiberg, also at Nagyag and Kapnik in Transylvania, near Elbingerode in the Hartz, and in other countries.

GENUS II. ZINC-BARYTE.

1. PRISMATIC ZINC-BARYTE.

Prismatic Calamine or Electric Calamine. JAM. Vol. II. p. 437. Man. p. 65. Siliceous Oxide of Zinc. Electric Calamine. PHILL. p. 254. Galmei (in part). WERN. Hoffm. H. B. IV. 1. S. 90. Zinkglas. HAUSM. I. S. 343. Galmei. LEONH. S. 316. *Zinc oxidé.* HAÜY. Traité, T. IV. p. 159. Tabl. comp. p. 102. *Zinc oxidé silicifère.* Traité, 2de Ed. T. IV. p. 175.

Fundamental form. Scalene four-sided pyramid $\mathrm{P} = 132^\circ\ 9', 101^\circ\ 9', 97^\circ\ 47'$. Vol. I. Fig. 9. AP.

$$a : b : c = 1 : \sqrt{2{\cdot}628} : \sqrt{1{\cdot}072}.$$

Simple forms. $\mathrm{P} - \infty\ (K)$; $\mathrm{P}\ (P)$; $(\breve{\mathrm{P}})^3$; $(\breve{\mathrm{P}} - 1)^4$; $(\breve{\mathrm{P}}\mathrm{r} + \infty)^3\ (d) = 76^\circ\ 7'$; $\bar{\mathrm{P}}\mathrm{r} - 1\ (l) = 128^\circ\ 27'$; $\frac{3}{4}\ \bar{\mathrm{P}}\mathrm{r} + 1\ (m) = 69^\circ\ 14'$; $\bar{\mathrm{P}}\mathrm{r} + \infty\ (s)$; $\breve{\mathrm{P}}\mathrm{r}\ (o) = 116^\circ\ 40'$; $\frac{3}{4}\ \breve{\mathrm{P}}\mathrm{r} + 2\ (p) = 56^\circ\ 46'$.

Char. of Comb. Prismatic. Different faces contiguous to the opposite ends of crystals.

Combinations. 1. $\breve{\mathrm{P}}\mathrm{r}$. $(\breve{\mathrm{P}}\mathrm{r} + \infty)^3$. $\bar{\mathrm{P}}\mathrm{r} + \infty$. Sim. Fig. 8. Leadhills, Scotland.

2. $\bar{\mathrm{P}}\mathrm{r} - 1$. $(\breve{\mathrm{P}}\mathrm{r} + \infty)^3$. $\bar{\mathrm{P}}\mathrm{r} + \infty$. Sim. Fig. 9. Rossegg, Carinthia.

3. $\bar{\mathrm{P}}\mathrm{r} - 1$. $\breve{\mathrm{P}}\mathrm{r}$. $\frac{3}{4}\ \breve{\mathrm{P}}\mathrm{r} + 2$. $(\breve{\mathrm{P}}\mathrm{r} + \infty)^3$. $\bar{\mathrm{P}}\mathrm{r} + \infty$. Rezbanya, Hungary.

4. $\mathrm{P} - \infty$. $\bar{\mathrm{P}}\mathrm{r} - 1$. $\breve{\mathrm{P}}\mathrm{r}$. $\frac{3}{4}\ \bar{\mathrm{P}}\mathrm{r} + 1$. $\frac{3}{4}\ \breve{\mathrm{P}}\mathrm{r} + 2$.

$(\breve{P}r + \infty)^3$. $\bar{P}r + \infty$. P. Fig. 37. Altenberg near Aix la Chapelle.

Cleavage, $\breve{P}r$ and $(\breve{P}r + \infty)^5$, both easily obtained, the latter highly perfect. Traces of $P - \infty$. Fracture uneven. Surface of $\bar{P}r + \infty$ and $(\breve{P}r + \infty)^3$ streaked parallel to their common intersections. The rest of the faces generally smooth: sometimes rounded, particularly $P - \infty$.

Lustre vitreous, inclining to pearly upon $\bar{P}r + \infty$, sometimes to adamantine upon curved faces of crystallisation. Colour white, prevalent. Occasionally blue, green, yellow or brown. Streak white. Transparent ... translucent.

Brittle. Hardness = 5·0. Sp. Gr. = 3·379, crystals from Rossegg in Carinthia.

Compound Varieties. Globular, botryoidal shapes: surface drusy, composition columnar. Massive: composition either granular or columnar; the former of them often impalpable, and strongly coherent, and then the fracture becomes uneven; the latter straight and divergent.

OBSERVATIONS.

1. Among the forms quoted above, only Var. 4. Fig. 37. has been observed on both ends, which have presented that remarkable dissimilarity of configuration. In the others, the figures to which they are referred, suppose the two apices to be similar. The species of prismatic Zinc-baryte affords another example of the co-existence of a different configuration of the opposite summits, with different kinds of electricity. The latter has been long ago observed; it is excited by the common changes of

temperature, and is said to remain even after having exposed the crystals to a red heat.

The union of this and the following species within a single one, which formerly took place in almost all mineralogical systems, and even now continues in some of them, is at present gradually giving way. The impossibility of uniting in one series rhombohedral and prismatic forms, or the degrees of specific gravity of the two substances, would each of them be a sufficient motive for effecting this separation.

2. The varieties of the present species consist of

Oxide of *Zinc*	66·00.		66.37.	
Silica	25·00.		26·23.	
Water	9·00.	BERTHIER.	7·40.	BERZELIUS.

Its chemical formula is $\ddot{Z}n^3 \dddot{Si}^2 + 3 Aq$, which corresponds exactly to the numbers given in the analysis by BERZELIUS. Reduced to powder, it is soluble in heated sulphuric or muriatic acid, and when cooled it forms a jelly. Before the blowpipe it decrepitates a little, loses its transparency, intumesces, and emits a green phosphorescent light. It is infusible without addition, but is dissolved by borax into a clear glassy globule, which becomes opake on cooling. It is phosphorescent by friction.

3. The present and the following species are frequently found accompanying each other in veins, and particularly in beds belonging to various classes of rocks, but chiefly calcareous ones. They are often associated with hexahedral Lead-glance, dodecahedral Garnet-blende, and some varieties of Iron-ores.

4. Considerable quantities occur at Bleiberg and Raibel in Carinthia, Rezbanya in Hungary, Freiburg in Brisgaw, Altenberg near Aix-la Chapelle, near Tarnowitz in Silesia, at Olkuzk and Medziana Gora in Poland, in Siberia, &c. It occurs in Leicestershire, Derbyshire, Flintshire, Somersetshire, &c. in England, at Wanlockhead and Leadhills in Scotland, and other places.

2. RHOMBOHEDRAL ZINC-BARYTE.

Rhombohedral Calamine. JAM. Syst. Vol. II. p. 440. Man. p. 66. Carbonate of Zinc. Calamine. PHILL. p. 355. Galmei (in part). WERN. Hoffm. H. B. IV. 1. S. 96. Galmei. HAUSM. 1. S. 345. Zinkspath. LEONH. S. 315. Zinc carbonaté. HAÜY. Traité, T. IV. p. 164. Tabl. comp. p. 103. Traité, 2de Ed. T. IV. p. 181.

Fundamental form. Rhombohedron. R = 107° 40′.* Vol. I. Fig. 7. WOLLASTON.

$$a = \sqrt{1{\cdot}95}.$$

Simple forms. $R - \infty$ (o); $R - 1$ (g) = 137° 8′; $\overset{*}{R}$ (P); $\overset{*}{R} + 2$ (m) = 66° 29′; $P + \infty$ (u).

Char. of Comb. Rhombohedral.

Combinations. 1. R. $P + \infty$. Sim. Fig. 118. Siberia.

2. $R - \infty$. R. $R + 2$. Sim. Fig. 115. Rezbanya, Hungary.

3. R. $R + 2$. $P + \infty$. Rezbanya.

Cleavage. R, perfect, often curved. Fracture, uneven, imperfect conchoidal. Surface; R generally curved, and often rough. The other forms frequently a little more even.

Lustre vitreous, inclining to pearly. Colour white, frequent, though seldom pure. Generally grey, green, or brown. Streak white. Semi-transparent … translucent.

Brittle. Hardness = 5·0. Sp. Gr. = 4·442, a honey-yellow crystallised variety from Aix-la Chapelle.

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* Mr PHILLIPS gives this angle = 106° 30′, which would make $a = \sqrt{2{\cdot}055}$.

Compound Varieties. Reniform, botryoidal, stalactitic, and other imitative shapes: surface generally rough, composition columnar. Massive: composition granular, sometimes impalpable; strongly coherent. By decomposition it becomes friable and earthy. Crystalline coats and pseudomorphoses formed after crystals of rhombohedral Lime-haloide.

OBSERVATIONS.

1. The present species and the preceding one, though they essentially differ in several of their characters, are allied with each other by such high degrees of natural-historical resemblance, that in the present state of our information it becomes necessary to unite them within one and the same genus. This resemblance contains the reason why those mineralogists, who have attended only to the external characters, though not always with sufficient accuracy, did unite them into one single species.

2. According to SMITHSON, a variety of the present species from Derbyshire consists of

Oxide of Zinc 65·20.
Carbonic Acid 34·80.

Its chemical formula is $\ddot{Z}n\,\ddot{C}^2$, which corresponds to 64·64 oxide of zinc, and 35·36 carbonic acid. It is soluble with effervescence in nitric and muriatic acid. Before the blowpipe it loses its transparency, but is infusible; the carbonic acid is driven off, and the residue acts like pure oxide of zinc. It is negatively electrified by friction.

3. The varieties of the present species in general share the repositories of the preceding one. They are often accompanied by species of the order Malachite, and the genera Lime-haloide and Iron-ore.

4. It occurs in the Bannat of Temeswar in Hungary, at Raibel and Bleiberg in Carinthia, at Tarnowitz in Silesia, at Medziana Gora in Poland, at Aix-la-Chapelle; also in

France, in various counties of England, enumerated in the preceding species. A reniform variety of a fine yellow colour has lately been found in Cumberland.

5. Both the species of the genus Zinc-baryte are usefully employed in extracting zinc; and also in the production of brass.

GENUS III. SCHEELIUM-BARYTE.

1. PYRAMIDAL SCHEELIUM-BARYTE.

Pyramidal Tungsten. JAM. Syst. Vol. II. p. 432. Man. p. 68. Tungsten. Tungstate of Lime. PHILL. p. 256. Schwerstein. WERN. Hoffm. H. B. IV. 1. S. 236. Schwerstein. HAUSM. III. S. 967. Scheelit. LEONH. S. 594. Schéelin calcaire. HAÜY. Traité, T. IV. p. 320. Tabl. comp. p. 118. Traité, 2de Ed. T. IV. p. 372. BOURNON. Journ. des Mines. Vol. XIII. p. 161.

Fundamental form. Scalene four-sided pyramid. $P = 107° 27', 113° 35'$. Vol. I. Fig. 8. HAÜY.

$$a = \sqrt{2{\cdot}3333}.$$

Simple forms. $P - \infty$; $\frac{3}{2\sqrt{2}} P - 5 = 157° 33', 31° 58'$; $\frac{4}{5} P - 2 = 147° 25', 46° 45'$ BOURN.; $\frac{2\sqrt{2}}{3} P - 2 = 131° 11', 71° 4'$ PHILL.; $P - 2 = 129° 10', 74° 45'$ PHILL.; $\frac{9}{8} P - 2 = 125° 7', 81° 21'$; $\frac{3}{5} P = 122° 55', 85° 1'$ BOURN.; $P - 1 = 117° 29', 94° 25'$; $\overset{*}{P}$ (*g*), Zinnwald, Saxony; $P + 1$ (*P*) $= 100° 8', 130° 20'$[*]; $\left(\frac{2\sqrt{2}}{3} P - 2\right)^5$ (*a*) $= 164° 25'$, inclination upon P; $\left(\frac{2\ 2}{3} P - 4\right)^6 = 172° 3'$, inclination upon P; $(P + 1)^3$ (*b*).

Char. of Comb. Hemi-pyramidal with parallel faces.

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[*] This angle is given $= 129° 2'$ by MR BROOKE, $= 128° 40'$ by MR PHILLIPS. H.

Combinations. 1. $P-\infty$. $\frac{3}{2\sqrt{2}}P-5$. Sim. Fig. 92. Zinnwald, Saxony.

2. $\frac{3}{2\sqrt{2}}P-5$. P. Sim. Fig. 105. Schlaggenwald, Bohemia.

3. P. $P+1$. Zinnwald.

4. P. $\frac{r}{l}\frac{\left(\frac{2\sqrt{2}}{3}P-2\right)^3}{2}$. $P+1$. Carrock, Cumberland.

5. P. $P+1$. $\frac{l}{r}\frac{(P+1)^3}{2}$. Schlaggenwald.

6. P. $\frac{r}{l}\frac{\left(\frac{2\sqrt{2}}{3}P-2\right)^3}{2}$. $P+1$. $\frac{l}{r}\frac{(P+1)^3}{2}$. Fig. 108. Schlaggenwald.

Cleavage. P and $P+1$. Generally more splendent in the direction of the latter, though more interrupted by small conchoidal fracture than the other cleavage in the direction of P. Traces parallel to $P-\infty$. Fracture imperfect conchoidal, uneven. Surface; $P-\infty$ commonly drusy or rough; P irregularly streaked parallel to the edges of combination with $\frac{(P+1)^3}{2}$, sometimes concave. The faces of the rest of the forms, and particularly $P+1$ generally smooth.

Lustre vitreous, inclining to adamantine. Colour, generally white, often inclining and passing into yellowish-grey, yellowish- and reddish-brown, sometimes almost orange-yellow. Streak white. Semi-transparent...translucent.

Brittle. Hardness = 4·0...4·5. Sp. Gr. = 6·076, a white cleavable variety from Schlaggenwald.

Compound Varieties. Twin crystals. Axis of revolution perpendicular, face of composition parallel to one of the faces of $P + \infty$; the individuals are continued beyond the face of composition. The best means of recognising this composition consists in the disposition of the above-mentioned striæ upon the faces of P, which abruptly assume another direction upon faces, that *seem* to belong to one individual. Reniform shapes: surface drusy, composition columnar. Massive: composition granular, faces of composition sometimes irregularly streaked.

OBSERVATIONS.

1. Pyramidal Scheelium-baryte, as yet the only species of this genus, consists, according to Berzelius, of

Lime	19·40.
Oxide of Scheelium	80·42.

The chemical formula is $\ddot{C}a\,\dddot{W}^2$, which gives 19·10 of lime and 80·90 of oxide of scheelium. Alone upon charcoal it is infusible before the blowpipe, except that the thinnest edges are converted in a very strong heat into a semi-transparent vitrified mass. It gives a white glass with borax, the transparency of which is proportioned to the quantity of the salt employed.

2. More generally this species occurs in the repositories of pyramidal Tin-ore, both beds and veins, accompanied chiefly with prismatic Scheelium-ore, prismatic Topaz, rhombohedral Quartz, octahedral Fluor-haloide, and certain species of Talc-mica, sometimes with octahedral and prismatic Iron-ore. It is met with besides in beds containing gold, in primitive mountains, along with rhombohedral Quartz. A third mode of its occurrence in nature is in lead-veins traversing greywacke, where it is associated with prismatic Scheelium-ore, brachytypous Parachrose-baryte, and other species.

3. Among the best known localities are Schlackenwald and Zinnwald in Bohemia, Zinnwald and Ehrenfriedersdorf in Saxony, and Pengelly croft mine in the parish of Breage in Cornwall, where it occurs with tin-ores. In Sweden it is found at Bispberg, in a bed of octahedral Iron-ore, at Schellgaden in Salzburg, and Pösing in Hungary, in beds worked for gold, contained in gneiss and granite, at Neudorf in Anhalt-Bernburg, upon veins traversing greywacke. It is likewise met with in Dauphiny and America. Splendid specimens have been lately found at Carrock in Cumberland.

GENUS IV. HAL-BARYTE.

1. PERITOMOUS[*] HAL-BARYTE.

Di-prismatic Baryte or Strontianite. JAM. Syst. Vol. II. p. 420. Pyramido-Prismatic Baryte or Strontianite. Man. p. 69. Strontianite. Carbonate of Strontian. PHILL. p. 186. Stronthian. WERN. Hoffm. H. B. III. 1. S. 186. Strontianit. HAUSM. III. S. 979. Kohlensaurer Strontian. LEONH. S. 604. Strontiane carbonatée. HAÜY. Traité, T. II. p. 327. Tabl. comp. p. 15. Traité, 2de Ed. T. II. p. 43.

Fundamental form. Scalene four-sided pyramid, the horizontal section of which is = 117° 19′. Vol. I. Fig. 9.

$$a : b : c = a : 1 : \sqrt{0{\cdot}3709}.$$

Simple forms. $P - \infty$ (o); $P - 1$ (z)[†]; P (y);

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[*] From περὶ round, and τέμνω I cleave, cleavable with equal facility in the direction of several faces, parallel to one axis. H.

[†] The obtuse terminal edge of this form is given by Mr PHILLIPS = 108° 12′. He mentions besides two horizontal prisms, parallel to the short diagonal of the prism $P + \infty$, having their faces inclined to those of $\breve{P}r + \infty$ at angles of 126° 5′ and of 143° 20′. H.

$P + \infty\ (M) = 117^\circ\ 19'$ R. G.; $\bar{P}r - 1$; $\breve{P}r + 1\ (P)$; $\breve{P}r + \infty\ (h)$.

Char. of Comb. Prismatic.

Combinations. 1. P. $\breve{P}r + 1$. $P + \infty$. $\breve{P}r + \infty$. Bräunsdorf, Saxony.

2. $P - \infty$. P. $\breve{P}r + 1$. $P + \infty$. $\breve{P}r + \infty$. Leogang, Salzburg.

3. $P - \infty$. $P - 1$. P. $P + \infty$. $\breve{P}r + \infty$. Leogang.

4. $P - \infty$. $P - 1$. P. $\breve{P}r + 1$. $P + \infty$. $\breve{P}r + \infty$. Fig. 28. Leogang.

Cleavage. $P + \infty$ rather perfect; $\breve{P}r + 1$ less easily obtained. Faint traces of cleavage observable in the direction of $\breve{P}r + \infty$, or at least small conchoidal fracture. Fracture in other directions uneven. Surface, $P - \infty$ often rough, though even, and streaked parallel to the edges of combinations with $\breve{P}r + 1$. $P + \infty$ deeply streaked in a horizontal direction, and hence often curved (barrel-shaped prisms). The pyramids and horizontal prisms smooth; P sometimes streaked parallel to its obtuse terminal edges.

Lustre vitreous, slightly inclining to resinous upon the uneven faces of fracture. Colour asparagus-green and apple-green; pale yellowish-brown, yellow and grey; white. Streak white. Transparent ... translucent.

Brittle. Hardness $= 3{\cdot}5$. Sp. Gr. $= 3{\cdot}605$, the variety in acicular crystals from Bräunsdorf near Freiberg.

Compound Varieties. Twin crystals: axis of revolution perpendicular, face of composition parallel to a face of $P + \infty$. The individuals generally continued beyond the face of composition. This composition is very similar to some that occur in prismatic Lime-haloide. The product of it is a six-sided prism, having four edges of 117° 19′ and two of 128° 22′. As in the above mentioned species, particles of the two individuals alternate in parallel layers with each other. Indistinct globular masses: surface drusy, composition columnar. Massive: composition columnar, the individuals generally straight, long, and a little divergent; the composition is seldom granular.

OBSERVATIONS.

1. **Klaproth** found a variety of the present species to consist of

Strontia	69·50.
Carbonic Acid	30·00.
Water	0·50.

It is $\ddot{S}r\,\ddot{C}^2$, which corresponds to 70·16 of Strontia, and 29·84 Carbonic acid. It is soluble with effervescence in the muriatic and nitric acids; and paper, dipped into this solution and afterwards dried, will burn with a red flame. It melts before the blowpipe at a temperature not very elevated, but only on the thinnest edges. It intumesces, and spreads a brilliant light; the flame at the same time assumes a reddish hue. It is dissolved by borax with a violent effervescence into a clear globule.

2. The repositories of this species of Hal-baryte are metallic veins traversing primitive and transition mountains either containing hexahedral Lead-glance, prismatic Hal-baryte, &c. or prismatic Arsenical-pyrites, rhombohedral Quartz, and other species. It seems also to occur in beds.

3. It was first discovered at Strontian in Argyleshire in Scotland, and found afterwards at Bräunsdorf in Saxony, in large crystals at Leogang in Salzburg, and also in Peru.

2. DI-PRISMATIC HAL-BARYTE.

Rhomboidal Baryte or Witherite. JAM. Syst. Vol. II. p. 394. Di-prismatic Baryte or Witherite. Man. p. 70. Witherite. Carbonate of Barytes. PHILL. p. 182. Witherit. WERN. Hoffm. H. B. III. 1. S. 150. Witherit. HAUSM. III. S. 1004. Kohlensaurer Baryt. LEONH. S. 613. Baryte carbonatée. HAÜY. Traité, T. II. p. 308. Tabl. comp. p. 13. Traité, 2de Ed. T. II. p. 25.

Fundamental form. Scalene four-sided pyramid, of unknown dimensions. Vol. I. Fig. 9.

Simple forms. P — ∞ (*o*); P; P + ∞ (*M*) = 118° 30′ PHILL.; P̆r — 1 (*x*); P̆r (*P*); P̆r + 1 (*s*) *; P̆r + ∞ (*h*).

Char. of Comb. Prismatic.

Combinations. 1. P̆r. P + ∞. P̆r + ∞. Sim. Fig. 9.

2. P. P̆r + 1. P + ∞. P̆r + ∞.

3. P — ∞. P. P̆r + 1. P + ∞. P̆r + ∞.

4. P̆r — 1. P̆r. P̆r + 1. P + ∞. P̆r + ∞. Sim. Fig. 23. All of them from Anglesark, Lancashire.

Cleavage. P̆r + ∞, P + ∞ and P̆r + 1, imperfect; the last of these difficultly observed. Fracture uneven. Surface of P + ∞ horizontally

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* Inclination of these prisms to P̆r + ∞ = 110° 30′, 126° 16′, and 145° 30′, according to PHILLIPS. H.

streaked; that of $\breve{P}r + 1$ parallel to the edges of combination with P.

Lustre vitreous, inclining to resinous. The latter more distinct in the fracture. Colour white, generally yellowish, approaching to orange-yellow; sometimes passing into various shades of grey. Streak white. Semi-transparent ... translucent.

Brittle. Hardness = 3·0 ... 3·5. Sp. Gr. = 4·301, a white semi-transparent cleavable variety.

Compound Varieties. Twin-crystals: axis of revolution perpendicular, face of composition parallel to a face of $P + \infty$. The individuals continued beyond it, as in the preceding species. Globular, tuberose, reniform, botryoidal shapes: surface rough, uneven, and drusy; composition granular, often strongly coherent. Massive: composition either granular, or columnar; more frequently the latter. Sometimes multifarious composition.

OBSERVATIONS.

1. According to Bucholz, the di-prismatic Hal-baryte consists of

Baryta	79·66.
Carbonic Acid	20·00.
Water	0·33.

Its chemical formula is $\ddot{B}a\ \ddot{C}^2$, which corresponds to 77·66 of baryta, and 22·34 of carbonic acid. Before the blowpipe it decrepitates slightly, and melts easily into a transparent bead, which loses its transparency on cooling. It is soluble with effervescence in dilute nitric or muriatic acid.

2. It occurs in veins traversing limestone, which rests upon red sandstone, and alternates with sandstone, slaty clay and coal seams, accompanied by prismatic Hal-ba-

ryte, which generally occurs in the higher parts of the veins, hexahedral Lead-glance and dodecahedral Garnet-blende, with several Lime-haloides, and other species; it is also found in lead-veins traversing greywacke, and in irregular beds along with paratomous Lime-haloide in clay slate.

3. Large quantities of this species are found in England, in the counties of Durham, Westmoreland, Lancaster, and Salop, in veins; also near Neuberg in Stiria in irregular beds. It has been mentioned from Hungary, Salzburg, Siberia, Sicily, and other places, where it seems to occur only in small quantities.

4. It is a violent poison, and has been used in several parts of England for killing rats.

3. PRISMATIC HAL-BARYTE.

Prismatic Baryte or Heavy-spar. JAM. Syst. Vol. II. p. 398. Man. p. 71. Heavy spar. Sulphate of Barytes. PHILL. p. 183. Schwerspath. WERN. Hoffm. H. B. III. 1. S. 155. Baryt. Hepatit. HAUSM. III. S. 991. 1000. Schwefelsaurer Baryt. LEONH. S. 606. Baryte sulfatée. HAÜY. Traité, T. II. p. 295. Tabl. comp. p. 12. Traité, 2de Ed. T. II. p. 5.

Fundamental form. Scalene four-sided pyramid. $P = 128^\circ\ 23',\ 91^\circ\ 26',\ 110^\circ\ 44'$. Vol. I. Fig. 9. R. G.

$$a : b : c = 1 : \sqrt{1{\cdot}7045} : \sqrt{0{\cdot}6627}.$$

Simple forms. $P - \infty\ (k)$; $P\ (z)$; $P + \infty\ (n) = 106^\circ\ 7'$; $(\breve{P})^5 = 69^\circ\ 9'$*; $(\breve{P} + \infty)^3 = 47^\circ\ 49'$; $(\breve{P} - 2)^4 = 74^\circ\ 54'$†; $(\breve{P})^4 = 54^\circ\ 40'$*;

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[*] The faces of these pyramids occur with parallel edges of combination between the faces of *z* and *P*; the angle given is that which two faces will produce, if enlarged to their intersection over the face *M*. H.

[†] This edge of the pyramid possesses the same inclination towards the principal axis, as the edge of 113° 44′ in $(\breve{P}r - 1)^3$ (*y*), which corresponds to the obtuse terminal edge of the fun-

$(\breve{P}+\infty)^4 = 43° 42'$; $(\breve{P})^5 = 44° 56'$*; $(\breve{P}+\infty)^6 = 25° 0'$; $(\breve{P})^8 = 28° 59'$*; $(\breve{P}r-1)^3$ (*y*) $= 113° 44'$, $128° 1'$, $88° 57'$, $(\breve{P}r)^3 = 91° 55'$*; $(\breve{P}r+\infty)^3$ (*d*) $= 77° 27'$; $\bar{P}r-1 = 116° 53'$; $\bar{P}r$ (*M*) $= 78° 18'$; $\frac{3}{4}\bar{P}r+1$ (*t*) $= 56° 59'$; $\bar{P}r+1 = 44° 18'$; $\bar{P}r+\infty$ (*s*); $\breve{P}r$ (*o*) $= 105° 6'$; $\breve{P}r+\infty$ (*P*).

Char. of Comb. Prismatic.

Combinations. 1. $\bar{P}r$. $\breve{P}r+\infty$. Felsöbanya, Hungary.

2. $\bar{P}r$. $(\breve{P}r+\infty)^3$. $\breve{P}r+\infty$. Sim. Fig. 8. Mies, Bohemia.

3. $\breve{P}r$. $(\breve{P}r+\infty)^3$. $\breve{P}r+\infty$. Sim. Fig. 9. Freiberg, Saxony.

4. $\breve{P}r$. $\bar{P}r$. P. $(\breve{P}r+\infty)^5$. $\breve{P}r+\infty$. Fig. 21. Roya, Auvergne.

5. $P-\infty$. $\breve{P}r$. $\bar{P}r$. P. $(\breve{P}r+\infty)^3$. $\breve{P}r+\infty$. Przibram, Bohemia.

6. $P-\infty$. $\breve{P}r$. $(\breve{P}r-1)^3$. $\breve{P}r$. P. $P+\infty$. $(\breve{P}r+\infty)^3$. $(\breve{P}+\infty)^4$. $(\breve{P}+\infty)^6$. $\bar{P}r+\infty$. Dufton, Westmoreland.

Cleavage. $\bar{P}r$ and $\breve{P}r+\infty$ perfect. The latter commonly more easily obtained, the first sometimes interrupted. $P-\infty$ is less distinct, still less so $\bar{P}r+\infty$. There are sometimes traces of P and $(\breve{P}r+\infty)^3$. Fracture conchoidal, seldom observable. Surface in a few examples only, faintly streaked. The same faces, which in cer-

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damental form. The faces of $(\breve{P}-2)^4$ appear as truncations of the edges between *y* and *P*. H.

tain combinations are rough, in others are perfectly smooth, while the reverse takes place in other faces; so that they do not constantly present the same appearances.

Lustre vitreous, inclining to resinous. Colour white, prevalent; inclining to grey, yellow, blue, red, or brown. Among some more remarkable tints, we notice smalt-blue, pale sky-blue, and almost indigo-blue; likewise wood-brown and hair-brown. Bright red and yellow colours owing to admixtures of hemi-prismatic and prismatoidal Sulphur. Streak white. Transparent ... translucent.

Brittle. Hardness = 3·0 ... 3·5. Sp. Gr. = 4·446, a white crystallised variety from Freiberg, the same from the measurement of which the above dimensions of the crystalline forms have been derived.

Compound Varieties. Globules, both imbedded and implanted, also reniform shapes: surface drusy, uneven and rough, composition either lamellar, generally imperfect, or columnar, the latter often very thin. In the reniform shapes the curved lamellar particles of composition consist of imperfectly straight lamellar, or of columnar ones. Massive: composition as in the imitative shapes, more frequently distinctly straight lamellar masses are aggregated in a granular composition. The composition is sometimes granular, and even impalpable. Without coherence of the particles, friable.

OBSERVATIONS.

1. It cannot excite our surprise to see the varieties of a species, which are so numerous as in prismatic Hal-baryte, particularly in regard to composition, variously divided in the mineralogical systems into sub-species and kinds, notwithstanding the close connexion of all these varieties by immediate transitions. First the friable varieties were separated from the rest under the denomination of *Earthy Heavy-Spar*. Among the crystallised ones, those of a tabular appearance, or such as have the face $\breve{P}r + \infty$ predominant, also the massive varieties, consisting of straight lamellar particles of composition, have been called *Straight lamellar Heavy-Spar*, while *Granular* and *Compact Heavy-Spar* applied to such massive varieties as consist of granular or impalpable particles of composition. *Prismatic Heavy-Spar* refers to crystals in which the faces of either vertical or horizontal four-sided prisms form the most prominent feature, and which prisms are sometimes aggregated in massive varieties, consisting of longish granular particles of composition; *columnar Heavy-Spar* to very thin crystals that are aggregated longitudinally. Implanted globular or reniform shapes, also massive varieties, shewing the curved lamellar composition, are comprehended under the denomination of the *Curved lamellar Heavy-Spar*, sometimes called *Fibrous*, if the composition be very delicate. *Radiated Heavy-Spar* or *Bolognese-Spar* is a particular denomination of a variety of this species in imbedded globules, consisting of columnar particles, generally a little broad and radiating from the centre. Some mineralogists have moreover distinguished *Hepatite* (*Baryte sulfatée fétide.* Haüy), or those varieties which develope a hepatic odour, on being broken or rubbed with hard bodies. Some varieties at last were separated from the rest on account of their being more or less decomposed, and designated by the addition of that word.

All these distinctions are founded upon characters which are not essential. It is rendered probable, however, by several observations, that the species of prismatic Hal-baryte, as it is now determined, still contains the varieties of several other species, which are to one another in a similar relation as the different species of the genus Lime-haloide, of which the fundamental form is a rhombohedron, or those of the genus Feld-spar, whose forms are hemi- or tetarto- prismatic.

2. According to **Berthier**, the prismatic Hal-baryte consists of

Baryta	66·00.
Sulphuric Acid	34·00.

It is represented by the formula $\ddot{B}a\ \dddot{S}^{2}$, which corresponds to 65·63 of baryta and 34·37 of sulphuric acid. Several varieties contain substances foreign to this mixture, which must be considered as impurities, as silica, oxide of iron, alumina, &c. If heated too quickly before the blowpipe, it decrepitates; but is difficultly fusible. Several varieties emit a phosphorescent light, if carefully treated, and retain this property for some time even after cooling. In the interior flame it assumes a burning hepatic taste. Several coloured varieties lose their colour on being exposed to heat.

3. Many varieties of this species, but more particularly the granular and compact ones, occur in beds accompanying hexahedral Lead-glance, dodecahedral Garnet-blende, &c.; others are found in iron-stone beds, along with prismatic Iron ore, and brachytypous Parachrose-baryte. It is frequently met with in veins, in rocks of various ages, either with the above mentioned species, or with various cupriferous minerals; also with Manganese-ores, with prismatoidal Antimony-glance, and hemi-prismatic Sulphur. Almost all the varieties distinguished by mineralogical authors have been found under these circumstances. Fibrous Heavy-spar occurs principally in iron-stone veins; the imbedded globular masses are engaged in beds of clay.

4. Compact Heavy-spar occurs in the Rammelsberg near Goslar, also at Clausthal in the Hartz, at Freiberg in Saxony, and at Riegelsdorf in Hessia. It is also found in Staffordshire and Derbyshire, where it is termed *Cawk.* The granular variety has been found near Frohnleithen and

Peggau in Stiria; the curved lamellar one in several veins near Freiberg in Saxony, in Derbyshire, in sandstone and trap-rocks in Scotland. Large and beautiful crystals have been found in the mines of Cumberland, Durham, and Westmoreland in England, also at Felsöbanya and Cremnitz in Hungary, at Freiberg, at Marienberg, and other places in Saxony, at Przibram and Mies in Bohemia, at Roya and Roure in Auvergne, &c. Very pure masses of considerable dimensions occur at Hüttenberg in Carinthia, in iron-stone beds. Columnar Heavy-spar has been found in the now abandoned mine of Lorenz Gegentrum near Freiberg, and the varieties of prismatic Heavy-spar in various localities in Saxony, at Przibram and Mies in Bohemia, in Auvergne, &c.; fibrous varieties are known from Mies, from Leiningen in the Palatinate, from the vicinity of Liege and from America; the radiated variety chiefly from Monte Paterno near Bologna. Crystals of the present species have been artificially obtained by dissolving sulpho-cyanuret of barium in sulphuric acid, and allowing this solution to be slowly decomposed by the influence of the atmosphere. The crystals are, according to MITSCHERLICH, similar to the first of the above mentioned varieties, that is, to the rhomboidal prism of 101° 42′ and 78° 18′.

5. Little use is made of the varieties of the present species. Pure white varieties are ground and used as a white paint, either alone or mixed with white lead, which cannot be considered as an imposition. If associated with ores of iron, it possesses bad influences upon the process of extracting this metal.

4. PRISMATOIDAL HAL-BARYTE.

Axifrangible Baryte or Celestine. JAM. Syst. Vol. II. p. 423. Prismatoidal Baryte or Celestine. Man. p. 78. Celestine Sulphate of Strontian. PHILL. p. 187. *Zölestin.* WERN. Hoffm. H. B. III. 1. S. 190. *Zölestin.* HAUSM. III. S. 982. Schwefelsaurer Strontian. LEONH. S. 600. Strontiane sulfatée. HAÜY. Traité, T. II. p. 313. Tabl. comp. p. 14. Traité, 2de Ed. T. II. p. 30.

Fundamental form. Scalene four-sided pyramid. $P = 128° 35', 89° 33', 112° 35'$. Vol. I. Fig. 9. R. G.

$$a : b : c = 1 : \sqrt{1{\cdot}6363} : \sqrt{0{\cdot}6111}.$$

Simple forms. $P - \infty$ (k); P (z); $(\breve{P}r - 1)^3$ (y) $= 113° 14', 126° 29', 90° 37'$; $(\breve{P}r + \infty)^3$ (d) $= 78° 35'$; $(\breve{P} + \infty)^4$ (l) $= 44° 30'$; $\bar{P}r$ (M) $= 76° 2'$; $\bar{P}r + \infty$ (s); $\breve{P}r$ (o) $= 103° 58'$; $\breve{P}r + \infty$ (P).

Char. of Comb. Prismatic.

Combinations. 1. $\breve{P}r$. $(\breve{P}r + \infty)^3$. $\bar{P}r + \infty$. Sim. Fig. 9. Bristol.

2. $\breve{P}r$. $\bar{P}r$. $(\breve{P}r + \infty)^3$. $\breve{P}r + \infty$. Strontian island, lake Erie.

3. $\bar{P}r$. P. $(\breve{P}r + \infty)^3$. $\breve{P}r + \infty$. Sim. Fig. 17. Montecchio near Vicenza.

4. $\breve{P}r$. $\bar{P}r$. $(\breve{P}r - 1)^3$. $\breve{P}r + \infty$. Lengthened in the direction of the edges between $\breve{P}r$ and $\breve{P}r + \infty$. Ghibesa, Sicily.

5. $\breve{P}r$. $\bar{P}r$. P. $(\breve{P}r + \infty)^3$. $\breve{P}r + \infty$. Sim. Fig. 21. Lengthened in the same direction. Bex, Switzerland.

6. $\breve{P}r$. $(\breve{P}r - 1)^3$. $\bar{P}r$. P. $(\breve{P}r + \infty)^3$. $(\breve{P} + \infty)^4$. $\breve{P}r + \infty$. Monte Viale near Verona.

Cleavage. $\breve{P}r + \infty$, highly perfect; $\bar{P}r$ less easily obtained, and often interrupted by conchoidal fracture; $P - \infty$ is still less distinct, and only faint traces are observable parallel to $\bar{P}r + \infty$. Fracture imperfect conchoidal, uneven. Surface, $P - \infty$ generally rough; $\breve{P}r$ sometimes streaked parallel to the edges of combination with P and $\bar{P}r$; $\bar{P}r + \infty$ streaked horizontally. For the rest as in the preceding species.

Lustre vitreous, inclining to resinous, sometimes also a little to pearly upon the perfect faces of cleavage. Colour white prevalent, passing into blueish-grey, sky-blue, and smalt-blue. Also reddish-white and flesh-red. Transparent ... translucent.

Brittle. Hardness = 3·0...3·5. Sp. Gr. = 3·858, a white, translucent, cleavable variety from the Tyrol.

Compound Varieties. Imperfect globular shapes, surface drusy, composition columnar. Plates, more or less thin: surface rough, composition columnar, thin and parallel. Massive: composition either lamellar, and aggregated into larger granular masses; or columnar, generally straight and divergent; or granular, the individuals being of various sizes. Faces of composition smooth, rough, or irregularly streaked.

OBSERVATIONS.

1. The subdivisions in the present species are very analogous to those effected in the preceding one. Tabular crystals and lamellar compound masses were called *Foliated Celestine*, others of columnar crystallisations and compositions *prismatic Celestine*. Among the massive varieties were distinguished, *radiated Celestine*, consisting of thin columnar compositions, radiating from a centre, *fibrous Celestine*, comprehending the thin plates, formed by delicate columnar particles of composition, and *compact Celestine*, which

seems to be a mechanical mixture of prismatoidal Hal-baryte and rhombohedral Lime-haloide.

2. The chemical composition of the present species is, according to Klaproth,

Strontia	56·00.
Sulphuric Acid	42·00.

According to Berzelius, these two constituents are in the proportion of 56·36 : 43·64, and expressed by the formula $\ddot{Sr}\,\dddot{S}^2$. It is the pure sulphate of strontia, only accidentally mixed with a small quantity of sulphate of baryta, oxide of iron, silica, lime or water. Before the blowpipe it decrepitates and melts, without perceptibly colouring the flame, into a white friable enamel. It loses its transparency on being heated, and acquires a caustic taste, different from that of prismatic Hal-baryte, if exposed to heat under the same circumstances. Reduced to powder it phosphoresces upon red hot iron.

3. In greywacke this species occurs but rarely; more frequently it is met with in modern limestone, sandstone, and trap rocks, in single kidney-shaped masses, of various sizes; also in larger massive concretions, and in vesicular cavities of amygdaloidal rocks. It is often associated with prismatoidal Gypsum-haloide and prismatic Sulphur in beds in gypsum rocks, and occurs by itself in thin seams in marl, alternating with clay and prismatoidal Gypsum-haloide.

4. Beautiful crystals of a prismatic shape and massive columnar varieties, occur in the sulphur mines of Sicily; also under the same circumstances at Bex in Switzerland, and Conil near Cadiz in Spain. Tabular crystals and lamellar compositions are found in beautiful varieties at Monte Viale near Verona, and in the Bristol Channel in England. Magnificent crystals have been brought from Strontian island, in Lake Erie in North America. Fine varieties occur in the Seiseralpe in the Tyrol. The blue varieties, in greywacke, have been found at Leogang in Salzburg; pale blue ones occur at Meudon near Paris, in fissures of chalk flints. It occurs besides in several parts of Italy, Germany, England and Scotland, Brazil, &c. The

blue varieties in plates, consisting of thin columnar composition, are found at Dornburg near Jena, at Frankstown in Pennsylvania, and in France; the compact Celestine is a product of the tertiary gypsum of Montmartre near Paris. In the Vicentine it is very frequently found in vesicular cavities of amygdaloidal rocks.

GENUS V. LEAD-BARYTE.

1. DI-PRISMATIC LEAD-BARYTE.

Di-prismatic Lead-Spar. JAM. Syst. Vol. II. p. 376. Man. p. 81. Carbonate of Lead. PHILL. p. 338. Schwarzbleierz. Weissbleierz. Bleierde. WERN. Hoffm. H. B. IV. 1. S. 18. 21. 44. Bleiweiss. Bleischwärze. HAUSM. III. p. 1107. 1111. Kohlensaures Blei. LEONH. S. 240. Plomb carbonaté. HAÜY. Traité, T. III. p. 475. Tabl. comp. p. 81. Traité, 2de Ed. T. III. p. 365.

Fundamental form. Scalene four-sided pyramid. P = 130° 0′, 108° 28′, 92° 19′. Vol. I. Fig. 9. R. G.

$$a : b : c = 1 : \surd 2{\cdot}6865 : \surd 1{\cdot}4047.$$

Simple forms. $P - \infty$ (g); $P - 1$ (w); P (t); $P + \infty$ (P) = 108° 16′; $(\breve{P}r)^3$ (v); $(\breve{P}r + \infty)^3$ (u) = 69° 20′; $(\bar{P}r)^3$ (o); $(\bar{P}r + \infty)^3$ (s) = 140° 15′; $\frac{3}{5}\,\breve{P}r$ = 139° 47′; $\breve{P}r$ (M) = 117° 13′; $\frac{3}{4}\,\breve{P}r + 2$ (e) = 57° 17′; $\breve{P}r + \infty$ (l); $\bar{P}r + 1$ (y) = 61° 18′; $\bar{P}r + \infty$ (h).

Char. of Comb. Prismatic.

Combinations. 1. P. $(\breve{P}r + \infty)^3$. Mies, Bohemia.

2. $\breve{P}r$. $(\breve{P}r + \infty)^3$. Sim. Fig. 2. Nertschinsk, Siberia.

3. $\breve{P}r$. $(\breve{P}r + \infty)^3$. $\breve{P}r + \infty$. Sim. Fig. 9. Johanngeorgenstadt, Saxony.

4. $\breve{P}r$. P. $(\breve{P}r + \infty)^3$. $(\bar{P}r + \infty)^3$. $\breve{P}r + \infty$.

The individuals in Fig. 38. Bleiberg, Carinthia.

5. $\breve{P}r$. P. $\frac{3}{4}\,\breve{P}r + 2$. $(\breve{P}r + \infty)^3$. $(\bar{P}r + \infty)^3$. $\breve{P}r + \infty$. Fig. 31. Johanngeorgenstadt.

6. $P - \infty$. $P - 1$. $\breve{P}r$. P. $(\breve{P}r)^3$. $\frac{3}{4}\,\breve{P}r + 2$. $\bar{P}r + 1$. $(\bar{P}r)^3$. $P + \infty$. $(\breve{P}r + \infty)^3$. $(\bar{P}r + \infty)^3$. $\breve{P}r + \infty$. $\breve{P}r + \infty$. Fig. 169. Leadhills.*

Cleavage. $\breve{P}r$ and $(\breve{P}r + \infty)^3$ often perfect, generally interrupted by conchoidal fracture. Traces of $\breve{P}r + \infty$ and $(\bar{P}r + \infty)^3$. Fracture conchoidal. Surface, P sometimes streaked parallel to the edges of combination with $(\breve{P}r + \infty)^3$ or with $\breve{P}r$; $\breve{P}r + \infty$ almost always streaked, vertically and at the same time also horizontally, the latter however less deeply.

Lustre adamantine passing into resinous. The former is often metallic, if the colours be dark. Very thin crystals, and columnar compositions of them often possess pearly lustre. Colour white prevalent, passing into yellowish-grey, ash-grey, and smoke-grey, or even into greyish-black. Sometimes tinged green or blue by several species of the order Malachite. Streak white. Transparent ... translucent.

Rather brittle. Hardness = 3·0...3·5. Sp. Gr. = 6·465 of a white translucent variety.

Compound Varieties. Twin-crystals: axis of

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* A crystal of this form is preserved in the collection of Mr ALLAN. H.

revolution perpendicular, face of composition parallel to one of the faces of $\breve{P}r$. The composition is often repeated, not only in parallel laminæ, as in prismatic Lime-haloide, but likewise parallel to both the faces of $\breve{P}r$. The individuals are generally continued beyond the face of composition. Thus are formed the well known star-like compound crystals of the present species, as represented in Fig. 38. Massive: composition often granular, or even impalpable, and strongly connected; more rarely columnar. Faces of composition rough, or longitudinally or irregularly streaked.

OBSERVATIONS.

1. The species distinguished by mineralogists within the varieties of di-prismatic Lead-baryte, are *White Lead-Spar*, *Black Lead-Spar*, and *Earthy Lead-Spar*. The last of these comprehends impalpable compositions, often mixed with clay, silica, oxide of iron, &c., and thence variously coloured. It is farther named *indurated* or *friable*, agreeably to the state of coherence of its particles. The other two are distinguished only in colour, so that those whose colour is not black are called *white* lead-spar, while the rest forms the *black* lead-spar. The varieties of the latter are generally less perfectly formed than those of the former, which, like the colour, seems to be a consequence of mere accidental circumstances in their formation.

2. A variety of the present species has yielded to KLAPROTH,

Oxide of Lead	82·00.
Carbonic Acid	16·00.
Water	2·00.

It is expressed by the formula $\dot{P}b\ \ddot{C}^2$, which corresponds to 83·52 oxide of lead, and 16·48 carbonic acid. The black varieties are said to contain a small proportion of carbon.

It effervesces in dilute nitric acid, and is easily soluble. Before the blowpipe it decrepitates and changes its colour into yellow and red; if properly managed, it yields a globule of metallic lead. Reduced to powder and thrown upon ignited charcoal, it emits a phosphorescent light.

3. Among the species of the present genus the di-prismatic Lead-baryte is that most commonly found in nature. It occurs in veins and beds in various classes of rocks, accompanied chiefly by hexahedral Lead-glance, several species of Baryte and Malachite, Iron-pyrites, dodecahedral Garnet-blende, octahedral Fluor-haloide, and other species. Crystallised varieties are more generally found in higher levels of veins, like other species of the present genus.

4. Beautiful crystallised and other varieties of the di-prismatic Lead-baryte are found in various mining districts of Saxony, particularly at Johanngeorgenstadt; at Clausthal and Zellerfeld in the Hartz; at Freiburg in Brisgaw; at Tarnowitz in Silesia; at Mies, Przibram, and other places in Bohemia, at Bleiberg in Carinthia, in France, and many other countries of the European continent. Splendid crystals have been brought from the Daurian mountains in Siberia, on the frontiers of China; fine varieties are found at Wanlockhead and Leadhills in Scotland, in the mines of Cumberland and Durham, at Wheal Crenver in Cornwall, &c. The localities of Black Lead-spar are Freiberg and Zschopau in Saxony, and Leadhills in Scotland. Earthy Lead-spar occurs in Poland, Silesia, Siberia, in the district of Eiffel in Germany, &c.

5. If found in considerable quantities, the present species is usefully employed as an ore of lead. It is the most important species in this respect after the hexahedral Lead-glance, with which it generally is found and melted together.

2. RHOMBOHEDRAL LEAD-BARYTE.

Rhomboidal Lead-Spar. Jam. Syst. Vol. II. p. 369. Man. p. 85. Phosphate of Lead. Arseniate of Lead.

Phill. p. 344. 345. Braunbleierz. Grünbleierz. Wern. Hoffm. H. B. IV. 1. S. 15. 27. Pyromorphit. Traublenblei. Hausm. III. S. 1090. 1093. Phosphorsaures Blei. Leonh. S. 236. Plomb phosphaté. Haüy. Traité, T. III. p. 490. Tabl. comp. p. 82. Traité, 2de Ed. T. III. p. 385.

Fundamental form. Rhombohedron. $R = 88° 29'$. Vol. I. Fig. 7. R. G.

$$a = \sqrt{4{\cdot}878}.$$

Simple forms. $R - \infty$ (*o*); R; $-R$; $R + \infty$ (*g*); P (*P. s*) $= 142° 12', 80° 44'$; $P + 1$; $P + 2$; $P + \infty$ (*n*).

Char. of Comb. Di-rhombohedral. $2(R) = 131° 5', 111° 48'$.

Combinations. 1. $R - \infty$. $P + \infty$. Przibram, Bohemia.

2. $R - \infty$. P. $P + \infty$. Sim. Fig. 118. Zschopau, Saxony.

3. $R - \infty$. P. $R + \infty$. $P + \infty$. Freiburg, Baden.

Cleavage. P imperfect and interrupted. Traces of $P + \infty$. Fracture imperfect conchoidal, uneven. Surface, $P + \infty$ almost always horizontally streaked, and often uneven. Owing to these striæ, the prisms are often barrel-shaped, or contracted at the ends of the prisms. $R - \infty$ rough, and often excavated.

Lustre resinous. Colour, generally green or brown. There is an uninterrupted series from various shades of white through siskin-green, asparagus-green, grass-green, pistachio-green, olive-green, oil-green; wax-yellow, honey-yellow, orange-yellow; aurora-red, hyacinth-red; hair-brown, clove-brown; pearl-grey and ash-grey. Streak white, sometimes inclining to yellow. Semi-transparent...translucent on the edges.

Brittle. Hardness = 3·5 ... 4·0. Sp. Gr. = 7·098, of a green variety from Zschopau.

Compound Varieties. Globular, reniform, botryoidal, fruticose shapes: composition columnar; faces of composition rough, irregularly streaked, seldom smooth. Massive: composition columnar, or granular; the latter in most cases strongly coherent.

OBSERVATIONS.

1. The preceding general description refers to the varieties in which phosphate of lead has been found to form the greatest proportion in the constituent parts. The angles were measured in minute splendent crystals, of a green colour from Brisgaw, a variety of which the specific gravity is given = 6·9111 by Haüy. The variety from Johanngeorgenstadt in Saxony, which consists of arseniate of lead, yielded by measurement the lateral edge of the pyramid P = 79° 40′, from which the terminal edge follows = 142° 39′, and $a = \sqrt{4{\cdot}696}$. It seems therefore that it will be necessary in future to consider it as a particular species, different from rhombohedral Lead-baryte. The crystalline varieties are much the same in both these substances; thus $P.\ P+\infty$, (Fig. 117.), and $R-\infty.\ P.\ 2(R).\ R+\infty.\ P+\infty$ have been found at Johanngeorgenstadt. The faces $2(R)$ are uneven, and $P+1$, and particularly $P+\infty$, which occur in the same variety, are rough. Twin crystals have been found joined in a face perpendicular to one of the terminal edges of P. The specific gravity is = 7·208.

Formerly two species used to be distinguished, the *Green* and *Brown Lead-Spar*, merely according to the shades of colours, which, however, as in rhombohedral Emerald, or other well determined species, form but one uninterrupted species, in which only arbitrary limits can be fixed. Green Lead-spar referred to varieties of green or greenish colours, while Brown Lead-spar comprehended those in which the colours approached more to brown tints. What has been called *Blue* Lead possesses the shape of the crystals of the present species, the substance of which has been replaced by hexahedral Lead-glance. There are varieties of Blue Lead, which consist of rhombohedral Lead-baryte of a dark blueish-grey colour.

2. In two varieties, one of a brown colour from Huelgoet, the other a green one from Zschopau in Saxony, Klaproth found the following ingredients:

Oxide of Lead	78·58	78·40.
Phosphoric Acid	19·73	18·37.
Muriatic Acid	1·65	1·70.
Oxide of Iron	0·00	0·10.

The proportion of oxide of lead and phosporic acid, corresponding to the formula $\ddot{\mathrm{P}}\mathrm{b}^5\,\overset{:\cdot:}{\mathrm{P}}{}^4$, is that of 79·27 : 20·73. Two specimens containing arsenic acid, yielded to Rose,

Oxide of Lead	77·50	77·50.
Phosphoric Acid	0·00	7·50.
Arsenic Acid	19·00	12·50.
Muriatic Acid	1·53	1·50.
Oxide of Iron	0·25	0·00.

The rhombohedral Lead-baryte is soluble without effervescence in heated nitric acid. Before the blowpipe it melts by itself upon charcoal, and the bead assumes a polyhedral form of a dark colour. In the interior flame the globule becomes blueish, in the moment of crystallisation it is luminous, and the faces become larger. The form itself has not been accurately examined; it seems to consist of several crystalline individuals.

3. The varieties of the present species occur chiefly

in veins, particularly in their higher levels, in various rocks, but they are also found in beds. Upon veins they are accompanied by hexahedral Lead-glance, and various species of the genus Lead-baryte, by prismatic Hal-baryte, dodecahedral Garnet-blende, octahedral Fluor-haloide, rhombohedral Quartz, &c.; sometimes also by different ores of silver, &c.

4. Finely crystallised and other varieties are found at Zschopau and other places in Saxony, Przibram, and Mies in Bohemia, Freiburg in the Brisgaw, in Hungary, in the Hartz, at Poullaouen and Huelgoet in Brittany, at Leadhills and Wanlockhead in Scotland, in Cornwall, and in several counties of the north of England. The finest crystallised varieties of the arseniate of lead occur at Johanngeorgenstadt in Saxony, in silver veins.

3. HEMI-PRISMATIC LEAD-BARYTE.

Prismatic Lead-Spar, or Red Lead-Spar. Jam. Syst. Vol. II. p. 366. Hemi-prismatic Lead-Spar, or Red Lead-Spar. Man. p. 87. Chromate of Lead. Phill. p. 349. Rothbleierz. Wern. Hoffm. H. B. IV. 1. S. 33. Kallochrom. Hausm. III. S. 1084. Chromsaures Blei. Leonh. S. 246. Plomb chromaté. Haüy. Traité, T. III. p. 467. Tabl. comp. p. 81. Traité, 2de Ed. T. III. p. 357.
Soret. Ann. des Mines. T. III. p. 481.

Fundamental form. Scalene four-sided pyramid. $P = \begin{Bmatrix}119° & 0'\\ 107° & 30'\end{Bmatrix}$, 109°.37′, 105° 45′. Inclination of the axis = 12° 30′ in the plane of the short diagonal. Vol. I. Fig. 41. Ap.

$$a : b : c : d = 4{\cdot}52 : 4{\cdot}82 : 5{\cdot}02 : 1.$$

Simple forms. $P - \infty\,(P)$; $\pm\frac{P}{2}\begin{Bmatrix}t\\ v\end{Bmatrix} = \begin{Bmatrix}119° & 0'\\ 107° & 30'\end{Bmatrix}$; $P + \infty\,(M) = 93°\,40'$; $-\frac{(\bar{P})^3}{2}$; $(\breve{P}r + \infty)^3$

$= 56° 7'$; $(\bar{P}r + \infty)^5 = 129° 40'$*; $\pm\frac{\bar{P}r}{2}\begin{Bmatrix}k'\\k\end{Bmatrix} = \begin{Bmatrix}39° 42'\\52° 40'\end{Bmatrix}$; $-\frac{\frac{3}{4}\bar{P}r + 2}{2} = 20° 9'$; $\pm\frac{\bar{P}r + 2}{2}\begin{Bmatrix}l'\\l\end{Bmatrix} = \begin{Bmatrix}13° 30'\\15° \ \ 6'\end{Bmatrix}$; $\bar{P}r + \infty$ (f); $\breve{P}r$ (z) $= 96° 1'$; $\breve{P}r + 1$ (y) $= 58° 3'$; $\breve{P}r + \infty$ (g).

Char. of Comb. Hemi-prismatic. Inclination of $P - \infty$ on $\bar{P}r + \infty = 102° 20'$, of $P - \infty$ on $P + \infty = 99° 11'$.

Combinations. 1. $\frac{P}{2}$. $P + \infty$. $(\breve{P}r + \infty)^4$. HAÜY.

2. $\frac{P}{2}$. $-\frac{\breve{P}r + 2}{2}$. $P + \infty$. $(\breve{P}r + \infty)^5$.

3. $\frac{\bar{P}r}{2}$. $\frac{P}{2}$. $-\frac{P}{2}$. $P + \infty$. $(\breve{P}r + \infty)^4$. $\breve{P}r + \infty$. Fig. 53.

4. $\frac{P}{2}$. $\breve{P}r$. $\breve{P}r + 1$. $-\frac{\bar{P}r}{2}$. $-\frac{P}{2}$. $-\frac{(\bar{P})^5}{2}$. $P + \infty$. $(\breve{P}r + \infty)^3$. $\breve{P}r + \infty$. $\bar{P}r + \infty$. Fig. 170.† All of them from Beresof.

Cleavage. $P + \infty$, pretty easily observable, $\breve{P}r + \infty$ and $\bar{P}r + \infty$ indistinct. None of them perfect. Fracture small conchoidal, uneven. Surface, the prisms parallel the axis streaked in the direction of

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* Four-sided prisms of 64° 36′ and of 120° 41′ are quoted by Messrs HAÜY and SORET. They are represented by the signs $(\breve{P}r + \infty)^4$ and $(\bar{P}r + \infty)^4$. H.

† In the cabinet of Mr ALLAN. H.

that line, often very considerably; $\frac{P}{2}$ sometimes faintly streaked parallel to the edges of combination with $P + \infty$; $-\frac{\bar{P}r + 2}{2}$ generally curved. The faces are almost always smooth and shining.

Lustre adamantine. Colour, various shades of hyacinth red. Streak orange-yellow. Translucent, sometimes only on the edges.

Sectile. Hardness = 2·5 ... 3·0. Sp. Gr. = 6·004.

Compound Varieties. Massive: composition imperfect columnar or granular.

OBSERVATIONS.

1. According to PFAFF, the hemi-prismatic Lead-baryte consists of

Oxide of Lead	68·00.
Chromic Acid	32·00.

Its chemical formula is $\ddot{P}b\,\dddot{C}h$, agreeing with 68·15 of oxide of lead, and 31·85 of chromic acid. Before the blowpipe it becomes black and decrepitates if quickly heated; it may be melted, however, into a shining slag, containing globules of metallic lead. It colours glass of borax green, is soluble without effervescence in nitric acid, and produces a yellow solution.

2. It has been found particularly in Siberia, where it occurs in the neighbourhood of Beresof, in narrow veins, traversing a rock, the true nature of which is not yet known, accompanied by hexahedral crystals of Iron-pyrites, generally in a state of decomposition, also by hexahedral Lead-glance, rhombohedral and di-prismatic Lead-baryte, sometimes also by hexahedral Gold. In Brazil it is met with in sandstone, probably under similar circumstances.

4. PYRAMIDAL LEAD-BARYTE.

Pyramidal Lead-Spar. JAM. Syst. Vol. II. p. 362. Man. p. 88. Molybdate of Lead. PHILL. p. 348. Gelbbleierz. WERN. Hoffm. H. B. IV. 1. S. 36. Bleigelb. HAUSM. III. S. 1101. Molybdänsaures Blei. LEONH. S. 249. Plomb molybdaté. HAÜY. Traité, T. III. p. 498. Tabl. comp. p. 83. Traité, 2de Ed. T. III. p. 397.

Fundamental form. Isosceles four-sided pyramid. P = 99° 40′, 131° 35′. Vol. I. Fig. 8. R. G.

$$a = \sqrt{4{\cdot}9484}.$$

Simple forms. $P - \infty$ (a); $P - 3$ (c) = 128° 9′, 76° 22′; $P - 1$ (e) = 106° 44′, 115° 7′; $\overset{*}{P}$ (P), Bleiberg, Carinthia; $\frac{2\sqrt{2}}{3} P - 3$ (b) = 130° 11′, 73° 7′; $\frac{2\sqrt{2}}{3} P - 2$ (d) = 118° 26′, 92° 43′; $P + \infty$; $[P + \infty]$; $[(P + \infty)^5]$.

Char. of Comb. Pyramidal.

Combinations. 1. $P - \infty$. $\frac{2\sqrt{2}}{3} P - 3$. Fig. 92. Annaberg, Austria.

2. $P - \infty$. $P - 3$. Bleiberg, Carinthia.

3. $P - \infty$. P. Windisch Kappel, Carinthia.

4. $P - \infty$. $\frac{2\sqrt{2}}{3} P - 3$. $P - 3$. Fig. 94. Bleiberg.

5. $P - \infty$. $\frac{2\sqrt{2}}{3} P - 3$. P. Fig. 93. Annaberg.

6. $\frac{2\sqrt{2}}{3} P - 3$. $\frac{2\sqrt{2}}{3} P - 2$. $P - 1$. P. Fig. 95. Bleiberg.

Cleavage. P very smooth, but often interrupted by conchoidal fracture. $P - \infty$ and $\frac{2\sqrt{2}}{3} P - 3$ less distinct and not observable in every individual. Fracture conchoidal, generally imperfect. Surface, $P - \infty$, and particularly P, also several forms not enumerated above, smooth, $P - \infty$

sometimes striated parallel to the edges of combination with P. $P - 3$ commonly rough, $\frac{2\sqrt{2}}{3}P - 3$ often, $P - 1$ and $[P + \infty]$ always rough; $P + \infty$ and $[(P + \infty)^5]$ smooth, but curved, so that if they occur together in a crystal, they are joined without producing a distinct edge between them.

Lustre resinous. Colour generally wax-yellow; passing into siskin-green and olive-green, also into orange-yellow, yellowish-grey, and greyish-white. Streak white. Semi-transparent, translucent on the edges.

Brittle. Hardness = 3·0. Sp. Gr. = 6·760, orange-yellow crystals from Annaberg in Austria.

Compound Varieties. Massive, composition granular, of various sizes of individuals, and firmly coherent.

OBSERVATIONS.

1. The pyramidal Lead-baryte, according to KLAPROTH and HATCHETT, consists of

Oxide of Lead	64·42	58·40.
Molybdic Acid	34·25	38·00.
Oxide of Iron	0·00	2·08.
Silica	0·00	0·28.

The chemical formula is $\ddot{Pb}\,\dddot{Mo}^2$, which is equivalent to 60·86 oxide of lead, and 39·14 molybdic acid. It is with difficulty and slowly soluble in acids. Before the blowpipe it decrepitates briskly, and assumes a darker colour, which, however, again disappears. Alone upon charcoal it melts, is absorbed by it, and leaves behind some reduced globules of metallic lead.

2. The varieties of this species are found in beds and

veins in newer limestone, with ores of lead and zinc, also with rhombohedral Lime-haloide; it is seldom met with in primitive rocks, associated with the same species, or also with hemi-prismatic Habroneme-malachite.

3. It occurs in many of the lead mines of Carinthia, as at Deutsch- and Windisch-Bleiberg, Windisch-Kappel, &c., also, and likewise in limestone, at Annaberg in Austria. It is found in the copper mines of Rezbanya in Upper Hungary, and in the lead mines of Pennsylvania and Massachusetts, and at Zimapan in Mexico, in compact limestone. Minute crystals of an almost hyacinth-red colour have lately been discovered at Moldawa in the Bannat, and, on account of their bright red colour, considered as hemi-prismatic Lead-baryte.

5. PRISMATIC LEAD-BARYTE.

Tri-prismatic Lead-spar, or Sulphate of Lead. JAM. Syst. Vol. II. p. 359. Prismatic Lead-spar, or Sulphate of Lead. Man. p. 89. Sulphate of Lead. PHILL. p. 346. Vitriol-bleierz. WERN. Hoffm. H. B. IV. 1. S. 41. Bleivitriol. HAUSM. III. S. 1115. Blei-Vitriol. LEONH. S. 232. Plomb sulfaté. HAÜY. Traité, T. III. p. 503. Tabl. comp. p. 83. Traité, 2de Ed. T. III. p. 402.

Fundamental form. Scalene four-sided pyramid. P = 128° 58′, 89° 59′, 111° 48′. Vol. I. Fig. 9. R. G.

$$a : b : c = 1 : \sqrt{1{\cdot}6935} : \sqrt{0{\cdot}6286}.$$

Simple forms. $P - \infty$ (x); $P - 1$; P (s); $(\breve{P}r - 2)^3$; $(\breve{P}r - 1)^3$; $(\breve{P}r + \infty)^3$ $(P' \, P'') = 78° \, 45'$; $(\breve{P} + \infty)^4 = 44° \, 37'$; $\breve{P}r$ $(t) = 104° \, 55'$; $\breve{P}r + \infty$ (n); $\bar{P}r$ $(P \, P''') = 76° \, 11'$; $\bar{P}r + \infty$ (o).

Char. of Comb. Prismatic.

Combinations. 1. $\bar{P}r$. $(\breve{P}r + \infty)^3$. Parys mine, Anglesea.

2. $\bar{P}r$. P. $(\breve{P}r+\infty)^3$. $\breve{P}r+\infty$. Leadhills, Scotland.
3. $\breve{P}r$. P. $(\breve{P}r+\infty)^3$. $(\breve{P}r+\infty)^4$. $\breve{P}r+\infty$. Leadhills.
4. $\breve{P}r$. $\bar{P}r$. P. $(\breve{P}r+\infty)^3$. $\breve{P}r+\infty$. Sim. Fig. 21. Mellanoweth, Cornwall.
5. $(\breve{P}r-2)^3$. $\breve{P}r$. $\bar{P}r$. P. $(\breve{P}r+\infty)^3$. Anglesea.
6. $P-1$. $\breve{P}r$. $(\breve{P}r-1)^3$. $\bar{P}r$. P. $(\breve{P}r+\infty)^3$. $\breve{P}r+\infty$. Siegen, Prussia.

Cleavage $\bar{P}r$ and $\breve{P}r+\infty$, imperfect and interrupted, the latter rather more distinct. Traces of $P-\infty$. Fracture conchoidal. Surface, $P-1$ and $(\breve{P}r-2)^3$ uneven, curved and almost always rough; the faces of $\breve{P}r+\infty$ and the vertical prisms are often striated parallel to the axis, $\bar{P}r+\infty$ in a horizontal direction, and $(\breve{P}r-1)^3$ parallel to the edges of combination with P. In general the faces are smooth, and often of high degrees of lustre.

Lustre adamantine, inclining to vitreous or resinous. Colour yellowish-, greyish-, or greenish-white, also yellowish-, smoke-, and ash-grey. Sometimes faintly tinged green or blue. Streak white. Transparent ... translucent.

Brittle. Hardness = 2·5 ... 3.0. Sp. Gr. = 6·298 of white semi-transparent crystals from Leadhills.

Compound Varieties. Massive: composition lamellar, also granular of various sizes of individuals. Often strongly connected. Faces of composition rough.

OBSERVATIONS.

1. According to **Stromeyer**, the prismatic Lead-baryte consists of

Oxide of Lead	72·47.
Sulphuric Acid	26·09.
Water	0·12.
Hydrous Oxide of Iron	0·09.
Oxide of Manganese	0·06.
Silica, &c.	0·51.

Its composition, when pure, is expressed by $\ddot{\mathrm{P}}\mathrm{b}\,\dddot{\mathrm{S}}^{2}$, or 73·56 oxide of lead and 26·44 sulphuric acid. It decrepitates in the flame of a candle, and frequently assumes a slight reddish tinge on the surface. Reduced to powder, it melts easily before the blowpipe into a white slag, which is reduced to metallic lead by the addition of soda.

2. It is found in lead and copper veins traversing clay slate and greywacke slate, particularly in the upper parts, along with various ores of lead and copper, also with prismatic Hal-baryte, prismatic Iron-ore, rhombohedral Quartz, and other species.

3. Prismatic Lead-baryte is found at Leadhills and Wanlockhead in Scotland, Parys mine in Anglesea, Mellanoweth in Cornwall; also at Clausthal and Zellerfeld in the Hartz, near Freiberg in Saxony, in Baden, in the mining district of Siegen in Prussia, in Spain, Siberia, and the United States of North America.

6. AXOTOMOUS LEAD-BARYTE.

Plomb carbonaté rhomboidal. **Bournon.** Cat. p. 343. Sulphato-tri-Carbonate of Lead. **Brooke.** Edinb. Phil. Journ. Vol. III. p. 118. **Haidinger.** Trans. Roy. Soc. Edin. Vol. X. p. 217.

Fundamental form. Scalene four-sided pyramid.

$\mathrm{P} = \left\{\begin{matrix}72° \; 36'\\72° \; 10'\end{matrix}\right\}$, 124° 50′, 137° 0′. Inclination of the axis = 0° 29′ in the plane of the long diagonal. Vol. I. Fig. 41. HAIDINGER.

a : b : c : d = 120 : 95 : 54·5 : 1.

Simple forms. $\mathrm{P} - \infty \; (a)$; $\frac{\check{\mathrm{P}}\mathrm{r} - 1}{2} \; (i) = 147° \, 23'$; $\frac{\check{\mathrm{P}}\mathrm{r}}{2} (f) = 38° \, 11'$; $\pm \frac{\check{\mathrm{P}}\mathrm{r} + 1}{2} \left\{\begin{matrix}e\\e'\end{matrix}\right\} = \left\{\begin{matrix}21° \, 31'\\21° \, 40'\end{matrix}\right\}$; $\check{\mathrm{P}}\mathrm{r} + \infty \; (b)$; $\pm \frac{\mathrm{P} - 1}{2} \left\{\begin{matrix}g\\g'\end{matrix}\right\} = \left\{\begin{matrix}94° \; 18'\\93° \; 52'\end{matrix}\right\}$; $\pm \frac{\mathrm{P}}{2} \left\{\begin{matrix}P\\P'\end{matrix}\right\} = \left\{\begin{matrix}72° \; 36'\\72° \; 10'\end{matrix}\right\}$; $\mathrm{P} + \infty \; (c) = 59° \, 40'$; $\pm \frac{(\check{\mathrm{P}}\mathrm{r} - 1)^5}{2} \left\{\begin{matrix}k\\k'\end{matrix}\right\} = \left\{\begin{matrix}111° \; 32'\\111° \;\; 5'\end{matrix}\right\}$; $\pm \frac{(\mathrm{P} - 2)^4}{2} \left\{\begin{matrix}h\\h'\end{matrix}\right\} = \left\{\begin{matrix}142° \; 26'\\142° \;\; 8'\end{matrix}\right\}$; $(\check{\mathrm{P}} + \infty)^5 = 119° \, 40'$; $(\check{\mathrm{P}} + \infty)^4 \; (d) = 132° \, 54'$; $\pm \frac{(\check{\mathrm{P}} - 2)^8}{2} \left\{\begin{matrix}o\\o'\end{matrix}\right\}$; $\bar{\mathrm{P}}\mathrm{r} - 2 \; (l) = 122° \; 20'$; $\bar{\mathrm{P}}\mathrm{r} - 1 \; (m) = 84° \; 30'$; $\frac{3}{4} \bar{\mathrm{P}}\mathrm{r} \; (n) = 62° \, 24'$.

Char. of Comb. Hemi-prismatic. Inclination of $\mathrm{P} - \infty$ on $\check{\mathrm{P}}\mathrm{r} + \infty = 90° \, 29'$; of $\mathrm{P} - \infty$ on $\mathrm{P} + \infty = 90° \, 14'$.

Combinations. 1. $\mathrm{P} - \infty. \quad \frac{\check{\mathrm{P}}\mathrm{r} + 1}{2}. \quad -\frac{\mathrm{P}}{2}.$

Sim. Fig. 113.

2. $\mathrm{P} - \infty. \quad \frac{\check{\mathrm{P}}\mathrm{r} + 1}{2}. \quad \frac{\mathrm{P}}{2}. \quad -\frac{\mathrm{P}}{2}. \quad -\frac{\check{\mathrm{P}}\mathrm{r} + 1}{2}.$

$\mathrm{P} + \infty. \quad \check{\mathrm{P}}\mathrm{r} + \infty.$ Sim. Fig. 112.

3. $P - \infty$. $\frac{\breve{P}r - 1}{2}$. $\frac{\breve{P}r}{2}$. $\frac{\breve{P}r + 1}{2}$. $\frac{P - 1}{2}$.
$\frac{(\breve{P} - 2)^4}{2}$. $\frac{(\breve{P}r - 1)^3}{2}$. $\frac{P}{2}$. $\frac{(\breve{P} - 2)^8}{2}$.
$\bar{P}r - 2$. $\bar{P}r - 1$. $\frac{3}{4}\,\bar{P}r$. $-\frac{\breve{P}r + 1}{2}$.
$-\frac{P - 1}{2}$. $-\frac{(\breve{P} - 2)^4}{2}$. $-\frac{(\breve{P}r - 1)^3}{2}$.
$-\frac{P}{2}$. $-\frac{(\breve{P} - 2)^8}{2}$. $P + \infty$. $(\breve{P} + \infty)^4$.
$\breve{P}r + \infty$. Fig. 171.

Cleavage, $P - \infty$, highly perfect, and easily obtained, traces of $P + \infty$ and $\breve{P}r + \infty$. Fracture conchoidal, scarcely observable. Surface, $R - \infty$ very smooth and even, some of the faces, particularly $\frac{\breve{P}r + 1}{2}$ curved, or uneven.

Lustre resinous, inclining to adamantine, pearly upon $P - \infty$. Colour yellowish-white, passing into various pale grey, green, yellow, and brown tints. Streak white. Transparent ... translucent.

Rather sectile. Hardness = 2·5. Sp. Gr. = 6·266 of crystals resembling var. 1.

Compound Varieties. Twin-crystals very frequent; axis of revolution perpendicular, faces of composition parallel to one of the faces of $(\breve{P} + \infty)^3$. In a similar composition, the variety Fig. 171., in Mr Allan's cabinet, has been observed. This composition often takes place parallel to the other face also, and is variously repeated in parallel layers, as is indicated in the striæ visible upon the terminal plane. The portions of individuals have their terminal planes inclined to each other at angles of 179° 10′ and 180° 50′. There is also a regular composition parallel to $\frac{\breve{P}r}{2}$. Massive: composition lamellar or granular.

OBSERVATIONS.

1. The two systems of coloured rings, which plates of the present species exhibit in polarized light, are observable with great facility. They had been discovered by Dr **Brewster**, previous to the exact description of the forms, as belonging to the hemi-prismatic system. Mr **Brooke** has called in question the accuracy of the observations indicative of these forms, owing perhaps to his not having examined a greater number of the different crystalline varieties of the species.

2. According to **Berzelius**, 100 parts of axotomous Lead-baryte yield by analysis

Carbonate of Lead	71·1.
Sulphate of Lead	30·0.

with traces of muriatic acid and lime, giving an excess of 1·1, probably owing to the existence of a subsalt of lead in the mineral, and not agreeing with the definite proportions. Professor **Irving** had obtained a similar result. Mr **Brooke** had obtained three atoms of carbonate, and one atom of sulphate of lead, in the proportions of 72·5 to 27·45. Before the blowpipe this mineral first intumesces a little, and then becomes yellow, but re-assumes a white colour on cooling. It effervesces briskly in nitric acid, and leaves a white residue.

3. The varieties of the present species, and among them the crystallisations quoted above, occur principally at Lead-

hills in Scotland, in a vein traversing grey-wacke, accompanied with various other ores of lead. Under similar circumstances they have been lately brought from Spain.

4. Several species have been lately discovered, which will probably require to be included in the genus Lead-baryte, and of which we shall here give a short notice. These are the *Sulphato-carbonate*, the *Cupreous Sulphato-carbonate*, and the *Cupreous Sulphate of Lead*, determined by Mr Brooke, the *Hornblei* of Werner and Klaproth, and another compound of oxide of lead and chloride of lead, discovered by Berzelius, and described without giving it a name.

i. *Sulphato-carbonate of Lead.*

Brooke, Edin. Phil. Journ. Vol. III. p. 117. Phill. p. 341.

Hemi-prismatic. The crystals are generally oblique angular four-sided prisms, with curved faces, terminated by two planes, set obliquely on the obtuse edges of the prisms, but producing a horizontal edge with each other. They admit of cleavage with great facility parallel to a plane, which replaces obliquely their acute lateral edges. There are two less perfect cleavages besides, intersecting the former at angles of about 120° 45′ and 88° 45′. The inclination of the axis takes place in a plane perpendicular to the perfect plane of cleavage, and the plane of inclination has traces of cleavage parallel to it. The laminæ resulting from cleavage are flexible, like prismatoidal Gypsum-haloide. Lustre adamantine, inclining to resinous, pearly upon the perfect face of cleavage. Colour, greenish-white or yellowish-white, sometimes inclining to grey. Streak white. Translucent. Sectile. Hardness = 2·0...2·5. Sp. Gr. = 6·8...7·0, Brooke.

According to Mr Brooke, it consists of 46·9 of carbonate and 53·1 of sulphate of lead. The effervescence, while dissolving in nitric acid, is scarcely perceptible. It is found in columnarly aggregated crystals at Leadhills in Scotland, with various other species of the genus Lead-baryte. It had been first noticed and described by Count BOURNON, as a variety of di-prismatic Lead-baryte.

ii. *Cupreous Sulphato-Carbonate of Lead.*

BROOKE. Edin. Phil. Journ. Vol. III. p. 117. PHILL. p. 342.

Prismatic. General form of crystals, a broad rectangular four-sided prism, Sim. Fig. 25., terminated by a horizontal prism $\bar{\mathrm{P}}\mathrm{r}$ (*i*), of 95°, set upon the broad faces. There occurs also a horizontal prism in the direction of the other diagonal, of 143° 42′, and a vertical one, of 109°, inclined to the broad face *T* at an angle of 144° 30′, according to Mr BROOKE, and various faces of scalene pyramids having one of their edges situated like the horizontal prism of 95°. Cleavage parallel to this same prism *i*, also to the faces *T* and *M*, indistinct. Fracture uneven. Surface streaked, the vertical prisms parallel to their own intersections, the inclined faces parallel to the intersections with $\bar{\mathrm{P}}\mathrm{r}$. Lustre resinous. Colour deep verdigris-green; inclining to mountain-green, if the crystals be very delicate. Streak greenish-white. Translucent. Rather brittle. Hardness = 2·5... 3·0. Sp. Gr. = 6·4, about, BROOKE.

Mr BROOKE found it to consist of 55·8 of sulphate, 32·8 of carbonate of lead, and 11·4 of carbonate of copper. It occurs at Leadhills, along with the preceding species. It was first described by Mr SOWERBY as green carbonate of copper.

iii. *Cupreous Sulphate of Lead.*

BROOKE, Ann. of Phil. IV. p. 117. PHILL. p. 347.

Hemi-prismatic. A combination is described by Mr BROOKE, consisting of $\mathrm{P} - \infty\ (M)$. $\pm\frac{\breve{\mathrm{P}}\mathrm{r}}{2}\left\{\begin{matrix} b \\ T \end{matrix}\right\} = \left\{\begin{matrix} 9^\circ\ 5' \\ 18^\circ 30' \end{matrix}\right\}$. $\bar{\mathrm{P}}\mathrm{r}\ (b) = 61^\circ\ 0'$; $\breve{\mathrm{P}}\mathrm{r} + \infty$ and $\bar{\mathrm{P}}\mathrm{r} + \infty\ (P)$. The angle of inclination of $\mathrm{P} - \infty$ upon $\breve{\mathrm{P}}\mathrm{r} + \infty$ is $= 95^\circ\ 45'$. The inclination of the axis in the plane of the long diagonal = 5° 45′. Cleavage parallel to $P - \infty$ very perfect, and $-\frac{\breve{P}r}{2}$. Surface generally smooth and shining, some of the faces rough. It occurs also in twin-crystals. Lustre adamantine. Colour deep and beautiful azure-blue. Streak pale-blue. Faintly translucent. Rather brittle. Hardness = 2·5 ... 3·0. Sp. Gr. = 5·30 ... 5·43, BROOKE.

It consists of 74·4 sulphate of lead, 18 oxide of copper, and 4·7 water, according to Mr BROOKE. The locality of this species is Leadhills, where it occurs along with the preceding ones. It has also been found at Linares in Spain. It was discovered by Mr SOWERBY, and described as carbonate of copper in his *British Mineralogy*, III. 5.

iv. *Corneous Lead.*

Corneous Lead. JAM. Syst. Vol. II. p. 388. Man. p. 468.
Murio-carbonate of Lead.

Pyramidal. Combinations like Fig. 101., having the summit replaced by a plane perpendicular to the axis. Inclination of s to g = 135°, BROOKE. Cleavage parallel to $P + \infty$, cross-fracture conchoidal. Lustre adamantine. Colour white and pale tints of grey, yellow, and green. Streak white. Transparent...translucent. Rather sectile. Hardness below 3·0, inferior to that of di-prismatic Lead-baryte. Sp. Gr. = 6·056, CHENEVIX.

According to KLAPROTH it consists of 85·5 oxide of lead, 8·5 muriatic acid, and 6·0 carbonic acid. Before the blowpipe it melts quickly into a yellow globule, which becomes white, and crystallises upon the surface, when cooling. Upon charcoal it is reduced. The localities of this mineral are Matlock in Derbyshire, Hausbaden near Badenweiler in Germany, and Southampton in Massachusetts, North America. It is found with other ores of lead, with octahedral Fluor-haloide, prismatic Hal-baryte, &c.

v. *Peritomous Lead-baryte.*

A new ore of lead. **Berzelius.** Ann. of Phil. XLIV. p. 154. Edin. Journ. of Science, Vol. I. p. 379.

Prismatic. Cleavage highly perfect and easily obtained, parallel to a four-sided prism of 102° 27′, and traces in the direction of its short diagonal. Traces of cleavage apparently parallel to a horizontal prism, having its axis parallel to the long diagonal of the vertical prism, **Haidinger.** Fracture imperfect conchoidal, uneven. Colour yellowish-white, straw-yellow, rose-red, pale. Lustre adamantine, particularly upon the cross-fracture, inclining to pearly upon faces of cleavage. Translucent. Rather brittle. Hardness = 2·5 ... 3·0. Sp. Gr. = 7·077, **Haidinger.**

It consists, according to **Berzelius**, of oxide of lead 90·13, muriatic acid 6·84, carbonic acid 1·03, water 0·54, and silica 1·46. The carbonic acid in this and the preceding species are supposed by **Berzelius** to be accidental. He considers the present species as a compound of two atoms of oxide and one atom of chloride of lead, in the proportion of 38·28 to 61.72, while the preceding one contains one atom of each, and the ordinary artificial submuriate, one atom of chloride and three atoms of oxide of lead. It decrepitates slightly before the blow-pipe, and is easily melted; the globule is of a deeper yellow than the mineral. On charcoal it is reduced, and emits fumes of muriatic acid. Treated with peroxide of copper and salt of phosphorus, the flame assumes an intense blue colour. It has been found near Churchhill, in the Mendip hills in Somersetshire, in radiated masses engaged in Manganese-ores, and accompanied by several other Lead-barytes and rhombohedral Lime-haloide.

GENUS IV. ANTIMONY-BARYTE.

1. PRISMATIC ANTIMONY-BARYTE.

Prismatic White Antimony. **Jam.** Syst. Vol. II. p. 205.

Man. p. 113. White Antimony. Oxide of Antimony. Phill. p. 331. Weisspiesglaserz. Wern. Hoffm. H. B. IV. 1. S. 119. Spiessglanzweiss. Hausm. I. S. 341. Antimonblüthe. Leonh. S. 160. Antimoine oxidé. Haüy. Traité, T. IV. p. 273. Tabl. comp. p. 113. Traité, 2de Ed. T. IV. p. 308.

Fundamental form. Scalene four-sided pyramid. $P = 105° 38', 79° 44', 155° 17'$. Vol. I. Fig. 9.

$a : b : c = 10 : \sqrt{12{\cdot}5} : \sqrt{7{\cdot}77}$.

Simple forms. $P (P)$; $(\bar{P}r + \infty)^5 (M) = 136° 58'$, R. G.; $\breve{P}r - 1 (p) = 70° 32'$, Ap. $\breve{P}r + \infty$.

Char. of Comb. Prismatic.

Combinations. 1. $\breve{P}r - 1$. $(\bar{P}r + \infty)^3$. $\breve{P}r + \infty$. Sim. Fig. 9. Bräunsdorf, Saxony.

2. $\breve{P}r - 1$. P. $(\bar{P}r + \infty)^3$. $\breve{P}r + \infty$. Fig. 14. Bräunsdorf.

Cleavage. $(\bar{P}r + \infty)^3$ highly perfect, and easily obtained. Scarcely traces parallel to $\breve{P}r + \infty$. Fracture not observable. Surface $\breve{P}r - 1$ and P curved; $\breve{P}r + \infty$ smooth and even; $(\bar{P}r + \infty)^3$ very even, though sometimes a little rough.

Lustre adamantine, particularly upon the curved faces, upon $\breve{P}r + \infty$ often pearly lustre. Colour white prevalent, passing into peach-blossom-red and ash-grey. Streak white. Semi-transparent ... translucent.

Sectile. Hardness = 2·5 ... 3·0. Sp. Gr. = 5·566, the simple crystals from Bräunsdorf.

Compound Varieties. Crystals, compressed between $\breve{P}r + \infty$, are joined parallel to this face. If the individuals be very thin, the common varieties of this species are formed, which used to be considered as simple forms, and the faces of composition as faces of cleavage with a pearly lustre. In trying the experiment of ascertaining their hardness, we must be careful, on account of the crystals being very fragile. Massive: composition granular, lamellar, columnar; faces of composition of the granular individuals in general irregularly streaked.

OBSERVATIONS.

1. The present species I formerly included in the order Mica, as prismatic Antimony-mica. Owing to the compound state of the then known varieties, among others those from Przibram, and which was considered as cleavage, the true cleavage has long been overlooked, and the hardness examined in the same varieties indicated as less considerable than it is in nature. Simple varieties of the species have since been found at Bräunsdorf near Freiberg, which yielded the characters indicated above, and which have even served to simplify the Characteristic.

2. According to Vauquelin, the present species consists of

Oxide of Antimony	86·00.
Oxide of Antimony and Iron	3·00.
Silica	8·00.

It is pure oxide of antimony, $\dddot{\mathrm{Sb}}$, according to Berzelius, equal to 84·32 of metal, and 15·68 of oxygen. It is soluble in nitro-muriatic acid. It melts at the flame of a candle. Before the blowpipe, upon charcoal, it is entirely volatilised, and produces a white coating upon the support. It is frequently produced during chemical operations, and crystallised from sublimation. If metallic antimony is melted before the blowpipe, it emits fumes which crystallise round the globule, and at last cover it entirely. First yellowish octahedral crystals, probably of antimonious acid, are formed, and then a beautiful tissue of acicular prisms of oxide of antimony. They are sufficiently thin to reflect green and red colours, but admit nevertheless of being measured by means of the reflective goniometer.

3. It occurs in small quantities in veins, traversing primitive or greywacke rocks, associated with ores of lead and antimony, with dodecahedral Garnet-blende, rhombohedral Lime-haloide, and very often rhombohedral Quartz.

4. Beautiful, though generally compound varieties of aggregated tabular crystals, have been found at Przibram in Bohemia, prisms of considerable thickness at Bräunsdorf in Saxony. It is found also at Malaczka in Hungary, in Baden, in Nassau, and at Allemont in Dauphiny.

ORDER III. KERATE.

I. PEARL-KERATE.

1. HEXAHEDRAL PEARL-KERATE.

Hexahedral Corneous Silver. JAM. Syst. Vol. II. p. 350. Man. p. 90. Muriate of Silver. Horn Silver. PHILL. p. 295. Hornerz. WERN. Hoffm. H. B. III. 2. S. 51. Hornsilber. HAUSM. III. p. 1010. Silber-Hornerz. LEONH. S. 208. Argent muriaté. HAÜY. Traité, T. III. p. 418. Tabl. comp. p. 75. Traité, 2de Ed. T. III. p. 292.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. $\overset{*}{H}$, Johanngeorgenstadt, Saxony; $\overset{*}{O}$, Vol. I. Fig. 2., Siberia; $\overset{*}{D}$, Vol. I. Fig. 31. Siberia.

Char. of Comb. Tessular.

Combinations. 1. H. O. Vol. I. Fig. 3. and 4. Wheal Mexico, Cornwall.

2. H. D. Fig. 151. Johanngeorgenstadt.

Cleavage none. Fracture more or less perfect conchoidal. Surface of the hexahedron sometimes faintly streaked parallel to the edges of combination with the dodecahedron.

Lustre resinous, passing into adamantine. Faces of fracture often more splendent than those of crystallisation. Colour pearl-grey, passing on one hand into lavender-blue and violet-blue, on the other into greyish-, yellowish-, and greenish-white, into siskin-green, asparagus-green, pistachio-green, and leek-green. The colour becomes brown on being exposed to light. Streak shining. Translucent...feebly translucent on the edges.

Sectile. Hardness = 1·0 ... 1·5. Sp. Gr. = 5·552, a white granular variety from Peru.

Compound Varieties. In crusts: composition scarcely observable, sometimes columnar. Massive: composition granular, strongly coherent, or imperfect columnar, and often bent; faces of composition rough.

OBSERVATIONS.

1. KLAPROTH found two varieties of the present species, one from Saxony, and the other from Peru, to consist of

Silver	67·75	76·0.
Oxygen	6·75	7·6.
Muriatic Acid	14·75	16·4.
Oxide of Iron	6·00	0·0.
Alumina	1·75	0·0.
Sulphuric Acid	0·25	0·0.

The formula for its chemical composition is $\ddot{A}g\ \ddot{M}^2$, or 80·903 oxide of silver and 29·097 muriatic acid. It is fusible in the flame of a candle, and emits fumes of muriatic acid. Upon charcoal it may be almost entirely reduced before the blowpipe, and is likewise easily reduced if rubbed wet upon a clean surface of iron or zinc. It is insoluble in nitric acid or in water. It may be obtained in a crystallised state, either from fusion, or from the evaporation of a solution of muriate of silver in ammonia.

2. The present species is most frequently found in the upper parts of veins in clay-slate, but occurs also in beds, generally along with other ores of silver, very often also with ochry varieties of prismatic Iron-ore, or with similar varieties of decomposed Iron-pyrites. Sometimes, though as it seems not in veins, hexahedral Gold is found accompanying it. It is associated also with several species of the orders Malachite, Pyrites, Haloide, Baryte, &c.

3. Formerly it occurred in considerable quantities in the Saxon mining districts of Johanngeorgenstadt and Freiberg; also at Joachimsthal in Bohemia. In small quantities it is found in France, in Spain, at Kongsberg in Norway, in Cornwall, and Siberia; but in large masses, frequently associated with hexahedral silver, in Mexico and Peru, where particularly the green varieties of colours occur.

4. It is used for extracting silver.

2. PYRAMIDAL PEARL-KERATE.

Pyramidal Corneous Mercury. Jam. Syst. Vol. II. p. 356. Man. p. 91. Muriate of Mercury. Phill. p. 359. Quecksilber-Hornerz. Wern. Hoffm. H. B. III. 2. S. 25. Hornquecksilber. Hausm. III. S. 1017. Quecksilber-Hornerz. Leonh. S. 191. Mercure muriaté. Haüy, Traité, T. III. p. 447. Tabl. comp. 78. Traité, 2de Ed. T. III. p. 331.

Fundamental form. Isosceles four-sided pyramid. $P = 98° 4'$, $136° 0'$. Vol. I. Fig. 8. Brooke.

Simple forms. $\frac{2\sqrt{2}}{2}P - 3\ (a) = 138° 11', 60° 11'$; $\frac{2\sqrt{2}}{3}P - 2\ (c^1)$; $P\ (c^2) = 126° 31', 79° 3'$; $P + \infty\ (M)$; $[P + \infty]\ (d)$.

Char. of Comb. Pyramidal.

Combinations. 1. P. $[P + \infty]$. Sim. Fig. 97.

$2. \frac{2\sqrt{2}}{3} P - 3. \frac{2\sqrt{2}}{3} P - 2. P + \infty. [P + \infty).$
Sim. Fig. 102.

Cleavage $P + \infty$ very indistinct. Fracture perfect conchoidal. Surface smooth.

Lustre adamantine. Colour yellowish-grey or ash-grey, also yellowish- and greyish-white. Streak white. Translucent, sometimes only on the edges.

Sectile. Hardness = 1·0...2·0. Sp. Gr. = 6·482.

Compound Varieties. Crystalline coats, probably formed originally upon globules of fluid mercury: composition not observable. Massive: composition granular.

OBSERVATIONS.

1. The mixture of pyramidal Pearl-Kerate is expressed by $\dot{Hg}\,\ddot{M}$, which corresponds to

Oxide of Mercury	88·48.
Muriatic Acid	11·52.

Before the blowpipe, upon charcoal, it is entirely volatilised, if pure. According to Gmelin, it is not soluble in water.

2. This rare mineral occurs in the repositories of peritomous Ruby-blende in secondary rocks, sometimes upon veins of Iron-ore; it is accompanied by various ores of mercury, also by ochry varieties of prismatic Iron-ore, &c.

3. Its chief locality is Moschellandsberg in Deuxponts, but it occurs also at Idria in Carniola, and Almaden in Spain. At Horzowitz in Bohemia it has been found with peritomous Ruby-blende in veins traversing a bed of Iron-ore.

ORDER IV. MALACHITE.

GENUS I. STAPHYLINE[*]-MALACHITE.

1. UNCLEAVABLE STAPHYLINE-MALACHITE.

Common Copper-Green or Chrysocolla. Jam. Syst. Vol. II. p. 305. Uncleavable Copper-Green. Man. p. 92. Chrysocolla. Phill. p. 312. Kupfergrün. Eisenchüssig Kupfergrün. Wern. Hoffm. H. B. III. 2. S. 152. 155. Kieselmalachit. Hausm. III. S. 1029. Kiesel-Kupfer. Leonh. S. 289. Cuivre carbonaté vert (in part). Haüy. Traité, T. III. p. 571. Cuivre carbonaté vert terreux. Tabl. comp. p. 90. Cuivre hydrosiliceux ou Cuivre hydraté siliceux (in part). Traité, 2de Ed. T. III. p. 471.

Regular forms unknown. Cleavage none. Fracture conchoidal.

Colour, emerald-green, pistachio-green, asparagus-green, passing into sky-blue. If they incline to brown, the mineral is impure. Streak white, a little shining. Semi-transparent ... translucent on the edges.

Rather sectile. Hardness = 2·0 ... 3·0. Sp. Gr. = 2·031, a semi-transparent variety.

Compound Varieties. Botryoidal, reniform shapes or massive varieties: composition impalpable; fracture more or less perfectly conchoidal. Pseudomorphoses in the shape of octahedral Copper-ore, rhombohedral Euchlore-mica, &c. Impure varieties are often earthy.

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[*] From ϛαφυλὴ, the grape. The varieties hitherto known generally present botryoidal shapes.

OBSERVATIONS.

1. *Copper-Green* and *Ironshot Copper-Green*, into which the varieties of the present species used formerly to be distinguished, differ in nothing but the greater or less pureness of their substance. The latter of these, comprehending the dark-coloured and brown varieties, was again subdivided into *slaggy* and *earthy* ironshot copper-green, the one firm, and presenting a conchoidal fracture, the other earthy, and of a friable consistency. Some mineralogists unite the earthy varieties with the hemi-prismatic Habroneme-malachite, from which some of them may possibly derive their existence, and formerly all the varieties of it were comprehended by some within that species.

2. Two analyses, one by KLAPROTH, another by JOHN, have yielded

Copper	40·00	42·00.
Oxygen	10·00	7.63.
Silica	26·00	28·37.
Water	17·00	17·50.
Carbonic Acid	7·00	3·00.
Sulphate of Lime	0·00	1·50.

Before the blowpipe upon charcoal it first becomes black, in the inner flame red, without melting. With borax it melts into a green glassy globule, and is partly reduced, as the metallic particles shew, which this globule contains. If pure it is soluble without effervescence in nitric acid, and leaves a residue of silica.

3. The natural repositories of the present species are those of other ores of copper, where it is found along with them; and also with ochry varieties of prismatic Iron-ore, prismatic Hal-baryte, rhombohedral Quartz, &c.

4. It occurs at Saalfeld in Thuringia, at Lauterberg in the Hartz, at Saska and Moldawa in the Bannat, at Herrengrund in Lower Hungary, at Falkenstein and Schwatz in the Tyrol, in the Lizard district in Cornwall, in Norway, Siberia, Mexico, and Chili.

5. Where it occurs in sufficient quantity, it is used for extracting copper.

6. The only author who quotes crystals of the present species is the Abbé Haüy (*Traité*, 2*de Ed. T.* III. p. 471., and *Traité de Cryst. T.* II. p. 577.). Crystals of this species in fact may occur; yet those which he describes certainly cannot be varieties of it, if they possess a specific gravity = 2·733. The forms are described as being prismatic, in which the ratio of the lines a : b : c is = 1 : 2 : √2·5, the observed simple forms, P — ∞ (*P*); P + ∞ (*M*) = 103° 20′; P̆r (*l*) = 126° 52′; P̄r (*d*) = 115° 22′; P̄r + ∞ (*r*), and the combinations: 1. P̆r. P + ∞. Sim. Fig. 2.; 2. P — ∞. P + ∞. P̄r + ∞; 3. P̄r. P + ∞. P̄r + ∞. Sim. Fig. 9. Cleavage is said to take place parallel to P + ∞. The crystals are from Catharinenburg in Siberia, and very rare.

The natural-historical determination of a species, besides a knowledge of its forms, requires also the accurate investigation of hardness and specific gravity. The latter does not agree with that of uncleavable Staphyline-malachite; the former has been passed over in silence. Much is therefore still wanting for a complete determination of the species to which the crystals belong, which have been described.

GENUS II. LIROCONE*-MALACHITE.

1. PRISMATIC LIROCONE-MALACHITE.

Di-prismatic Olivenite or Lenticular Copper. Jam. Syst. Vol. II. p. 333. Prismatic Liriconite. Man. p. 94. Octahedral Arseniate of Copper. Phill. p. 316. Linsenerz. Wern. Hoffm. H. B. III. 2. S. 165. Linsenkupfer. Hausm. III. S. 1051. Linsenerz. Leonh. S. 282. Cuivre arséniaté primitif. Haüy. Tabl. comp. p. 90. Cuivre arséniaté octaèdre obtus. Traité, 2de Ed. T. III. p. 509.

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* From λειρὸς pale, and κονία dust or powder.

Fundamental form. Scalene four-sided pyramid. $P = 129° 25', 85° 11', 116° 40'$. Vol. I. Fig. 9. AP.

$$a : b : c = 1 : \sqrt{0{\cdot}5085} : \sqrt{1{\cdot}51}.$$

Simple forms. $\bar{P}r\ (o) = 71° 59'$; $P + \infty\ (d) = 119° 45'$.

Char. of Comb. Prismatic.

Combination. 1. $\bar{P}r$. $P + \infty$. Fig. 1.

Cleavage, $\bar{P}r$ and $P + \infty$ imperfect, the first rather more distinct. Fracture imperfect conchoidal, uneven. Surface of both forms faintly streaked parallel to their edges of combination.

Lustre vitreous, inclining to resinous. Colour sky-blue ... verdigris-green. Streak corresponding to the colour, very pale. Semi-transparent ... translucent.

Nearly sectile. Hardness = 2·0...2·5. Sp. Gr. = 2·926.

Compound Varieties. Massive: composition granular, sometimes very distinct, but altogether rare.

OBSERVATIONS.

1. According to CHENEVIX, the prismatic Lirocone-malachite consists of

Oxide of Copper	49·00.
Arsenic Acid	14·00.
Water	35·00.

Before the blowpipe it loses both colour and transparency, emits fumes of arsenic, and is changed into a friable scoria, containing some white metallic globules. With borax it yields a green globule, and is partly reduced. In nitric acid it is soluble without effervescence.

2. The varieties of the present species occur in copper veins along with various other ores of copper, also with prismatic Iron-ore, rhombohedral Quartz, hexahedral Iron-pyrites, &c.

3. It has been hitherto found only in some of the copper mines near Redruth in Cornwall, and in minute crystals at Herrengrund in Hungary.

2. HEXAHEDRAL LIROCONE-MALACHITE.

Hexahedral Olivenite or Cube-Ore. JAM. Syst. Vol. II. p. 341. Hexahedral Liriconite. Man. p. 95. Arseniate of Iron. PHILL. p. 241. Würfelerz. WERN. Hoffm. H. B. III. 2. S. 177. Pharmakosiderit. HAUSM. III. S. 1066. Arseniksaures Eisen. LEONH. S. 363. Fer arseniaté. HAÜY. Tabl. comp. p. 100. Traité, 2de Ed. T. IV. p. 135.
PHILLIPS. Trans. Geol. Soc. Vol. I. p. 23.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. H; O, Vol. I. Fig. 2; D, Vol. I. Fig. 31. B, Vol. I. Fig. 33.

Char. of Comb. Semi-tessular with inclined faces. $\pm\frac{O}{2}$, Vol. I. Figs. 13. 14.; $\pm\frac{B}{2}$, Vol. I. Figs. 17. 18.

Combinations. 1. H. $\frac{O}{2}$. 2. H. $\frac{B}{2}$.

3. H. $\frac{O}{2}$. $\frac{B}{2}$. 4. H. $\frac{O}{2}$. D. $\frac{B}{2}$. $-\frac{B}{2}$.

Cleavage. Hexahedron, difficult and imperfect. Fracture conchoidal, uneven. Surface of the hexahedron sometimes streaked parallel to the edges of combinations with the tetrahedron. The other faces, with exception of the dodecahedron, often curved.

Lustre adamantine, not very distinct. Colour olive-green, passing into yellowish-brown bordering sometimes upon hyacinth-red and blackish-brown; also into grass-green and emerald-green. Streak olive-green ... brown, commonly pale. Translucent on the edges.

Rather sectile. Hardness = 2·5. Sp. Gr. = 3·000, BOURNON.

Compound Varieties. Massive: composition granular, rare.

OBSERVATIONS

1. The hexahedral Lirocone-malachite consists of

Oxide of Iron	45·50	48·00.
Arsenic	31·00	18·00.
Oxide of Copper	9·00	0·00.
Silica	4·00	0·00.
Carbonate of Lime	0·00	2·00.
Water	10·50 CHENEVIX.	32·00. VAUQUELIN.

Exposed to a gentle heat, its colour is changed into red. In a higher degree of temperature it intumesces, gives little or no arsenic, and leaves a red powder. Upon charcoal it emits copious fumes of arsenic, and melts in the inner flame into a metallic scoria, which acts upon the magnetic needle.

2. The chief repositories of this Malachite are veins of copper ores in the older classes of rocks, where it is accompanied by prismatic Copper-glance and pyramidal Copper-pyrites, by prismatic Iron-ore, often in ochrey varieties, and by rhombohedral Quartz.

3. It is principally found in Cornwall, in several copper-mines in the neighbourhood of Redruth; but has been

found also at St Leonhard in France, and at Schwarzenberg in Saxony.

Genus III. OLIVE-MALACHITE.

1. PRISMATIC OLIVE-MALACHITE.

Acicular Olivenite. Jam. Syst. Vol. II. p. 335. Prismatic Olivenite, (excepting the first sub-species) Man. p. 96. Right Prismatic Arseniate of Copper. Phill. p. 319. Olivenerz. Wern. Hoffm. H. B. III. 2. S. 170. Olivenkupfer. Hausm. III. S. 1045. Olivenit. Leonh. S. 283. Cuivre arseniaté (in part). Haüy. Traité, T. III. p. 575. Cuivre arseniaté octaèdre aigu. Tabl. comp. p. 91. Traité, 2de Ed. T. III. p. 510.

Fundamental form. Scalene four-sided pyramid. Vol. I. Fig. 9.

Simple forms. $P + \infty$ (r) $= 92^\circ\ 30'$, Phill.; $\breve{P}r$ (l) $= 110^\circ\ 50'$, Phill.; $\breve{P}r + \infty$ (n); $\bar{P}r + \infty$.

Char. of Comb. Prismatic.

Combinations. 1. $\breve{P}r$. $P + \infty$. $\bar{P}r + \infty$. Fig. 8.
2. $\breve{P}r$. $P + \infty$. $\breve{P}r + \infty$. $\bar{P}r + \infty$.

Cleavage. Traces parallel to $\breve{P}r$ and $P + \infty$, the former being a little more distinct. Fracture conchoidal, uneven. Surface, $\breve{P}r$ and $\bar{P}r + \infty$ concave, $P + \infty$ convex, the faces parallel to the axis being curved in the direction of the same line. At the same time uneven. $\breve{P}r + \infty$ very smooth and even.

Lustre adamantine, indistinct. Colour, various shades of olive-green, passing into leek-green, pistachio-green and blackish-green, into liver-brown and wood-brown, or also into siskin-green.

Streak olive-green ... brown. Semi-transparent ... opake.

Brittle. Hardness = 3·0. Sp. Gr. = 4·2809. BOURNON.

Compound Varieties. Globular and reniform shapes: surface rough, sometimes drusy; composition columnar, generally very perfect, straight and divergent, rarely promiscuous. If the composition be very thin, the lustre becomes pearly. Massive: composition columnar. Sometimes repeated composition; granular and columnar; curved lamellar and columnar. The faces of the first composition rough, of the second composition smooth.

OBSERVATIONS.

1. The prismatic Olive-malachite has been found to consist of

Oxide of Copper	50·62	50·00.
Arsenic Acid	45·00	29·00.
Water	3·50 KLAPROTH.	21·00. CHENEVIX.

Alone it remains unchanged before the blowpipe. Upon charcoal it melts, with a kind of deflagration, and is reduced. A white metallic globule is formed, which in the process of cooling becomes covered with a red coating of sub-oxide of copper. In some varieties a scoria is formed round the metallic globule. This mineral is soluble in nitric acid.

2. It is found in veins, chiefly consisting of various ores of copper and rhombohedral Quartz. It is accompanied by these, and by prismatic Iron-ore and decomposed Iron-pyrites.

3. It occurs in the copper mines near Redruth in Cornwall, and has been lately discovered in Tynehead mine, near Alstonmoor in Cumberland.

2. DI-PRISMATIC OLIVE-MALACHITE.

Prismatic Olivenite, or Phosphate of Copper (in part). JAM. Syst. Vol. II. p. 331. Di-prismatic Olivenite. Man. p. 98. Phosphate of Copper. PHILL. p. 314. Olivenerz (in part). WERN. Hoffm. H. B. III. 2. S. 170. Blättriger Pseudomalachit (in part). HAUSM. III. S. 1036. Phosphorsaures Kupfer (in part). LEONH. S. 273. Cuivre phosphaté (in part). HAÜY. Tabl. comp. p. 92. Traité, 2de Ed. T. III. p. 519.

Fundamental form. Scalene four-sided pyramid. $P = 122° \, 58', 117° \, 8', 89° \, 59'$. Vol. I. Fig. 9. LEONH.

$$a : b : c = 1 : \sqrt{2{\cdot}194} : \sqrt{1{\cdot}839}.$$

Simple forms. P (P); $(\check{P}r)^3$. $P + \infty$ $(u) = 95° \, 2'$; $(\bar{P}r + \infty)^3 = 130° \, 48'$; $\check{P}r$ $(o) = 111° \, 58'$.

Char. of Comb. Prismatic.

Combinations. 1. $\check{P}r. \; P + \infty$. Sim. Fig. 2.
2. $\check{P}r. \; P. \; P + \infty$. Fig. 5.

Cleavage, indistinct traces parallel to $\check{P}r$ and $P + \infty$. Fracture conchoidal, uneven. Surface of P very smooth and even; $\check{P}r$ striated parallel to its edges of combination with P, $P + \infty$ in a vertical direction, often uneven.

Lustre resinous. Colour olive-green, generally dark. Streak olive-green. Translucent on the edges.

Brittle. Hardness = 4·0. Sp. Gr. = 3·6 ... 3·8.

OBSERVATIONS.

1. According to BUCHOLZ, the present species consists of phosphate of copper; but no accurate analysis of it has yet been published. Mineralogists are not entirely agreed respecting its classification. Some unite it with the preceding species, others with the prismatic Habroneme-

malachite. Even though we should not pay attention to the geometrical characters, hardness and specific gravity would be sufficient for their distinction.

2. It occurs engaged in cavities of rhombohedral Quartz, and associated with pyramidal Copper-pyrites, in a bed in primitive rocks, at Libethen near Neusohl in Hungary; also at Gunnislake in Cornwall.

GENUS IV. AZURE-MALACHITE.

1. PRISMATIC AZURE-MALACHITE.

Blue Copper or Prismatic Malachite. JAM. Syst. Vol. II. p. 313. Prismatic Blue Malachite. Man. p. 98. Blue Carbonate of Copper. PHILL. p. 309. Kupferlasur. WERN. Hoffm. H. B. III. 2. S. 134. Kupferlasur. HAUSM. III. S. 1020. Kohlensaures Kupfer (in part). LEONH. S. 276. Cuivre carbonaté bleu. HAÜY. Traité, T. III. p. 562. Tabl. comp. p. 89. Cuivre carbonaté (in part). Traitè, 2de Ed. T. III. p. 488.
CORDIER. Ann. des Mines. Vol. IV. p. 3.

Fundamental form. Scalene four-sided pyramid. $P = \left\{ \begin{matrix} 116^\circ\ \ 7' \\ 118^\circ\ 16' \end{matrix} \right\}$, 107° 22′, 104° 7′. Inclination of the axis = 2° 21′ in the plane of the short diagonal. Vol. I. Fig. 41. R. G.

$$a : b : c : d = 24{\cdot}30 : 25{\cdot}25 : 28{\cdot}70 : 1.$$

Simple forms $P - \infty\ (s)$; $\pm \frac{P}{2} \left\{ \begin{matrix} x \\ x' \end{matrix} \right\} = \left\{ \begin{matrix} 116^\circ\ \ 7' \\ 118^\circ\ 16' \end{matrix} \right\}$; $P + \infty\ (f) = 97^\circ\ 24'$; $-\frac{(\check{P}r - 1)^3}{2}\ (k)$; $(\check{P}r + \infty)^3\ (P) = 59^\circ\ 14'$; $(\check{P}r + \infty)^5\ (l) = 119^\circ\ 18'$; $\frac{(\bar{P}r - 1)^6}{2}\ (e)$; $\frac{(\check{P}r - 1)^7}{2}\ (d)$; $\check{P}r - 1\ (g) = 134^\circ\ 7'$; $\check{P}r\ (M) = 99^\circ\ 32'$;

$\breve{P}r + \infty$; $\pm \frac{\bar{P}r - 1}{2} \left\{ \begin{matrix} v \\ b \end{matrix} \right\} = \left\{ \begin{matrix} 66° \, 12' \\ 62° \, 23' \end{matrix} \right\}$; $\pm \frac{\bar{P}r}{2}$ $\left\{ \begin{matrix} a \\ c \end{matrix} \right\} = \left\{ \begin{matrix} 47° \, 17' \\ 44° \, 52' \end{matrix} \right\}$; $\bar{P}r + \infty$ (h).

Char. of Comb. Hemi-prismatic. Inclination of $P - \infty$ to $\bar{P}r + \infty = 87° \, 39'$.

Combinations. 1. $\breve{P}r$. $\bar{P}r + \infty$. Chessy, France.

2. $\breve{P}r$. $- \frac{(\breve{P}r - 1)^5}{2}$. $\bar{P}r + \infty$. Chessy.

3. $P - \infty$. $\frac{(\breve{P}r - 1)^7}{2}$. $(\breve{P}r + \infty)^3$. $\bar{P}r + \infty$. Fig. 63. Bannat.

4. $P - \infty$. $\frac{\bar{P}r}{2}$. $\frac{P}{2}$. $\breve{P}r$. $- \frac{(\breve{P}r - 1)^5}{2}$. $\bar{P}r + \infty$. Fig. 64. Chessy.

5. $P - \infty$. $\frac{\bar{P}r}{2}$. $\breve{P}r$. $- \frac{\bar{P}r - 1}{2}$. $- \frac{(\breve{P}r - 1)^3}{2}$. $(\breve{P}r + \infty)^3$. $(\bar{P}r + \infty)^5$. $\bar{P}r + \infty$. Fig. 65. Chessy.

6. $P - \infty$. $\frac{\bar{P}r}{2}$. $\frac{P}{2}$. $\frac{(\breve{P}r - 1)^7}{2}$. $\frac{(\breve{P}r - 1)^6}{2}$. $\bar{P}r - 1$. $\breve{P}r$. $- \frac{(\breve{P}r - 1)^3}{2}$. $- \frac{\bar{P}r}{2}$. $P + \infty$. $(\breve{P}r + \infty)^3$. $(\bar{P}r + \infty)^5$. $\bar{P}r + \infty$. Fig. 66. Chessy.

Cleavage. $(\breve{P}r + \infty)^3$ perfect, but interrupted by conchoidal fracture. Less distinct, $P - \infty$; imperfect in the direction of $\breve{P}r$. Fracture conchoidal. Surface, $P - \infty$ sometimes streaked parallel to the edges of combination with

$\bar{P}r + \infty$, $\bar{P}r + \infty$ parallel to those with $P - \infty$ or also with $P + \infty$. The faces of some of the forms, as of $\frac{\bar{P}r - 1}{2}$, and of $\frac{(\breve{P}r - 1)^3}{2}$ rough. $\bar{P}r + \infty$ sometimes concave, the greater part of the other faces even and smooth.

Lustre vitreous, almost adamantine. Colour various shades of azure-blue, passing into blackish-blue and berlin-blue. Streak blue, lighter than the colour. Transparent ... translucent on the edges.

Brittle. Hardness $= 3{\cdot}5 \ldots 4{\cdot}0$. Sp. Gr. $= 3{\cdot}831$, crystals from Chessy.

Compound Varieties. Twin-crystals: face of composition parallel, axis of revolution perpendicular to $\frac{\bar{P}r}{2}$.* Globular, reniform, botryoidal, stalactitic shapes, implanted and imbedded: surface drusy and rough; composition columnar, more or less perfect and distinct, faces of composition generally rough. Massive: composition columnar, more rarely granular. Sometimes there is another curved lamellar composition, the curved faces of which often possess a darker colour than the rest, and are covered with asperities. Rarely in an earthy state.

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* A beautiful specimen of this rare variety is preserved in the cabinet of Mr ALLAN.

OBSERVATIONS.

1. From a comparison of the general description given of the present species and of hemi-prismatic Habroneme-malachite, or even from that of their characters, as given in the Characteristic, it appears that they cannot be united within one and the same species, as has been done by several celebrated mineralogists, who founded their opinion chiefly on the agreement of the chemical analyses. In other respects, the present and the former determinations differ only in regard to the establishment of *Earthy Blue Copper* into a particular sub-species, and the division of the rest of the varieties, or the *Radiated Blue Copper*, according to their mechanical composition.

2. Two analyses of the present species, one by KLAPROTH, the other by VAUQUELIN, have yielded

Copper	56·00	56·00.
Oxygen	14·00	12·50.
Carbonic Acid	24·00	25·00.
Water	6·00	6·50.

Its chemical formula is $\ddot{C}u\ Aq^2 + 2\ \ddot{C}u\ \ddot{C}^2$, corresponding to 69·16 oxide of copper, 25·61 carbonic acid, and 5·23 of water. It is soluble with effervescence in nitric acid, becomes black if exposed alone to high degrees of temperature, melts upon charcoal, and colours glass of borax green in the oxidating flame.

3. It is met with in veins and beds, included in rocks of different ages. It is generally accompanied by other ores of copper, and among these principally by hemi-prismatic Habroneme-malachite, with which it is often intimately connected, so that crystals of the form of the present species, consist entirely, or at least with only the exception of a thin film on the surface, of the delicate green fibres of the hemi-prismatic Habroneme-malachite. It is often engaged in ochrey varieties of prismatic Iron-ore, and associated with di-prismatic Lead-baryte, sometimes with hexahedral Lead glance, and prismatic Cobalt-mica; besides also with prismatic Hal-baryte, rhombohedral Quartz, rhombo-

hedral Lime-haloide, &c. In veins it is generally found in the higher levels.

4. Most beautiful varieties, particularly crystallised ones, have lately been found in a bed in secondary mountains at Chessy near Lyons in France. Also in Siberia, very fine crystals have been obtained. Those from the Bannat, though of a smaller size, are often very distinct. Fine crystallised varieties occur at Wheal Buller, near Redruth in Cornwall. Prismatic Azure-malachite occurs, besides, at Saalfeld in Thuringia, in Mansfeld, in Hessia, in Würtemberg, in the Hartz, in Silesia, at Schwatz in the Tyrol, in Spain, Chili, &c. The earthy blue copper is chiefly known from Thuringia, Hessia, and from the Hartz.

5. Wherever it occurs in sufficient quantities, it is an useful mineral for extracting copper.

GENUS V. EMERALD-MALACHITE.

1. RHOMBOHEDRAL EMERALD-MALACHITE.

Rhombohedral Emerald Copper or Dioptase. JAM. Syst. Vol. II. p. 347. Rhomboidal Emerald-Malachite. Man. p. 100. Dioptase. Emerald Copper. PHILL. p. 312. Kupfersmaragd. WERN. Hoffm. H. B. III. 2. S. 158. Dioptas. HAUSM. III. S. 1032. Kupfer-Smaragd. LEONH. S. 288. Dioptase. HAÜY. Traité, T. III. p. 136. Cuivre dioptase. Tabl. comp. p. 91. Traité, 2de Ed. T. III. p. 477.

Fundamental form. Rhombohedron. $R = 126°\ 17'$. Vol. I. Fig. 7. PHILL.

$$a = \sqrt{0{\cdot}8413}.$$

Simple forms. $R + 1\ (r) = 95°\ 48'$; $P + \infty\ (s)$.

Char of Comb. Rhombohedral, as to the simple forms observed, but the striæ upon the faces of R seem to indicate a hemi-rhombohedral character.

Combination. 1. $R.\ P + \infty$. Fig. 118.

Cleavage. R, perfect. Fracture conchoidal, uneven. Surface streaked parallel to the edges of combination, inclined upon R, either to the right or to the left.

Lustre vitreous inclining to resinous. Colour, emerald-green, also blackish-green, and verdigris-green. Streak green. Transparent...translucent.

Brittle. Hardness = 5·0. Sp. Gr. = 3·278.

OBSERVATIONS.

1. Two analyses, one by Lowitz, another by Vauquelin, have yielded,

Oxide of Copper	55·00	25·57.
Carbonate of Lime	0·00	42·85.
Silica	33·00	28·57.
Water	12·00	0·00.

It decrepitates before the blowpipe, and upon charcoal it becomes black in the exterior flame, and red in the interior one, without melting. It is easily soluble in glass of borax, and imparts to it a green colour. It is soluble without effervescence in muriatic acid.

2. It has been found accompanied by hemi-prismatic Habroneme-malachite and rhombohedral Lime-haloide, but the nature of its original repositories is not known. It occurs in the Kirghese steppes, from whence it was brought by Achir Mehemet, a Bucharian merchant, and named in consequence *Achirite*. According to Mr Phillips, it occurs in minute crystals with the prismatic Zinc-baryte from Rezbanya in Hungary.

GENUS VI. HABRONEME*-MALACHITE.

1. PRISMATIC HABRONEME-MALACHITE.

Prismatic Olivenite or Phosphate of Copper. Jam. Syst. Vol. II. p. 331. Prismatic Green Malachite. Man. p. 101. Hydrous Phosphate of Copper. Phill. p. 315. Phosphorkupfererz (in part). Wern. Hoffm. H. B. III. 2. S. 183. Pseudomalachit. Hausm. III. S. 1036. Phosphorsaures Kupfer (in part). Leonh. S. 273. Cuivre phosphaté (in part). Haüy. Tabl. comp. p. 90. Traité, 2de Ed. T. III. p. 519.

Fundamental form. Scalene four-sided pyramid. P = 117° 49′, 137° 10′, 101° 32′. Inclination of the axis in the plane of the long diagonal = 0. Vol. I. Fig. 41. Ap.

$$a : b : c : d = 2 : 3\sqrt{2} : 3 : 0.$$

Simple forms. $P - \infty$ (*a*); $\frac{P}{2}$ (*P*) = 117° 49′; $-\frac{(\bar{P}r - 1)^3}{2}$ (*d*); $(\bar{P}r + \propto)^3$ (*f*) = 38° 56′; $\bar{P}r$ (*o*) = 112° 37′; $\pm\frac{\check{P}r - 1}{2}$ $\left\{\begin{matrix} b \\ b' \end{matrix}\right\} = \left\{\begin{matrix} 76^\circ\ 34' \\ 76^\circ\ 34' \end{matrix}\right\}$; $\check{P}r + \infty$ (*e*).

Char. of Comb. Hemi-prismatic.

Combinations. 1. $P - \infty.\ \frac{P}{2}.\ (\bar{P}r + \infty)^3.$

2. $P - \infty.\ \frac{\check{P}r - 1}{2}.\ \frac{P}{2}.\ (\bar{P}r + \infty)^3.\ \check{P}r + \infty.$

3. $P - \infty.\ \frac{\check{P}r - 1}{2}.\ \frac{P}{2}.\ \bar{P}r.\ -\frac{\bar{P}r - 1}{2}.$

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[*] From ἁβρὸς, delicate, and νῆμα, the thread or fibre.

$-\frac{(\bar{P}r - 1)^3}{2}$. $(\bar{P}r + \infty)^3$. $\check{P}r + \infty$. Fig. 71. All of them from the Rhine.

Cleavage. Slight indications parallel to $-\frac{\check{P}r - 1}{2}$ and $\check{P}r + \infty$. Fracture small conchoidal, uneven. Surface $P - \infty$ and $\frac{P}{2}$ a little rough, though even; $(\bar{P}r + \infty)^3$ smooth and uneven, $-\frac{(\bar{P}r - 1)^3}{2}$ curved, the rest of the faces smooth and even.

Lustre adamantine, inclining to vitreous. Colour, emerald-green, verdigris-green, blackish-green, often darker on the surface. Streak green, a little paler than the colour. Translucent, often only on the edges.

Brittle. Hardness = 4·5 ... 5·0. Sp. Gr. = 4·205, a crystallised variety from Rheinbreitbach near Bonn.

Compound Varieties. Reniform, rather imperfect: composition imperfect columnar; surface drusy, and often of a darker colour. Massive: composition as above.

OBSERVATIONS.

1. Formerly the varieties of di-prismatic Olive-malachite were confounded with the present species, as has been observed above (p. 166). Count BOURNON gives the angle of the prism $P + \infty = 110°$, according to the preceding dimensions it would be $= 109° 28'$. Yet the angles

require perhaps some correction from admeasurements of better pronounced crystals. Those to which the above description refers, are preserved in the Wernerian collection at Freiberg. Messrs LEVY, PHILLIPS, and BROOKE, have also observed the hemiprismatic character of combinations. Mr BROOKE gives the angle of the prism $(\bar{P}r + \infty)^3 = 37° 30'$, but likewise from imperfect crystals.

2. Two analyses of the variety from the Rhine have yielded,

Oxide of Copper	68·13	62·847.
Phosphoric Acid	30·95	21·687.
Water	0·00 KLAPROTH.	15·454. LUNN. Ed. Ph. Journ. Vol. V. p. 213.

Before the blowpipe it melts and boils easily, and is converted into a small vesicular metalloidal globule. It is soluble without effervescence in nitric acid, particularly if heated.

3. The prismatic Habroneme-malachite is found in veins traversing greywacke slate, and is accompanied by several varieties of rhombohedral Quartz, and ores of copper, as in the Virneberg near Rheinbreitbach on the Rhine.

2. HEMI-PRISMATIC HABRONEME-MALACHITE.

Malachite. JAM. Syst. Vol. II. p. 321. Di-prismatic Green Malachite or Common Malachite. Man. p. 102. Green Carbonate of Copper. PHILL. p. 310. Malachit. WERN. Hoffm. H. B. III. 2. S. 144. Malachit. HAUSM. III. S. 1025. Kohlensaures Kupfer (in part). LEONH. S. 276. Cuivre carbonaté vert. HAÜY. Traité, T. III. p. 571. Tabl. comp. p. 90. Cuivre carbonaté (in part). Traité, 2de Ed. T. III. p. 488.

Fundamental form. Scalene four-sided pyramid. P = 139° 17′, 127° 25′, 68° 33′. Inclination of the axis in the plane of the short diagonal = 0. Vol. I. Fig. 41. AP.

$$a : b : c : d = 1 : \sqrt{5\cdot64} : \sqrt{3\cdot48} : 0$$

Simple forms. $\mathrm{P}-\infty$; $\frac{\mathrm{P}}{2} = 139° 17'$; $\mathrm{P}+\infty$ $(M) = 103° 42'$; $-\frac{\bar{\mathrm{P}}\mathrm{r}}{2}$ $(p) = 61° 49'$; $\bar{\mathrm{P}}\mathrm{r}+\infty$ (s).

Char. of Comb. Hemi-prismatic.

Combinations. 1. $\mathrm{P}-\infty$. $\mathrm{P}+\infty$. $\bar{\mathrm{P}}\mathrm{r}+\infty$. Chessy.

2. $-\frac{\bar{\mathrm{P}}\mathrm{r}}{2}$. $\mathrm{P}-\infty$. $\bar{\mathrm{P}}\mathrm{r}+\infty$. Chessy.

3. $\mathrm{P}-\infty$. $\frac{\mathrm{P}}{2}$. $\mathrm{P}+\infty$. $\bar{\mathrm{P}}\mathrm{r}+\infty$. Chessy.

Cleavage. Highly perfect in the direction of $-\frac{\bar{\mathrm{P}}\mathrm{r}}{2}$ and of $\breve{\mathrm{P}}\mathrm{r}+\infty$, the former, however, still more easily obtained. Fracture conchoidal, uneven, scarcely observable in crystallised varieties. Surface, $\mathrm{P}-\infty$ rough; $\frac{\mathrm{P}}{2}$ curved; $\bar{\mathrm{P}}\mathrm{r}+\infty$ sometimes vertically streaked. The rest of the faces smooth.

Lustre adamantine, inclining to vitreous. Colour grass-green, emerald-green, verdigris-green. Streak green, rather paler than the colour. Translucent, sometimes only on the edges.

Brittle. Hardness $= 3{\cdot}5 \ldots 4{\cdot}0$. Sp. Gr. $= 4{\cdot}008$ a cleavable variety from Chessy.

Compound Varieties. Twin crystals: axis of revolution perpendicular, face of composition parallel to $\bar{\mathrm{P}}\mathrm{r}+\infty$. Fig. 78. This composition occurs in almost every variety, and even in those masses which consist of columnar particles of composition. It then seems as if both the faces belonging to a horizontal prism were present, forming a dihedral termination of each individual, of 123° 37′, while in fact there exists only one of them. Fascicular aggregations of delicate crystals. Tuberose, globular, reniform, botryoidal, and stalactitic shapes: surface drusy, rough, sometimes smooth; composition columnar, generally very thin, often impalpable. Very thin columnar composition produces a satiny lustre; impalpable composition is the cause of conchoidal fracture. Massive: composition as above. The composition is often repeated; granularly compound masses consist of columnar ones radiating from a centre; curved lamellar ones are likewise composed of thin columnar individuals. The surface of the second composition is often rough, and particularly in curved lamellar compositions, covered with a white coating.

OBSERVATIONS.

1. The species of *Malachite* has been divided into *fibrous* and *compact* Malachite. If the columnar particles of composition decrease in size, the fibrous Malachite is gradually converted into compact Malachite, which therefore is always a compound mineral. These two kinds pass insensibly into each other, and it is often difficult to tell, to which of them a specimen occurring in nature should be referred.

2. Two analyses of hemi-prismatic Habroneme-malachite, one by KLAPROTH, and another by VAUQUELIN, have yielded,

Copper	58·00	56·10.
Oxygen	12·50	14·00.
Carbonic Acid	18·00	21·25.
Water	11·50	8·75.

Its chemical formula is $\ddot{\mathrm{C}}\mathrm{u}\,\ddot{\mathrm{C}} + \mathrm{Aq}$, which requires 71·886 oxide of copper, 19·962 carbonic acid, and 8·208 water. It is soluble without residue in nitric acid. Before the blowpipe it decrepitates, becomes black, and is partly infusible, partly converted into a black scoria. It is easily dissolved in glass of borax, imparts to it a deep green colour, and yields a globule of metallic copper.

3. It occurs in the same repositories as prismatic Azure-malachite, by which it is often accompanied. Beautiful varieties of fibrous Malachite are found at Chessy in France, in Siberia, and at Moldawa in the Bannat of Temeswar; the compact Malachite is chiefly known from Schwatz in the Tyrol. It occurs, besides, in small quantities in Cornwall, Wales, and various other countries.

4. Several varieties, that are sufficiently compact, are cut into vases, snuff-boxes, ring-stones, and other ornaments. Others are used as pigments. If it occurs in considerable quantities, it is a valuable ore for extracting copper.

ORDER V. MICA.

GENUS I. EUCHLORE*-MICA.

1. RHOMBOHEDRAL EUCHLORE-MICA.

Prismatic Copper Mica. Jam. Syst. Vol. II. p. 184. Hemi-prismatic Copper-Mica. Man. p. 106. Rhomboidal Arseniate of Copper. Phill. p. 317. Kupferglimmer. Wern. Hoffm. H. B. III. S. 162. Kupferglimmer. Hausm. III. S. 1043. Kupferglimmer.

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* From εὔχλωρος, bright, lively green.

Leonh. S. 286. Cuivre arseniaté lamelliforme. **Haüy.** Traité, T. III. p. 578. Tabl. comp. p. 90. Cuivre arseniaté hexagonal lamelliforme. Traité, 2de Ed. T. III. p. 509.
Brooke. Ed. Phil. Journ. Vol. VI. p. 132.

Fundamental form. Rhombohedron. R = 68° 45′. Vol. I. Fig. 7. **Brooke.**

$$a = \sqrt{22 \cdot 26}.$$

Simple forms. $R - \infty$ (o); R (R); $P + \infty$.

Char. of Comb. Rhombohedral.

Combinations. 1. $R - \infty$. R. Fig. 119. Tingtang, Cornwall. 2. $R - \infty$. R. $R + \infty$. Tingtang.

Cleavage. $R - \infty$ highly perfect. Traces of R. Fracture conchoidal, scarcely observable. Surface, $R - \infty$ smooth, sometimes striated in triangular directions. R often a little uneven.

Lustre pearly upon $R - \infty$, both as faces of cleavage, and as faces of crystallisation. The faces R possess a lustre intermediate between vitreous and adamantine. Colour emerald-green, grass-green. Streak emerald-green ... apple-green, rather paler than the colour. Transparent ... translucent.

Sectile. Hardness = 2·0. Sp. Gr. = 2·5488, **Bournon.**

Compound Varieties. Massive: composition granular of various sizes of individuals; faces of composition uneven and rough.

OBSERVATIONS.

1. According to Mr **Brooke**, the terminal edge of R is

between 68° 38′ and 68° 53′, the mean term of which is 68° 45′, as given above. Besides the forms mentioned there, he likewise indicates an obtuse rhombohedron, in parallel position with R, having a terminal edge of 179° 30′, which possesses brilliant planes and sharp edges, but "is not easily reduced to the common laws of decrement." Obtuse rhombohedrons of this kind, and also pyramids, occur in nature, but they have not yet been sufficiently described. They are easily explained upon the supposition of the series of forms existing in the crystalline series of a species. If we attend only to the principal series, we have R — 8 = 178° 47′ in parallel position, R — 9 = 179° 23′ in transverse position, R — 10 = 179° 42′, again *in parallel position.* Considering the uncertainty of the angles of R, for Mr Phillips gives them as 69° 12′, and the same measurement quoted in Mr Brooke's *Introduction to Crystallography* is 69° 30′, and the difficulty of obtaining a perfectly accurate result also from the admeasurement of the obtuse angle, it is impossible to decide whether and which member of the series the observed rhombohedron should be.

2. The rhombohedral Euchlore-mica consists of

Oxide of Copper	39·00	58·00.
Arsenic Acid	43·00	21·00.
Water	17·00 Vauquelin.	21·00. Chenevix.

It decrepitates before the blowpipe, is transformed into a black spongy scoria, and then melts into a black globule, having almost no vitreous appearance.

3. It is found in copper veins traversing killas, associated with various ores of copper, particularly of the order Malachite, also with ochrey varieties of prismatic Iron-ore and rhombohedral Quartz.

4. Several of the copper-mines in the vicinity of Redruth in Cornwall, as Tingtang, Wheal Gorland, Wheal Unity, &c. have yielded varieties of the present species.

2. PRISMATIC EUCHLORE-MICA.

Kupferschaum. Wern. Letztes Mineral-System. S. 19. 50.

Fundamental form. Scalene four-sided pyramid of unknown dimensions. Vol. I. Fig. 9.

Simple forms. $P - \infty$; $P + \infty$; $\breve{P}r + \infty$.

Char. of Comb. Prismatic.

Combinations. 1. $P - \infty$. $P + \infty$. Schwatz, Tyrol.
2. $P - \infty$. $P + \infty$. $\breve{P}r + \infty$. Schwatz.

Cleavage, $P - \infty$ perfect. Fracture not observable. Surface, $P + \infty$ deeply streaked in a horizontal direction. The rest of the faces smooth.

Lustre pearly upon $P - \infty$, both as faces of crystallisation and of cleavage; vitreous upon the other faces. Colour pale apple-green and verdigris-green, inclining to sky-blue. Streak of the same colour, only paler. Translucent, generally only on the edges.

Very sectile. Thin laminæ are flexible. Hardness = 1·0...1·5. Sp. Gr. = 3·098 of a crystallised variety from Schwatz.

Compound Varieties. Reniform and botryoidal shapes: surface drusy, composition columnar, faces of composition a little rough.

OBSERVATIONS.

1. According to Mr Brooke, the present species consists of hydrate of zinc and copper.

2. It occurs in beds and veins, accompanied by other ores of copper, particularly prismatic Azure-malachite, also by prismatic Zinc-baryte, rhombohedral Quartz, rhombohedral Lime-haloide, and octahedral Fluor-haloide.

3. The known localities of this species are the Bannat of

Temeswar, Libethen in Hungary, Schwatz in the Tyrol, Saalfeld in Thuringia, and Matlock in Derbyshire.

3. PYRAMIDAL EUCHLORE-MICA.

Pyramidal Uranite. JAM. Syst. Vol. II. p. 187. Pyramidal Uran Mica. Man. p. 107. Uranite. Phosphate of Uranium. PHILL. p. 267. Uran-glimmer. WERN. Hoffm. H. B. IV. 1. S. 275. Uranoxyd. HAUSM. I, S. 327. Uranglimmer. LEONH. S. 306. Urane oxydé. HAÜY. Traité, T. IV. p. 283. Tabl. comp. p. 114. Traité, 2de Ed. T. IV. p. 319. PHILLIPS. Trans. Geol. Soc. Vol. III. p. 112.

Fundamental form. Isosceles four-sided pyramid. P = 95° 46′, 143° 2′. Vol. I. Fig. 8. AP.

$$a = \sqrt{8{\cdot}95}.$$

Simple forms. P — ∞ (*o*); P — 3 (*c*) = 118° 10′, 93° 13′, PHILL.; $\overset{*}{\mathrm{P}}$ (*P*) Johanngeorgenstadt, Saxony; $\frac{2\sqrt{2}}{3}$ P — 3 (*e*) = 120° 5′, 89° 50′; $\frac{2\sqrt{2}}{3}$ P — 1 (*f*) = 101° 35′, 126° 44′; $\frac{4}{5}$ P — 4 (*d*) = 137° 0′, 61° 47′; P + ∞ (*n*); [P + ∞] (*m*).

Char. of Comb. Pyramidal.

Combinations. 1. P — ∞. P. Ehrenfriedersdorf, Saxony.

2. P — ∞. P + ∞. Johanngeorgenstadt, Saxony.

3. P — ∞. $\frac{2\sqrt{2}}{3}$ P — 2. P. Sim. Fig. 93. Wheal Buller, Cornwall.

4. P — ∞. P. [P + ∞]. Sim. Fig. 11. Tincroft, Cornwall.

Cleavage, P — ∞ highly perfect and easily obtained. Traces of P + ∞. Fracture not observable. Surface, P — ∞ smooth; the pyramids which are in a parallel position with P horizontally streaked; [P + ∞] rough.

Lustre pearly upon P — ∞, both as faces of crystallisation and of cleavage; adamantine upon the other faces. Colour emerald-green, and grass-green, less frequently leek-green, apple-green, or siskin-green. Streak corresponding to the colour, though paler. Transparent ... translucent, sometimes only on the edges.

Sectile. Hardness = 2·0 ... 2·5. Sp. Gr. = 3·115, a variety from Gunnislake, Cornwall.

Compound Varieties. Massive: composition granular, of various sizes, faces of composition rarely observable.

OBSERVATIONS.

1. According to Mr R. Phillips (Ann. of Phil. New Ser. V. 57.), the present species consists of

Oxide of Uranium	60·00.
Phosphoric Acid	16·00.
Oxide of Copper	9·00.
Silica	0·50.
Water	14·50.

Alone it becomes yellow before the blowpipe, and loses its transparency. Upon charcoal it intumesces a little, and melts into a black globule, with traces of crystallisation upon the surface. With borax it yields a yellowish-green bead, and produces a yellow solution in nitric acid.

2. The varieties of pyramidal Euchlore-mica occur upon veins of copper, silver, tin and iron ores, and also sometimes in beds. It is accompanied by ores of copper, tin, and uranium, generally by rhombohedral Quartz, less frequently by rhombohedral Emerald or prismatic Feld-spar.

3. Beautiful varieties have been obtained from Gunnis-

lake mine in Cornwall, also from several mines in the neighbourhood of St Austle and Redruth, as Tincroft, Wheal Buller, &c. In the Saxon mining districts of Johanngeorgenstadt, Schneeberg, and Eubenstock, it is found in silver and iron veins; in the same manner in the bordering districts of Bohemia. It occurs in veins in granite at St Symphorien near Autun, and at St Yrieix near Limoges in France. It is likewise met with at Bodenmais in Bavaria, and near Baltimore in North America.

GENUS II. COBALT-MICA.

1. PRISMATIC COBALT-MICA.

Prismatic Red Cobalt. JAM. Syst. Vol. II. p. 192, Man. p. 109. Red Cobalt. Cobalt Bloom. Arseniate of Cobalt. PHILL. p. 281. Rother Erdkobold. WERN. Hoffm. H. B. IV. 1. S. 201. Kobaltblüthe. HAUSM. III. S. 1124. Arseniksaures Kobalt. LEONH. S. 304. Cobalt arseniaté. HAÜY. Traité, T. IV. p. 216. Tabl. comp. p. 107. Traité, 2de Ed. T. IV. p. 232.

Fundamental form. Scalene four-sided pyramid. $P = \left\{ \begin{matrix} 118° \, 23' \\ 111° \;\; 8' \end{matrix} \right\}$, 134° 44′, 82° 50′. Inclination of the axis = 9° 47′, in the plane of the long diagonal. Vol. I. Fig. 41. AP.

$$a : b : c : d = 5{\cdot}8 : 11{\cdot}4 : 8{\cdot}1 : 1.$$

Simple forms. $\frac{P}{2}\,(l) = 118° \, 23'$; $(\breve{P} + \infty)^3\,(k) = 130° \, 10'$; $(\breve{P}r + \infty)^5\,(s) = 94° \, 12'$; $\frac{\breve{P}r}{2}\,(M) = 55° \, 9'$; $-\frac{\frac{4}{3}\breve{P}r - 2}{2}\,(o) = 89° \, 52'$; $-\frac{\breve{P}r + 2}{2}\,(q) = 27° \, 29'$; $\breve{P}r + \infty\,(T)$; $\bar{P}r + \infty\,(P)$.

Char of Comb. Hemi-prismatic. $-\frac{\breve{P}r}{2} = 70^\circ\,38'$.

Inclination of $P - \infty$ on $\breve{P}r + \infty = 99^\circ\,47'$.

Combinations. 1. $\frac{\breve{P}r}{2}$. $\breve{P}r + \infty$. $\bar{P}r + \infty$. Fig. 46. Schneeberg, Saxony.

2. $\frac{\breve{P}r}{2}$. $-\frac{\frac{4}{3}\breve{P}r - 2}{2}$. $(\breve{P}r + \infty)^5$. $\bar{P}r + \infty$. Platten, Bohemia.

3. $\frac{\breve{P}r}{2}$. $-\frac{\breve{P}r + 2}{2}$. $(\breve{P}r + \infty)^5$. $\breve{P}r + \infty$. $\bar{P}r + \infty$. Schneeberg.

4. $\frac{\breve{P}r}{2}$. $\frac{P}{2}$. $(\breve{P}r + \infty)^3$. $(\breve{P}r + \infty)^5$. $\breve{P}r + \infty$. $\bar{P}r + \infty$. Fig. 172. Schneeberg.

Cleavage, $\bar{P}r + \infty$ highly perfect. Traces of $\breve{P}r + \infty$ and $-\frac{\frac{4}{3}\breve{P}r - 2}{2}$. Fracture not observable. Surface, $\bar{P}r + \infty$ streaked parallel to the edges of combination with $\breve{P}r + \infty$, the rest of the faces streaked parallel to those with $\bar{P}r + \infty$.

Lustre pearly upon $\bar{P}r + \infty$, particularly if produced by cleavage. The rest of the faces possess adamantine lustre inclining to vitreous.

Colour, crimson-red, cochineal-red, peachblossom-red, sometimes pearl-grey or greenish-grey. The red tints of the former, by transmitted light, incline much more to blue, if seen in a direction perpendicular to $\bar{P}r + \infty$, than in that perpendicular to $\breve{P}r + \infty$. Streak corresponding to the colour, though a little paler. If the mineral be crushed into powder in a dry state, this powder possesses a deep lavender-blue tinge, which is not the case if the powder be comminuted in water. Transparent...translucent on the edges. Crystals are least transparent in a direction perpendicular to $\bar{P}r + \infty$.

Sectile; thin laminæ are flexible parallel to the intersection of $\bar{P}r + \infty$ with $-\frac{\frac{4}{3}\check{P}r - 2}{2}$. Hardness = 1·5 ... 2·0, the lowest degrees upon $\bar{P}r + \infty$. Sp. Gr. = 2·948, a red crystallised variety from Schneeberg.*

Compound Varieties. Implanted globular and reniform shapes; surface drusy; composition more or less perfectly columnar, of various sizes of individuals, faces of composition either smooth or rough. Massive, composition columnar, often stellularly divergent, and aggregated in a second granular composition, faces of composition rough. Sometimes in a state of powder as a coating upon other minerals.

OBSERVATIONS.

1. The species *Red Cobalt* is generally divided into two sub-species, *Cobalt-Bloom* and *Cobalt-Crust.* The for-

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* The Privy Counsellor, Baron VON HERDER, kindly communicated to me several beautiful varieties of the species, to which the preceding general description more particularly refers. M.

mer of these contains the more perfectly formed varieties, which appear as crystals, as micaceous scales, aggregated into globular masses, or crystalline coats, as long as the individuals are still recognisable. When they cease to be observable, the second sub-species is formed, which consists of a peachblossom-red powder, either coating other minerals, or mixed up with, and imparting to them, an extraneous colour. The black, brown, and yellow Cobalt-Ochre do not stand in any *natural-historical* relation with the present species.

2. The chemical composition has been found by **Bucholz** to be,

Oxide of Cobalt	39·00.
Arsenic Acid	37·00.
Water	22·00.

Its chemical formula is $\ddot{\mathrm{Co}}^{3}\ \overset{:\cdot:}{\mathrm{As}}^{2}+12\,\mathrm{Aq}$, and the corresponding ratio of its ingredients, 39·95 oxide of cobalt, 40·90 arsenic acid, and 19·15 water. Alone before the blowpipe it assumes a darker colour. Upon charcoal it emits copious arsenical fumes, and melts in the inner flame into a bead of arseniuret of cobalt. With borax and other fluxes it yields a fine blue coloured glass.

3. It occurs in veins traversing rocks of various ages, and also in beds. It is accompanied by various minerals, as Nickel- and Cobalt-pyrites, octahedral Bismuth, several species of the orders Malachite and Glance, also by ochrey varieties of prismatic Iron-ore, and particularly by rhombohedral Quartz, prismatic Hal-baryte, and rhombohedral Lime-haloide.

4. The principal localities of this species are, Schneeberg and Annaberg in Saxony, and Platten in Bohemia, where it occurs in veins in primitive rocks; Saalfeld in Thuringia, Riegelsdorf and Bieber in Hessia, where it is found in veins in secondary mountains. It is besides found in Würtemberg, in the district of Siegen in Prussia, in the Tyrol, in Norway and in Sweden. It is met with also in several places in England and in Scotland.

5. Where it occurs in sufficient quantities, it is used as a valuable mineral in the process of obtaining smalt.

GENUS III. IRON-MICA.

1. PRISMATIC IRON-MICA.

Prismatic Blue Iron. JAM. Syst. Vol. II. p. 209. Man. p. 115. Phosphate of Iron. Vivianite. PHILL. p. 238. Blaue-Eisenerde. Krystallisirte Blaueisenerde. Vivianit. WERN. Hoffm. H. B. III. 2. S. 302., IV. 2. S. 144. Min. Syst. S. 9. 41. Eisenblau. HAUSM. III. S. 1075. Phosphorsaures Eisen. LEONH. S. 357. Fer phosphaté. HAÜY. Tabl. comp. p. 99. Traité, 2de Ed. T. IV. p. 126.

Fundamental form. Scalene four-sided pyramid. $P = \left\{\begin{matrix} 119^\circ\ 4' \\ 110^\circ\ 59' \end{matrix}\right\}$, $134^\circ\ 31'$, $82^\circ\ 48'$. Inclination of the axis $= 10^\circ\ 53'$ in the plane of the long diagonal. Vol. I. Fig. 41. AP.

$$a : b : c : d = 5{\cdot}2 : 10{\cdot}2 : 7{\cdot}3 : 1.$$

Simple forms. $\frac{P}{2} = 119^\circ\ 4'$; $(\breve{P}r + \infty)^3 = 111^\circ\ 6'$; $(\breve{P}r + \infty)^6 = 154^\circ\ 14'$; $\frac{\breve{P}r}{2} = 54^\circ\ 13'$; $\breve{P}r + \infty$; $\bar{P}r + \infty$.

Char. of Comb. Hemi-prismatic. $-\frac{\breve{P}r}{2} = 71^\circ\ 34'$.

Inclination of $P - \infty$ to $\breve{P}r + \infty = 100^\circ\ 53'$.

Combinations. 1. $\frac{\breve{P}r}{2}$. $\breve{P}r + \infty$. $\bar{P}r + \infty$. Sim. Fig. 46. Bodenmais, Bavaria.

2. $\frac{\breve{P}r}{2}$. $\frac{P}{2}$. $(\breve{P}r + \infty)^3$. $\breve{P}r + \infty$. $\bar{P}r + \infty$.

Sim. Fig. 72., only having the edge of the pyramid replaced. St Austle, Cornwall.

3. $\frac{\breve{P}r}{2}$. $(\breve{P}r + \infty)^3$. $(\breve{P} + \infty)^6$. $\breve{P}r + \infty$. $\bar{P}r + \infty$. Cornwall.

Cleavage. $\bar{P}r + \infty$ highly perfect. Traces of $\breve{P}r + \infty$ and $-\frac{\frac{4}{3}\breve{P}r - 2}{2} = 90° 55'$. Fracture not observable. Surface, $\bar{P}r + \infty$ smooth; the rest of the faces streaked parallel to the edges of combination with $\bar{P}r + \infty$.

Lustre pearly, almost metallic upon $\bar{P}r + \infty$. The rest of the faces possess vitreous lustre.

Colour pale blackish-green ... indigo-blue. It is green in the direction of the axis and in the plane of inclination, also perpendicular to the latter, but of a pure blue colour nearly in the directions of $(\breve{P}r + \infty)^3$, and perpendicular upon $\bar{P}r$. The united effect of both produces the common dirty indigo-blue colour. Streak blueish-white, very soon changed into indigo-blue. The powder produced by crushing the mineral in a dry state is liver-brown. Transparent ... translucent; least transparent in a direction perpendicular upon $\bar{P}r + \infty$.

Sectile. Thin laminæ are perfectly flexible parallel to the intersection of $\bar{P}r + \infty$ with $-\frac{\frac{4}{3}\bar{P}r - 2}{2}$. Hardness = 1·5 ... 2·0, the lowest degrees upon $Pr + \infty$. Sp. Gr. = 2·661, a crystal from Cornwall.

Compound Varieties. Small reniform and globular shapes, and imbedded nodules; also superficial coatings of dusty particles. Composition impalpable, earthy or easily reduced to powder.

OBSERVATIONS.

1. The forms of the present species possess a remarkable analogy with those of other hemi-prismatic species, particularly of prismatoidal Gypsum-haloide and prismatic Cobalt-mica.

The cornish varieties in transparent crystals have been distinguished from the rest under the name of *Vivianite.* The rest of the crystallised varieties under the denomination of the *Prismatic Blue Iron*, were again separated from the compact and earthy varieties, or the *Earthy Blue Iron.* These distinctions, however, seem to have been introduced only from the succession of the discovery in regard to the varieties which they comprehend, and not from any scientific or classificatory principle.

2. In two varieties, a friable one analysed by KLAPROTH, and a crystallised one from Bodenmais in Bavaria by VOGEL, the following chemical constituents have been discovered :

Protoxide of Iron	47·50	41·00.
Phosphoric Acid	32·00	26·40.
Water	20·00	31·00.

Its chemical formula, derived from the second analysis, is $\overset{\cdot\cdot}{Fe}^{2}\,\overset{:\cdot:}{P} + 12\,Aq$, which corresponds to 43·88 protoxide of iron, 22·28 phosphoric acid, and 33·84 water. It decrepitates before the blowpipe, but melts, if first reduced to powder, into a dark brown or black scoria, which moves the magnetic needle. It is soluble in dilute sulphuric and nitric acids. The friable varieties are found white in their original repositories, but like the white powder of the crystals, they soon assume a blue tinge, on being exposed to the air.

3. The varieties of the present species occur in different kinds of natural repositories. Some of them are found crystallised, particularly accompanied by hexahedral Iron-pyrites in copper and tin veins; others in very narrow veins traversing greywacke, partly with hexahedral Gold, and other species, which accompany the latter; still others, probably in beds, along with rhombohedral Iron-pyrites, octahedral Iron-ore, and some at last are disseminated in basalt, and other trap rocks. The compound, friable varieties are imbedded in clay, and in the depositions of bog iron-ore, which indicate a more recent formation of it.

4. The first varieties exhibited in the cabinets of minerals were those from Vöröspatak in Transylvania, where they are found in the gold mines, and have been considered as blue gypsum. The Vivianite occurs near St Agnes in Cornwall, the Prismatic Blue Iron at Bodenmais in Bavaria, in several districts of France, in Isle de France, &c. partly imbedded in mountain rocks. The Earthy Blue Iron is found in the Gail valley in Carinthia, at Ligist and other places in Stiria, at Eckartsberge in Thuringia, in Würtemberg and Baden, in Lusatia, and other countries. It has been discovered in several peat mosses in the Shetland Islands, also at Ballagh in the Isle of Man, where it is associated with elks' horns, in river mud near Liverpool, &c.

GENUS IV. GRAPHITE-MICA.

1. RHOMBOHEDRAL GRAPHITE-MICA.

Rhomboidal Graphite. JAM. Syst. Vol. II. p. 216. Man. p. 117. Plumbago. Graphite. Black Lead. PHILL. p. 364. Graphit. WERN. Hoffm. H. B. III. 1. S. 309. Graphit. HAUSM. I. S. 67. Graphit. LEONH. S. 334. Fer carburé. HAÜY. Traité, T. IV. p. 98. Graphite. Tabl. comp. p. 70. Fer carburé ou Graphite. Traité, 2de Ed. T. IV. p. 85.

Fundamental form. Rhombohedron of unknown dimensions. Vol. I. Fig. 7. Simple forms $R - \infty$; $R + \infty$; P; $P + \infty$; in various combinations, as : $R - \infty$. P. $P + \infty$, similar to Fig. 112, &c. but possessing a tabular aspect. Character of combinations di-rhombohedral.

Cleavage, $R - \infty$ highly perfect. Fracture uneven, scarcely observable. Surface, $R - \infty$ and P generally smooth or faintly striated parallel to their edges of combination, the rest of the faces rough.

Lustre metallic. The highest degrees of lustre are found upon $R - \infty$, both as faces of crystallisation and of cleavage. Colour iron-black, dark steel-grey. Streak black, shining. Opake.

Sectile. Thin laminæ are highly flexible. Hardness $= 1{\cdot}0 \ldots 2{\cdot}0$. Sp. Gr. $= 2{\cdot}0891$, Haüy.

Compound Varieties. Massive : composition granular, the individuals flat and scaly, of various sizes, frequently impalpable. Of the latter, the fracture is conchoidal or even.

OBSERVATIONS.

1. The division of the species *Graphite* into *Scaly* and *Compact* Graphite, depends upon the size of the grain in the compositions, the former comprehending those which are still discernible, while in the latter they are withdrawn from observation. The simple varieties have been either united with scaly Graphite, or they have been considered as a particular sub-species (Hoffm. H. B. IV. 2. S. 171.).

2. The rhombohedral Graphite-mica consists of

Carbon	81·00	92·00	96·00.
Iron	10·00	8·00	4·00.
Oxygen	9·00. Scheele.	0·00. Vauq.	0·00. Sauss.

In a high degree of heat it is combustible, and leaves a residue of oxide of iron. It is infusible alone, and with additions.

3. The varieties of this species are found in beds, or form beds by themselves, in slaty and ancient trap-rocks. They seem often to replace the different species of Talc-mica in mixed rocks, particularly in gneiss, if containing a great proportion of Feld-spar. In the beds of rhombohedral Lime-haloide, the rhombohedral Graphite-mica occurs in single crystals, or in imbedded massive varieties. It is likewise met with in the coal formation.

4. One of the most remarkable repositories of rhombohedral Graphite-mica is at Borrowdale in Cumberland, a bed of trap very much interrupted, and alternating with clay-slate. In the neighbourhood of Hafnerzell, Griesbach, &c. in Passau, in Austria, Moravia, and other countries, it forms a constituent part of gneiss; in Lower Stiria it is imbedded in granular limestone. It occurs crystallised in Greenland, in the parish of Pargas in Finland, and different varieties are known from the Tyrol, Salzburg, Piedmont, France, Spain, Norway, and America. In the coal formation it is found at Cumnock in Ayrshire.

5. The chief employment of this mineral is in manufacturing pencils and crucibles, the latter particularly for the purposes of the mint. It is also used for giving a gloss to iron stoves and railings, and for diminishing the friction in machines.

Genus V. TALC-MICA.

1. PRISMATIC TALC-MICA.

Rhomboidal Mica (in part). Jam. Syst. Vol. II. p. 221. Prismatic Talc-Mica (in part). Man. p. 119. Talc. Green Earth. Chlorite. Phill. p. 116. 117. 120.

Topfstein. Grünerde. Chlorit. Talk. WERN. Hoffm. H. B. II. 2. S. 131. 134. 195. 267. Chlorit. Topfstein. Talk. HAUSM. II. S. 490. 496. 497. Chlorit. Talk. Topfstein. LEONH. S. 465. 466. 467. Talc (in part). HAÜY. Traité, T. III. p. 252. Tabl. comp. p. 56. Traité, 2de Ed. T. II. p. 489.

Fundamental form. Scalene four-sided pyramid of unknown dimensions. Vol. I. Fig. 9. Simple forms. $P - \infty$; $P + \infty = 120°$ (nearly); $\breve{P}r + \infty$; $\bar{P}r + \infty$; in various combinations presenting hexagonal, rhomboidal, and rectangular plates.

Cleavage, $P - \infty$, commonly highly perfect. Fracture not observable. Surface $P - \infty$ smooth. The faces of the other forms streaked parallel to the edges of combination with $P - \infty$.

Lustre pearly upon $P - \infty$, both as faces of crystallisation and of cleavage. The faces of the other forms possess vitreous lustre, inclining to adamantine, generally low degrees.

Colour, various shades of green, as blackish-green, leek-green, celandine-green, and apple-green, passing into greenish-grey, greenish-white, and greyish-white. Streak corresponding to the colour, green ... white. Semi-transparent ... translucent. Different colours in different directions. Some individuals are of a bright green colour if viewed in a direction perpendicular to the laminæ, while parallel to them they exhibit in other directions a fine brown tinge. In the latter direction they are much more transparent than in the former.

Sectile, in a high degree. Thin laminæ are easily flexible. Hardness = 1·0...1·5. Sp. Gr. = 2·713 a dark-green variety, compound of large individuals.

Compound Varieties. Imperfect globules and stellular groupes: composition imperfect columnar. Sometimes several crystals are engaged with each other, so as to produce conical and cylindrical aggregations. Massive: composition granular of various sizes of individuals, often impalpable; sometimes imperfect columnar. The individuals are sometimes strongly coherent with each other, or flat, so as to give rise to an imperfect slaty structure. Often earthy, without connexion of its particles.

OBSERVATIONS.

1. The difference among the species and sub-species, comprehended within prismatic Talc-mica, depends upon various properties at the same time, both of the individuals themselves and of their compositions, and it is not therefore without many difficulties. The varieties of dark-green (leek-green, celandine-green, &c.) colours, inclining to brown, constitute the *Chlorite*, subdivided into *foliated* and *common*, *slaty* and *earthy* Chlorite. The first of these contains the crystallised varieties, and such compound ones as consist of easily separable individuals, not presenting a slaty structure. The second contains those granularly compound varieties, in which the individuals can scarcely be traced, or in which they are not observable at all. Chlorite-slate, or slaty Chlorite, refers to such compound varieties as have a slaty texture, and earthy Chlorite to such as are but loosely coherent, or already in a state of loose scaly particles; and it is distinguished from foliated Chlo-

rite only by the smallness of its grain. Immediately with those varieties of Chlorite whose composition is impalpable, the *Green Earth* is connected, from which, however, we must except what has been termed crystallised Green-earth, and which consists of decomposed crystals of paratomous Augite-spar. The species *Talc* comprehends the varieties of generally pale green, particularly apple-green, grey and white varieties, and is divided into *common*, *earthy*, and *indurated* Talc. Simple varieties are common Talc; also such compound ones in which cleavage is transformed into slaty structure, the latter being generally very perfect; or such as consist of columnar particles of composition; earthy Talc, or *Nacrite*, consists of loose particles, or such as are but slightly cohering; and indurated Talc refers to imperfect and coarse slaty varieties, in which this kind of structure is more the consequence of composition than of imperfect cleavage. If this structure be sufficiently imperfect to become coarse and indistinctly granular, *Pot-stone* or *Lapis ollaris* is formed, which, possessing the united properties of softness and tenacity, may be easily turned into vessels;* and it is perhaps only for that reason that it used to be distinguished as a particular species. It must be remarked, however, that several of the most important natural-historical properties of the substances at present comprised within the species of prismatic Talc-mica, are too little known to admit of an exact comparison, so that they may possibly require in future to be divided into several species.

2. Three varieties of the present species, foliated Talc analysed by VAUQUELIN, slaty Chlorite analysed by GRUNER, and Green Earth analysed also by VAUQUELIN, have yielded:

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* I have been informed by Captain STEWART, that the translucent white variety of common Talc from Almorah, in the Himalayah mountains, is employed for the same purposes. H.

Silica	62·00	29·50	52·00.
Magnesia	27·00	21·39	6·00.
Oxide of Iron	3·50	23·39	23·00.
Alumina	1·50	15·62	7·00.
Water	6·00	7·38	4·00.
Potash	0·00	0·00	7·50.
Lime	0·00	1·50	0·00.

These analyses, as well as those of several other varieties of the species, shew that our information also in respect to its chemical constituents is still very defective. Before the blowpipe some of them lose their colour, and are difficultly fusible, others are changed into a black scoria, still others are infusible. In these phenomena also there is so little agreement between the varieties employed, that we are forced to draw the conclusion, either that the varieties were not pure enough, or not simple ones, which they always should be if we wish to arrive at a correct result, or that they belonged to different species.

3. Common Talc, indurated Talc, Potstone and slaty Chlorite, constitute themselves beds in primitive mountains. The latter frequently contains imbedded crystals of octahedral Iron-ore; some of the former contain rhombohedral Fluor-haloide, several species of Lime-haloide, of Augite-spar, &c. Common Chlorite in particular is found in beds in primitive rocks, consisting chiefly of ores of iron, rhombohedral Lime-haloide, and several species of the genus Augite-spar. Other varieties, and among these the small scaly crystals of foliated Chlorite and earthy Chlorite, occur in veins of various descriptions, and in the crystal caves of the Alps. Green-earth, and sometimes also foliated Chlorite, occur in amygdaloidal rocks, where they are found either lining the vesicular cavities, or as imbedded nodules in the body of the rock itself. Earthy Talc or Nacrite, of whose natural historical properties but little is known, has been found in lead veins.

4. Those varieties which by themselves form mountain masses, are met with in the primitive districts of several countries, as in the Tyrol, in Salzburg, Switzerland, Swe-

den, Norway, Corsica, &c., in the Grampians in Scotland, in Unst, one of the Shetland isles. Upon beds and veins with metallic ores and Pyrites they are found in considerable quantities in Cornwall, where they are known by the name of *Peach*, also in Saxony, Salzburg, Sweden, &c. The crystallised varieties occur in veins, frequently in mount St Gothard in Switzerland, also in Salzburg, Sweden, and other countries. The chief localities of Green-earth are the Monte Baldo near Verona, Iceland, the Faroe islands, Tyrol, Hungary and Transylvania, and various places in Great Britain and Ireland.

5. Some of the varieties occurring in beds in large masses, are used as fire-stones in iron furnaces. In Switzerland potstone is turned into culinary and other vessels, and worked into plates for the construction of stoves. Green-earth is used, both raw as a green colour, and burnt as a reddish-brown colour, for painting houses, &c. The *Venetian Talc*, a variety of common Talc of a greenish-white colour, formerly used as a medicine, seems to be no longer in use.

2. RHOMBOHEDRAL TALC-MICA.

Rhomboidal Mica (in part). JAM. Syst. Vol. II. p. 221. Rhomboidal Talc-Mica. Man. p. 127. Mica. PHILL. p. 106. Glimmer. WERN. Hoffm. H. B. II. 2. S. 115. Glimmer. HAUSM. II S. 487. Glimmer. LEONH. S. 461. Mica. HAÜY. Traité, T. III. p. 208. Tabl. comp. p. 53. Traité, 2de Ed. T. III. p. 111.

Fundamental form. Rhombohedron of unknown dimensions. Vol. I. Fig. 7. Simple forms. $R - \infty$ (P); $R + \infty$; P (x, x'); $P + \infty$ (M, r). Various combinations of these forms, whose character seems to be di-rhombohedral, as 1. $R - \infty.\ P + \infty$; 2. $R - \infty.\ P.\ P + \infty$; 3. $R. - \infty.\ P.\ R + \infty.\ P + \infty$, &c.

Cleavage, $R - \infty$, highly perfect, and easily obtained, passing in less perfectly formed varieties into slaty structure. Traces of $P + \infty$. Fracture scarcely observable, uneven. Surface P and $P + \infty$ horizontally streaked, the other faces, particularly $R - \infty$, smooth.

Lustre pearly, often inclining to metallic upon $R - \infty$; the other faces, if they are smooth enough, present a kind of lustre between vitreous and adamantine. Colour various shades of grey, generally passing into green, brown, and black, also into white and red (particularly peachblossom-red). Superficial tinges of pinchbeck-brown. Streak white, grey. Transparent, imperfectly...translucent on the edges. It is less transparent in the direction of the axis than perpendicular to it. There is also a difference of colours observable in these directions, for instance, oil-green in the first, and liver-brown in all the others.

Sectile. Thin laminæ are elastic. Hardness $= 2{\cdot}0 \ldots 2{\cdot}5$. The acute edges of the laminæ, however, will sometimes scratch glass. Sp. Gr. $= 2{\cdot}949$, a greenish-black variety in large individuals.

Compound Varieties. Globular forms, both imbedded and implanted: surface of the latter rough; composition columnar, sometimes joining in a second curved lamellar composition. Massive: composition granular of various sizes of individuals; or also imperfect columnar, faces of composition irregularly streaked and rough.

OBSERVATIONS.

1. The substances hitherto comprised under the name of *Mica*, do not all belong to the species of rhombohedral Talc-mica; but it would be impossible, from the present imperfect state of our information, to draw clear lines of separation between the various species designated by that name. Although in several of them the system of crystallisation be known, yet we are not acquainted with the respective series of crystallisation, that is to say, with the angles of the fundamental rhombohedrons or scalene four-sided pyramids; and the distinctive characters which then remain are not in general sufficient to give security and evidence to the determination of the species. The optical researches, however, of Dr **Brewster** and M. **Biot**, have shewn that the various kinds of Mica differ considerably in their action upon light, some of them possessing only one axis of double refraction, and shewing one system of coloured rings, while others possess two axes, and shew therefore two systems of coloured rings. Among the first again, some possess a positive optical axis like rhombohedral Quartz, though the greater part of them exhibit a negative one, like rhombohedral Lime-haloide. The resultant axes, or those of no polarisation in the other, are inclined to each other at various angles, and, besides, are situated in planes perpendicular to the laminæ, which in some of them pass through the long diagonal, in others through the short diagonal of a rhombic prism of 120° and 60°, supposed to result from the enlargement of four of the lateral faces of the six-sided laminæ. Count **Bournon** assumes an oblique rhombic prism for the primitive form of Mica. According to Mr **Soret**, who likewise supposes the primitive form of certain varieties of mica to be an oblique prism, the plane of the resultant axes passes in these through the short diagonal of the base, and this takes place in several micas from Sweden and Siberia. In others, where the primitive form is a right prism, the plane of the resultant axes passes through the long diagonal of the base,

and this is the case in the micas from St Gothard and from Altenberg in Saxony. Several crystallised varieties from Vesuvius, of a pale green colour, and others from various localities, presenting green, brown, and black colours, possess one axis of double refraction. The forms of the minerals called Mica thus appear to belong to three different systems of crystallisation; they are sufficient to shew how much there is yet to be done in examining their varieties.

2. Not less at variance, and partly in opposition with each other, we find the results of chemical analyses of the different kinds of mica, as comparatively instituted and published by **Klaproth**, **Rose**, and **Peschier**.

Ingredients.	Mica from Zinnwald.	From Siberia.		From St Gothard.	From Kimito.
Alumina	20·00	34·25	22·00	0·00	36·80
Silica	47·00	48·00	40·25	19·50	46·36
Oxide of Iron	15·50	4·50	8·75	26·50	4·53
Ox. of Titanium	0·00	0·00	13·00	25·40	0·00
Ox. of Manganese	1·75	a trace	2·00	25·25	0·00
Magnesia	0·00	0·50	0·00	0·00	a trace
Lime	0·00	0·00	1·75	0·00	0·00
Potash	14·50	8·75	7·25	0·00	9·22
Fluoric acid and water	0·00	0·00	3·24	0·00	1·81
	Klapr.	Klapr.	Pesch.	Pesch.	Rose.

From a comparison of these analyses, it appears that there exist differences among the varieties of mica, which, however, it is impossible to reduce to fixed points, so long as we are in want of an accurate natural-historical determination of the species. This determination must flow from principles of Natural History, and can the less depend upon chemical relations, as the very object of a great part of the present researches of chemistry consists in examining the nature of the composition in those bodies which form species in Natural History. Before the blowpipe, several varieties first lose their transparency, and then melt into a scoria, white or coloured, or even black. Others are infusible, and they shew in general as much difference in this respect as in their composition.

3. Mica forms one of the constituent parts of various rocks, as granite, gneiss, mica-slate, and of several varieties of porphyry. They form sometimes more or less considerable nodules and concretions in these rocks, and then contain imbedded crystals of prismatic Topaz, rhombohedral Tourmaline, and other species. As single crystals, they appear not unfrequently imbedded in granular limestone, in basalt and wacke, in implanted crystals upon the specimens ejected by Mount Vesuvius. Several varieties of mica accompany in metalliferous beds, the ores of tin and scheelium, and they occur likewise in ancient veins, which consist of those species which are contained in the rocks which they traverse.

4. Remarkable varieties of Mica are found in Siberia, particularly cleavable ones in large individuals, crystallised ones at Zinnwald in Saxony, possessing two axes of double refraction. It is also found in the Hörlberg in Bavaria, in imbedded globules in Moravia, in Mount St Gothard in Switzerland, at Finbo in Sweden, in Pargas in Finland, here with curved faces of cleavage; at Wiesenthal in Saxony, and Joachimsthal in Bohemia, imbedded in basalt and wacke, &c. At Mount Vesuvius, crystals of Mica with one axis, often of considerable size and transparency, occur in the drusy cavities of the ejected specimens. It occurs besides in great variety in many other countries.

5. Perfectly cleavable varieties, which are transparent at least if reduced to a considerable tenuity, are used in Siberia, in Mexico and Peru, instead of window glass; and from the first of these countries, they have on that account received the name of *Muscovy glass.* In Siberia, the extraction of the large crystalline masses imbedded in granite, forms an object of mining. It is sometimes used for various optical purposes, and enters the composition of the artificial avanturine.

6. *Lepidolite*, a substance included by some authors within the species of mica, possesses two axes of double refraction, and its forms therefore are likely to belong to

the prismatic system, though they have not yet been observed. It occurs in granular compositions of a peachblossom-red colour, sometimes passing into several pale shades of green. The specific gravity of Lepidolite is constantly lower than that of the rest of the varieties of mica, having been found in a very pure variety = 2·832. Its chemical constituents are, according to WENZ,

Alumina	33·61.
Silica	49·06.
Oxide of Manganese	1·40.
Magnesia	0·41.
Lithia	3·60.
Potash	4·18.
Fluoric Acid	3·45.
Water	4·18.

and a trace of oxide of iron. Before the blowpipe upon charcoal, it intumesces, and fuses very easily into a transparent globule. It has been found near Rozena in Moravia, and at Utö in Sweden, in primitive rocks. It is cut into snuff-boxes and various ornaments.

7. *Clay-slate* is in a very close connexion with the different substances comprised within the name of Mica, and uninterrupted transitions may be found from those possessing low degrees of perfection in their cleavage into the varieties of clay-slate. This substance, besides, cannot be considered as a particular species, being generally not only compound, but even mixed. Its varieties are in immediate connection with mica-slate, which is again united to granite by means of gneiss. The proportion of mica, which forms one of the constituents of the latter, increases; and while the others diminish in quantity and size, so as to be not observable at all in clay-slate, it imparts to this rock most of the properties by which it is characterized. This is the result of immediate observation, and hence may also be explained the varieties met with in clay-slate, and which have given occasion for designating some of them by particular names. Most of the other slaty rocks are more or less allied to clay-slate.

Also the results of chemical analysis correspond with this mode of viewing the subject. M. D'AUBUISSON has found one of its varieties to consist of

Alumina	23·50.
Silica	48·60.
Oxide of Iron	11·30.
Oxide of Manganese	0·50.
Magnesia	1·60.
Potash	4·70.
Water	7·60.
Carbon	0·30.
Sulphur	0·10.

Clay-slate melts into a scoria. It forms rocks, and is associated and alternates with various other rocks possessing a slaty structure. It occurs in primitive and transition mountains. Sometimes it includes crystals of Chiastolite, more frequently it contains crystals of hexahedral Iron-pyrites. It is spread over many countries as a rock, giving in many places occasion to important mining proceedings. It is used also as a roofing slate, for manufacturing slates for drawing and writing, and some varieties also as whetstones. It is employed as a flux in melting ores of iron; but most of its varieties are useless for purposes of building or paving.

GENUS VI. PEARL-MICA.

1. RHOMBOHEDRAL PEARL-MICA.

Rhomboidal Pearl Mica. JAM. Man. p. 129. Margarite (of Fuchs). PHILL. p. 208. Perlglimmer. LEONH. S. 655.

Fundamental form. Rhombohedron of unknown dimensions. Vol. I. Fig. 7. Simple forms $R - \infty$; P; $P + \infty$. Combinations of these with each other.

Cleavage, R — ∞ highly perfect. Traces of P + ∞. Fracture not observable. Surface, R — ∞ triangularly, P and P + ∞ horizontally streaked, though faintly.

Lustre, common pearly upon R — ∞, both as faces of crystallisation and of cleavage, vitreous upon the other faces. Colour pale pearl-grey, passing into reddish- and yellowish-white. Streak white. Translucent.

Rather brittle. Hardness = 3·5 ... 4·5. Sp. Gr. = 3·032.

Compound Varieties. Massive: composition granular, individuals of various sizes, faces of composition seldom observable, rough, sometimes smooth.

OBSERVATIONS.

1. The determination of the crystalline system of the forms belonging to the present substance is not altogether to be depended on, from a want of sufficient observation. It may prove in future to be prismatic.

2. A variety of rhombohedral Pearl-mica has yielded to Mr Du Menil.

Silica	37·00.
Alumina	40·50.
Oxide of Iron	4·50.
Lime	8·96.
Soda	1·24.
Water	1·00.

On account of the considerable loss of 6·80, Mr Du Menil wishes to have the analysis repeated.

3. Rhombohedral Pearl-mica has been found in a bed in primitive rocks, mixed with and engaged in the variety of prismatic Talc-mica, called foliated Chlorite, at Sterzing in

the Tyrol, where it is accompanied by rhombohedral Fluor-haloide and axotomous Iron-ore.

ORDER VI. SPAR.

GENUS I. SCHILLER-SPAR.

1. DIATOMOUS* SCHILLER-SPAR.

Common Schiller-Spar. JAM. Syst. Vol. II. p. 117. Diatomous Schiller-Spar. Man. p. 130. Schiller-Spar (in part). PHILL. p. 71. Schillerstein. WERN. Hoffm. H. B. II. 2. S. 264. Talkartiger Diallag. HAUSM. II. S. 715. Schillerspath. LEONH. S. 518. Spath chatoyant. HAÜY. Traité, T. IV. p. 395. Diallage métalloïde (in part). Tabl. comp. p. 47. Traité, 2de Ed. T. II. p. 455.

Fundamental form. Scalene four-sided pyramid of unknown dimensions. Simple forms, character of combinations, &c. unknown, the latter probably hemi- or tetarto-prismatic.

Cleavage in two directions, with different distinctness, one of them being highly perfect and easily obtained, while the other appears only in slight traces. Inclination between 135° and 140°. Fracture uneven, splintery.

Lustre, metallic-pearly and eminent upon the perfect faces of cleavage, indistinctly vitreous upon the other faces. Colour olive-green and blackish-green, inclining to pinchbeck-brown upon the perfect faces of cleavage. Streak greyish-

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[*] From διὰ through, and τέμνω I cut, easily cleavable in one direction through the crystals.

white, inclining a little to yellow. Translucent on the edges.

Rather sectile. Hardness = 3·5 ... 4·0. Sp. Gr. = 2·692, the variety from the Baste in the Hartz.

Compound Varieties. Massive: composition granular, of various sizes of individuals. The individuals are often as if interlarded with serpentine.

OBSERVATIONS.

1. The diatomous Schiller-spar consists of

Silica	52·00	62·00	41·00.
Magnesia	6·00	10·00	29·00.
Alumina	23·33	13·00	3·00.
Lime	7·00	0·00	1·00.
Oxide of Iron	17·50	13·00	14·00.
		and manganese.	
Water	0·00	0·00	10·00.
	HEYER.	VAUQUELIN.	DRAPPIER.

If exposed to a high degree of heat, it becomes hard, and forms a porcelain-like mass.

2. The varieties of the present species occur in imbedded simple and compound crystalline masses in serpentine, with which they are mixed; and the only locality of them, which can be indicated with certainty, is the Baste in the forest of Harzeburg in the Hartz. All the other localities mentioned for this species are uncertain, as it has not hitherto been sufficiently distinguished from the hemi-prismatic Schiller-spar.

2. HEMI-PRISMATIC SCHILLER-SPAR.

Schiller-Spar (Bronzite). JAM. Syst. Vol. II. p. 175.
Hemi-prismatic Schiller-Spar, or Bronzite. Man. p. 131.
Bronzite. Schiller-Spar (in part). PHILL. p. 25. 71.
Blättriger Anthophyllit. WERN. Hoffm. H. B. I. S. 676.
Schillerstein ? Bronzit. HAUSM. II. S. 717. Bronzit.

Leonh. S. 518. Diallage métalloïde (in part). **Haüy.** Tabl. comp. p. 47. Diallage fibro-laminaire métalloïde. Traité, 2de Ed. T. II. p. 455.

Fundamental form. Scalene four-sided pyramid of unknown dimensions. Vol. I. Fig. 41. Simple forms and combinations unknown. Character of combinations hemi-prismatic (inferred from cleavage), perhaps tetarto-prismatic.

Cleavage $\breve{P} + \infty$ highly perfect, though generally a little curved, less distinct $P + \infty = 94°$ (nearly). Traces of $\frac{\bar{P}r}{2} = 72°$ (nearly) and $\breve{P}r + \infty$. Fracture uneven, splintery.

Lustre, metallic-pearly upon $\breve{P}r + \infty$; for the rest low degrees of an imperfect vitreous lustre. Colour dirty shades of leek-green and blackish-green, also liver-brown, hair-brown and clove-brown, greenish- and ash-grey. They are heightened by a metalloidal appearance upon $\breve{P}r + \infty$, and often incline to pinchbeck-brown. Streak corresponding to the colour, yellowish- or greyish-white. Translucent, sometimes only on the edges.

Rather sectile. Hardness = 4·0...5·0. Sp. Gr. = 3·251, a brown variety from Bayreuth.

Compound Varieties. Massive: composition granular, of various sizes of individuals, strongly connected.

OBSERVATIONS.

1. The hemi-prismatic Schiller-spar consists, according to **Klaproth**, of

Silica	60·00.
Magnesia	27·50.
Oxide of Iron	10·50.
Water	0·50.

By the action of fire it assumes a lighter colour, and loses its water, but is by itself infusible before the blowpipe.

2. The varieties of this species occur in imbedded crystalline particles, either simple or compound, in serpentine and greenstone rocks. There are even beds included in the serpentine formation, which consist almost entirely of hemi-prismatic Schiller-spar, and are mixed with compound varieties of hemi-prismatic Augite-spar. It is often associated with those species which are commonly found in serpentine rocks.

3. It is found in considerable quantities, in and near the Gulsen mountain, in the vicinity of Kraubat in Stiria, where it forms those beds in serpentine, of considerable extent, alluded to above. It occurs near Hof in Bayreuth, at the Baste in the Hartz in green-stone, in the Bacher mountain in Lower Stiria, and the Lizard district of Cornwall in serpentine, and under similar circumstances in various other countries.

3. PRISMATOIDAL SCHILLER-SPAR.

Hypersthene or Labrador Schiller-Spar. JAM. Syst. Vol. II. p. 178. Prismatoidal Schiller-spar or Hypersthene. Man. p. 132. Hypersthene. PHILL. p. 70. Paulit. WERN. Hoffm. H. B. II. 2. S. 143. Hypersthen. HAUSM. II. S. 718. Hypersthen. LEONH. S. 519. Diallage metalloïde. HAÜY. Traité, T. III. p. 127. Hypersthène. Tabl. comp. p. 44. Traité, 2de Ed. T. II. p. 447.

Fundamental form. Scalene four-sided pyramid of unknown dimensions. The simple forms and the character of the combinations are also unknown.

Cleavage, parallel to the sides of a four-sided prism of about 93°, more perfectly parallel to the short diagonal of that prism, traces parallel to the long diagonal. Fracture uneven.

Lustre eminent metallic-pearly upon the single perfect faces of cleavage; in other directions more or less distinctly vitreous. Colour greyish- or greenish-black; several varieties almost copper-red upon the perfect face of cleavage. Streak greenish-grey. Opake, in some varieties slightly translucent on the edges.

Brittle. Hardness = 6·0. Sp. Gr. = 3·389, the American variety.

Compound Varieties. Massive: composition granular, sometimes of considerable size of individuals; faces of composition uneven and rough.

OBSERVATIONS.

1. According to Klaproth, the prismatoidal Schiller-spar consists of

Silica	54·25.
Magnesia	14·00.
Alumina	2·25.
Lime	1·50.
Oxide of Iron	24·50.
Water	1·00.

and a trace of oxide of manganese. If heated alone, it is little altered in appearance, but melts upon charcoal into a greenish-grey opake globule, easily soluble in borax.

2. The varieties of the present species occur engaged in a mixture of Labradore, a species of the genus Feld-spar, of hemi-prismatic and paratomous Augite-spar. The rock often contains octahedral Iron-ore, and seems to be

analogous to syenite or greenstone. They are also said to have been found in a slaty rock with dodecahedral Garnet, and in serpentine along with Saussurite.

3. It has first been brought from the coast of Labrador in North America, and in reference to this locality, it was named Labradore hornblende; which name, however, was afterwards exchanged for Paulite, from the island of St Paul. It has been mentioned from Cornwall, where it is said to occur in serpentine, and in primitive slate in Greenland. The variety from the latter place with a blue opalescence parallel to the short diagonal of the prism, which has been considered as a variety of the present species, presents two faces of cleavage inclined at an angle of about 124½°, and must be referred to the species of hemi-prismatic Augite-spar, as has first been observed by Mr BROOKE.

5. PRISMATIC SCHILLER-SPAR.

Anthophyllite. JAM. Syst. Vol. II. p. 181. Prismatic Schiller-spar or Anthophyllite. Man. p. 133. Anthophyllite. PHILL. p. 69. Strahliger Anthophyllit. WERN. Hoffm. H. B. I. S. 673. Anthophyllit. HAUSM. II. S. 720. Anthophyllit. LEONH. S. 432. Anthophyllite. HAÜY. Tabl. comp. p. 58. Anthophyllite. Traité, 2de Ed. T. II. p. 600.

Fundamental form. Scalene four-sided pyramid of unknown dimensions; so are also simple forms and the character of combinations.

Cleavage, parallel to the sides of a four-sided prism of about 124½° and both its diagonals, the cleavage parallel to the long diagonal being more distinct, and easily obtained. Fracture uneven. Surface streaked parallel to the axis.

Lustre pearly, inclining to metallic, particularly upon the perfect face of cleavage. Colour between yellowish-grey and clove-brown. Streak white. Translucent, sometimes only on the edges.

Brittle. Hardness = 5·0 ... 5·5. Sp. Gr. = 3·129. Blöde.

Compound Varieties. Massive: composition columnar, straight, sometimes divergent, and rather broad; faces of composition irregularly streaked. They are often aggregated in a second composition, which is angulo-granular and wedge-shaped.

OBSERVATIONS.

1. An analysis by John states the component parts of the present species to be

Silica	56·00.
Alumina	13·30.
Magnesia	14·00.
Lime	3·33.
Oxide of Iron	6·00.
Oxide of Manganese	3·00.
Water	1·43.

Alone it is not altered, and infusible before the blow-pipe. It is dissolved, though with difficulty, by borax, and yields a glass coloured by iron.

2. The prismatic Schiller-spar occurs in beds of mica-slate, accompanied by rhombohedral Quartz, dodecahedral Garnet, several varieties of Talc-mica, of hemi-prismatic Augite-spar, prismatic Feld-spar, of Cobalt- and Copper-pyrites, &c. Thus it has been found at Kongsberg, and the cobalt mines of Modum in Norway. With hemi-prismatic Augite-spar it has been discovered in Greenland.

3. Although, according to the present state of our information, and agreeably to the principles of Natural History, the determination of the present genus seems to be unexceptionable; yet much is still necessary for a perfect deter-

mination of the species which it comprehends. The opinions of mineralogists have been much at variance in regard to these substances ; but generally they have placed them near each other in their systems, on account of their close resemblance, upon which depends the determination of the genus. A more accurate examination of their forms will remove in future every doubt on the determination of the species, and then only will it be possible to adapt the systematic nomenclature to the geometrical properties of the species, which always must correspond to the state of our information. Mr HAIDINGER has shewn, (Trans. of the Royal Soc. of Edinb. Vol. X. p. 127.) that one of the formerly supposed species of the present genus, the Green Diallage of HAÜY, contains nothing but varieties of two other species, the hemi-prismatic and paratomous Augite-spar, either pure or variously blended with each other. An exact comparison of several varieties of the remaining species with the same two species of the genus Augite-spar, with which they agree so nearly in many of their properties, will afford in future an excellent test for the correctness of their determination.

GENUS II. DISTHENE-SPAR.

1. PRISMATIC DISTHENE-SPAR.

Prismatic Kyanite. JAM. Syst. Vol. II. p. 94. Man. p. 134. Kyanite. Cyanite. PHILL. p. 81. Cyanit. Rhætizit. WERN. Hoffm. H. B. II. 2. S. 313. IV. 2. S. 128. Kyanit. HAUSM. II. S. 636. Disthen. LEONH. S. 422. Disthène. HAÜY. Traité, T. III. p. 220. Tabl. comp. p. 54. Traité, 2de Ed. T. II. p. 357.

Fundamental form. Scalene four-sided pyramid of unknown dimensions, the axis of which is inclined in the planes of both diagonals. Vol. I. Fig. 42.

Simple forms. $\frac{\breve{P}r}{2}\ (P) = 73^\circ\ 45'$ Phillips; r $\frac{P+\infty}{2}\ (T) = 79^\circ\ 10'$ Ph.; $\breve{P}r + \infty\ (M)$.

Char. of Comb. Tetarto-prismatic. Inclination of $\frac{\breve{P}r}{2}$ upon r $\frac{P+\infty}{2}. = 93^\circ\ 15'$ Ph.

Combination. 1. $\frac{\breve{P}r}{2}$. r $\frac{P+\infty}{2}$. $\breve{P}r + \infty$. Fig. 82.

Cleavage. $\breve{P}r + \infty$ highly perfect and easily obtained, less distinct r $\frac{P+\infty}{2}$, least of all $\frac{\breve{P}r}{2}$. Fracture uneven. Surface, streaked parallel to the common edges of intersection, between the forms.

Lustre pearly upon $\breve{P}r + \infty$, particularly if produced by cleavage; inclining to vitreous, or vitreous upon the rest of the faces, the former particularly upon faces of cleavage parallel to $\frac{P+\infty}{2}$, if they are easily obtained. Colour generally white, often passing into blue, sometimes inclining to green or grey. Frequently spots of berlin-blue elongated in one direction, upon a paler ground. Streak white. Transparent ... translucent.

Brittle. Hardness = 5·0 ... 7·0; the lowest degrees upon $\breve{P}r + \infty$, the highest on the solid angles and edges. Sp. Gr. = 3·675, a blue, transparent variety, cut and polished; 3·559 a milk-white variety of Rhætizite.

Compound Varieties. Twin-crystals: faces of composition parallel, axis of revolution perpendicular to $\breve{P}r + \infty$. Massive: composition broad columnar, sometimes straight lamellar, often curved or divergent; faces of composition in most cases irregularly streaked.

OBSERVATIONS.

1. The two varieties formerly distinguished as particular species, which the prismatic Disthene-spar comprehends, are *Kyanite* and *Rhætizite*, but they are so nearly allied to each other, that the colour is the only property in which they can be said to differ, the latter of them referring to those varieties whose colour is white, without any delineations of blue.

2. Three varieties of the present species, analysed, the first by SAUSSURE, the second by LAUGIER, the third by KLAPROTH, have yielded,

Alumina	54·50	55·50	55·50.
Silica	30·62	38·50	43·00.
Lime	2·02	0·50	0·00.
Magnesia	2·30	0·00	0·00.
Oxide of Iron	6·00	2·75	0·50.
Water	4·56	0·75	0·00.
Potash	0·00	0·00	a trace.

It is not altered on being exposed to heat, and is infusible even in very high degrees of temperature. The Rhætizite becomes first red, but again white, if further heated. They are difficultly, but entirely soluble in borax. Some crystals exhibit positive, others negative electricity, on being rubbed, and to this property in particular the name *Disthene* refers, given by HAÜY to the present species.

3. The varieties of prismatic Disthene-spar occur in crystals, or massive, imbedded in rocks, as gneiss, mica slate, &c. The former are often accompanied by prismatoidal Garnet, united with them in a remarkable manner. It is found

also in beds along with rhombohedral Quartz, dodecahedral Garnet, and several species of Augite-spar and Schiller-spar. In single small crystals it is met with in the rock called *white-stone*.

4. Crystals and large cleavable varieties are found at St Gothard in Switzerland, the Zillerthal in the Tyrol, the Saualpe in Carinthia, the Bacher mountain in Stiria. It is likewise met with at Langenloys in Austria, at Sebes in Transylvania, in Bohemia, Moravia, and Saxony; in Banffshire in Scotland, and in various places of North and South America, in Siberia, &c. The Rhætizite is chiefly known from Pfitsch in the Tyrol.

5. Thin laminæ of this mineral are sometimes employed as a support in making experiments before the blowpipe. Blue transparent varieties are cut and polished, and then sometimes sold as an inferior kind of Sapphire, which is a variety of rhombohedral Corundum.

GENUS III. TRIPHANE-SPAR.

1. PRISMATIC TRIPHANE-SPAR.

Prismatic Spodumene. JAM. Syst. Vol. II. p. 91. Man. p. 135. Spodumene. PHILL. p. 142. Spodumen. WERN. Hoffm. H. B. II. 1. S. 341. Triphan. HAUSM. II. S. 526. Triphan. LEONH. S. 484. Triphane. HAÜY. Traité, T. IV. p. 407. Tabl. comp. p. 37. Traité, 2de Ed. T. III. p. 134.

Fundamental form. Scalene four-sided pyramid of unknown dimensions; so are also simple forms and the character of combinations.

Cleavage, $P + \infty = 93°$ BROOKE; $\breve{P}r + \infty$ rather more distinct. Fracture uneven.

Lustre pearly. Colour various shades of greyish-green; passing into greenish-white. Streak white. Translucent.

Brittle. Hardness = 6·5 ... 7·0. Sp. Gr. = 3·170, a variety from Utön.

Compound Varieties. Massive: composition granular, of various sizes of individuals, generally large.

OBSERVATIONS.

1. According to **Arfvedson**, the prismatic Triphane-spar consists of

Silica	66·40.
Alumina	25·30.
Lithia	8·85.
Oxide of Iron	1·45.

If exposed to a red heat, it loses transparency and colour. Before the blowpipe it intumesces, and then melts into a nearly colourless transparent glass.

2. It occurs in primitive rocks, massive, and engaged in rhombohedral Quartz, along with rhombohedral Tourmaline, prismatic Feld-spar, &c.

3. It was first discovered at Utön in Südermanland, Sweden; but has afterwards been found also at Sterzing in the Tyrol, and Killiney in Ireland.

2. AXOTOMOUS TRIPHANE-SPAR.

Prismatic Prehnite. **Jam.** Syst. Vol. I. p. 338. Axotomous Prehnite. Man. p. 136. Prehnite. **Phill.** p. 36. Prehnit. **Wern.** Hoffm. II. B. II. 1. S. 220. Prehnit. **Hausm.** II. S. 560. Prehnit. **Leonh.** S. 442. Prehnite. **Haüy.** Traité, T. III. p. 167. Tabl. comp. p. 50. Traité, 2de Ed. T. II. p. 603.

Fundamental form. Scalene four-sided pyramid, whose dimensions have not been exactly ascertained. Vol. I. Fig. 9.

Simple forms. $P - \infty$ (P); P; $P + \infty$ (M) $= 99^\circ\,30'$ (nearly); $\bar{P}r = 90^\circ$ (nearly); $\bar{P}r + \infty$ (k); $\check{P}r + n$ (o) $= 31^\circ$ (nearly); $\check{P}r + \infty$ (l).

Char. of Comb. Prismatic.

Combinations. 1. $P - \propto$. $P + \infty$. Dauphiny.
2. $P - \propto$. $\breve{P}r + \infty$. $P + \infty$. $\bar{P}r + \infty$. Dauphiny.
3. $P - \infty$. $\breve{P}r + n$. $P + \infty$. $\breve{P}r + \infty$. Fig. 13. Ratschinges, Tyrol.

Cleavage. Very distinct in the direction of $P - \infty$; less easily obtained parallel to $P + \infty$. Surface $P - \infty$ streaked parallel to the edges of combination with $\bar{P}r$, often divided in two faces, meeting at a very obtuse angle of about 177° 30′. P and $\bar{P}r$ are smooth, the rest of the faces streaked parallel to their edges of combination with $P - \infty$.

Lustre vitreous, except upon $P - \infty$, which possesses pearly lustre, particularly if produced by cleavage. Colour various shades of green, as leek-green, mountain-green, apple-green, siskin-green, &c.; passing into white and grey. Streak white. Semi-transparent ... translucent.

Brittle. Hardness = 6·0 ... 7·0. Sp. Gr. = 2·926, a greenish-white cleavable variety.

Compound Varieties. Reniform, globular, stalactitic shapes: surface generally drusy; composition columnar, sometimes broad, imperfect, and strongly coherent; if the particles of composition be distinct, the surface is often pretty smooth. Massive: composition either columnar, as above, or granular, and even sometimes impalpable. Sometimes compound varieties are again aggregated in a second composition, the faces of composition being rough and uneven.

OBSERVATIONS.

1. The mechanical composition of the different varieties of the present species has given occasion for dividing it into two sub-species. Individuals and massive varieties of a granular composition are *foliated Prehnite;* while imitative shapes and massive varieties exhibiting a columnar composition, are called *fibrous Prehnite.*

2. From two analyses, one of them referring to a variety from the Cape by **Klaproth**, and the other to a variety from Reichenbach in the Palatinate by **Laugier**, it appears that the chemical composition of axotomous Triphane-spar is as follows:

Silica	43·83	42·50.
Alumina	30·33	28·50.
Lime	18·33	20·40.
Oxide of Iron	5·66	3·00.
Water	1·83	2·00.
Potash and Soda	0·00	0·75.

Before the blowpipe it is transformed into a white frothy scoria, and then melts into a compact coloured globule; with borax it melts into a transparent bead. In dilute muriatic acid it is slowly dissolved, and leaves a flaky residue. It shews electric poles when heated.

3. Axotomous Triphane-spar is met with in various repositories. It occurs in veins in primitive mountains, with prismatic Axinite, several species of Augite-spar, with prismatic and tetarto-prismatic Feld-spar, and other species. It is found in beds with octahedral Iron-ore and some species of the order Pyrites. It is very frequent in trap-rocks of all ages, particularly the newer ones, either in amorphous masses, or in very irregular veins, and in vesicular cavities, with various species of the genus Kouphone-spar, sometimes with octahedral Copper.

4. It was first brought to Europe by Colonel **Prehn** from the Cape of Good Hope, in bright coloured apple-green varieties. Since that time it has been discovered in

crystallised and massive varieties, in the alps of Savoy and Dauphiny, in St Gothard in Switzerland, in the Tyrol, in Salzburg, Carinthia, in the Pyrenees, in Norway and Sweden. It is found in considerable quantity near Glasgow in Scotland, also at Reichenbach near Oberstein in the Palatinate, in the Faroe islands, in America, &c.

GENUS IV. DYSTOME-SPAR.

1. PRISMATIC DYSTOME-SPAR.

Prismatic Datolite. JAM. Syst. Vol. I. p. 345. Man. p. 139. Datholite. Borate of Lime. PHILL. p. 177. Datholith. WERN. Hoffm. H. B. III. 1. S. 143. Datolith. HAUSM. III. S. 865. Datolith. LEONH. S. 588. Chaux boratée siliceuse. HAÜY. Tabl. comp. p. 17. Traité, 2de Ed. T. I. p. 590.
Humboldtite. LEVY. Ann. of Phil. Febr. 1823. p. 130. Id. PHILL. p. 380.

Fundamental form. Scalene four-sided pyramid. $P = \left\{\begin{matrix} 122° & 0' \\ 120° & 51' \end{matrix}\right\}$, 133° 47', 77° 41'. Inclination of the axis = 1° 41′ 30″, in the plane of the long diagonal. Vol. I. Fig. 41. LEVY.*

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* The angles of incidence and dimensions of the regular forms of the present species are those given for Humboldtite by Mr LEVY ; as calculated from the angles given for the substance, $\bar{P}r = 115° 45'$, $P + \infty = 77° 30'$ and the inclination of the axis = 1° 41′ 30″. There can be no doubt, that the crystals represented in Figs. 68. 69. and 70., from the collection of the Johanneum at Gratz, are this same Humboldite, which Mr MOHS recognised to be Datolite, from the comparison of the rest of their characters, particularly hardness and specific gravity. Also the varieties from Arendal frequently possess a hemi-prismatic character, as is evident from Fig. 67. The position in which Mr LEVY compared the crystals of Datolite with those of Humboldite is different from that adopted in the present work. The want of symmetry in those of Datolite, as referred to his Fig. 2., is contiguous to the opposite acute lateral edges of $m = 76° 35'$, a prism which agrees in position

$$a : b : c : d = 33{\cdot}8 : 67{\cdot}17 : 53{\cdot}95 : 1.$$

Simple forms. $P - \infty$ (b); $\pm\frac{P}{2}\left\{\frac{P}{n}\right\} = \left\{\begin{matrix}122^\circ\ 0'\\120^\circ\ 51'\end{matrix}\right\}$; $P + \infty$ $(f) = 77^\circ\ 30'$; $\frac{(\bar{P}r)^3}{2}$ (q); $-\frac{(\breve{P}r)^3}{2}$ (e); $-\frac{(\breve{P}r + 1)^3}{2}$ (h); $(\breve{P}r + \infty)^3$ $(g) = 116^\circ\ 9'$; $-\frac{(\bar{P} - 1)^3}{2}$ (p); $-\frac{(\breve{P})^4}{2}$ (l); $-\frac{(\breve{P}r)^5}{2}$ (i); $-\frac{(\breve{P})^5}{2}$ (m); $\frac{\breve{P}r + 1}{2}$ $(a) = 43^\circ\ 56'$; $\breve{P}r + \infty$ (s); $\bar{P}r$ $(d) = 115^\circ\ 45'$; $\frac{3}{4}\bar{P}r + 1$ $(r) = 93^\circ\ 26'$; $\bar{P}r + 1$ $(o) = 77^\circ\ 4'$; $\bar{P}r + \infty$ (u).

Char. of Comb. Hemi-prismatic. Inclination of $P - \infty$ on $\breve{P}r + \infty = 91^\circ\ 41'\ 30''$.

Combinations. 1. $P - \infty$. $\frac{P}{2}$. $\frac{\breve{P}r + 1}{2}$. $\bar{P}r + 1$. $P + \infty$. $\frac{(\breve{P}r + \infty)^3}{2}$. $\breve{P}r + \infty$. Fig. 67. Arendal, Norway.

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with *f* of the figures, and with his prism $e^1 = 77^\circ\ 30'$ in Humboldtite, while the prisms $a^1 = 115^\circ\ 32'$ in Datolite, and $m = 115^\circ\ 45'$ in Humboldtite, also possess a similar situation, that of *d* in the figures. The difference in the angles, particularly the incidence of $P - \infty$ on $P + \infty$, given as 90° in Datolite, and 91° 41′ 30″ in Humboldtite, remain to distinguish the crystals of the two bodies; but a new comparison of them, under this point of view, would yet be desirable. Their hemi-prismatic character was first given in the *Characteristic of the Natural History System* of Mohs, the angles, from want of other measurements, were indicated upon the authority of Haüy. Also the variety from America is decidedly hemi-prismatic. H.

2. $P - \infty.\ \frac{P}{2}.\ \frac{\breve{P}r + 1}{2}.\ \bar{P}r.\ -\frac{(\breve{P}r)^5}{2}.$ $P + \infty.$ $(\breve{P}r + \infty)^3.$ Fig. 68. Theiss near Brixen, Tyrol.

3. $P - \infty.\ \frac{P}{2}.\ \frac{\breve{P}r + 1}{2}.\ \frac{(\bar{P}r)^3}{2}.\ \bar{P}r.\ Pr + 1.$ $-\frac{P}{2}.\ -\frac{(\breve{P}r)^3}{2}.\ -\frac{(\breve{P}r)^5}{2}.\ P + \infty.$ $(\breve{P}r + \infty)^3.\ \bar{P}r + \infty.$ Fig. 69. Tyrol.

4. $P - \infty.\ \frac{P}{2}.\ \frac{\breve{P}r + 1}{2}.\ \frac{(\bar{P}r)^3}{2}.\ \bar{P}r.\ \frac{3}{4}\ \bar{P}r + 1.$ $\bar{P}r + 1.\ -\frac{P}{2}.\ -\frac{(\breve{P}r)^3}{2}.\ -\frac{(\bar{P} - 1)^3}{2}.$ $-\frac{(\breve{P}r)^5}{2}.\ -\frac{(\breve{P})^4}{2}.\ -\frac{(\breve{P}r + 1)^3}{2}.\ -\frac{(\breve{P})^5}{2}.$ $P + \infty.$ $(\breve{P}r + \infty)^3.$ Fig. 70. Tyrol.

Cleavage very indistinct, parallel to $P + \infty$, somewhat more easily observed $\breve{P}r + \infty$. Fracture uneven, imperfect conchoidal. Surface, $\frac{\breve{P}r + 1}{2}$ striated in three directions, parallel to the edges of combination with $P - \infty$ and with $\frac{P}{2}$, the vertical prisms parallel to their own intersections, $\bar{P}r$ and $-\frac{P}{2}$ rough. The rest of the faces generally of nearly the same physical quality, are often altogether rough, or at least devoid of polish.

Lustre vitreous, and particularly in the fracture inclining to resinous. Colour white inclining to green, yellow, and grey; sometimes of a dirty olive-green or honey-yellow tinge. Streak white, more or less translucent.

Brittle. Hardness = 5·0 ... 5·5. Sp. Gr. = 2·989, a variety from Arendal.

Compound Varieties. Massive: composition granular, of various sizes of individuals; faces of composition rough and irregularly streaked.

OBSERVATIONS.

1. The substance called *Botryolite*, is considered by HAÜY and others, as a variety of the present species; while in the system of WERNER, it is considered as a species of its own. It has hitherto been observed only in compound varieties of reniform, botryoidal and globular shapes, consisting of very thin individuals, which in fact possess some properties, nearly agreeing with those of prismatic Dystome-spar, but which do not yet allow us to draw any decisive inferences, in regard to the determination of the species.

2. According to KLAPROTH, the simple varieties of Datolite, and the compound ones of Botryolite, consist of

Silica	36·50	36·00.
Lime	35·50	39·50.
Boracic Acid	24·00	13·50.
Oxide of Iron	0·00	1·00.
Water	4·00	6·50.

The chemical fomula of the first is $\ddot{C}a\ \ddot{B}^4 + \ddot{C}a\ \dddot{Si}^2 + 2$, Aq, that of the second $\ddot{C}a\ B^2 + \ddot{C}a\ \dddot{Si}^2 + 2$ Aq. Exposed to the flame of a candle, it becomes friable. Before the blowpipe it loses its transparency, intumesces and melts into a glassy globule. It is easily soluble in nitric acid and leaves a siliceous gelatine.

3. It occurs in beds of iron-ore in primitive rocks, accompanied by rhombohedral Lime-haloide, sometimes also by octahedral Fluor-haloide, several species of the genus Augite-spar, rhombohedral Quartz, and axotomous Triphane-spar. With the latter, and several species of Kouphone-spar, it is found in agate-balls and irregular veins traversing trap-rocks.

4. Upon the beds of iron-ore described above, the varieties of Datolite and Botryolite are met with at Arendal in Norway. In agate balls the Humboldtite occurs in the Seiseralp in the Tyrol, in irregular veins in greenstone, in Salisbury-craig near Edinburgh, and in America.

GENUS V. KOUPHONE[*]-SPAR.

1. TRAPEZOIDAL KOUPHONE-SPAR.

Dodecahedral Zeolite or Leucite. JAM. Syst. Vol. I. p. 351. Trapezoidal Zeolite or Leucite. Man. p. 141. Leucite. PHILL. p. 107. Leuzit. WERN. Hoffm. H. B. I. S. 482. Leuzit. HAUSM. II. S. 588. Leuzit. LEONH. S. 459. Amphigène. HAÜY. Traité, T. II. p. 559. Tabl. comp. p. 33. Traité, 2de Ed. T. III. p. 61.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple form. $\overset{*}{C}_1$ (*g*) Vol. I. Fig. 34. Irregular forms, grains.

Cleavage very imperfect, parallel to the hexahedron and the dodecahedron. Fracture conchoidal. Surface of crystals even, though generally rough, of grains uneven and smooth.

Lustre vitreous. Colour reddish-, yellowish-, or greyish-white; ash-grey or smoke-grey. Streak white. Semi-transparent ... translucent.

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[*] From κοῦφος, light.

Brittle. Hardness = 5·5 ... 6·0. Sp. Gr. = 2·483, a semi-transparent yellowish-grey variety.

Compound Varieties. Massive: composition granular; faces of composition irregularly streaked. Rare.

OBSERVATIONS.

1. The tessular form is given here on the authority of **Haüy**. According to the observations of Dr **Brewster**, this species possesses two axes of double refraction, and must therefore be considered as one of those instances in which we have to look forward to future observations, that may enable us to account for this apparent exception to the general law, that tessular forms are connected with that structure which possesses no double refraction.

2. The trapezoidal Kouphone-spar is composed of

	From Vesuvius.	From Albano.	
Silica	53·750	54·00	56·10.
Alumina	24·625	23·00	23·10.
Potash	21·350	22·00	21·15.
Oxide of Iron	0·000	0·00	0·90.
	Klaproth.		Arfvedson.

Its chemical composition is $\ddot{K}^3 \dddot{Si}^4 + 6 \dddot{Al} \dddot{Si}^2$, or in words, 20·89 potash, 22·76 alumina, and 56·35 silica. Alone it is infusible before the blowpipe: but it fuses with borax or carbonate of lime, though with difficulty, into a clear globule. Reduced to powder it changes the colour of the blue tincture of violets into green.

2. This species occurs chiefly in imbedded crystals and grains in lava, sometimes in compound varieties in the specimens ejected by Mount Vesuvius. Besides this locality, it is also found at Albano and Frascati near Rome.

2. DODECAHEDRAL KOUPHONE-SPAR.

Soda'ite. Jam. Syst. Vol. II. p. 52. Dodecahedral *Zeo-*

lite. Man. p. 142. Sodalite. Phill. p. 127. Sodalit. Hausm. II. S. 524. Sodalit. Leonh. S. 457. Sodalite. Haüy. Traité, 2de Ed. T. III. p. 59.

Fundamental form. Hexahedron. Vol. I. Fig. 1. Simple forms. H; $\overset{*}{D}$, Vol. I. Fig. 31. Vesuvius. Combination. 1. H. D. Fig. 151, the faces of the hexahedron very small. Greenland.

Cleavage, dodecahedron perfect. Fracture conchoidal, uneven. Surface smooth, sometimes rather uneven.

Lustre vitreous. Colour green, greenish-white, passing into greyish- and snow-white. Streak white. Translucent.

Brittle. Hardness = 5·5 ... 6·0. Sp. Gr. = 2·295, crystals from Greenland.

Compound Varieties. Massive: composition granular; faces of composition uneven.

OBSERVATIONS.

1. Two analyses of the present species, one by Ekeberg, another by Thomson, have yielded

Silica	36·00	38·52.
Alumina	32·00	27·48.
Lime	0·00	2·10.
Oxide of Iron	0·15	1·00.
Soda, and a little Potash	25·00	23·50.
Muriatic Acid	6·75	3·00.
Volatile substances	0·00	2·10.

Its chemical formula is $\dot{N}a^3\ \dddot{Si}^2 + 4\ \overline{\dddot{Al}}\ \dddot{Si}$, which corresponds to 27·62 of soda, 30·25 alumina, and 42·13 silica. Before the blowpipe it melts, with intumescence and developement of air bubbles, into a colourless glassy globule: with borax it melts difficultly, but only if added in a small proportion. The fresh fracture of the Greenland variety often presents a beautiful crimson-red tint, which, however, soon fades, the mineral being exposed to light, as has been first observed by Mr ALLAN.

2. The dodecahedral Kouphone-spar is found in West Greenland, in a bed in mica-slate, from six to twelve feet thick, and is accompanied by several species of the genera Augite-spar and Feld-spar, also by pyramidal Zircon and Eudialyte. It occurs likewise among the minerals ejected by Mount Vesuvius.

3. HEXAHEDRAL KOUPHONE-SPAR.

Hexahedral Zeolite, or Analcime. JAM. Syst. Vol. I. p. 355. Man. p. 142. Analcime. PHILL. p. 129. Analzim (Cubizit). WERN. Hoffm. H. B. II. 1. S. 251. Analzim. HAUSM. II. S. 586. Analzim. LEONH. S. 458. Analcime. HAÜY. Traité, T. III. p. 180. Tabl. comp. p. 51. Traité, 2de Ed. T. III. p. 170.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. H. (P); D Vol. I Fig. 31.; $\dot{C}_1$ (o) Vol. I. Fig. 34. Kollefiord, Stromoe, one of the Faroe islands.

Char. of Comb. Tessular.

Combinations. 1. H. C_1. Fassa, Tyrol. Fig. 153. 2. H. D. C_1.* Vesuvius.

Cleavage, hexahedron difficultly obtained; and even when distinct, of a very interrupted appearance†. Fracture imperfect conchoidal, uneven.

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[*] This rare and new variety is preserved in the cabinet of Mr ALLAN. H.

[†] I have observed it in some translucent varieties in Mr ALLAN's collection; the transparent ones present more perfectly conchoidal fracture. Dr BREWSTER has found that the crystals of this substance are composed in a singular manner of

Surface in general smooth, faintly streaked parallel to those edges of the icositetrahedron, which meet in the solid angle of three faces, often they appear a little convex.

Lustre vitreous. Colour white, prevalent, passing into grey, more frequently into reddish-white and flesh-red. Streak white. Transparent ... translucent.

Brittle. Hardness = 5·5. Sp. Gr. = 2·068, crystals from the Tyrol.

Compound Varieties. Massive: composition granular, of various, often considerable sizes of individuals, more or less strongly coherent. Faces of composition uneven and rough, and often irregularly streaked.

OBSERVATIONS.

1. VAUQUELIN has found a variety of the present species to consist of

Silica	58·00.
Alumina	18·00.
Soda	10·00.
Lime	2·00.
Water	8·50.

Its chemical constitution is expressed, according to BERZELIUS, by $\ddot{\mathrm{N}}^3\ \dddot{\mathrm{Si}}^4 + 6\,\dddot{\mathrm{A}}\ \dddot{\mathrm{Si}}^2 + 12\,\mathrm{Aq}$, which corresponds to

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twenty-four solids, such as would arise from laying planes parallel to those of the dodecahedron through their centres; each of them on the surface of Fig. 34. Vol. I. being contiguous to the solid angle *a*, to one of those marked *b*, and to two adjacent ones marked *c*. These solids are symmetrically arranged in respect to the axes of the icositetrahedron; but each of them possesses a separate optical structure, and a double refraction, as if modified by a succession of strata of variable density. H.

13·73 of soda, 22·55 alumina, 55·84 silica, and 7·90 water. Upon charcoal it melts without intumescence or ebullition, into a clear, a little vesicular, glassy globule, and gelatinises in muriatic acid.

2. The hexahedral Kouphone-spar chiefly occurs in the cavities of amygdaloidal rock, and several kinds of basalt; less frequently it is found in small irregular veins, and in a few rare instances, in beds and veins belonging to more ancient rocks. In the first of these they line the sides of the cavities, or fill them up altogether. It is accompanied by various other species of the present genus, particularly the prismatic and pyramidal Kouphone-spars. In beds it occurs along with dodecahedral Garnet, several species of Augite-spar and Iron-ore, rhombohedral Lime-haloide, &c.; the latter species, and paratomous and prismatoidal Kouphone-spar, are found with it in metalliferous veins.

3. Fine, and particularly large crystals of the present species, are found at the Seiser Alp in the Tyrol, at Dumbarton in Scotland, near Almas and Tökörö in Transylvania, &c. Other varieties of it are found in several parts of Scotland, particularly in the Western isles; also in the Faroe islands and in Iceland; near Catania, at Monte Somma, in the Cyclopic islands, &c. It is met with in the ironstone beds of Arendal in Norway, and in the silver veins of Andreasberg in the Hartz.

4. PARATOMOUS KOUPHONE-SPAR.

Pyramidal Zeolite or Cross-Stone. JAM. Syst. Vol. I. p. 362. Pyramido-prismatic Zeolite or Cross-Stone. Man. p. 143. Harmotome. PHILL. p. 56. Kreuzstein. WERN. Hoffm. H. B. II. 1. S. 261. Harmotom. HAUSM. II. S. 557. Harmotom. LEONH. S. 451. Harmotome. HAÜY. Traité, T. III. p. 191. Tabl. comp. p. 52. Traité, 2de Ed. T. III. p. 142.

Fundamental form. Scalene four-sided pyramid. Vol. I. Fig. 9.

Simple forms. P (*P*); P̆r (*s*); P̆r + 2 (*t*); P̆r + ∞ (*o*); P̄r + ∞ (*g*).

Char. of Comb. Prismatic.

Combinations. 1. P. P̄r + ∞. P̆r + ∞. Sim. Fig. 10, without *P*. Oberstein, Deuxponts.
2. P̆r. P. P̄r + ∞. P̆r + ∞. Strontian, Scotland.
3. P̆r. P. P̆r + 2. P̄r + ∞. P̆r + ∞. Fig. 22. Andreasberg, Hartz.

Cleavage, P, also P̄r + ∞, and a little more distinctly P̆r + ∞, though imperfect in all directions. Fracture uneven, imperfect conchoidal. Surface, P̆r and P streaked parallel to their common edges of combination; so are also the faces of several other forms appearing between P̆r and P; P̆r + 2 uneven; P̆r + ∞ generally rough or uneven; P̄r + ∞ smooth, but in most cases divided into four faces meeting at very obtuse angles, as in certain hexahedral varieties of octahedral Fluor-haloide.

Lustre vitreous. Colour white prevalent, passing into grey, yellow, red, and brown. Streak white. Semi-transparent ... translucent.

Brittle. Hardness = 4·5. Sp. Gr. = 2·392, crystals from Andreasberg.

Compound Varieties. Twin-crystals. Face of composition parallel, axis of revolution perpendicular to one of the faces of P + ∞. The individuals are continued beyond the face of composition, and produce the common cruciform crystals, one of which is represented in Fig. 40. Massive: composition granular, rare.

OBSERVATIONS.

1. The dimensions of the crystalline forms of this species have not yet been ascertained with sufficient exactness. As a point of comparison, the isosceles pyramid of 121° 58′, 86° 36′, given by Haüy, may be useful, although it supposes the prism $P + \infty$ to be a rectangular four-sided prism, like that produced by the enlargement of *o* and *q*. Mr Phillips finds the edge replaced by the horizontal prism $\breve{P}r$ to be $= 119° 4'$, and the angle of that prism itself $= 110° 26'$, from which two data the other terminal edge of P would follow 121° 6′.

2. According to Klaproth, the paratomous Kouphone-spar consists of

Silica	49·00.
Alumina	16·00.
Baryta	18·00.
Water	15·00.

Alone upon charcoal it melts, without intumescence, into a clear globule. It phosphoresces with a yellow light, and is not easily acted upon by acids.

3. Paratomous Kouphone-spar occurs pretty frequently in metalliferous veins, but is found also in vesicular cavities of amygdaloidal rocks, like most other species of the present genus. The crystallised varieties in cruciform twins from Andreasberg in the Hartz, and in simple crystals from Strontian in Scotland, are very generally known. They occur in metalliferous veins, traversing greywacke-rocks, accompanied by rhombohedral Lime-haloide, hexahedral Lead-glance, and in the first locality, also by prismatoidal Kouphone-spar. This species is likewise met with in veins traversing mica-slate and hornblende-slate, with ores of silver, &c.

3. Besides Andreasberg and Strontian, veins are the repositories of the present species at Kongsberg in Norway. It is very frequent in amygdaloid, as in various places in Scotland; at Oberstein in Deuxponts, where it is found in the agate balls; in Baden; near Engelhaus and Buchau in Bohemia, and in the vicinity of Mount Vesuvius.

5. RHOMBOHEDRAL KOUPHONE-SPAR.

Rhombohedral Zeolite, or Chabasite. Jam. Syst. Vol. I. p. 359. Man. p. 145. Chabasie. Phill. p. 138. Schabasit. Wern. Hoffm. H. B. II. 1. S. 257. Chabasin. Hausm. II. S. 585. Chabasie. Leonh. S. 449. Chabasie. Haüy. Traité, T. III. p. 176. Tabl. comp. p. 50. Traité, 2de Ed. T. III. p. 163.

Fundamental form. Rhombohedron. R = 94° 46′. Vol. I. Fig. 7. Phillips.

$$a = \sqrt{3{\cdot}538}.$$

Simple forms. R − 1 (*n*) = 125° 13′; $\overset{*}{\mathrm{R}}$ (*P*), Faroe; R + 1 (*r*) = 72° 53′; P + ∞ (*u*).

Char. of Comb. Rhombohedral.

Combinations. 1. R − 1. R. R + 1. Fig. 120. Oberstein, Bavaria.

2. R − 1. R. R + 1. P + ∞. The individuals in Fig. 173. Giant's Causeway, Ireland.

Cleavage, R, pretty distinct. Fracture uneven. Surface, R − 1 and P + ∞ streaked parallel to the edges of combination with R; R + 1 smooth. The faces of R are generally streaked parallel to their own terminal edges, which striæ are produced by a scalene six-sided pyramid having terminal edges of about 173½° and 103½°, in parallel position with R.

Lustre vitreous. Colour white, little modified. Streak white. Semi-transparent ... translucent.

Brittle. Hardness = 4·0 ... 4·5. Sp. Gr. = 2·100, crystals from Bohemia.

Compound Varieties. Twin-crystals. 1. Face of composition parallel, axis of revolution perpendicular to R — ∞, the individuals being continued beyond the face of composition. Fig. 128. Aussig, Bohemia; Fig. 173. Giant's Causeway. 2. Face of composition parallel, axis of revolution perpendicular to one of the faces of R, the individuals terminating at the face of composition. Fassa, Tyrol. Massive: composition granular, of various sizes; faces of composition uneven.

OBSERVATIONS.

1. According to the optical researches of Dr **Brewster**, the rhombohedron, given above as the fundamental form of rhombohedral Kouphone-spar, is composed in a remarkable symmetrical manner of several solids, possessing each of them two axes of double refraction. They are often disposed in laminæ round a kernel, which has only one optical axis, coincident with the principal axis of the rhombohedron.

2. According to **Vauquelin**, the present species consists of

Silica	43·33.
Alumina	22·66.
Lime	3·34.
Potash with Soda	9·34.
Water	21·00.

Alone before the blowpipe it melts into a white spumous mass, and is not acted upon by acids.

3. Also this species occurs, like several others of the present genus, chiefly in the cavities of amygdaloidal rocks, the sides of which are often coated with Green-earth. It is accompanied by other species of the genus Kouphone-spar, by rhombohedral Lime-haloide and rhombohedral Quartz. It occurs also in narrow veins in different trap rocks.

4. The largest and most distinct crystals are found in Iceland, the Faroe islands, and the vicinity of Aussig in Bohemia. It is contained in the agate balls of Oberstein in Deux Ponts. Various simple and compound varieties occur in the Tyrol and other places in Germany, in Scotland and particularly the Western Isles, in Ireland, &c.

6. DIATOMOUS KOUPHONE-SPAR.

Di-prismatic *Z*eolite or Laumonite. Jam. Syst. Vol. I. p. 365. Diatomous *Z*eolite or Laumonite. Man. p. 146. Laumonite. Phill. p. 45. Lomonit. Wern. Hoffm. H. B. II. 1. S. 267. Laumonit. Hausm. II. S. 555. Laumontit. Leonh. S. 448. Zeolite efflorescente? Haüy. Traite, T. IV. p. 410. Laumonite. Tabl. comp. p. 19. Traite, 2de Ed. T. III. p. 151. Bournon. Trans. Geol. Soc. Vol. I. p. 77.

Fundamental form. Scalene four-sided pyramid. Inclination of the axis in the plane of the long diagonal. Vol. I. Fig. 41.

Simple forms. $P+\infty\ (M) = 86^\circ\ 15'$*; $\pm\frac{\breve{P}r}{2}\left\{\begin{matrix}P\\c\end{matrix}\right\}$; $\breve{P}r+\infty\ (s)$; $\bar{P}r+\infty\ (l)$.

Char. of Comb. Hemi-prismatic. Inclination of $\frac{\breve{P}r}{2}$ to $P+\infty = 113^\circ\ 30'$*; of $-\frac{\breve{P}r}{2}$ to $P+\infty = 104^\circ\ 20'$*.

Combinations. 1. $\frac{\breve{P}r}{2}$. $P+\infty$. Fig. 44. Iceland.

2. $\frac{\breve{P}r}{2}$. $P+\infty$. $\breve{P}r+\infty$. $\bar{P}r+\infty$. Schemnitz, Hungary.

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* According to Brooke and Phillips.

3. $\frac{\breve{P}r}{2}$. — $\frac{\breve{P}r}{2}$. $P + \infty$. $\bar{P}r + \infty$. Huelgoet, Brittany.

Cleavage, $\breve{P}r + \infty$ distinct; traces of $\bar{P}r + \infty$. Fracture uneven, scarcely observable. Surface, $\frac{\breve{P}r}{2}$ either smooth or uneven. The faces parallel to the principal axis striated in that direction.

Lustre vitreous, inclining to pearly upon the more distinct faces of cleavage. Colour white, passing into some reddish, yellowish, or greyish tints. Streak white. Translucent.

Not very brittle. Hardness unknown. Sp. Gr. = 2·3, HAÜY.

Compound Varieties. Massive: composition granular, commonly elongated in one direction, faces of composition generally streaked.

OBSERVATIONS.

1. According to two analyses, one by L. GMELIN, and another by VOGEL, the present species consists of

Silica	48·30	49·00.
Alumina	22·70	22·00.
Lime	12·10	9·00.
Water	16·00	17·50.
Carbonic Acid	0·00	2·50.

Before the blowpipe it gives the same results as the preceding species. It gelatinises with acids, and acquires negative electricity by friction, if isolated. It is decomposed by the action of the atmosphere, and loses its water; it is therefore generally met with in a friable state, and most of its properties are on that account but imperfectly known.

2. It occurs in veins traversing clay-slate, with rhombo-

hedral Lime-haloide. Along with the same species it is likewise found in irregular veins and imbedded masses in porphyry, and in the cavities of amygdaloidal rocks.

3. The first variety noticed of this species was discovered by GILLET LAUMONT, in the lead mines of Huelgoet in Brittany, and has received its name in compliment to the discoverer. It was afterwards found near Schemnitz in Hungary in porphyry. It occurs likewise in Mount St Gothard with rhombohedral Fluor-haloide, in Faroe, Iceland, and various parts of Scotland and Ireland.

7. PRISMATIC KOUPHONE-SPAR.

Prismatic Zeolite or Mesotype. JAM. Syst. Vol. I. p. 368. Man. p. 146. Mesotype. PHILL. p. 123. Faserzeolith (in part). WERN. Hoffm. H. B. II. 1. S. 233. Zeolith (in part). HAUSM. II. S. 564. Mesotyp (in part). LEONH. S. 452. Mésotype. HAÜY. Traité, T. III. p. 151. Tabl. comp. p. 48. Traité, 2de Ed. T. III. p. 179.

Fundamental form. Scalene four-sided pyramid. P = 143° 20′, 142° 40′, 53° 20′. Vol. I. Fig. 9. R. G.

$$a : b : c = 1 : \sqrt{8{\cdot}07} : \sqrt{7{\cdot}794}.$$

Simple forms. P (o); $P + \infty$ (M) = 91° 0′; $\breve{P}r + \infty$ (r).

Char. of Comb. Prismatic. Combination. P. $P + \infty$.

Cleavage, $P + \infty$, perfect. Fracture conchoidal, uneven. Surface, $\breve{P}r + \infty$, vertically streaked, the rest of the faces smooth.

Lustre vitreous. Colour, few shades of white, generally greyish. Streak white. Transparent … translucent.

Brittle. Hardness = 5·0 … 5·5. Sp. Gr. = 2·249.

Compound Varieties. Implanted globular shapes:

surface drusy, composition columnar. Massive: composition columnar, consisting of delicate, straight, and generally divergent individuals, radiating from a centre; sometimes aggregated into angulo-granular masses. Spheroidal shapes formed in vesicular cavities.

OBSERVATIONS.

1. Mr Phillips has given the first good representation of a crystal belonging to the present species, greatly resembling that of Fig. 174. The inclination of b on b has been found = 146° 16′, e on M = 117° 14′, while that of o on M is = 116° 40′. The only variety to which the preceding description and the characters of the Characteristic refer, is that from Auvergne. However similar in various respects it may be to other varieties, as to those from Iceland, Scotland, the Tyrol, Faroe, and other localities; yet it cannot be united with them within one and the same species, on account of the difference of several of their properties. The real difference between several of them have been sufficiently demonstrated by the labours of Professor Fuchs, Dr Brewster, Mr Brooke, Mr Phillips, &c.; and no doubt an accurate investigation of all the physical properties of these substances will enrich the remarkable genus of Kouphone-spar, with several new species. From this investigation it will also appear which of the various kinds of Mesotype must be united with the present species.[*]

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[*] The angle of the prism M is given in the variety from

Auvergne	91° 20′	91° 10′.
Högau (Natrolite)	91° 35′	91° 10′.
Iceland (Mesolite)	91° 22′ Phillips.	91° 20′. Brooke.

From various observations I have found the first of these from 90° 59′ to 91° 3′, the third from 91° 23′ to 91° 27′; moreover, a variety from Faroe = 91° 28′ — 91° 29′, and one from the district of Maloa in East India = 91° 23′.

2. Several analyses have been published referring to the varieties formerly comprehended within the Mesotype of Haüy. Thus Messrs Gehlen and Fuchs, who first discovered the difference among several of these substances, obtained from

	Scolezite from Staffa.	*Mesolite* from Iceland.	*Natrolite* from Hohentwiel.	*Natrolite* from Tyrol.
Silica	46·75	47·46	47·21	48·63
Alumina	24·82	25·35	25·60	24·82
Soda	0·39	4·87	16·12	15·69
Lime	14·20	10·04	0·00	0·00
Water	13·64	12·41	8·88	9·60
Oxide of Iron	0·00	0·00	1·35	0·21

With these analyses, other varieties have been found to agree more or less. The chemical formula of Natrolite is given by Berzelius $\ddot{\mathrm{N}}\mathrm{a}^{3}\,\dddot{\mathrm{S}}\mathrm{i}^{2} + 2\,\dddot{\mathrm{A}}\mathrm{l}\,\dddot{\mathrm{S}}\mathrm{i} + 4\,\mathrm{Aq}$, which corresponds to 15·93 of soda, 26·19 alumina, 48·64 silica, and 9·24 water. The Natrolite loses its transparency before the blowpipe, and melts into a glassy globule; the radiated varieties exfoliate, and the compact ones intumesce. They are with difficulty soluble in borax. Some of them assume, by heat, faint degrees of opposite kinds of electricity on their opposite ends, and become positively electric by friction.

3. The general repository of all the species here under consideration, are the vesicular cavities of amygdaloidal rocks. They are accompanied by various species of the present genus, and by rhombohedral Lime-haloide. Some

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Fig. 175. represents a crystal of the Iceland variety; there is a face of composition passing through the crystals, which therefore appear to be twins. This composition has been first observed by Dr Brewster. I obtained by measurement the incidence of *o* of one individual, on the face *o″* of the other = 179° 0′ of *o* on *o′* = 141° 53′, of *o″* on *o′* = 142° 53′; *o* on the adjacent face over α = 145° 10′. The edges marked α, and those between *o* and *M*, are often replaced, by additional faces, the first of which are striated parallel to the edges of combination with *o*, the latter rough. H.

varieties of Natrolite occur in veins traversing clinkstone, others in amygdaloid.

4. The variety of Mesotype, to which the preceding general description refers, is found in several localities near Clermont-Ferrand in Auvergne. Other varieties occur in Iceland, the Faroe islands, Tyrol, Italy, the Lipari islands, &c.; the Natrolite is met with at Hohentwiel in Swabia, and at Bilin in Bohemia, some varieties of it also in the valley of Fassa in Tyrol, &c.

8. PRISMATOIDAL KOUPHONE-SPAR.

Prismatoidal Zeolite or Stilbite (Radiated Zeolite). Jam. Syst. Vol. I. p. 378. Man. p. 149. Stilbite. Phill. p. 37. Strahlzeolith. Wern. Hoffm. H. B. II. 1. S. 237. Blättrich-strahliger. Stilbit. Hausm. II. S. 575. Stilbit (in part). Leonh. S. 445. Stilbite (in part). Hauy. Traité, T. III. p. 161. Tabl. comp. p. 48. Traité, 2de Ed. T. III. p. 155. Brooke, Edin. Phil. Journ. Vol. VI. p. 112.

Fundamental form. Scalene four-sided pyramid. $P = 119^\circ 15', 114^\circ 0', 96^\circ 0'$. Vol. I. Fig. 9. Brooke.

$$a : b : c = 1 : \sqrt{1{\cdot}7502} : \sqrt{1{\cdot}5087}.$$

Simple forms. $P - \infty$ (P); P (r); $P + \infty = 94^\circ 15'$. $\breve{P}r + \infty$ (T); $\bar{P}r + \infty$ (M).

Char of Comb. Prismatic.

Combinations. 1. $P. \breve{P}r + \infty. \bar{P}r + \infty$. Iceland.

2. $P - \infty. P. \breve{P}r + \infty. \bar{P}r + \infty$. Fig. 10. Faroe.

3. $P - \infty. P. P + \infty. \breve{P}r + \infty. \bar{P}r + \infty$. Campsie, Stirlingshire.

Cleavage, $\breve{P}r + \infty$ highly perfect, traces of $\bar{P}r + \infty$. Fracture uneven. Surface, $P - \infty$ often curved, $\breve{P}r + \infty$ vertically streaked, still more so $\bar{P}r + \infty$.

Lustre vitreous. The faces $\breve{P}r + \infty$, both as faces of crystallisation and of cleavage, exhibit perfect pearly lustre. Colour white prevalent, various shades, passing into yellow, red, and brown. Streak white. Semi-transparent ... translucent. Brittle. Hardness = 3·5...4·0. Sp. Gr. = 2·161, white crystals from Iceland.

Compound Varieties. Twin-crystals: face of composition parallel, axis of revolution perpendicular to one of the faces of P̄r, the individuals are continued beyond the face of composition, so that the whole assumes a cruciform aspect.* The crystals are frequently aggregated in the form of sheafs. Implanted globules, surface very drusy, composition imperfectly columnar, and strongly cohering. Massive: composition imperfect columnar, individuals broad, straight, and radiating from a common centre, strongly coherent. Often these compositions are again aggregated into granular masses. Globular shapes formed in vesicular cavities.

OBSERVATIONS.

1. The present species was first distinguished from the following one, in the *Characteristic of the Natural History System.* Their difference was afterwards pointed out by Mr Brooke, who gave the latter species the name of *Heulandite.* They are chiefly distinguished by their forms, which are prismatic in Stilbite, and hemi-prismatic in the Heulandite; their hardness and specific gravity agree very near with each other. This difference in the forms is not only sufficient, but its necessary consequence is the perfect diversity

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* A beautiful crystal of this variety from Faroe, is preserved in the cabinet of Mr Allan. H.

of the two species, because the fundamental forms in the two cannot be united by any regular geometrical process, and therefore belong to different systems of crystallisation.

2. According to HISINGER, the prismatoidal Kouphone-spar consists of

Alumina	16·10.
Silica	58·00.
Lime	9·20.
Water	16·40.

Its chemical formula is $\ddot{\mathrm{Ca}}\,\dddot{\mathrm{Si}}^{2} + 2\,\overset{\dots}{\overline{\mathrm{Al}}}\,\dddot{\mathrm{Si}}^{3} + 12\,\mathrm{Aq}$, which corresponds to 8·77 lime, 15·82 alumina, 58·78 silica, and 16·63 water. Before the blowpipe it yields an opake vesicular globule. It does not gelatinise with acids.

3. The varieties of the present species and of the following one, agree very nearly in regard to their modes of occurrence in nature, and are rarely met with, except when accompanying each other. Their principal repositories are the vesicular cavities of amygdaloidal rocks, and certain metalliferous veins. In the first they are found deposited upon the walls, which have often a coating of green-earth, along with other species of the present genus, with rhombohedral Lime-haloide, rhombohedral Quartz, &c. Besides the metalliferous veins, where it occurs also with various Kouphone-spars, and with ores of silver and lead, it is found in metalliferous beds in primitive mountains, with ores of copper and iron, and several species of the genus Augite-spar.

4. Magnificent crystals of a white colour are met with in the vesicular cavities of the amygdaloids of Iceland and the Faroe islands. Similar varieties have been brought also from Indore in the Vendyah mountains in East India. Those from the Tyrol are mostly compound, and of a brick-red colour. Beautiful crystals of this colour occur near Campsie in Stirlingshire, though the present species is less common in Scotland and the Western Isles, than the following one. The crystals from the silver-veins of Andreasberg in the Hartz, are generally small, so are also those which occur in

the ironstone beds of Arendal in Norway, and in the beds of copper-ore in the Bannat of Temeswar.

9. HEMI-PRISMATIC KOUPHONE-SPAR.

Prismatoidal Zeolite or Stilbite (in part. Foliated Zeolite). JAM. Syst. Vol. I. p. 378. Hemi-prismatic Zeolite. Man. p. 150. Heulandite. PHILLIPS, p. 38. Blätterzeolith. WERN. Hoffm. H. B. II. 1. S. 240. Blättriger Stilbit. HAUSM. II. S. 573. Stilbit (in part). LEONH. S. 445. Stilbite (in part). HAÜY. Traité, T. III. p. 161. Tabl. comp. p. 48. Traité, 2de Ed. T. III. p. 155.
BROOKE. Edin. Phil. Journ. Vol. VI. p. 112.

Fundamental form. Scalene four-sided pyramid. Vol. I. Fig. 41.

Char. of Comb. Hemi-prismatic. The relations among the simple forms not being yet ascertained with sufficient exactness, the 50th Figure may serve as a point of comparison for such varieties as may be found in nature.

The following are approximate measurements nearly agreeing with Mr BROOKE's, expressed in round numbers:

s on T' = 114° 0′, u on u = 146° 40′,
s on s' = 129° 40′, z on z = 136° 0′,
s' on T = 116° 20′, x on x = 95° 0′,

x being two faces, which replace the edges between M and T, so as to produce an edge with u, which is parallel to that between u and s. Generally several crystals, very little divergent, are grown the one upon the other, in such a manner that the centres of M are deeper than its margins, which prevents them very frequently from being measured by means of the reflective goniometer.

Cleavage, M, highly perfect. Fracture imperfect conchoidal, uneven. Surface of all the forms more or less uneven; *M* often concave, *s* and *s'* convex.

Lustre vitreous. The faces *M* possess high degrees of pearly lustre, both as faces of cleavage and of crystallisation. Colour, various shades of white, prevalent, passing into red, grey, and brown. Streak white. Transparent … translucent on the edges.

Brittle. Hardness = 3·5…4·0. Sp. Gr. = 2·200, white crystals from Iceland.

Compound Varieties. Massive: composition granular, the individuals being of various sizes, sometimes easily separable, sometimes strongly cohering; faces of composition in most cases uneven and rough. Globules formed in vesicular cavities.

OBSERVATIONS.

1. Of several of the older analyses of Stilbite, it is impossible to say whether they refer to this or to the preceding species. Laugier obtained from 1., a red variety from the Tyrol, and Walmstedt from 2., a variety called *Heulandite*, the following results:

	1.	2.
Alumina	10·00.	7·19.
Silica	45·00.	59·90.
Carbonate of Lime	16·00.	0·00.
Lime	11·00.	16·87.
Water	12·00.	13·43.
Oxide of Iron	4·00.	0·00.
Oxide of Manganese	0·50.	0·00.

Before the blowpipe this and the preceding species give nearly the same results.

2. What has been said in general of the natural repositories of the prismatoidal Kouphone-spar, refers also to the hemi-prismatic one; they occur both in Iceland and the

Faroe islands in beautiful crystals. The hemi-prismatic species is more frequently found in the Tyrol and in Scotland than the prismatoidal one, while the reverse takes place in the Hartz and in Norway. It occurs in beautiful varieties in the Vendyah mountains in Hindostan.

10. PYRAMIDAL KOUPHONE-SPAR.

Axifrangible Zeolite or Apophyllite (in part). JAM. Syst. Vol. I. p. 384. Pyramidal Zeolite or Apophyllite. Man. p. 151. Apophyllite. PHILL. p. 110. Albin. WERN. Syst. S. 6. 37. Apophyllit (in part). LEONH. S. 590. Mésotype époint*é*e. HAÜY. Traité, T. III. p. 154. Tabl. comp. p. 48. Apophyllite (in part). Traité, 2de Ed. T. III. p. 191.

Fundamental form. Isosceles four-sided pyramid. P = 104° 2′, 121° 0′. Vol. I. Fig. 8. HAÜY.

$$a = \sqrt{3{\cdot}125}.$$

Simple forms. $P - \infty$. (*o*); $P - 3$ (*c*) = 135° 59′, 64° 0′; P (*P*); $\frac{2\sqrt{2}}{3} P - 3$ (*e*) = 137° 55′, 61° 2′; $\frac{4}{5} P - 5$ (*b*) = 160° 15′, 28° 4′; $\frac{4}{5} P - 4$ (*d*) = 152° 44′, 38° 56′; $P + \infty$; $P + \infty$ (*m*); $[(P + \infty)^3]$ (*r*) = 143° 7′ 48″, 126° 52′ 12″.

Char. of Comb. Pyramidal.

Combinations. 1. P. $[P + \infty]$. Fig. 97. Cziklowa, Bannat.

2. $P - \infty$. P. $[P + \infty]$. Sim. Fig. 11. Fassa, Tyrol.

3. P. $[P + \infty]$. $[(P + \infty)^3]$. Iceland.

4. $P - \infty$. $\frac{4}{5} P - 5$. $\frac{4}{5} P - 4$. $\frac{2\sqrt{2}}{3} P - 3$. $P - 3$. P. $[P + \infty]$. $[(P + \infty)^3]$. Utön, Sweden.

Cleavage. $P - \infty$, highly perfect; $[P + \infty]$ imperfect. Fracture uneven. Surface, $P - \infty$ very smooth, shining and even; P smooth, but frequently curved; the obtuse pyramids are even, though generally rather rough, and $\frac{4}{5}$ P — 4 horizontally streaked; the vertical prisms, particularly [P + ∞] are streaked parallel to the axis.

Lustre vitreous. The faces of P — ∞, both in crystals, and as obtained by cleavage, possess common pearly lustre. Colour, several shades of white, greyish, blueish, or reddish, little different. Streak white. Transparent ... translucent.

Brittle. Hardness = 4·5 ... 5·0. Sp. Gr. = 2·335, a crystallised variety from Iceland.

OBSERVATIONS.

1. The present species has not yet been sufficiently distinguished from the following one, and it is even possible that they may constitute but a single one. It appears that they do not differ in regard to chemical composition, as will be seen in the Observations on the following species.

2. The natural repositories of pyramidal Kouphone-spar are much the same as those of the other species of the present genus, either in the vesicular cavities of amygdaloidal rocks with the same and with rhombohedral Lime-haloide, or in metalliferous beds with prismatic Augite-spar, rhombohedral Lime-haloide, Copper-pyrites, &c.

3. Some of the finest varieties are found in the amygdaloids of Iceland and of the Faroe islands. Likewise near Indore in India. This is also the mode of its appearance in nature near Aussig in Bohemia, whence the variety called *Albine* has first been noticed, and in New South Shetland. It occurs in the drusy cavities of a considerable and very extensive bed of limestone in gneiss, containing ores of copper, at Cziklowa near Orawitza in the Bannat. It is difficult to decide, whether some of the localities commonly quoted, belong to one or the other of these two species.

11. AXOTOMOUS KOUPHONE-SPAR.

Axifrangible Zeolite or Apophyllite (in part). Jam. Syst. Vol. I. p. 384. Man. p. 151. Apophyllit. Phill. p. 110. Ichthyophthalm. Wern. Hoffm. H. B. II. 1. S. 357. Apophyllit. Hausm. II. S. 580. Apophyllit (in part). Leonh. S. 590. Apophyllite (in part). Haüy. Tabl. comp. p. 36. Traité, 2de Ed. T. III. p. 191.

Fundamental form. Scalene four-sided pyramid. $\mathrm{P} = 106^\circ\,52',\ 101^\circ\,37',\ 120^\circ\,34'$. Vol. I. Fig. 9. Haüy.

$$a : b : c = 1 : \sqrt{0{\cdot}6923} : \sqrt{0{\cdot}6154}.$$

Simple forms. $\mathrm{P} - \infty\ (P)$, $\mathrm{P}\ (r)$; $\breve{\mathrm{P}}\mathrm{r} + \infty\ (M)$; $\bar{\mathrm{P}}\mathrm{r} + \infty\ (T)$. One of the combinations generally quoted is represented Fig. 11.

Cleavage, $\mathrm{P} - \infty$ highly perfect, traces of $\breve{\mathrm{P}}\mathrm{r} + \infty$ and $\bar{\mathrm{P}}\mathrm{r} + \infty$. Fracture uneven, imperfect conchoidal. Surface, $\breve{\mathrm{P}}\mathrm{r} + \infty$ and $\bar{\mathrm{P}}\mathrm{r} + \infty$ faintly streaked in a vertical direction, $\mathrm{P} - \infty$ parallel to the edges of combination with P.

Lustre vitreous. It is pearly upon $\mathrm{P} - \infty$, both upon faces of crystallisation and of cleavage. Colour, several shades of white. Streak white. Transparent ... translucent.

Brittle. Hardness = 4·5 ... 5·0. Sp. Gr. = 2·467, Haüy.

OBSERVATIONS.

1. The forms quoted in the above description were formerly given by Haüy for the variety of Apophyllite from Fassa in the Tyrol, but have since been abandoned by him in the second edition of his *Traité*, where he united all the varieties within a single species, having pyramidal forms. Dr Brewster has observed, that in certain va-

rieties to which he has given the name of *Tesselite*, the phenomena of double refraction cannot be explained upon the supposition of a single axis, and that even the properties of the mineral are not uniform in this respect throughout the whole mass, but that it appears composed of various parts acting differently upon light. It will depend upon a future accurate examination of the crystalline forms and other properties of this substance, in comparison with these observations, whether they will concur in fixing the limits of the species, or whether this will depend solely upon the optical structure of the mineral. The varieties from Utön, and from the Seiseralpe in the Tyrol, evidently belong to the preceding species.

2. According to two analyses by BERZELIUS, referring to 1., the Apophyllite from Utön, and 2., the Tesselite from Faroe, and one by STROMEYER of 3., the variety from Greenland, the present species appears to consist of,

Silica	1. 52·13	2. 52·38	3. 51·26.
Lime	24·71	24·98	25·20.
Potash	5·27	5·27	5·14.
Fluoric Acid	0·82	0·64	0·00.
Water	16·20	16·20	16·04.

Its chemical formula, according to BERZELIUS, is $\ddot{K}\,\dddot{Si}^4 + 8\,\ddot{Ca}\,\dddot{Si}^2 + 32\,Aq$, which corresponds to the ratios of potash, lime, silica, and water = 5·26 : 25·40 : 53·18 : 16·16, no attention being given to the small portion of fluoric acid. Before the blowpipe it first exfoliates, then intumesces like borax, and melts at last into a white vesicular globule. It is easily dissolved by borax. It is positively electrified by friction, not by heat. It likewise exfoliates in acids, and its powder forms a gelatine with them.

3. Like the preceding species, the present one occurs in vesicular cavities of trap-rocks, and in beds in ancient rocks, associated partly with other species of the present genus, particularly hexahedral Kouphone-spar, and with rhombohedral Quartz, partly with hemi-prismatic Augite-spar, octahedral Iron-ore, &c.

4. The localities quoted are the Faroe islands, and several iron mines in Sweden and Norway.

GENUS VI. PETALINE-SPAR.

1. PRISMATIC PETALINE-SPAR.

Prismatic Petalite. JAM. Man. p. 152. Petalite. PHILL. p. 143. Petalit. LEONH. S. 485. Pétalite. HAÜY. Traité, 2de Ed. T. III. p. 137.

Fundamental form. Scalene four-sided pyramid of unknown dimensions. Simple forms, character of combinations, &c. unknown. Combinations not observed.

Cleavage, a prism of 95° nearly, more distinct its long diagonal. Fracture imperfect conchoidal.

Lustre vitreous, inclining to resinous; it inclines to pearly upon perfect faces of cleavage. Colour white, in various reddish and greyish shades, sometimes inclining to green. Streak white. Translucent.

Brittle. Hardness $= 6{\cdot}0 \ldots 6{\cdot}5$. Sp. Gr. $= 2{\cdot}439$, a cleavable reddish-white variety.

Compound Varieties. Massive: composition columnar, of various sizes of individuals, sometimes impalpable and generally strongly coherent. If the composition be impalpable, fracture becomes splintery.

OBSERVATIONS.

1. The cleavage of the present species is said by HAÜY to take place parallel to the planes of a four-sided prism of

137° 10′, and its short diagonal. One of the faces of this prism is smooth and even, and easily obtained, the other is not so easily obtained, and possesses a kind of resinous lustre, similar to that face which passes through the diagonal, though this seems not properly to be the diagonal of a rhombic prism. Since faces of different physical quality cannot belong to one and the same simple forms, it is rather probable that those two less distinct faces produce a prism of about 95°, parallel to the long diagonal of which the more distinct face of cleavage is situated. More accurate examinations must decide, whether this more simple hypothesis, which has been introduced in the present work, be correct, or whether the forms of the species, as it is probable, possess a hemi-prismatic or tetarto-prismatic character. There are, moreover, traces of cleavage nearly perpendicular to the axis of this prism.

2. According to ARFVEDSON, the varieties of the present species consist of

Silica	79·212.
Alumina	17·225.
Lithia	5·761.

If exposed to a high degree of heat, before the blowpipe upon charcoal, it becomes glassy, semi-transparent and white, but melts with difficulty, and only on the edges. If gently heated it emits a blue phosphorescent light.

3. The prismatic Petaline-spar has been hitherto found only in the Swedish island of Utön, where it is said by some to occur in a narrow vein traversing the beds of octahedral Iron-ore, which are worked in that place; by others, in large boulders. It is accompanied by rhombohedral Lime-haloide, prismatic Feld-spar, rhombohedral Quartz, rhombohedral Tourmaline, &c. It has also been said to occur at the Lake Ontario in North America.

GENUS VII. FELD-SPAR.

1. RHOMBOHEDRAL FELD-SPAR.

Rhomboidal Felspar or Nepheline. JAM. Syst. Vol. II. p. 46. Man. p. 153. Sommite. PHILL. p. 125. Nephelin. WERN. Hoffm. H. B. II. 1. S. 365. Nephelin. HAUSM. II. S. 552. Nephelin. LEONH. S. 417. Népheline. HAÜY. Traité, T. III. p. 186. Tabl. comp. p. 51. Traité, 2de Ed. T. III. p. 347.

Fundamental form. Rhombohedron. $R = 83° 55'$. Vol. I. Fig. 7. AP.

$$a = \sqrt{6{\cdot}317}.$$

Simple forms. $R - \infty\ (P)$; $R + \infty$; $P\,(r) = 139° 19', 88° 6'$; $P + 1 = 127° 16', 125° 20'$; $P + \infty\ (M)$.

Char. of Comb. Di-rhombohedral.

Combinations. 1. $R - \infty.\ \ P + \infty.$ Vesuvius.
2. $R - \infty.\ \ P.\ \ P + \infty.$ Fig. 112.

Cleavage, $R - \infty$ and $P + \infty$, both imperfect. Fracture conchoidal. Surface smooth and even.

Lustre vitreous. Colour white. Streak white. Transparent ... translucent.

Brittle. Hardness = 6·0. Sp. Gr. = 2·560.

Compound Varieties. Massive: composition granular, of various sizes of individuals. Faces of composition rather rough.

OBSERVATIONS.

1. Two analyses, 1. by VAUQUELIN, of a variety from Monte Somma, 2. by CARPI, of a variety from Capo di Bove, have yielded:

Alumina	1. 49·00	2. 9·00.
Silica	46·00	40·20.

Lime	2·00	20·80.
Oxide of Iron	1·00	1·10.
Oxide of Manganese	0·00	12·60.
Potash	0.00	12·00.

Before the blowpipe upon charcoal its edges are rounded off. It yields a colourless vesicular glass, but cannot be melted into a perfect globule. Fragments of it thrown into nitric acid lose their transparency, and assume a nebulous appearance. This has suggested to Haüy the name of *Nepheline.*

2. Rhombohedral Feld-spar chiefly occurs at Monte Somma, in the cavities of limestone rocks ejected by Vesuvius, along with pyramidal Feld-spar and Garnet, with rhombohedral Talc-mica, &c. It has also been found in narrow veins, traversing a kind of basalt or lava at Capo di Bove near Rome, sometimes associated with paratomous Augite-spar.

2. PRISMATIC FELD-SPAR.

Prismatic Feld-spar. Jam. Syst. Vol. II. p. 1. Man. p. 154. Felspar. Ice-spar. Cleavelandite. Phill. p. 113. 206. 377. Feldspath (Gemeiner Feldspath, Adular, Labrador, Glasiger Feldspath). Eisspath. Wern. Hoffm. H. B. II. 1. S. 295. 369. Feldstein. Hausm. II. S. 528. Feldspath. Leonh. S. 468. Feldspath. Haüy. Traité, T. II. p. 570. Tabl. comp. p. 35. Traité, 2de Ed. T. III. p. 79.

Weiss. Schweigger's Journal. X. 223. Id. Abhandl. der Acad. der Wissensch. in Berlin für 1816 und 1817. Fuchs. Denkschr. der Adad. der Wissensch. zu München, für 1818 und 1819. G. Rose. über den Feldspath, Albit, Labrador und Anorthit. Gilberts Ann. der Phys. 1823. St. 2.

Fundamental form. Scalene four-sided pyramid. P = 134° 57′, 126° 12′, 72° 43′. Inclination of the axis in the plane of the long diagonal = 0° 0′. Vol. I. Fig. 41. R. G.

$$a : b : c : d = 1 : \sqrt{4{\cdot}419} : \sqrt{3{\cdot}168} : 0.$$

Simple forms. $\frac{\mathrm{P}}{2}\,(s) = 126°\,12'$; $-\frac{(\bar{\mathrm{P}}\mathrm{r})^{5}}{2}\,(n)$; $(\breve{\mathrm{P}}\mathrm{r}+\infty)^{3}\,(T,l) = 118°\,52'$; $(\bar{\mathrm{P}}\mathrm{r}+\infty)^{5}\,(z,z') = 58°53'$; $\frac{\frac{4}{3}\breve{\mathrm{P}}\mathrm{r}-2}{2}\,(q)$; $\pm\frac{\breve{\mathrm{P}}\mathrm{r}}{2}\begin{Bmatrix} x \\ P \end{Bmatrix} = \begin{Bmatrix} 64°34' \\ 64°34' \end{Bmatrix}$; $\frac{\frac{3}{4}\breve{\mathrm{P}}\mathrm{r}+2}{2}\,(y) = 35°12'$; $\breve{\mathrm{P}}\mathrm{r}+\infty\,(k)$; $\bar{\mathrm{P}}\mathrm{r}+\infty\,(M)$.

Char. of Comb. Hemi-prismatic.

Combinations. 1. $-\frac{\breve{\mathrm{P}}\mathrm{r}}{2}.\ (\breve{\mathrm{P}}\mathrm{r}+\infty)^{3}.$ Sim. Fig. 44., reversed. St Gothard, Switzerland.

2. $\frac{\breve{\mathrm{P}}\mathrm{r}}{2}.\ -\frac{\breve{\mathrm{P}}\mathrm{r}}{2}.\ (\breve{\mathrm{P}}\mathrm{r}+\infty)^{3}.$ Sim. Fig. 1. St Gothard.

3. $\frac{\breve{\mathrm{P}}\mathrm{r}}{2}.\ -\frac{\breve{\mathrm{P}}\mathrm{r}}{2}.\ (\breve{\mathrm{P}}\mathrm{r}+\infty)^{3}.\ \bar{\mathrm{P}}\mathrm{r}+\infty.$ Siberia.

4. $\frac{\frac{3}{4}\breve{\mathrm{P}}\mathrm{r}+2}{2}.\ -\frac{\breve{\mathrm{P}}\mathrm{r}}{2}.\ (\breve{\mathrm{P}}\mathrm{r}+\infty)^{5}.\ \bar{\mathrm{P}}\mathrm{r}+\infty.$ Fig. 61.

5. $\frac{\breve{\mathrm{P}}\mathrm{r}}{2}.\ \frac{\mathrm{P}}{2}.\ \frac{\frac{3}{4}\breve{\mathrm{P}}\mathrm{r}+2}{2}.\ -\frac{\breve{\mathrm{P}}\mathrm{r}}{2}.\ (\breve{\mathrm{P}}\mathrm{r}+\infty)^{3}.\ \bar{\mathrm{P}}\mathrm{r}+\infty.$ The individuals of Fig. 79. St Gothard.

6. $\frac{\frac{4}{3}\breve{\mathrm{P}}\mathrm{r}-2}{2}.\ \frac{\breve{\mathrm{P}}\mathrm{r}}{2}.\ \frac{\mathrm{P}}{2}.\ \frac{\frac{3}{4}\breve{\mathrm{P}}\mathrm{r}+2}{2}.\ -\frac{\bar{\mathrm{P}}\mathrm{r}}{2}.\ (\breve{\mathrm{P}}\mathrm{r}+\infty)^{3}.\ (\bar{\mathrm{P}}\mathrm{r}+\infty)^{5}.\ \bar{\mathrm{P}}\mathrm{r}+\infty.$ Fig. 62.

Cleavage, $-\frac{\breve{\mathrm{P}}\mathrm{r}}{2}$ highly perfect and easily obtained. $\bar{\mathrm{P}}\mathrm{r}+\infty$ perfect, but often interrupted by conchoidal fracture, and less easily obtained. Traces of $(\breve{\mathrm{P}}\mathrm{r}+\infty)^{3}$, generally one of the faces a little more distinct. Fracture conchoidal ...

uneven. Surface frequently streaked, $\frac{\breve{P}r}{2}$ in a horizontal direction, the vertical prisms parallel to the axis, so is also $\bar{P}r + \infty$; $(\bar{P}r + \infty)^5$ is often rough. Most of the other faces are smooth.

Lustre vitreous, sometimes inclining to pearly upon the perfect faces of cleavage. Colour white, prevalent, inclining to grey, green, or red; sometimes grey, flesh-red, verdigris-green. Streak greyish-white. Transparent, translucent on the edges. A blueish opalescence observable in the direction of $\breve{P}r + \infty$, also sometimes of $\frac{\frac{3}{4}\breve{P}r + 2}{2}$: most distinctly in transparent varieties. The variety called Moonstone, from Ceylon, appears considerably more red and of a lower degree of transparency, if viewed perpendicular to $\breve{P}r + \infty$, than in any other direction.

Brittle. Hardness = 6·0. Sp. Gr. = 2·558, a white transparent variety; limits of the species = 2·53 ... 2·60.

Compound Varieties. Twin-crystals. 1. Face of composition parallel, axis of revolution perpendicular to a face of $-\frac{(\breve{P}r)^3}{2}$. Fig. 79. If this mode of composition be repeated on all the faces of the same form, four-sided prisms consisting of four individuals will be formed, which are nearly rectangular, and bounded on their extremities by the faces of $(\breve{P}r + \infty)^3$ and $\frac{\breve{P}r}{2}$, while the faces of $-\frac{\breve{P}r}{2}$ constitute their apparently lateral planes. This composition is frequently found in St Gothard. 2. Axis of revolution parallel to the principal axis, face of composition parallel either to the right, Fig. 80., or to the left faces, Fig. 81., of $\bar{P}r + \infty$. Both are found near Elbogen in Bohemia. 3. Axis of revolution perpendicular, face of composition parallel to $-\frac{\breve{P}r}{2}$ (HAÜY. Traite. 2de Ed. T. III. p. 91. Pl. 82. Fig. 256). 4. Axis of revolution perpendicular, face of composition parallel to a face of $\frac{P}{2}$. This and the preceding variety are found at la Clayette in the department of Saone and Loire in France; a beautiful crystal of the latter is preserved in Mr ALLAN's cabinet. Sometimes there occurs composition according to several of these laws at once. Massive: composition granular, of various sizes of individuals, sometimes lamellar.

OBSERVATIONS.

1. The forms, as contained in the preceding description, have been calculated from the observations of $\frac{P}{2}$ being $= 126° 12'$, and $(\breve{P}r + \infty)^3 = 118° 52'$. The inclination of the axis has been supposed $= 0$. It will depend upon future observations, whether this is in fact the case, or whether there exists also in the present species an inclination, as in most other hemi-prismatic forms. The angle of $(\breve{P}r + \infty)^3$ has been found in several varieties $= 119° 10'$.

Besides the present species of prismatic Feld-spar, there are several whose forms possess a hemi-prismatic or tetarto-prismatic character, which differ so much in this respect, as well as in their angles, and the specific gravity, that according to the principles of Natural History, they must be considered as particular species. Their occurrence is most important in regard to the idea of genus in the Natural History of the Mineral Kingdom, to which it imparts an additional degree of evidence, and clearly demonstrates the necessity of a systematic nomenclature: for there can be as little doubt of their being particular species, as there can be of their being species belonging to one and the same genus,—Feld-spar. Mr G. Rose has ascertained some of them with great precision, in the memoir quoted above. Inquiries of this kind are among the nicest in Mineralogy, and require great precautions to guard us from new species, whose admission might depend upon an error of observation. These ought therefore to be often repeated before finally settling the new species of the present genus. The following enumeration of some of them is intended merely for engaging mineralogists to inquire farther into their nature; and I have therefore abstained from quoting any observations from the papers published on this subject.

i. *Albite.*

The synonymes are included in those mentioned for prismatic Feld-spar.

Fundamental form. Scalene four-sided pyramid, the axis of which is inclined in the planes of both diagonals. Vol. I. Fig. 42.

Simple forms. ${}^{r}_{l}\frac{\mathrm{P}}{4}\begin{Bmatrix}s'\\ s\end{Bmatrix}$; $-{}^{r}_{l}\frac{(\bar{\mathrm{P}}\mathrm{r})^{3}}{4}\begin{Bmatrix}n\\ n'\end{Bmatrix}$; ${}^{r}_{l}\frac{(\check{\mathrm{P}}\mathrm{r}+\infty)^{3}}{2}\begin{Bmatrix}l\\ T\end{Bmatrix}$; ${}^{r}_{l}\frac{(\bar{\mathrm{P}}\mathrm{r}+\infty)^{5}}{2}\begin{Bmatrix}z\\ z'\end{Bmatrix}$; $\pm\frac{\check{\mathrm{P}}\mathrm{r}}{2}\begin{Bmatrix}x\\ P\end{Bmatrix}$; $\frac{\frac{3}{4}\check{\mathrm{P}}\mathrm{r}+2}{2}(y)$; $r\frac{\bar{\mathrm{P}}\mathrm{r}-1}{2}(g)$; $\bar{\mathrm{P}}\mathrm{r}+\infty\ (M)$.

Char. of Comb. Tetarto-prismatic.

Combinations. 1. $\frac{\check{\mathrm{P}}\mathrm{r}}{2}$. $r\frac{\mathrm{P}}{4}$. $-\frac{\check{\mathrm{P}}\mathrm{r}}{2}$. ${}^{r}_{l}\frac{(\bar{\mathrm{P}}\mathrm{r}+\infty)^{5}}{2}$. $\bar{\mathrm{P}}\mathrm{r}+\infty$. Fig. 84.

2. $\frac{\check{\mathrm{P}}\mathrm{r}}{2}$. $\frac{\frac{3}{4}\check{\mathrm{P}}\mathrm{r}+2}{2}$. $r\frac{\mathrm{P}}{4}$. $r\frac{\bar{\mathrm{P}}\mathrm{r}-1}{2}$. $-r\frac{(\bar{\mathrm{P}}\mathrm{r})^{3}}{4}$. $-\frac{\check{\mathrm{P}}\mathrm{r}}{2}$. ${}^{r}_{l}\frac{(\check{\mathrm{P}}\mathrm{r}+\infty^{3}}{2}$. ${}^{r}_{l}\frac{(\bar{\mathrm{P}}\mathrm{r}+\infty)^{5}}{2}$. $\bar{\mathrm{P}}\mathrm{r}+\infty$. Fig. 85.

3. $\frac{\breve{P}r}{2}$. ${}^{r}_{l}\frac{P}{4}$. $-r\frac{(\bar{P}r)^3}{4}$. $-\frac{\breve{P}r}{2}$. ${}^{r}_{l}\frac{(\breve{P}r+\infty)^3}{2}$. ${}^{r}_{l}\frac{(\bar{P}r+\infty)^5}{2}$. $Pr + \infty$. Fig. 86.

Measurements of angles: M on $P = 93° 20'$, M on $x = 93° 50'$, M on $o = 113° 32'$, T on $l = 121° 38'$. The re-entering angles produced in Fig. 87. by P and P' measure 186° 40′, those produced by x and x', 187° 40′.

Cleavage, $-\frac{\breve{P}r}{2}$ perfect; less distinct $\bar{P}r + \infty$; the cleavage parallel to $l\frac{\breve{P}r + \infty^3}{2}$ is sometimes more easily obtained than either. Fracture imperfect conchoidal, uneven. Surface, the prisms parallel the axis streaked parallel to their common intersections; $\frac{\breve{P}r}{2}$ generally uneven or a little rough; $-r\frac{(\bar{P}r)^3}{2}$ rough, but very even.

Lustre vitreous, often inclining to pearly upon perfect faces of cleavage. Colour white, passing into grey, red, and green. Streak white. Transparent, rare and only in small crystals, ... translucent on the edges.

Brittle. Hardness = 6·0. Sp. Gr. = 2·613, small transparent crystals from Dauphiny. Limits 2·61...2·68.

Compound Varieties. Twin-crystals. 1. Axis of revolution parallel, face of composition perpendicular to $\bar{P}r + \infty$. Fig. 87. 2. Axis of revolution parallel to the edges of combination between $\breve{P}r + \infty$ and $\bar{P}r + \infty$; face of composition parallel to $\bar{P}r + \infty$. The latter composition allows of two cases, and is similar to Fig. 80. and Fig. 81. It occurs frequently along with the preceding one, so that laminæ of four individuals alternate with each other, composed parallel to $\bar{P}r + \infty$. All these compound and simple varieties have been observed in the varieties from St Gothard and Dauphiny. Massive: composition granular of various sizes of individuals, sometimes compressed parallel to the faces of $\bar{P}r + \infty$ or $-\frac{\breve{P}r}{2}$, and then the composition assumes a lamellar appearance.

ii. *Labradorite.*

The varieties of the present species differ but little from the preceding one, in regard to their geometrical properties, at least their combinations likewise possess a tetarto-prismatic character, and the angle at which the two more distinct faces of cleavage meet is also nearly 93° 30′. They present very frequently the same kinds of twin-crystals, or regular compositions. Their cleavage, particularly in the direction of $\bar{P}r + \infty$, is less perfect than in most varieties of the two preceding species. The hardness is almost exactly identical, but the specific gravity of a variety from the coast of Labrador was found = 2·750. The limits are 2·69 ... 2·76. The remarkable opalescent and iridescent tints of colour appear most bright upon $\bar{P}r + \infty$, but they are also observed upon $-\frac{\breve{P}r}{2}$. The variety from Norway, commonly called Labradorite, in which the opalescence takes place in the direction of $\breve{P}r + \infty$, does not belong to the present species, but to that of prismatic Feld-spar.

iii. *Common Felspar from the Saualpe in Carinthia and from St Gothard.*

Some of the varieties found in these localities seem to belong likewise to a particular species. Their forms are tetarto-prismatic, but differing as it seems in regard to their angles from Albite. Cleavage is much more easily observed in the direction of $-\frac{\breve{P}r}{2}$ and $l\ \frac{(\breve{P}r + \infty)^3}{2}$, than in the direction of $\bar{P}r + \infty$, which generally appears only in very slight indications. The specific gravity is equal to that of prismatic Feld-spar, the limits being 2·54 ... 2·56. This species occurs in very remarkable twin-crystals, some of them like Fig. 80 and 81, or Fig. 87, some like Fig. 88. In the latter the face of composition is parallel to $-\frac{\breve{P}r}{2}$, while the axis of revolution is parallel to the edges of combination between $\frac{\breve{P}r}{2}$ and $-\frac{\breve{P}r}{2}$, that is, to the line *a b*. The degrees of transparency of the varieties hitherto observed are lower than those of prismatic Feld-spar or Albite.

iv. *Common Felspar from Baveno.*

These varieties are particularly distinguished from the rest by that highly perfect cleavage parallel to $-\frac{\breve{P}r}{2}$, which far surpasses the rest observable in the same species parallel to $(\breve{P}r + \infty)^3$, $\breve{P}r + \infty$ and $\bar{P}r + \infty$, and by their specific gravity, which is much inferior to all the species of the present genus, having been found in a crystal = 2·392. The limits appear to be 2·39 and 2·45. The combinations are hemi-prismatic, and from observations with the common goniometer they seem not to be very different from those of prismatic Feld-spar. They possess very low degrees of transparency, and often occur massive, having distinct lamellar particles of composition.

In the older systems, all these different species, and moreover *Chiastolite* or *Macle*, were comprised within the common name of *Felspar*, and variously subdivided into subspecies and kinds. First those grey varieties which possess bright iridescent colours were separated from the rest, and established into a particular subspecies under the name of *Labradore Felspar*. It comprehends varieties of prismatic Feld-spar, and of Labradorite, as has been observed above. The most transparent and pure varieties, generally in implanted crystals lining the walls of narrow veins in ancient rocks, were likewise considered as a particular subspecies, and called *Adularia*, in reference to the supposed oldest locality known of this variety. It is made up of varieties of prismatic Feld-spar and of Albite. The less transparent varieties were divided into *common* and *compact Felspar*, the first of which contained, though not exclusively, easily cleavable crystals, the second imbedded crystals having no distinct cleavage, and compound masses of small or impalpable and strongly connected individuals. Common Felspar contains varieties of all the species enumerated above, except perhaps Labradorite, which forms a great proportion of compact Felspar. From the latter subspecies, *Clinkstone*, which is commonly a mixed mineral, and forms the mass of porphyry slate, was distinguished as a particular species, and moreover *Variolite*, consisting of small globular masses imbedded in a mixed rock. It has not been exactly ascertained to what species Clinkstone and Variolite belong, nor is it possible to settle at present any thing in this respect. Imbedded crystals of considerable degrees of transparency in porphyry slate, occurring also in various other trachytic and volcanic rocks, were called *glassy Felspar*. Their forms are generally hemi-prismatic, as in the examples from Drachenfels and Ischia; but sometimes also tetarto-prismatic varieties are observed in similar rocks, as in those from the Gallopago islands, brought home by Captain BASIL HALL. *Ice-spar* occurs in white transparent crystals, greatly resembling Adularia and glassy Felspar, but implanted in the drusy cavities of rocks ejected by Mount Vesuvius. However complicated this division may be, it is not all that was to be considered in the various kinds of Felspar. In regard to the particular state in which the varieties of common Felspar occur, those which are more or less decomposed, were designated by the denomination of *earthy common Felspar*, and considered as a particular subspecies. If the decomposition has arrived at its limits, so that the whole is converted into a more or less firmly coherent powder, *Porcelain-Earth* is formed. This substance is not only considered as a distinct species in the Wernerian system, but it is not even contained in the same genus with the remaining subspecies. It is possible that porcelain earth arises from the decomposition of several species of the present genus, but we do not possess sufficient information in this respect. Professor FUCHS is of opinion that the porcelain-earth from Passau is produced by the decomposition of what he calls Porcelain-spar, probably a variety of Labradorite.

2. Among several analyses referring to varieties of prismatic Feld-spar, and the allied species of Albite and Labradorite, the following may serve for a comparison of their chemical constitution.

Prismatic Feld-spar.

	Adularia, analysed by Vauquelin.	Labradorite from Norway, by Klaproth.	Common Felspar from Carlsbad, by Klaproth.
Silica	64·00.	65·00.	64·50.
Alumina	20·00.	20·00.	19·75.
Potash	14·00.	12·25.	11·50.
Lime	2·00.	a trace.	a trace.
Oxide of Iron	0·00.	1·25.	1·75.
Water	0·00.	0·50.	0·75.

Albite.

	From Finbo by Eggertz.	From Arendal by Rose.	From Chesterfield in Massachusetts by Stromeyer.
Silica	70·48.	68·84.	70·68.
Alumina	18·45.	20·53.	19·80.
		With a little oxide of iron and lime.	
Soda	10·50.	9·12.	9·06.
Lime	0·55.	0·00.	0·23.
Oxide of Iron and Manganese	0·00.	0·00.	1·11.

Labradorite.

	From Labrador by Klaproth.	From Siebenlehn near Freiberg by Klaproth.	Porcelain-spar from Passau by Fuchs.
Silica	55·75.	51·00.	49·30.
Alumina	26·50.	30·50.	27·90.
Lime	11·00.	11·25.	14·42.
Soda	4·00.	4·00.	5·46.
Oxide of Iron	1·25.	1·75.	0·00.
Water	0·50.	1·25.	0·90.

The formulæ of the composition of these three species, according to the method of Berzelius, are $K S^3 + 3 A S^3$

for prismatic Feld-spar, $N S^3 + 3 A S^3$ for Albite, and $N S^3 + 3 C S^3 + 12 A S$ for Labradorite. Before the blowpipe upon charcoal, prismatic Feld-spar becomes glassy, semi-transparent and white, but melts only with difficulty on its edges into a semi-transparent vesicular glass. It is dissolved by borax, but slowly and without effervescence, into a clear globule. The rest of the species agree in this respect with prismatic Feld-spar. They are not acted upon by acids, except Labradorite, which is entirely dissolved by heated muriatic acid.

3. The discovery of the difference among the preceding species is too recent to have yet been taken notice of in regard to the geological relations of what formerly used to be called Felspar; so that wherever only Felspar is mentioned, we must expect to find one or the other, or perhaps several of the species designated by that common name.

Common Felspar frequently enters into the composition of rocks, and constitutes, with rhombohedral Quartz, and several species of the genus Talc-mica, the different kinds of granite and gneiss, with hemi-prismatic Augite-spar it forms syenite, green-stone, &c. Generally prismatic Feld-spar and Albite are found at the same time in granite, as in the varieties from Pompey's pillar, and from the block upon which the statue of Peter the Great in Petersburgh is raised, the Albite being of a greenish-white colour, while the prismatic Feld-spar is flesh-red. Albite is most frequently one of the constituents of syenite and greenstone, as in the neighbourhood of Dresden and Edinburgh. To several of these rocks large crystals of prismatic Feld-spar impart a porphyritic appearance; and it is a characteristic mark of the different kinds of porphyry more properly so called, to have isolated crystals of this species, and also of Quartz, Mica, &c. distributed throughout their compact mass: according to the latter, which in some cases, as in the clinkstone porphyry, itself belongs to the genus Feld-spar, they are distinguished and denominated. Compact Felspar (Labradorite) is frequently one of the constituents of greenstone slate, and a compact variety perhaps of another species, the prevailing mass of Weissstein. Basalt, and some other rocks, allied with it, as wacke and graustein, must be considered as most intimate mixtures of prismatic Feld-spar or Albite with hemi-prismatic or with paratomous Augite-spar, or with both these species, the individuals being so small as to be no longer recognizable. The two first have on that account been considered by mineralogists as particular species. In several of these rocks, which contain prismatic Feld-spar as one of their constituents, larger masses of it frequently form concretions separated from the rest, and assume the shape of more or less extended irregular beds. If these be decomposed by the action of the atmosphere, and their situation be favourable, Porcelain earth is formed, among the most remarkable of which we notice those in gneiss, at Aue near Schneeberg in Saxony, and at Hafnerzell in the district of Passau. At Carclaise and Cligga in Cornwall, the porcelain earth originates in the decomposition of granitic rocks. Common Felspar frequently occurs in beds along with ores of iron and titanium, with several species of the genera Augite-spar and Garnet, &c., but it may be rightly considered as a rarity in veins, except in those which are composed of the same species of which the rocks consist which they traverse. In these its varieties are accompanied by prismatic Axinite, rhombohedral Quartz, several ores of titanium, by rhombohedral Lime-haloide, and other species, and have their surface sometimes covered with scaly particles of prismatic Talc-mica. Sometimes hemi-prismatic crystals are covered with a tetarto-prismatic coat of another species, as in the varieties from Baveno, which have Albite disposed in parallel position upon some of their faces, particularly upon $\bar{P}r + \infty$. Labradorite occurs in syenitic rocks, also as a regular constituent in several kinds of gabbro rocks, with hemi-prismatic Schiller-spar and Serpentine. Those crystals which give a porphyritic appearance to the trachyte from the Drachenfels on the Rhine, are considered as a variety of glassy Felspar.

Among the most remarkable places of occurrence of some of the species of Feld-spars, certain meteoric stones deserve to be mentioned, as those which fell in 1807 at Stannern in Moravia, and those of 1821, at Aubenas (HAÜY. Traité, 2de Ed. T. III. p. 537.) in France. In general, these species appear to have a considerable share in the composition of the meteoric masses.

4. The finest crystals of Adularia, both prismatic Feld-spar and Albite, are found in the highest districts of St Gothard and the Alps of Savoy, several varieties occur also in Salzburg, the Tyrol, Bavaria, Dauphiny, the isle of Arran, in Cornwall and Wales, &c. The largest crystals of Albite hitherto known are from Keräbinsk in Siberia. Also of the prismatic Feld-spar large crystals have been found in that country; they are generally penetrated by rhombohedral Quartz, sometimes of considerable transparency. The twin-crystals from Carlsbad in Bohemia (Fig. 80. and 81.) are well known, and belong to prismatic Feld-spar. Amazone-stone, a verdigris-green variety of prismatic Feld-spar, often associated with small white crystals of Albite, occurs near Fort Troitzk in the Uralian mountains. Labradorite was first brought from the coast of Labradore; it occurs also in Ingria, in large but not well defined crystals in Greenland, and as a constituent of several rocks in various places of the Hartz, Saxony, near Florence, &c. It has been observed above, that what has been called Labradorite from Norway, in fact belongs to the species of prismatic Feld-spar; it occurs in the zircon-syenite of Friedrichsvärn. Compact felspar, forming the body of clinkstone-porphyry, is found in the Bohemian Mittelgebirge, in the Western Isles of Scotland, at Sahla in Sweden, in the Hartz, &c. Variolite has been noticed from Piedmont and Corsica. The finest varieties of Porcelain earth are those from China, where it is called *Kaolin*, from Saxony, from Passau, and from Limoges in France. The repository of porcelain-earth near Carlsbad in Bohemia, is of secondary formation, as it is there accompanied by basalt, clay, sandstone and coal.

5. Several varieties of the different species included in

the genus Feld-spar are used in the arts and manufactures. The purest opalescent varieties of Adularia are cut round and polished, and worn as ring-stones, &c. The finest of them are from Ceylon, and are called *Moonstones*. The *Sunstone* is likewise prismatic Feld-spar, having exceedingly minute scales of mica dispersed throughout its substance, which are disposed parallel to the face of $\breve{P}r + \infty$, and reflect a pinchbeck-brown tint. Labradorite, particularly the American variety, and Amazone-stone, are cut for various ornamental purposes, into snuff-boxes, &c.; this is also the case with *Graphic Granite*, which consists of a simple variety of common felspar, regularly mixed with long parallel crystals of rhombohedral Quartz, whose transverse angular sections bear some resemblance to certain letters. The pure varieties of prismatic Feld-spar are used in the composition of the paste of porcelain, also for the enamel with which it is covered; and the decomposed variety or Porcelain earth itself is the most important material in that department of manufactures.

3. PYRAMIDAL FELD-SPAR.

Pyramidal Felspar or Scapolite. Prismato-pyramidal Felspar or Meionite. Jam. Syst. Vol. II. p. 35. 43. Pyramidal Felspar. Man. p. 162. Dipyre. Scapolite. Meionite. Phill. p. 45. 137. 143. Schmelzstein. Skapolith. Mejonit. Wern. Hoffm. H. B. II. 1. S. 270. 345. 361. Tetraklasit. Meïonit. Hausm. II. S. 511. 550. Wernerit. Mejonit. Leonh. S. 479. 481. Meïonite. Wernerite. Dipyre. Scapolite. Haüy. Traité, T. II. p. 586. T. III. p. 119. 242. T. IV. p. 393. Wernerite. Paranthine. Dipyre. Meïonite. Tabl. comp. p. 34. 45. 55. Traité, 2de Ed. T. II. p. 582. 586. 596. T. III. p. 75.

Fundamental form. Isosceles four-sided pyramid. $P = 136° 7', 63° 48'$. Vol. I. Fig. 8. R. G.

$$a = \sqrt{0{\cdot}3874}.$$

Simple forms. $P - 1$ (*t*); P (*l*); $P + \infty$ (*s*); $[P + \infty]$ (*M*); $(P)^3$ (*z*); $(P + \infty)^3$ (*x*).

Char of Comb. Pyramidal. Frequently single faces are irregularly enlarged at the expence of the rest.*

Combinations. 1. P. P + ∞. [P + ∞]. Sim. Fig. 101. Akudlek, Greenland.

2. P — 1. P. P + ∞. [P + ∞]. Sim. Fig. 102. Pargas, Finland.

3. P — 1. P. $(P)^3$. P + ∞. [P + ∞]. Sim. Vol. I. Fig. 67. Vesuvius.

4. P. $(P)^3$. P + ∞. [P + ∞]. $(P + \infty)^3$. Vesuvius.

Cleavage, P + ∞ and [P + ∞], distinct but interrupted; traces of P — ∞, generally small conchoidal fracture in that direction. Fracture imperfect conchoidal, uneven. Surface of the prisms sometimes longitudinally streaked, but generally of nearly the same physical quality.

Lustre vitreous, inclining to resinous upon the cleavage, and fracture parallel to P — ∞, inclining to pearly upon P + ∞ and [P + ∞]. Colour, various shades of white, grey, and green. Red colours seem to arise from impurities. Streak greyish-white. Transparent ... translucent on the edges; the red varieties are opake.

Brittle. Hardness = 5·0 ... 5·5. Sp. Gr. = 2·612, Meionite; = 2·726, white crystallised Scapolite from Finland.

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[*] A crystal of the Scapolite, from Pargas, in the possession of Mr Nordenskiöld, presents at one extremity only the alternating faces of $(P)^3$, while the rest have disappeared. The opposite extremity could not be observed. H.

Compound Varieties. Massive: composition granular, of various sizes of individuals, sometimes elongated in one direction or wedge-shaped, and passing into columnar; generally strongly coherent.

OBSERVATIONS.

1. The varieties of the present species have been discovered at various periods, and in different kinds of repositories. Some of them indeed, at first sight, appear so little resembling each other, that it is not to be wondered, that they were considered as particular species; for in order to be certain in these determinations, a superficial inspection, or some information of the mode of occurrence or accompanying minerals, cannot suffice; even experiments before the blowpipe or the chemical analysis do not give that high degree of evidence which arises from an accurate examination of the physical properties of minerals, of their form and cleavage, hardness or specific gravity; and this becomes the more indispensable, if, as in the present case, the different varieties bear to each other but a slight degree of resemblance. Whatever may be the consequence of these examinations, it must always be a true, correct, and constant result, because it is founded upon those things which are constant in the productions of nature, their physical properties. *Meionite* contains the purest and most transparent varieties of the species of a white colour; and it seems by these characters to be perfectly distinguished from the rest. Yet the varieties of *Scapolite* from Finland, described by Mr NORDENSKIÖLD, and those brought from Greenland by Sir CHARLES GIESECKE, possess the same properties, though less distinctly, and unite Meionite with the rest of the varieties of Scapolite, which generally possess greenish colours, either pale and a little translucent, or dark, and then the crystals are very often nearly opake. Some of its varieties are coloured red, probably by oxide of iron. Upon this difference of colour, the division into *red* and *grey* Sca-

polite is founded. Among the varieties of the latter, there are some crystals, long and acicular and their composition columnar, possessing light shades of colour; others which are short and thick, granularly compound, and of darker shades of colour. These two kinds have been distinguished by the names of *radiated* and *foliated* Scapolite. *Dipyre* has been united with the present species, in reliance on those characters, which are quoted in most mineralogical works; it seems to differ from the preceding ones scarcely in any thing but in its reddish-white colour, and thin columnar composition in massive varieties. Mr BROOKE, however, quotes a very minute crystal in his possession, too imperfect to be determined by measurement, but whose form he supposes to be the regular hexagonal prism, as it was first described by HAÜY, and afterwards abandoned in consequence of renewed observations.

3. The following results were obtained, 1. by STROMEYER, from a variety of Meionite from Monte Somma; and 2. by NORDENSKIÖLD, from the Scapolite from Pargas.

	1.	2.
Silica	40·531.	43·83.
Alumina	32·726.	35·43.
Lime	24·245.	18·96.
Potash and a little Soda	1·812.	0·00.
Protoxide of Iron	0·182.	0·00.
Water	0·000.	1·03.

In a strong heat of the blowpipe, Scapolite melts into a vesicular glass, and intumesces considerably; then it assumes the appearance of ice, and does not melt any longer. It is dissolved by borax with effervescence, and melts with it into a clear globule. Dipyre yields almost the same results.

3. Meionite is met with among the minerals ejected by Mount Vesuvius, along with rhombohedral and prismatic Feld-spar, pyramidal Garnet, rhombohedral Talc-mica, &c. The varieties of Scapolite occur in primitive mountains, as in the beds of octahedral Iron-ore at Arendal in Norway, and in Wermeland in Sweden; and are generally accompa-

nied by several species of the genera Feld-spar and Augite-spar. Scapolite has been found also in large and beautiful crystals in the parish of Pargas in Finland, at Akudlek in Greenland, and some varieties near Chursdorf in Saxony. Dipyre is hitherto confined to the Western Pyrenees, where it occurs near Mauléon under similar circumstances.

GENUS VIII. AUGITE-SPAR.

1. PARATOMOUS AUGITE-SPAR.

Oblique-edged Augite. JAM. Syst. Vol. II. p. 99. Pyramido-prismatic Augite. Man. p. 165. Augite. Pyroxène. PHILL. p. 58. Kokkolith. Augit. Diopsid. Asbest (in part). Strahlstein (in part). Sahlit. Baikalit. Fassait. Omphazit. WERN. Hoffm. H. B. I. S. 443. 448. 467. II. 2. S. 277. 293. 319. IV. 2. S. 105. 111. 125. Pentaklasit. Asbest (in part). HAUSM. II. S. 687. 734. Augit. Asbest (in part). LEONH. S. 520. 533. Pyroxène. Malacolithe. HAÜY. Traité, T. III. p. 80. IV. p. 379. Pyroxène. Tabl. comp. p. 41. Traité, 2de Ed. T. II. p. 407.

Fundamental form. Scalene four-sided pyramid. P = 152° 12′; 120° 0′; 67° 4′. Inclination of the axis in the plane of the long diagonal = 0° 0′. Vol. I. Fig. 41. HAÜY.

$$a : b : c : d = 1 : \sqrt{12} : \sqrt{2{\cdot}7692} : 0$$

Simple forms. $\mathrm{P} - \infty\,(n)$; $\pm\frac{\mathrm{P}}{2}\begin{Bmatrix} s \\ s' \end{Bmatrix} = \begin{Bmatrix} 120^\circ\,0' \\ 120^\circ\,0' \end{Bmatrix}$; $-\frac{(\bar{\mathrm{P}}\mathrm{r})^3}{2}\,(z) = 81^\circ\,46'$; $(\check{\mathrm{P}}\mathrm{r} + \infty)^3\,(M) = 87^\circ\,42'$; $-\frac{(\check{\mathrm{P}})^3}{2}\,(u) = 131^\circ\,8'$; $\frac{(\check{\mathrm{P}}\mathrm{r})^5}{2}\,(o) = 95^\circ\,28'$; $\pm\frac{\check{\mathrm{P}}\mathrm{r}}{2}\begin{Bmatrix} P \\ t \end{Bmatrix} = \begin{Bmatrix} 73^\circ 54' \\ 73^\circ 54' \end{Bmatrix}$; $(\bar{\mathrm{P}}\mathrm{r} + \infty)^5 = 35^\circ\,36'$; $(\check{\mathrm{P}} + \infty)^6\,(f) = 141^\circ\,50'$; $\check{\mathrm{P}}\mathrm{r} + \infty\,(r)$; $\mathrm{Pr} + \infty\,(l)$.

Char. of Comb. Hemi-prismatic. Inclination of $\frac{\breve{P}r}{2}$ on $(\breve{P}r + \infty)^3 = 101^\circ\ 5'$.

Combinations. 1. $-\frac{\breve{P}r}{2}$. $(\breve{P}r + \infty)^3$. Sim. Fig. 44., reversed. Greenland.

2. $-\frac{\breve{P}r}{2}$. $\breve{P}r + \infty$. $\bar{P}r + \infty$. Sim. Fig. 46., reversed. Elba.

3. $\frac{P}{2}$. $(\breve{P}r + \infty)^3$. $\breve{P}r + \infty$. $\bar{P}r + \infty$. Fig. 72. Etna.

4. $\frac{\breve{P}r}{2}$. $-\frac{\breve{P}r}{2}$. $(\breve{P}r + \infty)^3$. $\breve{P}r + \infty$. $\bar{P}r + \infty$. Piedmont.

5. $\frac{\breve{P}r}{2}$. $\frac{P}{2}$. $\frac{(\breve{P}r)^5}{2}$. $-\frac{\breve{P}r}{2}$. $-\frac{(\bar{P}r)^3}{2}$. $(\breve{P}r + \infty)^3$. $\breve{P}r + \infty$. $\bar{P}r + \infty$. Fig. 73. Fassa, Tyrol.

6. $\frac{\breve{P}r}{2}$. $\frac{P}{2}$. $\frac{(\breve{P}r)^5}{2}$. $-\frac{\breve{P}r}{2}$. $-\frac{(\breve{P})^3}{2}$. $(\breve{P}r + \infty)^3$. $(\breve{P} + \infty)^6$. $\breve{P}r + \infty$. $\bar{P}r + \infty$. Fig. 176. Ala, Piedmont.

Cleavage, $(\breve{P}r + \infty)^3$ rather perfect, but interrupted, also $\breve{P}r + \infty$ and $\bar{P}r + \infty$; sometimes $\frac{P}{2}$ from which the adjective *paratomous* has been derived. Fracture conchoidal, sometimes perfect … uneven. Surface, $P - \infty$ frequently uneven and curved, the vertical faces, particularly $\breve{P}r + \infty$ and $\bar{P}r + \infty$, striated parallel to the axis. $\frac{\breve{P}r}{2}$ sometimes rough.

Lustre vitreous, inclining to resinous. Colour green, often inclining to brown, and passing into grey and white, and also into black. Streak white . . . grey, corresponding to the colour. Faintly transparent ... opake.

Brittle. Hardness = 5·0...6·0. Sp. Gr = 3·349 an ash-grey variety; = 3.327 Omphazite from the Saualpe; = 3·327 Fassaite; 3·274 a greyish-white variety compound in laminæ parallel to $\breve{P}r + \infty$; = 3·233 a grass-green variety from the Bacher mountain in Lower Stiria.

Compound Varieties. Twin-crystals: face of composition parallel, axis of revolution perpendicular to $\breve{P}r + \infty$. Sometimes crystals of this kind are in cruciform aggregations. Massive varieties compound in the direction of $-\frac{\breve{P}r}{2}$, as in Sahlite; this must not be taken for cleavage, as it does not continue throughout the whole mass, but only produces more or less thick laminæ, often separated from each other by some extraneous substance: it often possesses a slight pearly lustre: there is also composition parallel to $\breve{P}r + \infty$, as in Mussite. Massive: composition granular of various sizes of individuals, often but slightly cohering, but often also very intimately connected; faces of composition rough. The individuals of lamellar and columnar varieties are in most cases easily separated, and present striated faces of composition.

OBSERVATIONS.

1. According to the measurements of Mr BROOKE and

Mr PHILLIPS, with the reflective goniometer, the angle of $(\breve{P}r + \infty)^3$ is $= 87° 5'$. It will be interesting to ascertain how far the inclination of the axis extends to the forms of the present species. The incidence of $\frac{\breve{P}r}{2}$ on $\breve{P}r + \infty$ is stated in Augite by Mr PHILLIPS $= 105° 20'$, that of $-\frac{\breve{P}r}{2}$ on $\breve{P}r + \infty = 106° 15'$. But the inclination of the two faces of $\frac{P}{2}$ is given $= 120° 38'$, and the same inclination in $-\frac{P}{2}$ also $= 120° 38'$. $\frac{\breve{P}r}{2}$ on $(\breve{P}r + \infty)^3 = 100° 10'$.

The present species unites a large number of varieties, both simple and compound, among which there exist uninterrupted transitions; and for this in particular it becomes a most important subject in the study of Mineralogy; and, above all, for ascertaining the idea of the natural-historical species. But it is at the same time remarkable for the high degree of resemblance which it bears to the remaining species comprised within the same genus, particularly those of which a great many different varieties have been discovered; and thus it likewise demonstrates the existence of the natural-historical genus in Mineralogy, which is formed by uniting those species, which, notwithstanding their marked differences from each other, are yet united by the highest degrees of resemblance. Hence, on one hand, the difficulties become evident which arise from dividing one species into several; on the other hand, the easiness with which they may be confounded, if their characteristic properties be not properly attended to, of which but too many examples might be quoted from the writings and collections of chemists and mineralogists. A close examination, according to the principles of Natural History, will prevent us from falling into the same errors. The most ancient of those species which have been distinguished within the species of paratomous Augite-spar is *Augite*, which comprehends almost exclusively opake varieties, the colours of which are black or blackish-green. One of its subdivisions, *foliated*

Augite, occurs in imbedded crystals. *Conchoïdal* Augite refers to imbedded grains, whose fracture is perfectly conchoidal; *common* Augite occurs also in grains, but having an uneven fracture. Foliated Augite is transformed by decomposition, into those earthy masses which have been called crystallised Green-earth. *Coccolite* is of rather paler shades of green colours than the preceding varieties, and consists of very distinct granular particles of composition, which may be easily separated. The colours of *Sahlite* are generally paler green, and inclining to grey; it is faintly translucent on the edges, though there are some varieties of it as black and opake as Augite. It is compound parallel to the face of $-\frac{\breve{\mathrm{P}}\mathrm{r}}{2}$. If the colours become very pale, it passes into *Diopside*, which contains greenish-grey, greenish-white, &c., and semi-transparent crystals, or massive varieties also of pale colours, and compound parallel to the face of $\breve{\mathrm{P}}\mathrm{r}+\infty$. The latter is also the case in those dark-green varieties of *common Actinolite* which belong to the present species. *Baikalite* cannot be distinguished from Sahlite, even by such slight marks as those just quoted, and *Fassaite* is the name of those varieties which unite the green colours of Sahlite, or some that incline still more to yellow with crystalline forms, similar to those of Diopside. *Omphazite* is a compact leek-green variety, with an imperfect conchoidal or splintery fracture, and generally mixed with dodecahedral Garnet. That variety of *granular Actinolite* which belongs to the present species, and which has often been called *green Diallage*, is grass-green, either crystallised or massive, and in the latter case it presents a granular structure, or is composed parallel to $-\frac{\breve{\mathrm{P}}\mathrm{r}}{2}$ or to $\breve{\mathrm{P}}\mathrm{r}+\infty$, alternating in layers with particles of the following species, of the same colour. Very delicate crystals produce a kind of Asbestus, which is different from the one in connexion with hemi-prismatic Augite-spar, and different also from Picrosmine, a species that will be noticed in the Appendix.

2. The following analyses will shew the range of the constituent parts in the present species.

	White variety, analysed by Bonsdorf.	*Leek-green variety*, by Rose.	*Black variety*, by Rose.
Silica	54·83	54·08	53·36.
Lime	22·19	23·47	22·19.
Magnesia	18·55	11·49	4·99.
Alumina	0·28	0·00	0·00.
Protoxide of Iron	0·99	10·02	17·38.
Oxide of Manganese	0·00	0·61	0·09.
Loss by heating	0·32	0·00	0·00.

It may be considered as a bisilicate of lime and magnesia, in which part of the bases are replaced by protoxide of iron, part of the silica sometimes by alumina, which, in the conchoidal Augite from Sicily, amounts to 16·5. Before the blowpipe it melts pretty easily, and emits a few bubbles; it finally yields a glassy globule, more or less intensely coloured by iron. It is readily dissolved by borax. Several varieties of the present species have been obtained by way of fusion. Black crystals are not unfrequent among the slags from the iron furnaces in Sweden. They consist of bisilicate of iron. A white variety in perfect crystals has been obtained by Messrs BERTHIER and MITSCHERLICH, when mixing silica, lime, and magnesia, in the necessary proportion, and exposing this mixture in a charcoal crucible to the heat of the Sèvres porcelain furnaces. Many varieties of Pyroxene, if melted and then allowed to cool slowly, crystallise and assume an appearance little different from what they had before.

3. Paratomous Augite-spar occurs in imbedded crystals, in various kinds of rocks, in basalt, lava, &c.; also in beds in older rocks, both in crystals and compound massive varieties; it enters into the regular mixture or composition of several rocks, as the pyroxene rock, some varieties of greenstone and basalt: it likewise is found in veins traversing primitive rocks. Foliated, conchoidal, and common Augite are found in the first kind of these repositories; granular Augite, Coccolite, and Sahlite occur in the second, and are associated with ores of iron and titanium, with hemi-prismatic and prismatoidal Augite-spar, several species

of Feld-spar, &c. Also Omphazite occurs in beds with rhombohedral Quartz, dodecahedral Garnet, hemi-prismatic Augite-spar, &c. Diopside occurs in veins traversing serpentine, with dodecahedral Garnet and prismatic Talc-mica, and Fassaite and Baikalite also seem to occur in veins, where they are accompanied by rhombohedral Lime-haloide.

4. The imbedded varieties of Augite are found almost in every kind of basalt, and those rocks which are allied to it. The largest crystals occur near Aussig in Bohemia, but it is met with besides in the Rhön and Vogel mountains in Germany, in France and Italy, in Scotland and its Western Isles, &c.; granular Augite and Sahlite are chiefly obtained from Arendal in Norway, and Sahla in Sweden; Baikalite from the mouth of the Sljumanka river that falls into lake Baikal. Diopside is found in Piedmont, Fassaite in the valley of Fassa in the Tyrol, and in the Bannat of Temeswar, Omphazite in the Saualpe in Carinthia, and near Hof in Bayreuth. The beautifully green varieties of granular Actinolite occur in the Bacher mountain in Lower Stiria, the crystallised Green-earth in the valley of Fassa in the Tyrol. Pyroxene rock occurs in the Pyrenees; among those compound rocks, where it forms one of the constituents, we shall notice here only the greenstone from the celebrated Meissner mountain in Hessia. That black mineral, which is discernible in some meteoric stones, for instance those which fell at Stannern in Moravia, likewise seems to be paratomous Augite-spar. These meteoric stones, and the above mentioned greenstone from Meissner, but for the coarser grain of the latter, possess a high degree of resemblance to each other.

2. HEMI-PRISMATIC AUGITE-SPAR.

Straight-Edged Augite. Green Diallage. Jam. Syst. Vol. II. p. 117. 172. Axotomous Schiller-spar or Green Diallage. Hemi-prismatic Augite. Man. p. 130. 169. Hornblende. Smaragdite. Asbestus. Phill. p. 63. 71. Hornblende. Asbest (in part). Strahlstein (in part).

Tremolith. Karinthin. Kalamit. WERN. Hoffm. H. B. II. 2. S. 146. 277. 293. IV. 2. S. 103. 122. Hornblende. Strahlstein. Grammatit. Byssolith. Asbest (in part). Smaragdit. HAUSM. II. 699. 722. 728. 733. 734. 740. Smaragdit. Hornblende. Asbest (zum Theil). LEONH. S. 517. 527. 533. Amphibole. Actinote. Diallage verte. Grammatite. Asbest (in part). HAÜY. Traité, T. III. p. 58. 73. 126. 227. 245. Amphibole. Diallage verte. Asbeste. Tabl. comp. p. 39. 46. 55. Traité, 2de Ed. T. II. p. 372. 454. 481.

Fundamental form. Scalene four-sided pyramid P = 151° 8′, 149° 38′, 42° 22′. Inclination of the axis in the plane of the short diagonal = 0° 0′. Vol. I. Fig. 41. HAÜY.

$$a : b : c : d = 1 : \sqrt{14} : \sqrt{12{\cdot}6875} : 0.$$

Simple forms. $\frac{\mathrm{P}}{2}$ $(r) = 149° 38'$; $-\frac{\frac{3}{4}\mathrm{P}+2}{2}$ $(b) = 112° 53'$; $\frac{(\bar{\mathrm{P}}\mathrm{r})^3}{2}$ $(i) = 101° 32'$; $-\frac{(\breve{\mathrm{P}})^3}{2}$ $(k) = 155° 4'$; $-\frac{(\bar{\mathrm{P}}\mathrm{r})^3}{2}$ $(z) = 123° 4'$; $(\breve{\mathrm{P}}\mathrm{r}+\infty)^3$ $(M) = 124° 34'$; $\frac{(\breve{\mathrm{P}}\mathrm{r})^5}{2}$ (a); $(\bar{\mathrm{P}}\mathrm{r}+\infty)^5$ $(c) = 66° 25'$; $(\breve{\mathrm{P}}+\infty)^6 = 160° 7'$; $\pm\frac{\breve{\mathrm{P}}\mathrm{r}}{2} \begin{Bmatrix} P \\ P \end{Bmatrix} = \begin{Bmatrix} 75° 2' \\ 75° 2' \end{Bmatrix}$; $\pm\frac{\frac{3}{4}\breve{\mathrm{P}}\mathrm{r}+2}{2} \begin{Bmatrix} t \\ t \end{Bmatrix} = \begin{Bmatrix} 51° 17' \\ 51° 17' \end{Bmatrix}$; $\breve{\mathrm{P}}\mathrm{r}+\infty$ (s); $\bar{\mathrm{P}}\mathrm{r}+\infty$ (x).

Char. of Comb. Hemi-prismatic. Inclination of $\frac{\breve{\mathrm{P}}\mathrm{r}}{2}$ on $(\breve{\mathrm{P}}\mathrm{r}+\infty)^3 = 103° 13'$.

Combinations. 1. $-\frac{\breve{\mathrm{P}}\mathrm{r}}{2}$. $(\breve{\mathrm{P}}\mathrm{r}+\infty)^3$. Sim. Fig. 44., reversed. Arendal, Norway.

2. $\frac{P}{2}$. $(\breve{P}r + \infty)^3$. $\breve{P}r + \infty$. $\bar{P}r + \infty$. Sim. Fig. 72. (Tremolite) St Gothard.

3. $\frac{P}{2}$. $- \frac{\breve{P}r}{2}$. $(\breve{P}r + \infty)^3$. $\bar{P}r + \infty$. Fig. 74. Teplitz, Bohemia.

4. $\frac{P}{2}$. $\frac{(\bar{P})^3}{2}$. $- \frac{(\breve{P})^3}{2}$. $(\breve{P}r + \infty)^3$. $\bar{P}r + \infty$. Pargas, Finland.

5. $\frac{P}{2}$. $- \frac{\breve{P}r}{2}$. $- \frac{(\bar{P})^3}{2}$. $(\breve{P}r + \infty)^3$. $\bar{P}r + \infty$. Teplitz.

6. $\frac{P}{2}$. $\frac{\frac{5}{4}\breve{P}r + 2}{2}$. $\frac{(\bar{P})^3}{2}$. $\frac{(\breve{P}r)^5}{2}$. $- \frac{\breve{P}r}{2}$. $- \frac{(\bar{P}r)^3}{2}$. $- \frac{(\breve{P})^3}{2}$. $- \frac{\frac{3}{4}P + 2}{2}$. $(\breve{P}r + \infty)^3$. $(\bar{P}r + \infty)^5$. $\breve{P}r + \infty$. $\bar{P}r + \infty$. Fig. 76. Vesuvius.

Cleavage, $(\breve{P}r + \infty)^3$ highly perfect, less distinct $\bar{P}r + \infty$, least of all $\breve{P}r + \infty$. Fracture imperfect conchoidal, uneven. Surface, sometimes striated parallel to the axis; sometimes all the faces are uneven.

Lustre vitreous, inclining to pearly upon faces of cleavage in the varieties possessing pale colours. Colour, various shades of green, often inclining to brown; there is an uninterrupted series into perfectly white and into black varieties. Streak greyish-white ... brown. Nearly transparent ... opake.*

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* There is sometimes a blue opalescence observable in the

Brittle. Hardness = 5·0 ... 6·0. Sp. Gr. = 3·167 basaltic Hornblende from Lower Stiria; 3·127 Carinthine; 3·026, Actinolite from Zillerthal; 3·006, blackish-green common Hornblende; 2·931 white Tremolite.

Compound Varieties. Twin-crystals: face of composition parallel, axis of revolution perpendicular to $\breve{P}r + \infty$. This composition is also observable in massive varieties, sometimes in very thin laminæ, having often some foreign substance, particularly laminæ of the preceding species, interposed between them. There is also composition parallel to $-\frac{\breve{P}r}{2}$. Massive: composition granular, individuals of various sizes, generally strongly cohering, and producing in the great a tendency to slaty fracture; composition columnar, individuals of various sizes, sometimes very delicate, generally long, parallel, or diverging, and aggregated in a second granular composition. Compositions of short and irregularly distributed columnar particles possess in the great a slaty fracture. Very thin columnar composition produces a silky lustre.

OBSERVATIONS.

1. Hornblende, Actinolite, and Tremolite, together with

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direction of $\breve{P}r + \infty$. The varieties which present it are faintly translucent, and shew a pale brown colour in thin splinters, but appear dark grey in the mass. They were discovered at Kassigiengoit in Greenland by Sir CHARLES GIESECKE, and formerly considered as Hypersthene. Mr BROOKE first recognised them to belong to the present species. H.

certain kinds of Asbestus, comprehend far the greatest number of varieties belonging to the present species. *Hornblende* differs from the rest chiefly by its dark, blackish, or greenish colours, and is distinguished into three subspecies, *basaltic Hornblende*, *common Hornblende*, and *Hornblende slate.* The first contains black imbedded and perfectly cleavable crystals; the second refers to those imbedded crystals in which cleavage is not so easily obtained; it includes besides all implanted crystals and massive granular or columnar varieties, except such as are black and easily cleavable, and which have been distinguished from the rest by the name of *Carinthine.* Hornblende slate comprehends compound or even mixed varieties, consisting of confusedly aggregated columnar particles of composition, and possessing a slaty fracture. *Actinolite* includes the green varieties, frequently in acicular crystals, and has been subdivided into *common*, *glassy*, *asbestous*, and *granular Actinolite.* The varieties of the first subspecies are almost all paratomous Augite-spar, and have been mentioned in the preceding species. Glassy Actinolite contains crystals and columnar compositions of a green colour; asbestous Actinolite refers to capillary crystals and very thin columnar compositions, of other colours than white; granular Actinolite comprehends grass-green varieties, whose composition is granular. The varieties of *Tremolite*, similarly subdivided into subspecies, differ from the preceding ones, particularly by their pale green, grey, or white colours. *Common Tremolite* occurs in crystals, and in massive varieties of columnar compositions, which possess low degrees of transparency. More transparent varieties in similar compositions, consisting of thin individuals, are called *glassy Tremolite; asbestous Tremolite* forms masses of very thin, capillary crystals, exactly like asbestous Actinolite. *Calamite*, which has but lately deen discovered, is an asparagus-green, translucent variety in imbedded crystals, in a kind of serpentine. Asbestous Actinolite and asbestous Tremolite form a passage into *Asbestus*, of which, however, it must be remarked here, that the greater part does not belong to the genus Augite-spar. The passages demonstrate that there are varieties of Asbestus belonging to the present species, and moreover there are crystallised varieties, of common Hornblende, consisting in their interior or terminating on their ends in decided fibres of Asbestus in a parallel position. This is also the case in certain varieties of the preceding species; and we are led to conclude that the term Asbestus itself rather expresses the state of aggregation of several, than the substance of a distinct mineral. Asbestus in general has been divided into *Amiantus*, which consists of highly delicate fibres, often thinner than a hair, longitudinally cohering with each other, and easily separated; into *common* Asbestus, relating to coarser varieties, more firmly cohering, and yielding splintery fragments; into ***Rock-Cork***, in which the particles are aggregated in a loose felt-like texture, no longer recognisable, or to be separated from the rest; and into ***Rock-Wood*** or ***ligneous Asbestus***, in which a texture of the preceding kind, only more close, and resembling membranes, assumes the general appearance of wood. *Green Diallage* or *Smaragdite* has been found (Haidinger, Trans. Roy. Soc. Edin. Vol. X. p. 127.) in some cases to consist of laminæ of hemi-prismatic Augite-spar, with faces of composition parallel to $\breve{P}r + \infty$, in others of the same alternating with laminæ of paratomous Augite-spar, both often of bright green colours. This kind of composition of the two species is frequently found also in black varieties.

Among the varieties of this and the preceding species, if compared with each other, we are struck with the perfect analogy of certain varieties distributed as it were in parallel series. Augite and Hornblende, Sahlite and Actinolite, Diopside and Tremolite, stand in these relations, and both series terminate in their respective kinds of Asbestus.

2. Of the following analyses, three have been published by Bonsdorf, the fourth by Vauquelin:

	A white var.	A green var.	A black var.		Smaragdite from Corsica.
Silica	60·31	46·26	45·69.		50·0.
Magnesia	24·23	19·03	18·79.		6·0.
Lime	13·66	13·96	13·85.		13·0.
Alumina	0·26	11·48	12·18.		11·0.
Protoxide of Iron	0·15	3·43	7·32.	Oxide of Iron	5·5.
Protoxide of Manganese	0·00	9·36	0·22.	Ox. of Copper	1·50.
Fluoric acid	0·94	1·60	1·50.	Ox. of Chrome	7·50.
Water and foreign substances	0·10	1·04	0·00.		

Before the blowpipe it melts with difficulty, and a little intumescence, into a globule which is not clear, and variously coloured by iron or chrome, agreeably to the contents of the specimen. Also in borax it is but slowly soluble.

3. In its geological relations, the species of hemi-prismatic Augite-spar remarkably agrees with that of paratomous Augite-spar. Imbedded crystals of basaltic Hornblende are found like those of Augite, and frequently along with them in basalt and amygdaloidal rocks; crystals of common Hornblende and of Tremolite, also compound varieties of the latter occur in limestone rocks; the former likewise in porphyry and granite. Common Hornblende, Actinolite and Tremolite, particularly the asbestous varieties of the latter, occur in metalliferous beds in ancient rocks, with ores of iron and titanium, with Iron-pyrites, dodecahedral Garnet-blende, hexahedral Lead-glance, &c. Common Hornblende also frequently enters into the composition of rocks, as syenite, several kinds of greenstone, greenstone slate, &c. The finest varieties of Actinolite are found in imbedded crystals, or columnar compositions in talc slate; and capillary crystals of it and of Amiantus line the sides of narrow veins in primitive mountains. Hornblende slate, and certain varieties of common Hornblende, often mixed with rhombohedral Quartz, several kinds of Mica, dodecahedral Garnet, &c. form by themselves beds in primitive and transition mountains. Carinthine occurs in beds included

in gneiss, consisting of rhombohedral Quartz, dodecahedral Garnet, prismatoidal Augite-spar, &c.; Calamite in serpentine, along with imbedded crystals of rhombohedral Limehaloide and octahedral Iron-ore.

4. Basaltic Hornblende occurs in great abundance, and in beautiful crystals, near Teising and Teplitz in Bohemia, in large cleavable masses also, though not in regular crystals, at Toplitza in Transylvania. Large and very distinct crystals of a black colour are found imbedded in granular limestone in Pargas in Finland. Crystals of common hornblende are met with at Arendal and other places in Norway and in Sweden; also imbedded in limestone, and of a green colour, at Pargas in Finland, from whence the name of *Pargasite* is derived. The crystals in the drusy cavities of the Vesuvian minerals, though small, are generally very distinct, and possess a high degree of lustre. Common Hornblende occurs massive at Breitenbrunn, Ehrenfriedersdorf, and other places in Saxony; also in the Saualpe in Carinthia, &c. Here also the most distinct varieties of Carinthine have been found; but at the same time perfect transitions into common Hornblende. Calamite has been discovered at Normarken in Sweden. Many varieties of Actinolite are met with in Salzburg and the Tyrol, granular Actinolite in the Bacher mountain in Lower Stiria, asbestous Actinolite at Breitenbrunn, Raschau, and Ehrenfriedersdorf in Saxony. Common and glassy Tremolite occur at St Gothard, at Sebes in Transylvania, &c. always in granular limestone or dolomite, asbestous Tremolite in Switzerland, the Tyrol, the Bannat, at Längefeld in Saxony, and other places. Amiantus is found in great profusion in Corsica, also in Piedmont, Savoy, Salzburg, and Tyrol, in Upper Hungary, and Silesia; at Zöblitz and Waldheim in Saxony, where in some places there is also common Asbestus. Rock wood is still confined to Sterzing in the Tyrol, where it occurs in large masses in a metalliferous bed, often mixed with hexahedral Lead-glance. Rock Cork is found at Johanngeorgenstadt in Saxony, at Sahlberg in Sweden, in Moravia, Switzerland, and Spain, also at Portsoy, Lead-

hills, Wanlockhead, Strontian, and other places in Scotland. Green Diallage, generally accompanied by dodecahedral Garnet, and Saussurite, enters the composition of Euphotide or Gabbro rocks, and occurs in Corsica, on Monte Rosa, in the Bacher, and other places.

3. PRISMATOIDAL AUGITE-SPAR.

Prismatoidal Augite. JAM. Syst. Vol. II. p. 160. Man. p. 177. Epidote. PHILL. p. 41. Pistazit. Zoisit. Piemontischer Braunstein. WERN. Hoffm. H. B. I. S. 654. 665. IV. 1. S. 152. Epidot. HAUSM. II. 671. Epidot. LEONH. S. 438. Epidote. HAÜY. Traité, T. III. p. 120. Tabl. comp. p. 43. Traité, 2de Ed. T. II. p. 568. WEISS. Abh. der Akad. der Wissensch. zu Berlin, für 1818 and 1819. HAIDINGER. Edinb. Phil. Journ. Vol. X. p. 305.

Fundamental form. Scalene four-sided pyramid. $P = \left\{\begin{matrix} 70° \ 33' \\ 70° \ \ 9' \end{matrix}\right\}$, 151° 3′, 117° 33′. Inclination of the axis = 0° 33′ in the plane of the long diagonal. Vol. I. Fig. 41. R. G.

$$a : b : c : d = 105{\cdot}0 : 216{\cdot}8 : 66{\cdot}6 : 1.$$

Simple forms. $P - \infty\ (l)$; $\pm \frac{P}{2} \left\{\begin{matrix} n \\ z \end{matrix}\right\} = \left\{\begin{matrix} 70° \ 33' \\ 70° \ \ 9' \end{matrix}\right\}$; $-\frac{(\breve{P}r - 1)^3}{2}\ (u)$; $\pm \frac{(\breve{P})^3}{2} \left\{\begin{matrix} x \\ d \end{matrix}\right\}$; $(\breve{P}r + \infty)^3\ (o) = 63° \ 8'$; $(\breve{P} + \infty)^4\ (h) = 101° \ 35'$; $\pm \frac{\breve{P}r}{2} \left\{\begin{matrix} r \\ T \end{matrix}\right\} = \left\{\begin{matrix} 63° \ 43' \\ 64° \ 36' \end{matrix}\right\}$; $\frac{\breve{P}r + 1}{2}\ (s) = 45° \ 37$; $\frac{\frac{3}{4}\breve{P}r + 2}{2}\ (i) = 34° \ 21'$; $\breve{P}r + \infty\ (M)$; $\bar{P}r - 1\ (y) = 103° \ 30'$; $\bar{P}r\ (q) = 64° \ 46'$; $\breve{P}r + \infty\ (P)$.

Char. of Comb. Hemi-prismatic. Inclination of $P - \infty$ on $\breve{P}r + \infty = 90° \ 33'$.

Combinations. 1. $\frac{\breve{P}r}{2}.\ \frac{P}{2}.\ -\frac{\breve{P}r}{2}.\ \breve{P}r+\infty.$ Fig. 75.
Great St Bernard.

2. $P-\infty.\ \frac{\breve{P}r}{2}.\ -\frac{P}{2}.\ -\frac{\breve{P}r}{2}.\ \frac{(\breve{P}r-1)^3}{2}.$
$\breve{P}r+\infty.\ \bar{P}r+\infty.$ Dauphiny.

3. $\frac{\breve{P}r}{2}.\ \frac{P}{2}.\ -\frac{\breve{P}r}{2}.\ -\frac{(\breve{P}r-1)^3}{2}.\ (\breve{P}r+\infty)^3.$
$\breve{P}r-\infty.\ \bar{P}r+\infty.$ Dauphiny.

4. $P-\infty.\ \frac{\breve{P}r}{2}.\ \frac{P}{2}.\ \frac{(\breve{P})^3}{2}.\ \bar{P}r-1.\ \bar{P}r.\ -\frac{\breve{P}r}{2}.$
$-\frac{(\breve{P}r-1)^3}{2}.\ -\frac{P}{2}.\ -\frac{(\breve{P})^3}{2}.\ (\breve{P}r+\infty)^3.$
$\breve{P}r+\infty.$ Fig. 77. Arendal, Norway.

Cleavage, $\breve{P}r+\infty$ perfect; $-\frac{\breve{P}r}{2}$ less distinct. Fracture uneven. Surface, the horizontal prisms streaked parallel to the short diagonal of P, also $P-\infty$ and $\breve{P}r+\infty$ streaked parallel to their common edges of intersection. In general the faces are smooth.

Lustre vitreous, inclining to pearly upon perfect faces of cleavage and the corresponding faces of crystallisation. Colour, green and grey prevalent. Among the most common shades of the first is pistachio-green: in general the green tints are more inclined to yellow than in the two preceding species. The grey colours pass into white and a very pale flesh-red. Streak greyish-white. Semi-transparent ... translucent on the edges.

Viewed in a direction parallel to the axis, the colour of the crystals contains less yellow than in the directions perpendicular to it.

Brittle. Hardness = 6·0...7·0. Sp. Gr. = 3·269, Zoisite from the Saualpe; = 3·425, Pistazite from Arendal.

Compound Varieties. Twin-crystals: face of composition parallel, axis of revolution perpendicular to $-\frac{\breve{P}r}{2}$. This composition is very frequent, particularly among the varieties from Dauphiny. Several varieties consist of concentric coats, the outer ones of which being pealed off, leave a crystal with smooth faces. Massive: composition granular, of various sizes of individuals, sometimes impalpable, strongly connected: columnar, straight, and either parallel or divergent or irregular, and of various sizes of individuals.

OBSERVATIONS.

1. The two species, *Pistazite* and *Zoisite*, comprehended within the varieties of prismatoidal Augite-spar, are easily distinguished by their colours. The colours of the first are green, those of the second are white and grey, but there are transitions in the colours of both. The varieties of the present species, though less comprehensive than the two preceding ones, form a series, the members of which are analogous to the varieties of these species. Thus Pistazite corresponds to the varieties called Augite, Sahlite, Hornblende, and Actinolite, while Zoisite answers to Diopside and Tremolite. This comparison extends even to the fourth species or prismatic Augite-spar, whose varieties correspond to those called Diopside, Tre-

molite, and Zoisite; and it is likely that this will be found to be true even to a greater extent, when more varieties of that species shall have been discovered. The light reddish-black variety from Piedmont (*piemontischer Braunstein* of Werner, *Epidote manganèsifère* of Haüy) is a variety of Zoisite impregnated with oxide of manganese*.

2. The chemical composition of prismatoidal Augite-spar has been found as follows:

	Zoisite	*Pistazite*	
	From the Saualpe.	From Dauphiny.	From Norway.
Silica	45·00	37·00	37·00.
Alumina	29·00	27·00	21·00.
Lime	21·00	14·00	15·00.
Oxide of Iron	3·00	17·00	24·00.
Oxide of Manganese	0·00. Klapr.	1·50. Descot.	1·50. Vauq.

Before the blowpipe the varieties of the present species intumesce and partly exfoliate, but are difficultly fusible, and only on the thinnest edges, into a transparent glass. Those which contain more oxide of iron are more easily fusible than the rest. With borax, Pistazite likewise first intumesces, and then yields a clear globule.

3. Prismatoidal Augite-spar agrees in regard to its natural repositories with some of the varieties of the preceding species. Pistazite occurs along with them, frequently and in fine varieties, in beds of octahedral iron-ore; also in single drusy cavities of various rocks, without, however, entering into their composition as a regular ingredient. It is met with, besides, in narrow veins irregularly distributed through the rocks, and contemporaneous with them; also in distinct veins, where it is associated with prismatic

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* Zoisite is included in the present species, on the authority of Haüy, who states its forms to be identical with those of Epidote. Mr Brooke has found a difference in this respect, namely, that the perfect cleavage bisects the obtuse angle of 116° 30′ of a *rhombic* prism, which is probably oblique; and that there are faces of cleavage inclined to the obtuse edges of that prism. This would render it necessary to consider Zoisite as a particular species. H.

Axinite, axotomous Triphane-spar, rhombohedral Quartz, Asbestus, and various other minerals. Zoisite is found in single crystals, and crystalline masses in beds with hemi-prismatic Augite-spar, dodecahedral Garnet, rhombohedral Quartz, prismatic Disthene-spar, &c., or it constitutes beds itself with prismatic Feld-spar, as in the Saualpe in Carinthia, where it forms the repository of pyramidal Zircon. A reddish-white variety, consisting often of impalpable particles of composition, is found in the Radelgraben in Carinthia, along with prismatic Talc-mica, in primitive mountains.

4. Magnificent crystals of the present species are found at Arendal in Norway; and the name of *Arendalite* has been given to these varieties, from their locality. Similar varieties occur also in Sweden. Very fine crystallised varieties are known from Switzerland, Piedmont, also from the Pyrenees and the Upper Palatinate, in which localities they occur in veins. Less distinct varieties of the Pistazite occur in many countries, as, for instance, in the Saualpe, where certain varieties are found, which, by their colour, connect the Pistazite with the grey varieties of Zoisite. Besides this locality, Zoisite is also found in the Bacher mountain and Schwamberg Alpe in Lower Stiria, in the Fichtelgebürge, and in the Tyrol. The red manganesian varieties occur at St Marcel in the valley of Aosta in Piedmont.

4. PRISMATIC AUGITE-SPAR.

Prismatic Augite or Tabular Spar. Jam. Syst. Vol. II. p. 170. Man. p. 179. Tabular Spar. Phill. p. 23. Schalstein. Wern. Hoffm. H. B. III. 1. S. 55. Tafelspath. Hausm. II. S. 583. Tafelspath. Leonh. S. 660. Spath en Tables. Haüy. Tabl. comp. p. 66. Wollastonite. Traité, 2de Ed. T. II. p. 438.

Fundamental form. Scalene four-sided pyramids of imperfectly determined dimensions. Vol. I. Fig. 42.

Cleavage, in the direction of two faces intersecting each other at angles of 95° 25′, both being easily obtained, but one of them more perfect and smooth. There are besides imperfect traces of cleavage in various directions, which render it probable that the forms of this species will be found hemi-prismatic or tetarto-prismatic*. Fracture uneven.

Lustre vitreous, inclining to pearly, particularly upon the perfect faces of cleavage. Colour white, inclining to grey, yellow, red, and brown. Streak white. Semi-transparent … translucent on the edges.

Rather brittle. Hardness = 4·0 … 5·0. Sp. Gr. = 2·805, of a brownish-white variety from the Bannat.

Compound Varieties. Massive: composition lamellar, generally longish, and aggregated into a second large grained and angular composition; strongly coherent.

OBSERVATIONS.

1. A variety of the present species from Cziklowa has

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[*] A tetarto-prismatic crystal is quoted by Mr **PHILLIPS.** Comparing it with Fig. 82., the obtuse edge produced by the two faces of cleavage *M* and *T*, which he gives = 95° 20′, is replaced by a face inclined at angles of 139° 45′ on *T*, and of 135° 30′ on *M*. *P* is inclined on *M* at an angle of 126°, a face replacing the obtuse edge between *P* and *M*, on *P* at an angle of 156° 30′, and another which replaces the acute edge between *P* and the opposite face of *M*, is inclined towards *P* at an angle of 94° 15′. H.

been analysed by STROMEYER, another from Finland by ROSE; they have yielded the following results:

Silica	51·445	51·60.
Lime	47·412	46.41.
Protoxide of Iron	0·401	a trace.
Oxide of Manganese	0·257	0·00.
Water and loss by heating	0·076	0·00.
Mechanical admixtures	0·00	1·11.

Its chemical formula $\ddot{C}a^3\ \dddot{S}i$, agrees with 47·24 lime and 52·76 silica. Before the blowpipe it melts on the edges into a semi-transparent colourless enamel. It requires a strong heat for melting, and sometimes boils a little. It is easily dissolved by borax, and in considerable quantity, and forms with it a transparent globule. By fusing lime and silica in the required proportions, cleavable masses of the present species have been obtained, but not yet any crystals.

2. The oldest variety known of prismatic Augite-spar is from Cziklowa near Orawitza, in the Bannat of Temeswar, where it occurs in several copper mines. It is associated with several ores of copper, also with rhombohedral Lime-haloide, with pyramidal Kouphone-spar, &c. In Finland it occurs in limestone, at Edinburgh, in the greenstone of the Castle-hill; it is also found in several localities in America, and with Essonite in Ceylon. The variety from Capo di Bove near Rome, first called Wollastonite, but now supposed to be perhaps different from the present species, occurs in lava resembling basalt, and is associated with paratomous Augite-spar, trapezoidal Kouphone-spar, &c.

GENUS IX. AZURE-SPAR.

1. DODECAHEDRAL AZURE-SPAR.

Azurestone or Lapis Lazuli. JAM. Syst. Vol. I. p. 399. Man. p. 317. Lapis Lazuli. PHILL. p. 44. Lasurstein. WERN. Hoffm. H. B. II. 1. S. 276. Lasurstein. HAUSM. II. S. 543. Lasurstein. LEONH. S. 650. Lazulite. HAÜY. Traité, T. III. p. 145. Tabl. comp. p. 47. Traité, 2de Ed. T. III. p. 54.

Fundamental form. Hexahedron. Vol. I. Fig. 1.
Simple form. $\overset{*}{\mathrm{D}}$. Vol. I. Fig. 31.

Cleavage, dodecahedron imperfect. Fracture imperfect conchoidal, uneven. Surface even, though rough.

Lustre vitreous. Colour various shades of azure-blue. Streak blue, paler than the colour. Translucent, generally only on the edges.

Brittle. Hardness = 5·5 ... 6·0. Sp. Gr. = 2·959, KARSTEN; = 2·3 ... 2·4, BREITHAUPT.

Compound Varieties. Massive: composition granular, individuals strongly connected; fracture uneven.

OBSERVATIONS.

1. The difference in the two preceding statements of the specific gravity shews that the present place of the species cannot yet be considered as definitively settled.

2. Dodecahedral Azure-spar consists, according to GMELIN, of

Silica	49·00.
Magnesia	2·00.
Alumina	11·00.
Lime	16·00.
Potash and Soda	8·00.
Oxide of Iron	4·00.
Sulphuric Acid	2·00.,

with a trace of water and hydro-sulphuric acid. Before the blowpipe it melts with difficulty into a glassy globule, which is first of a blueish tinge, but soon becomes white. The compact varieties melt more easily and with a slight effervescence. It is dissolved with considerable effervescence by borax, and forms with it a clear globule. If previously burnt and reduced to powder, it loses its colour and forms a jelly with acids.

3. Nothing is known with certainty in regard to the geological relations of the present species. From its mixture with limestone, it seems to be found originally in beds. But it is also said to have been found in veins traversing primitive rocks. It is generally associated with hexahedral Iron-pyrites.

4. Dodecahedral Azure-spar has been long ago brought from Lesser Bucharia, Thibet, and China. It has been lately found at Lake Baikal in Siberia, as it is said, in veins with hexahedral Iron-pyrites, prismatic Feld-spar, and dodecahedral Garnet.

5. Ultramarine is obtained from it. It is also cut into various ornamental articles, as ringstones, snuff-boxes, &c.

2. PRISMATIC AZURE-SPAR.

Prismatic Azure-spar, first subsp. JAM. Syst. Vol. I. p. 392. Prismatic Azure-spar. Man. p. 180. Lazulite. Azurite. PHILL. p. 94. Lazulit. WERN. Hoffm. H. B. II. 1. S. 285. Körniger Lazulith. HAUSM. II. S. 372. Lazulith (in part). LEONH. S. 415. Lasulit de Werner. HAÜY. Tabl. comp. p. 62. Lazulite. Traité, 2de Ed. T. III. p. 54.

Fundamental form. Scalene four-sided pyramid. Vol. I. Fig. 9.

Simple forms. $\frac{4}{5}P - 2$?; $\frac{4}{3}P - 2$?; P; $P + \infty = 91° 30'$; $\bar{P}r = 58° 30'$; $\breve{P}r = 59° 20'$.

Char. of Comb. Prismatic. The crystals of this mineral possess in general a great deal of resemblance with those of prismatic Sulphur. As in the latter, P is an acute pyramid. Lateral edge = 136° 20′.*

Cleavage, P + ∞ indistinct. Fracture uneven. Surface smooth, all the faces alike.

Lustre vitreous. Colour various shades of a pure blue colour, particularly deep and beautiful, if viewed in the direction of one line, apparently the axis of the crystals, while perpendicular to it, it is of a pale greenish-blue colour. Streak white. Translucent, generally only on the edges, opake.

Brittle. Hardness = 5·0...5·5. Sp. Gr. = 3·056.

Compound Varieties. Massive: composition granular, individuals strongly connected.

OBSERVATIONS.

1. According to Fuchs, the prismatic Azure-spar from the Radelgraben in Salzburg consists of

Phosphoric Acid	41·81.
Alumina	35·73.
Magnesia	9·34.
Silica	2·10.
Protoxide of Iron	2·64.
Water	6·06.

Before the blowpipe it intumesces a little, and assumes a glassy appearance, where the heat has been highest, but does not melt. With borax it yields a clear colourless globule. Treated with boracic acid, and a piece of iron-wire, it gives a globule of phosphuret of iron.

2. It has been found in narrow veins, traversing clay-slate, both massive and crystallised, with rhombohedral

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[*] The angles are given according to Brooke and Phillips. H.

Quartz and brachytypous Parachrose-baryte. It occurs near Werfen in Salzburg, in the valleys called Schlanıming and Radelgraben. Whether or not the Lazulite from Waldbach in the district of Vorau in Stiria, and from the Rathhausberg in Salzburg, belong to the present species, is yet to be ascertained.

3. PRISMATOIDAL AZURE-SPAR.

Prismatoidal Azure-spar or Blue Spar. JAM. Syst. Vol. I. p. 396. Man. p. 180. Blue Felspar. PHILL. p. 115. Blauspath. WERN. Hoffm. H. B. II. 1. S. 287. Splittriger Lazulith. HAUSM. II. S. 373. Lazulith (in part). LEONH. S. 415. Feld-Spath bleu. HAÜY. Traité, T. II. p. 605. Tabl. comp. p. 60. Traité, 2de Ed. T. IV. p. 490.

Fundamental form. Scalene four-sided pyramid. Vol. I. Fig. 9. Simple forms and combinations unknown.

Cleavage, indistinct, sometimes pretty easily observed in only one direction. Also traces in other directions making oblique angles with the former. Fracture uneven.

Lustre vitreous, slightly inclining to pearly upon faces of cleavage. Colour smalt-blue, inclining sometimes to white or green. Streak white. Translucent on the edges, often nearly opake.

Brittle. Hardness = 5·5 ... 6·0. Sp. Gr. = 3·024, the Stirian variety.

Compound Varieties. Massive: composition granular, often in large individuals; strongly coherent. Fracture often splintery.

OBSERVATIONS.

1. So little is known of the geometrical properties of the

present species, that it is impossible to say whether it is really different from the preceding one, since the characters taken from hardness and specific gravity, and others very nearly agree. The chemical composition has been found to be almost exactly the same. R. Brandes obtained

Phosphoric Acid	43·32.
Silica	6·50.
Alumina	34·50.
Magnesia	13·56.
Lime	0·48.
Protoxide of Iron	0·80.
Water	0·50.

Before the blowpipe it loses its colour, but does not melt. It is slowly and difficultly dissolved in borax. With boracic acid and iron-wire it yields a globule of phosphuret of iron.

2. Prismatoidal Azure-spar occurs in masses, sometimes pretty considerable, also in large indistinct crystals imbedded in rhombohedral Quartz, and mixed with Mica. It has not been found in its original repositories, which seem to be beds.

3. It occurs in the valley of Freschnitz near Krieglach on the Mürz in Upper Stiria. Boulders of the rock containing the blue mineral are found also at Therenberg on the foot of the Wechsel mountain in Lower Austria.

Order VII. GEM.

Genus I. ANDALUSITE.

1. PRISMATIC ANDALUSITE.

Prismatic Andalusite, first subsp. Jam. Syst. Vol. I. p. 68. Man. p. 181. Andalusite. Phill. p. 108. Andalusit. Wern. Hoffm. H. B. II. 1. S. 291. Andalusit. Hausm. II. S. 506. Andalusit. Leonh. S. 475. Feld-Spath apyre. Haüy. Traité, T. IV. p. 362. Tabl. comp. p. 60. Traité, 2de Ed. T. IV. p. 486.

Fundamental form. Scalene four-sided pyramid. $P = 120^\circ\ 27', 118^\circ\ 39', 90^\circ\ 47'$. Vol. I. Fig. 9. LEONHARD.

$$a : b : c = 1 : \sqrt{2} : \sqrt{1\cdot8947}.$$

Simple forms. $P - \infty$ (P); $P + \infty$ (M) $= 91^\circ\ 33'$; $\breve{P}r$ (l) $= 109^\circ\ 28'$; $\bar{P}r = 108^\circ\ 0'$; $\bar{P}r + \infty$.

Char of Comb. Prismatic.

Combinations. 1. $P - \infty$. $P + \infty$. 2. $\breve{P}r$. $P + \infty$. 3. $P - \infty$. $\breve{P}r$. $P + \infty$. Fig. 3. All of them from Lisenz, Tyrol.

Cleavage. $P + \infty$ very distinct, often covered with scales of mica; $\bar{P}r + \infty$ more smooth and shining, but interrupted and less easily obtained. Traces of $\breve{P}r$, and $\breve{P}r + \infty$, the latter scarcely perceptible. Fracture uneven. Surface, uneven and rough, seldom smooth. Generally covered with plates of mica.

Lustre vitreous. Colour flesh-red, passing into pearl-grey. Streak white. Translucent on the edges.

Hardness = 7·5. Sp. Gr. = 3·104 of a cleavable variety.

Compound Varieties. Massive: composition indistinctly granular and columnar.

OBSERVATIONS.

1. Among the minerals which accompany the prismatic Andalusite from the Tyrol, there is one which possesses its form, but none of its other properties. Its hardness is = 5·0, the specific gravity = 3·543; besides, the crystals are compound, and seem to be pseudomorphic, perhaps be-

longing to the species of prismatic Disthene-spar. It has often been erroneously considered as grey Andalusite.

2. According to Bucholz, the prismatic Andalusite consists of

Alumina	60·5.
Silica	36·5.
Oxide of Iron	4·0.

Before the blowpipe it is infusible, even in thin splinters or in powder, but it becomes covered with white spots. It is difficultly soluble in borax, even when reduced to powder, and almost only on the edges in salt of phosphorus.

3. Crystals of prismatic Andalusite are found imbedded in mica slate, or implanted in the cavities of rocks, forming irregular beds or nodules in granite and primitive slate. It is generally associated with rhombohedral Quartz, sometimes with Pinite.

4. This species was first discovered in the province of Andalusia in Spain, from whence it has been called Andalusite. Varieties of it have been afterwards found near Bräunsdorf in Saxony, at Herzogau in the Upper Palatine, in several places in France, and at Kaplitz on the frontiers of Austria and Bohemia. Crystals of very considerable magnitude are found in the valley of Lisenz near Inspruck in the Tyrol.

GENUS II. CORUNDUM.

1. DODECAHEDRAL CORUNDUM.

Octahedral Corundum, second and third subsp. Jam. Syst. Vol. I. p. 41. 43. Dodecahedral Corundum. Man. p. 182. Spinelle Ruby. Pleonaste. Phill. p. 90. 92. Spinel (with exception of Salamstein). Zeilanit. Wern. Hoffm. H. B. I. S. 530. 535. Spinell. Pleonast. Hausm. II. S. 360. 363. Spinell. Leonh. S. 511. Spinelle. Pléonaste. Haüy. Traité, T. II. p. 496. T. III. p. 17. Tabl. comp. p. 31. Alumine magnésiée ou Spinelle (with exception of Sp. zincifère). Traité, 2de Ed. T. II. p. 166.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. Ȯ (*P*). Vol. I. Fig. 2.; Ḋ (*o*). Vol. I. Fig. 31. C_2 (*r*). Vol. I. Fig. 34.

Char. of Comb. Tessular. Combinations 1. O. D. 2. O. D. C_2. Irregular forms, grains.

Cleavage, octahedron difficult. Fracture conchoidal. Surface smooth, the icositetrahedron sometimes striated parallel to the edges of combination with the octahedron.

Lustre vitreous. Colour red, passing into blue and green, also into yellow, brown, and black. Sometimes nearly white. Streak white. Transparent ... translucent, only on the edges if the colour be very dark.

Hardness = 8·0. Sp. Gr. = 3·523, of a transparent variety, between cochineal- and carmine-red.

Compound Varieties. Twin-crystals, face of composition parallel, axis of revolution perpendicular to a face of the octahedron. Fig. 156. Sometimes parallel to several faces of the octahedron.

OBSERVATIONS.

1. The varieties called *Salamstein* by WERNER cannot be received in the species of dodecahedral Corundum, as their forms belong to the rhombohedral system, but it is necessary to include in it the varieties called *Zeilanite* or *Pleonaste*, which differ only in regard to colour, and perhaps to specific gravity, owing to an admixture of oxide of iron.

2. The contents of three varieties of dodecahedral Corundum have been found as follows:

	Blue Spinelle from Aker.	*Red Spinelle.*	*Pleonaste* from Ceylon.
Alumina	72·25	74·50	68·00,

Silica	5·45	15·50	2·00.
Magnesia	14·63	8·25	12·00.
Oxide of Iron	4·26	1·50	16·00.
Lime	0·00 Berz.	0·75 Klapr.	0·00. Descot.

Vauquelin discovered 6·18 per cent. of chromic acid in the red Spinelle. The pure varieties are designated by Berzelius with $\ddot{Mg}\,\dddot{Al}^4$, corresponding to 83·25 of alumina and 16·75 of magnesia. Pleonaste contains, besides, a proportion of oxide of iron. The red varieties, exposed to heat, become black and opake; on cooling, they appear first green, then almost colourless, and at last re-assume their red colour. They are difficultly fusible with borax, a little more easily with salt of phosphorus. Pleonaste yields a deep green globule. Dodecahedral Corundum assumes positive electricity by friction.

3. The original repositories of several varieties of the present species are certainly rocks or mountain masses; but it is not known with certainty whether this be everywhere gneiss, as it has been quoted for several localities. Crystals from Ceylon have been observed imbedded in limestone, mixed with mica, or in rocks containing adularia, which seem to have belonged to primitive rocks. Other varieties, commonly called Pleonaste, occur in the drusy cavities of rocks ejected by Vesuvius. The greater part, however, of the varieties of dodecahedral Corundum are found in more recent deposits, formed by diluvial or alluvial action, along with crystals of rhombohedral Corundum, pyramidal Zircon, and other gems, also with octahedral Iron-ore.

4. Dodecahedral Corundum is principally brought from Ceylon, where it occurs in isolated crystals in the sand, or also imbedded in gneiss. All the regular forms mentioned above, have been observed in this variety. In Südermanland in Sweden, blueish and pearl-grey varieties occur imbedded in granular limestone. Pleonaste occurs in Ceylon in sand, and in implanted crystals in Vesuvius.

5. Clear and finely coloured red varieties of the present

species are highly prized as ornamental stones. They go generally by the name of *Spinelle Ruby*, or *Balas Ruby.*

2. OCTAHEDRAL CORUNDUM.

Octahedral Corundum, first subsp. Jam. Syst. Vol. I. p. 39. Octahedral Corundum or Automalite. Man. p. 184. Automalite. Phill. p. 83. Automolit. Wern. Hoffm. H. B. I. S. 526. Gahnit. Hausm. II. S. 364. Gahnit. Leonh. S. 513. Spinelle zincifère. Haüy. Tabl. comp. p. 67. Traité, 2de Ed. T. II. p. 170.

Fundamental form. Hexahedron. Vol. I. Fig. 1.
Simple form. $\overset{*}{O}$ (*P*). Vol. I. Fig. 2.

Cleavage, octahedron, perfect. Fracture conchoidal. Surface rough, sometimes covered with mica, or with dodecahedral Garnet-blende.

Lustre vitreous, inclining to resinous. Colour dirty green tinges, inclining to black and blue. Streak white. Translucent on the edges ... nearly opake.

Hardness = 8·0. Sp. Gr. = 4·232.

Compound Varieties. Twin-crystals: face of composition parallel, axis of revolution perpendicular to a face of the octahedron. Fig. 156.

OBSERVATIONS.

1. Octahedral Corundum consists, according to Eckeberg, of

Alumina	60·00.
Oxide of *Zinc*	24·25.
Oxide of Iron	9·25.
Silica	4·75.

with a trace of oxide of manganese and lime. The pure mixture is considered by Berzelius to be expressed by

$\ddot{Z}n\ \dddot{A}l^4$, which corresponds to 71·86 of alumina, and 28·14 oxide of zinc, not giving attention to the contents of oxide of iron and silica. Alone it is infusible before the blowpipe, and nearly so with borax or salt of phosphorus. With soda it melts imperfectly into a dark scoria, which being melted again with soda, deposits upon the charcoal an areola of oxide of zinc.

2. The varieties of the present species generally occur imbedded in talcose slate and quartz, and accompanied with hexahedral Lead-glance and dodecahedral Garnet-blende; sometimes also with prismatic Gadolinite, dodecahedral Garnet, &c. It is found at Fahlun and Broddbo in Sweden, and in the vicinity of the Franklin iron-works in New Jersey.

3. RHOMBOHEDRAL CORUNDUM.

Rhomboidal Corundum. JAM. Syst. Vol. I. p. 48. Man. p. 148. Corundum. PHILL. p. 74. Saphir. Salamstein. Schmirgel. Korund. Demantspath. WERN. Hoffm. H. B. I. S. 541. 547. 561. 565. 572. Korund. HAUSM. II. S. 366. Korund. LEONH. S. 393. Télésie. Corindon. HAÜY. Traité, T. II. p. 480. T. III. p. 1. Corindon. Tabl. comp. p. 29. Traité, 2de Ed. T. II. p. 70.

Fundamental form. Rhombohedron. R = 86° 6′. R. G.

$$a = \sqrt{5{\cdot}5609}.$$

Simple forms. $R - \infty\ (o)$; $R\ (P)$; $R + 1\ (a) = 68°\ 45'$; $\overset{*}{P} + 1\ (r) = 128°\ 3',\ 122°\ 18'$; $P + 2\ (b) = 122°\ 22',\ 149°\ 12'$; $P + 3\ (e) = 120°\ 37',\ 164°\ 20'$; $\frac{5}{5}\ P + 1 = 136°\ 47',\ 94°\ 53'$; $\frac{7}{6}\ P + 1\ (c) = 126°\ 16',\ 129°\ 52'$; $\frac{5}{4}\ P + 2 = 124°\ 1',\ 139°\ 40'$; $\frac{5}{4}\ P + 3\ (l) = 121°\ 5',\ 159°\ 11'$; $\frac{5}{4}\ P + 4 = 120°\ 17',\ 169°\ 30'$; $R + \infty$;

$P + \infty$ (*s*); $(P + \infty)^5 = 133^\circ\ 10'\ 25''$, $166^\circ\ 49'\ 35''$.

Char. of Comb. Rhombohedral.

Combinations. 1. $R - \infty$. R. Sim. Fig. 111. Gellivara, Sweden.
2. $R - \infty$. $P + \infty$. Malabar.
3. $R - \infty$. R. $P + \infty$. Ceylon.
4. $R - \infty$. R. $P + 1$. $P + \infty$. Fig. 121. Ceylon.
5. $P + 1$. $R + 1$. $P + 2$. $P + \infty$. Fig. 122. Ceylon.
6. $R - \infty$. $\frac{7}{6} P + 1$. $\frac{5}{4} P + 3$. $P + 3$. $P + \infty$. Fig. 123. Ceylon.

Irregular forms, grains.

Cleavage, $R - \infty$ in some varieties perfect, but interrupted by conchoidal fracture. The faces obtained in the direction of the rhombohedron R, almost always originate in composition. The faces of cleavage and regular composition are striated parallel to their common edges of intersection. Fracture conchoidal, uneven. Surface, $R - \infty$ striated parallel to the edges of combination with R; sometimes also $P + \infty$ in the same direction. The isosceles pyramids and generally also $P + \infty$ are often deeply striated in a horizontal direction.

Lustre vitreous, much inclining in some varieties to pearly upon $R - \infty$. Colour blue, red, green, yellow, brown, grey, and white. Some of the blue, red, and yellow colours, very lively and beautiful. Streak white. Transparent ... translucent. In several varieties, if cut round, a six-sided opalescent star is observable in the direction of the axis.

Hardness = 9·0.

Sp. Gr. = 3·979, blue, transparent (Sapphire).
3·949, green, translucent (Corundum).
3·921, brown, faintly translucent (Adamantine-spar).
3·909, red, transparent (Ruby).

Compound Varieties. Regular composition parallel to one or more of the faces of R, repeated in parallel layers, very frequent. Massive: composition granular, often impalpable, and then the fracture becomes splintery and uneven.

OBSERVATIONS.

1. Among the varieties of rhombohedral Corundum, four species used formerly to be distinguished, for the greater part easily ascertained, but also united by such varieties as possess intermediate properties between them, and produce continuous transitions. By these transitions, however, also the *Salamstone* is included, which WERNER considered as a sub-species of Spinelle, and which consists of small transparent crystals, generally six-sided prisms, of pale reddish and blueish colours. Most of the transparent simple varieties, however, were designated by the name of *Sapphire*, while the compound ones were called *Emery*. The varieties of Sapphire generally possess an indistinct cleavage and a conchoidal fracture; the surface of its crystals is smooth, though not always even. The remaining varieties differ almost only in colour, *Corundum*[*]-

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[*] The corundum of Battagammana is frequently found in large six-sided prisms; it is commonly of a brown colour, whence it is called by the natives "Curundu galle," cinnamon-

stone comprehending those whose colour is green, blue, or red, and in most cases inclining to grey, while those of *Adamantine-spar* are hair-brown and reddish-brown. Both of them are easily cleavable, or at least shew faces of composition parallel to the fundamental rhombohedron, and the crystals possess a rough and uneven surface. There are many crystals, part of which is Sapphire, and part Adamantine-spar.

3. The following ingredients have been found in rhombohedral Corundum:

	Sapphire.	*Corundum-stone.*	*Emery.*
Alumina	98·50	89·50	86·00.
Silica	0·00	5·50	3·00.
Oxide of Iron	1·00	1·25	4·00.
Lime	0·50 Klapr.	0·00 Klapr.	0·00. Tennant.

Its chemical formula is $\overset{\cdots}{\mathrm{Al}}$, expressing 53·29 of aluminium, and 46·71 of oxygen. Before the blowpipe it is infusible whether alone or with soda; it is difficultly but entirely dissolved in borax, and if previously reduced to powder, also in salt of phosphorus. It is not acted upon by acids.

3. Rhombohedral Corundum is found in imbedded crystals and in massive varieties. The first of them, and particularly Sapphire and Salamstone, are chiefly met with in secondary repositories, as in the sand of rivers, &c. and is accompanied by crystals and grains of octahedral Iron-ore, and of several species of gems. Corundum-stone is found in imbedded crystals in a rock, which consists, according to Count Bournon, of Indianite, and contains Felspar, Fibrolite, several species of Augite-spar and Gem, and also octahedral Iron-ore. Adamantine-spar occurs with octahedral Iron-ore and Fibrolite in a sort of granite, containing no quartz. The varieties from Piedmont are imbedded in

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stone. Dr J. Davy's *Account of the Interior of Ceylon*, p. 25. Dr Davy adds, that the corundum and sapphire are so closely allied, that even the natives of Ceylon have not failed to observe the connexion. H.

compact Felspar. Some varieties have been discovered imbedded in octahedral Iron-ore and macrotypous Lime-haloide, and seem to occur in beds. Those compound varieties of which the original repository has been ascertained, occur in a bed of talcose slate, contained in mica-slate.

4. The finest varieties of Sapphire come from Pegu, where they occur in the Capelan mountains near Syrian. Some have also been found at Hohenstein in Saxony, at Bilin in Bohemia, at Puy in France, and in several other countries. Corundum occurs in the Carnatic in the East Indies; Adamantine-spar in the neighbourhood of Canton in China and the coast of Malabar. In St Gothard red and blue varieties of the present species occur in Dolomite. Those from Gellivara in Sweden, imbedded in octahedral Iron-ore, are of a yellowish-white colour. Emery is found in the higher part of Saxony, in the mountain called Ochsenkopf near Schneeberg, and is of a dark blue colour, inclining to grey; it approaches to the appearance of blue Corundum, whenever its individuals are of considerable size. In the island of Naxos, and several other islands of the Greek archipelago, also at Smyrna, Emery is found in large boulders on the surface of the earth mixed with other minerals.

5. The pure and transparent varieties of rhombohedral Corundum, if finely coloured, are in great estimation as ornamental stones. The red varieties are most highly valued, and go by the name of *Oriental Ruby*, the violet-blue are called *oriental Amethyste*, the green *oriental Emerald*, the yellow *oriental Topaz*, and the blue *oriental Sapphire*. *Asteria*is a variety of Sapphire, not perfectly transparent, and shewing a starlike opalescence in the direction of the axis if cut round. Much use is made of Corundum and Adamantine-spar, particularly in India and China, for cutting and polishing steel and gems, and it is said even of diamond, which has given occasion to the name of Adamantine-spar. Yet they are much inferior in this respect to the powder of diamond; and European artists therefore make use of the latter for cutting the diamond, and for ex-

ecuting fine works in other hard stones. Emery yields a well known grinding material.

4. PRISMATIC CORUNDUM.

Prismatic Corundum or Crysoberyl. Jam. Syst. Vol. I. p. 64. Man. p. 186. Chrysoberyl. Phill. p. 89. Krisoberil. Wern. Hoffm. H. B. I. S. 424. Chrysoberyll. Hausm. II. S. 385. Chrysoberyll. Leonh. S. 437. Cymophane. Haüy. Traité, T. II. p. 491. Tabl. comp. p. 30. Traité, 2de Ed. T. II. p. 303.

Fundamental form. Scalene four-sided pyramid. P = 139° 53′, 86° 16′, 107° 29′. Vol. I. Fig. 9. R. G.

$$a : b : c = 1 : \sqrt{2{\cdot}9731} : \sqrt{0{\cdot}6567}.$$

Simple forms. P (*o*); $P+\infty = 128^\circ\,35'$; $(\breve{P})^3$ (*n*); $(\breve{P}+\infty)^3$ (*s*) $= 70^\circ\,41'$; $(\breve{P}r+\infty)^5$ (*z*) $= 93^\circ\,33'$; $\breve{P}r$ (*i*) $= 119^\circ\,46'$; $\breve{P}r+\infty$ (*T*); $\bar{P}r+\infty$ (*M*).

Char. of Comb. Prismatic.

Combinations. 1. $\breve{P}r$. $\breve{P}r+\infty$. $\bar{P}r+\infty$. Haddam, Connecticut.

2. $\breve{P}r$. $(\breve{P}r+\infty)^3$. $\breve{P}r+\infty$. $\bar{P}r+\infty$. Haddam.

3. $\breve{P}r$. P. $(\breve{P}+\infty)^3$. $\breve{P}r+\infty$. $\bar{P}r+\infty$. Fig. 25. Siberia.

4. $\breve{P}r$. P. $(\breve{P})^3$. $(\breve{P}+\infty)^3$. $\breve{P}r+\infty$. $\bar{P}r+\infty$. Brazil.

Irregular forms, grains, pebbles.

Cleavage, $\breve{P}r+\infty$ and $\bar{P}r+\infty$, not very distinct, the first a little more easily obtained. Faint traces parallel to $P-\infty$. Fracture conchoidal. Surface, the vertical planes, and particularly $\bar{P}r+\infty$, striated parallel to their common edges of intersection. The rest generally smooth and even, P̆r sometimes a little rough.

Lustre vitreous. Colour asparagus-green, passing into greenish-white, olive-green and yellowish-grey. Streak white. Transparent ... translucent. Blueish opalescence upon P̆r and P̆r + ∞, or in general if viewed in a direction perpendicular to the short diagonal of the fundamental form.

Hardness = 8·5. Sp. Gr. = 3·754, a transparent asparagus-green variety.

Compound Varieties. Twin-crystals: face of composition perpendicular, axis of revolution parallel to one of the acute terminal edges of P. The composition is frequently repeated on all the similar terminal edges, nearly as in Fig. 38., and easily ascertained by the striæ on the faces of P̄r + ∞, which fall into one plane. The composition is very common in the present species.

OBSERVATIONS.

1. According to SEYBERT, who analysed two varieties, one from Brazil, and another from Haddam, it consists of

Alumina	68·666	73·60.
Glucina	16·000	15·80.
Silica	5·999	4·00.
Protoxide of Iron	4·733	3·38.
Oxide of Titanium	2·666	1·00.
Moisture	0·666	0·40.

It remains unchanged if exposed alone or with soda to the heat of the blowpipe, only the surface in the latter case becomes dull. It is difficultly, but perfectly fusible with borax and salt of phosphorus.

2. Also in this species the original repositories of some

varieties are not known, having been found only in the alluvial deposits of rivers along with other species of gems. Thus it occurs in Brazil, along with octahedral Diamond and prismatic Topaz; also in Ceylon. Near Haddam in Connecticut and Saratoga in New York, it occurs in a kind of granite, imbedded in Albite and rhombohedral Quartz, and associated with dodecahedral Garnet, rhombohedral Emerald, rhombohedral Tourmaline, and prismatic Tantalum-ore. The original matrix of the large Siberian crystals is not known.

GENUS III. DIAMOND.

1. OCTAHEDRAL DIAMOND.

Octahedral or Common Diamond. JAM. Syst. Vol. I. p. 1. Octahedral Diamond. Man. p. 187. Diamond. PHILL. p. 361. Demant. WERN. Hoffm. H. B. I. S. 358. Demant. HAUSM. I. S. 59. Diamant. LEONH. S. 115. Diamant. HAÜY. Traité, T. III. p. 287. Tabl. comp. p. 69. Traité, 2de Ed. T. IV. p. 419.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. H; $\overset{*}{O}$. Vol. I. Fig. 2.; $\overset{*}{D}$. Vol. I. Fig. 31.; T. Vol. I. Fig. 35.

Char of Comb. Tessular.

Combinations. 1. H. D. Fig. 151. 2. O. D. 3. O. T. 4. O. D. T. All of them from Brazil.

Irregular forms, grains.

Cleavage, octahedron, highly perfect. Fracture conchoidal. Surface, the octahedron sometimes faintly streaked parallel to its edges of combination, but in general very smooth. Also the dodecahedron if often streaked, rough, and uneven, the tetraconta-octahedron curved, and smooth. Grains possess a rough and granulated surface.

Lustre, bright adamantine. Colour white, prevalent. Also various shades of blue, red, yellow, green, brown, grey, and even black. Generally pale. Streak white. Transparent ... translucent, dark coloured varieties only on their edges. If cut and polished, it shews a most lively play of colour.

Hardness = 10·0. Sp. Gr. = 3·520 of a white variety.

Compound Varieties. Twin-crystals. 1. Face of composition parallel, axis of revolution perpendicular to a face of the octahedron. Fig. 156. 163. 2. Face of composition parallel, axis of revolution perpendicular to a face of the hexahedron. The individuals, having the general aspect of tetrahedrons, are continued beyond the face of composition.

OBSERVATIONS.

1. Many of the combinations occurring in the present species, possess a semi-tessular character. There occur also simple forms, which present the same peculiarity, as, for instance, the icositetrahedron, Vol. I. Fig. 25. and Fig. 26. Twin-crystals, like Fig. 164,* are possible only upon the supposition of semi-tessular forms. They have been first described in the Catalogue of the collection of Mr VON DER NÜLL. It will depend upon future observation, whether this character is general in the present species.

2. Octahedral Diamond is perfectly combustible at a tem-

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* This figure represents a very distinct crystal in the collection of Mr ALLAN. Similar varieties have been observed, and models illustrative of their formation, are exhibited in the British Museum. H.

perature of about 14° wedg and yields with oxygen, carbonic acid gas. It is not acted upon by acids or alcalis.

3. The rocks hitherto considered as the matrix of octahedral Diamond, are secondary ones, as several kinds of sandstone, consisting of aggregated quartz-pebbles. Octahedral Diamond is also found in strata of ironshot sand and clay, and in the loose sand of plains and rivers. In a specimen from Brazil, in the possession of Mr Heuland, it is associated with Skorodite, and imbedded in a compact variety of prismatic Iron-ore.

4. The octahedral Diamond was first discovered in the East Indies, where it has been worked for many centuries, and in Brazil. They are found in various places on the eastern coast of the British peninsula in India, but particularly between Golconda and Masulipatam, also near Panna in Bundelcund. There occur some likewise in the peninsula of Malacca, and the isle of Borneo. In Brazil they occur in the district of Serro do Frio in the capitania of Minas Geraes, and were first discovered in the Riacho Fundo, then in Rio do Peixe, and also in the Terra de St Antonio.

5. Octahedral Diamond is the most valued of all the gems, and is used as an ornamental stone. But it is employed likewise for cutting glass, and for engraving, cutting and polishing other hard stones and the octahedral Diamond itself.

Genus IV. TOPAZ.

1. PRISMATIC TOPAZ.

Prismatic Topaz. Jam. Syst. Vol. I. p. 78. Man. p. 188. Topaz. Phill. p. 84. Topas. Phisalit. Picnit, oder Schörlartiger Beril. Wern. Hoffm. H. B. I. S. 577. 620. IV. 114. Topas. Hausm. II. S. 648. Topas. Leonh. S. 405. Topaze. Pycnite. Haüy. Traité, T. II. p. 504. T. III. p. 236. Silice fluatée alumineuse. Topaze. Tabl. comp. p. 17. Alumine fluatée siliceuse ou Topaze. Traité, 2de Ed. T. II. p. 131.

Monteiro. Denkschr. der Akad. der Wissensch. zu München. Jahr 1811 and 1812. S. 223.

Fundamental form. Scalene four-sided pyramid. P = 141° 7′, 101° 52′, 90° 55′. Vol. I. Fig. 9. R. G.

$$a : b : c = 1 : \sqrt{4{\cdot}440} : \sqrt{1{\cdot}238}.$$

Simple forms. $P - \infty$ (*P*); $P - 1$ = 155° 37′, 122° 39′, 53° 52′; $\frac{4}{3}P - 1$ (*s*) = 149° 38′, 120° 32′, 68° 14′; P (*o*); $P + 1$ = 130° 27′, 74° 39′, 127° 36′; $P + \infty$ (*M*) = 124° 19′; $(\frac{4}{3}\breve{P}r - 1)^3$ (*x*) = 123° 1′, 126° 18′, 82° 8′; $(\breve{P}r + \infty)^3$ (*l*) = 86° 52′; $(\breve{P}r + \infty)^5$ = 103° 14′; $(\breve{P} + \infty)^3$ = 64° 31′; $\breve{P}r + 1$ (*n*) = 92° 59′; $\breve{P}r + 2$ (*y*) = 55° 34′; $\breve{P}r + \infty$ (*r*); $\bar{P}r + 1$ (*i*) = 58° 11′; $\bar{P}r + \infty$ = (*f*).

Char. of Comb. Prismatic. Some of the crystals shew different faces on opposite ends.

Combinations. 1. P. $P + \infty$. $(\breve{P}r + \infty)^5$. Brazil.

2. P. $\breve{P}r + 1$. $P + \infty$. $(\breve{P}r + \infty)^3$. Nertschinsk, Siberia.

3. P. $\breve{P}r + 1$. $\bar{P}r + 1$. $P + \infty$. $(\breve{P}r + \infty)^3$. Peru.

4. $P - 1$. $\frac{4}{3}P - 1$. $(\frac{4}{3}\breve{P}r - 1)^5$. P. $\breve{P}r + 1$. $P + \infty$. $(\breve{P}r + \infty)^5$. Mucla, Asia Minor.

5. $P - \infty$. $\frac{4}{3}P - 1$. $(\frac{4}{3}\breve{P}r - 1)^5$. P. $\breve{P}r + 1$. $\breve{P}r + 2$. $P + \infty$. $(\breve{P}r + \infty)^3$. Fig. 34. Schneckenstein, Saxony.

6. $(\frac{4}{3}\breve{P}r - 1)^5$. P. $\breve{P}r + 1$. $P + \infty$. $(\breve{P}r + \infty)^5$. $\breve{P}r + 1$. P. Fig. 36. Brazil.

Cleavage. $P - \infty$ highly perfect; $\breve{P}r + 1$ and $\bar{P}r + 1$ imperfect. Traces of $P + \infty$ and $(\breve{P}r + \infty)^3$ particularly in the Scottish varieties. Fracture more or less perfectly small conchoidal, uneven. Surface, $P - \infty$ rough, sometimes faintly striated parallel to the edges of combination with $(\breve{P}r + \infty)^3$. The vertical prisms always striated, sometimes deeply, parallel to their common edges of combination. The pyramids and horizontal prisms smooth.

Lustre vitreous. Colour, white, yellow, green, blue. Various, but generally pale shades. Streak white. Transparent ... translucent, sometimes only on the edges.

Hardness = 8·0. Sp. Gr. = 3·499 of a transparent crystallised variety; = 3·494, of the columnar compositions of Pycnite.

Compound Varieties. Massive: composition granular, of various sizes of individuals; faces of composition rough. There occurs also columnar composition, the individuals being thin, long and parallel, and easily separated, and their faces of composition longitudinally streaked.

OBSERVATIONS.

1. However easily the different varieties of prismatic Topaz may be found out and distinguished from the rest of minerals, if we attend to their characteristic properties, yet this has only succeeded after several unsuccessful attempts, and even now it forms in the Wernerian system three different species, though the varieties of rhombohedral Emerald, and of rhombohedral Tourmaline, which formerly were united with it, have at last been referred to their own peculiar species. *Topaz* contains crystalline varieties

either in crystals, which are generally implanted, and have a smooth surface, or in massive granularly compound varieties. Here we meet with the highest degrees of transparency and the brightest colours. The crystals of *Physalite* are imbedded, their surface is uneven and rough; in massive varieties they generally present large individuals, their colour inclines to a pale greenish-grey, and their translucency is very faint. *Pycnite* has not been found in single crystals, at least not distinctly, but consists only of thin and straight columnar particles of composition, forming larger or smaller masses imbedded in other rocks, and not possessing bright colours or high degrees of transparency. The varieties of the whole species are united by transitions, and render the distinction of any one of these three kinds difficult. The optical observations, however, even in transparent varieties, as in those from Brazil and Scotland, indicate a difference between some of them which probably may lead to the establishment of several species.

2. Prismatic Topaz consists, according to BERZELIUS, of

	Topaz, from Schneckenstein.	*Physalite,* from Finbo.	*Pycnite,* from Altenberg.
Alumina	57·45	57·74	51·00.
Silica	34·24	34·36	38·43.
Fluoric Acid	7·75	7·77	8·84.

In a strong heat the faces of crystallisation, but not those of cleavage, are covered with small blisters, which, however, immediately crack. With borax it melts slowly into a transparent glass. Its powder colours the tincture of violets green. Those crystals which possess different faces of crystallisation on opposite ends, acquire different kinds of electricity on being heated. By friction it acquires positive electricity.

3. Prismatic Topaz enters into the composition of several granitic rocks; thus it forms with rhombohedral Quartz and rhombohedral Tourmaline the Topaz rock of Saxony, and is found crystallised in its drusy cavities. It occurs also in irregular beds, either with quartz and mica, like the variety called Pycnite; or with prismatic Feld-spar, rhom-

bohedral Quartz, rhombohedral Emerald, &c., and this is the mode in which Physalite occurs. It is found likewise in veins and beds in gneiss, mica-slate, clay-slate, and porphyry, with pyramidal Tin-ore and prismatic Scheelium-ore, also with rhombohedral and octahedral Fluor-haloide, with rhombohedral Emerald, rhombohedral Quartz, &c. It is met with, besides, in tin stream works, and in the alluvial deposits of rivers, along with other gems.

4. Most perfect crystals of this species have been brought from Siberia, where they are found of green, blue, and white colours, along with rhombohedral Emerald, in the Uralian and Altai mountains, and also in Kamtschatka; from Brazil, where they are generally met with in loose crystals and pebbles of high yellow colours; from Mucla in Asia Minor, in pale straw-yellow, but well pronounced crystals, &c. They occur in the rock called Schneckenstein in Saxony, of a wine-yellow colour, at Ehrenfriedersdorf, Zinnwald, &c. along with Tin-ore, and in similar repositories at Schlaggenwald in Bohemia, and St Michaelsmount in Cornwall; with Lepidolite near Rozena in Moravia. Physalite is found at Finbo and Broddbo near Fahlun in Sweden, Pycnite at Altenberg in Saxony. In pebbles and isolated crystals, it is found in the stream-works of Eubenstock in Saxony, and in the granitic detritus at Cairngorm in Aberdeenshire, of various blueish and brownish tints, often regularly distributed in the same individual along the edges of the crystal. The varieties from the latter place are sometimes beautifully crystallised. This is also the kind of repository in which are found the white transparent varieties of New South Wales.

5. It is used as an ornamental stone, but less valued than some of the preceding species. The blue varieties are called *oriental Aquamarine* by lapidaries. If exposed to heat, the prismatic Topaz from Saxony loses its colour, and becomes white; the deep yellow Brazilian varieties assume a pale pink colour, and are then sometimes mistaken for Spinelle or Ballas ruby.

GENUS V. EMERALD.

1. PRISMATIC EMERALD.

Prismatic Emerald or Euclase. JAM. Syst. Vol. I. p. 89. Man. p. 190. Euclase. PHILL. p. 101. Euklas. WERN. Hoffm. H. B. I. S. 592. Euklas. HAUSM. II. S. 654. Euklas. LEONH. S. 506. Euclase. HAÜY. Traité, T. II. p. 531. Tabl. comp. p. 32. Traité, 2de Ed. T. II. p. 528. WEISS. Verhand. der Gesellsch. nat. Freunde zu Berlin. 1820. S. 110.

Fundamental form. Scalene four-sided pyramid. Vol. I. Fig. 41.

Char. of Comb. Hemi-prismatic.

Cleavage, highly perfect and very easily obtained parallel to the faces *T*, Fig. 54., less distinct parallel to *P*, which is a plane replacing the edge *k*, between *d'* and *d*, and parallel also to *M*, which replaces the edge *e* between *h'* and *h*. Fracture perfect conchoidal, and very easily obtained. Surface, the faces between *T* and *M* streaked parallel to their common intersection; *o* sometimes curved, the rest of the faces very smooth and shining.

Lustre vitreous. Colour mountain-green, passing into blue and white, always pale. Streak white. Transparent ... semi-transparent, generally the first.

Very brittle and fragile, from which property the name *Euclase* has been derived. Hardness = 7·5. Sp. Gr. = 3·098, a greenish-white crystal.

OBSERVATIONS.

1. Prismatic Emerald, as yet a very rare mineral, has

been hitherto always found in crystals, which at first sight seem to present no difficulty to the correct developement of their simple forms. Nevertheless this has not yet been effected. The first description given by Abbé Haüy, who determined the species, was drawn up after the crystal represented Fig. 54.; but he completed what appeared to him to be wanting, and thus transformed the distinctly hemi-prismatic crystal into a prismatic one, as given in Pl. XLV. Fig. 52. of the first edition of his *Traité.* Afterwards the hemi-prismatic character of the combinations was established by himself in a particular memoir on the subject, and in the second edition of that work, and by Professor Weiss, but without giving more accurate measurements than those which had first been given by Haüy as mere approximations.

The parallelism of the edges of combination between the terminal faces is not alone sufficient for their developement, without having recourse to those which they produce with the numerous prisms situated between *M* and *T*. According to Haüy, the ratio between b and c is in the prism $s = \sqrt{5} : \sqrt{12}$, in the prisms *l* and *h* it is = 2 b : 3 c and = 5 b : 12 c, the angles of the prisms = 114° 19′; 133° 26′; 149° 53′. A crystal in the collection of Dr Rohatsch at Freiberg contains three prisms similarly situated, but yielding by approximate measurement, the angles of 114° 36′; 128° 39′, and 144° 28′; according to the ratios of b : c; 3 b : 4 c and b : 2 c.* Perhaps the crystal described by Haüy in fact contains other prisms; but as the instrument which he made use of in his determinations is too little to be depended on, we cannot infer any thing from what has hitherto been published on the subject of the crystallisations of prismatic Emerald, but that its series of crystallisation is as yet unknown.

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* Mr Phillips gives the angles of thirteen prisms in the same situation, whose obtuse edges are as follows: 115° 4′; 117° 0′; 119° 40′; 127° 50′; 134° 20′; 136° 20′; 140° 40′; 142° 28′; 145° 20′; 147° 16′; 149° 32′; 152° 48′; 158° 20′. H.

Inclination of the faces.

d' on d = 151° 46′.
f' on f = 106° 18′*.
e' on e = 129° 58′.
n' on n = 143° 10′†.
o' on o = 112° 40′‡.
r' on r = 156° 10′.
u' on u = 134° 14′§.
i' on i = 99° 40′||.

Inclination of the edges.

k on e = 130° 8′.
(A fragment from the Wernerian collection gave the analogous inclination of P on M nearly = 131°)¶.
x (between e' and e) on e = 154° 37′.
y on e = 101° 55′.
z on e = 141° 40′.

The elevation of Fig. 54. is copied from the *Traité* of Haüy, Fig. 154., but the projection is taken immediately from the original. The facets a, not mentioned by Haüy, follow from the situation of the edges, those between a and d being parallel to those between d and the prism l, while those between a and n are parallel to those between n and u, or between n and the prism s.

2. According to Berzelius, prismatic Emerald consists of

Silica	43·22.
Alumina	30·56.
Glucina	21·78.
Oxide of Iron	2·22.
Oxide of Tin	0·70.

Before the blowpipe it intumesces in a strong heat, and becomes white. If the heat be still farther increased, it melts into a white enamel.

3. Nothing as yet is known with sufficient accuracy of the mode of its occurrence in nature. The first varieties of it were brought by Dombey from Peru. It has been found afterwards at Capao in the mining district of Villa-Ricca in Brazil, likewise in beautiful crystallised varieties. It occurs there in a chloritic slate, resting on sandstone, along with prismatic Topaz, but is generally brought to Europe in fractured crystals.

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* = 105° 20′ and 111° 12′. † = 143° 32′ and 143° 12′.
‡ = 114° 8′ and 113° 40′. § = 134° 20′. || = 99° 40′.
¶ = 130° 52′. According to Phillips. H.

2. RHOMBOHEDRAL EMERALD.

Rhomboidal Emerald. Jam. Syst. Vol. I. p. 92. Man. p. 191. Beryl. Aquamarine. Emerald. Phill. p. 102. 104. Smaragd. Beril (excepting Schörlartiger Beril). Wern. Hoffm. H. B. I. S. 596. 604. Smaragd. Hausm. II. S. 655. Smaragd. Leonh. S. 502. Emeraude. Haüy. Traité, T. II. p. 516. Tabl. comp. p. 31. Traite, 2de Ed. T. II. p. 504.

Fundamental form. Rhombohedron. R = 104° 40′. Vol. I. Fig. 7. R. G.

$$a = \sqrt{2\cdot23}.$$

Simple forms. R — ∞ (*P*); R (*s*); — R (*s*); R + ∞ (*n*); P (*t*) = 151° 9′, 59° 47′; P + 1 (*u*) = 135° 34′, 98° 2′; P + ∞ (*M*); $(P-2)^{5}$; $(P)^{\frac{5}{3}}$ (*a*).

Char. of Comb. Di-rhombohedral. 2 (R) = 138° 41′, 89° 45′.

Combinations. 1. R — ∞. P + ∞. Zwiesel, Bavaria.
2. R — ∞. P. P + ∞. Sim. Fig. 112. Siberia.
3. R — ∞. R + ∞. P + ∞. Schlaggenwald, Bohemia.
4. R — ∞. 2 (R). P + ∞. Peru.
5. R — ∞. P. 2 (R). P + 1. P + ∞. Vol. I. Fig. 60. Peru.
6. R — ∞. P. 2 (R). P + 1. $2\,(R)^{\frac{5}{3}}$. P + ∞. Fig. 150. Siberia.

Cleavage, R — ∞ and P + ∞, the first generally more easily obtained, the second interrupted. Fracture conchoidal, uneven. Surface, the prisms striated parallel to the axis, seldom smooth. The rhombohedrons and pyramids smooth. P — ∞

sometimes rough, sometimes having a very flat six-sided pyramid upon it, the terminal edges of which are about 179° 40′.

Lustre vitreous. Colour green, passing into blue, yellow, and white; the brightest of these colours is emerald-green, the greater part of the others is pale. Streak white. Transparent ... translucent.

Hardness = 7·5 ... 8·0. Sp. Gr. = 2·732 of a perfectly emerald-green variety; 2·678, apple-green beryl.

Compound Varieties. Massive: composition generally large granular, sometimes imperfectly columnar.

OBSERVATIONS.

1. The only remarkable differences between *Emerald* and *Beryl* are in their colours, which, however, produce such an uninterrupted series, that only arbitrary limits can be fixed within it. The colour of Emerald is emerald-green; all the varieties of other colours are Beryl. The division of the latter into precious and common Beryl depends upon the more or less perfect formation of the varieties concerned, particularly in regard to pureness and transparency. By divisions of this kind, however, the species becomes less interesting than it otherwise would be, on account of the great number of different varieties which it contains.

2. The analysis of a variety of Beryl from Broddbo has yielded to Berzelius, and that of a variety of Emerald from Peru to Klaproth,

Silica	68·35	68·50.
Alumina	17·60	15·75.
Glucina	13·13	12·50.
Oxide of Iron	0·72	1·00.

Oxide of Tantalum	0·27	0·00.
Oxide of Chrome	0·00	0·30.
Lime	0·00	0·25.

In a strong heat of the blowpipe, the edges are rounded off, and a shapeless vesicular scoria is produced. Transparent varieties become milky. It is dissolved by borax.

3. Rhombohedral Emerald occurs in imbedded crystals in various rocks, and in implanted crystals in veins, and also in beds. It is associated with Felspar, prismatic Topaz, &c., or with pyramidal Tin-ore, and other minerals commonly found with the latter species. It occurs also in fractured crystals and rolled masses in secondary repositories.

4. The finest crystals of emerald-green colours, or the real Emerald, comes from Peru, where it forms druses with rhombohedral Lime-haloide, and occurs, according to HUMBOLDT, in veins traversing hornblende slate, clay-slate, and granite. Sometimes rhombohedral Quartz and hexahedral Iron-pyrites are found along with them. Less distinct varieties, generally of muddy emerald-green colours, are found imbedded in mica-slate in the valley of Heubach, district of Pinzgau, Salzburg. The ancients procured their emeralds from Egypt. The localities however had been lost, till of very late years they have been re-discovered in Mount Zalara in Upper Egypt, where this species occurs in granite and mica-slate. Precious Beryl is chiefly found in Siberia and Brazil. In Siberia it occurs in the granitic district of Nertschinsk, also in the Uralian and Altai mountains, often in very large crystals, probably in veins; in Brazil it is found in fractured crystals in the sand of rivers; thus likewise it occurs in Aberdeenshire in Scotland, but has lately also been found engaged in the granite of Rubislaw quarry near Aberdeen. Varieties, both of precious and of common Beryl, are met with near Limoges in France, near Zwiesel on the Rabenstein in Bavaria, at Finbo and Broddbo near Fahlun in Sweden, in imbedded crystals and massive varieties; in some of the tin-mines of Saxony and Bohemia. It occurs in small quan-

tities in drusy cavities of primitive rocks in various places of Salzburg; in Elba; at Haddam in Connecticut, and other localities of America, &c.

5. Rhombohedral Emerald, when clear and transparent, is employed as an ornamental stone, and is highly valued if it is free from flaws, and possesses a fine emerald-green colour, and a certain size. Beryl is of much less value.

GENUS VI. QUARTZ.

1. PRISMATIC QUARTZ.

Iolite. JAM. Syst. Vol. I. p. 172. Prismato Rhomboidal Quartz or Iolite. Man. p. 193. Iolite. Dichroite. PHILL. p. 93. Iolite. Peliom. WERN. Hoffm. H. B. I. S. 589. IV. 2. S. 117. Dichroit. HAUSM. II. S. 659. Cordierit. LEONH. S. 420. Iolithe. HAÜY. Tabl. comp. p. 61. Cordierite. Traité, 2de Ed. T. III. p. 1.

CORDIER. Journ. des Mines. T. XXV. p. 129.

Fundamental form. Scalene four-sided pyramid of unknown dimensions. Vol. I. Fig. 9.

Simple forms. $P - \infty$; P; $P + \infty = 120°$ (nearly); $\breve{P}r + 1$; $\breve{P}r + \infty$; $\bar{P}r + \infty$.

Char. of Comb. Prismatic.

Combinations. 1. $P - \infty$. $P + \infty$. $\breve{P}r + \infty$. Cabo de Gata. 2. $P - \infty$. P. $\breve{P}r + 1$. $P + \infty$. $(\breve{P} + \infty)^3$. $\breve{P}r + \infty$. $\bar{P}r + \infty$. Ujordlersoak, Greenland.

Cleavage, $P + \infty$ and $\breve{P}r + \infty$ indistinct. Fracture conchoidal. Surface of some crystals rough and dull.

Lustre vitreous. Colour various shades of blue, generally inclining to black. Streak white. Transparent ... translucent; blue if viewed in the direction of the axis, yellowish-grey perpendicular to it.

Hardness = 7·0 ... 7·5. Sp. Gr. = 2·583, of a transparent variety.

Compound Varieties. Massive: composition granular, strongly connected, and difficultly recognised.

OBSERVATIONS.

1. If in the two species formerly distinguished among the varieties of prismatic Quartz, we pay no attention to their mode of occurrence and localities, no characters, however accidental, remain, by which they might be distinguished. *Steinheilite* and *Hard Fahlunite* likewise belong to the present species, and seem to contain varieties which will allow us some day to establish their forms with a greater degree of precision.

2. According to STROMEYER, the present species consists of

Silica	48·538.
Alumina	31·730.
Magnesia	11·305.
Oxide of Iron	5·686.
Oxide of Manganese	0·702.
Water or Loss	1·648.

Before the blowpipe it melts in a good heat, but with difficulty, and only on its edges, into a glass not inferior to the mineral, either in colour or transparency.

3. Prismatic Quartz occurs in aggregated crystals, with dodecahedral Garnet, rhombohedral Quartz, &c. at Cabo de Gata in Spain, in the bay of San Pedro, and these varieties have been called *Iolite.* *Peliom* occurs at Bodenmais in Bavaria, sometimes in very distinct crystals, but generally massive, with rhombohedral Iron-pyrites, &c. Other varieties have been found imbedded in various kinds

of granitic and other primitive rocks, sometimes with prismatic Feld-spar and dodecahedral Garnet. It occurs thus in fine crystals at Ujordlersoak in Greenland, at Arendal in Norway, at Orijerfvi in Finland, in Siberia and other places. The *Saphire d'eau* of jewellers is a transparent variety of the present species from Ceylon.

2. RHOMBOHEDRAL QUARTZ.

Rhomboidal Quartz (excepting Porcelain Jasper). Floatstone or Spongiform Quartz. Jam. Syst. Vol. I. p. 174. Man. p. 193. Quartz (exc. Hyalite). Cats Eye. Flint. Chalcedony (exc. Cacholong). Jasper (exc. Porcelain Jasper). Hornstone. Phill. p. 1. 9. 13. 14. 18. 21. Quarz. Eisenkiesel. Hornstein. Kieselschiefer. Feuerstein. Krisopras. Plasma. Heliotrop. Kalzedon. Jaspis (exc. Opaljaspis and Porzellanjaspis). Katzenauge. Faserkiesel. Schwimstein. Wern. Hoffm. H. B. II. 1. S. 60. 64. 75. 83. 98. 103. 105. 108. 161. 185. 189. II. S. 75. Quarz (exc. Quarzsinter). Eisenkiesel. Jaspis. Kieselschiefer. Hornstein. Feuerstein. Kalzedon. Schwimmkiesel. Hausm. II. S. 377. 395. 396. 399. 404. 406. 416. Quarz (exc. Kieseltuff). Leonh. S. 117. Quarz (exc. Q. hyalin concretionné and Q. résinite). Haüy. Traité, T. II. p. 406. Tabl. comp. p. 24. Traité, 2de Ed. T. II. p. 228. Weiss. Magazin der Gesellschaft naturforschender Freunde zu Berlin. VII. S. 163. Kupffer. Ann. de Chimie. T. XXV. p. 337.

Fundamental form. Rhombohedron. R = 75° 55′*. Vol. I. Fig. 7. Kupffer.

$a = \sqrt{10{\cdot}894}$.

Simple forms. R (*s*); — R (*s′*); $\overset{*}{P}$ (*P*, *z*) = 133° 44′, 103° 35′, Vöröspatak, Transylvania; $P + 1 = 124^\circ\,33'$, $137^\circ\,2'$; $P + 2$ (*b*) $= 121^\circ\,14'$, $157^\circ\,44'$; $\frac{5}{3}P$ (*a*) $= 126^\circ\,14'$, $129^\circ\,26'$; $\frac{3}{4}P + 2$ (*m*) $= 122^\circ\,10'$, $150^\circ\,36'$; $P + \infty$ (*r*)

$(P)^{\frac{5}{3}}$ $(o) = 129° 50'$*; $(P)^{\frac{7}{3}}$ $(x) = 143° 2'$*; $(P)^{3}$ $(y) = 150° 51'$*; $(P)^{\frac{11}{3}}$ $(n) = 155° 59'$*; $(P)^{5}$ $(z) = 162° 16'$*; $(P + \infty)^{\frac{3}{2}} = 162° 6' 12''$, $137° 53' 48''$.

Char. of Comb. Hemi-rhombohedral and hemi-di-rhombohedral, the rhombohedrons, $R + n$, and the scalene pyramids, $(P + n')^{m}$, with inclined faces; the isosceles pyramids, $P + n''$, with parallel faces. $\frac{\overset{*}{P}}{2} = 94° 15'$. Saualpe, Carinthia.

Combinations. 1. P. $P + \infty$. Sim. Fig. 114. Compostella, Spain.

2. $\frac{P}{2}$. $P + \infty$. Sim. Fig. 114. Iceland.

3. P. R. $P + \infty$. Niederalpel, Stiria.

4. P. R. $P + \infty$. $- R$. P. Fig. 145. Zirknitz, Carniola.

5. $-\frac{P - 1}{2}$. $\frac{P}{2}$. $-\frac{P}{2}$. $P + \infty$. Quebec.

6. P. R. $\frac{l}{-l}\frac{(P)^{\frac{5}{3}}}{2}$. $\frac{r}{-r}\frac{(P)^{\frac{11}{3}}}{2}$. $P + \infty$. St. Gothard.

7. P. R. $\frac{r}{r}\frac{(P)^{\frac{7}{3}}}{2}$. $\frac{r}{r}\frac{(P)^{3}}{2}$. $\frac{r}{r}\frac{(P)^{\frac{11}{3}}}{2}$. $\frac{r}{r}\frac{(P)^{5}}{2}$. $P + \infty$. Fig. 146. Dauphiny.

8. P. $\frac{+}{-}\frac{R}{2}$. $\frac{r}{-r}\frac{(P)^{\frac{5}{3}}}{2}$. $\frac{l}{-l}\frac{(P)^{\frac{7}{3}}}{2}$. $\frac{l}{-l}\frac{(P)^{3}}{2}$.

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* Lateral edges of the pyramids.

$$\frac{l}{-l}\,\frac{(\mathrm{P})^{1\frac{1}{3}}}{2}.\ \frac{l}{-l}\,\frac{(\mathrm{P})^{5}}{2}.\ \tfrac{5}{3}\,\mathrm{P}.\ \tfrac{3}{4}\,\mathrm{P}+2.\ \mathrm{P}+2.$$

$$\mathrm{P}+\infty.\ \frac{[(\mathrm{P}+\infty)^{\frac{3}{2}}]}{2}.$$ Fig. 147*. Chamouny.

Irregular forms, grains.

Cleavage, P and P + ∞. The alternating faces of the pyramid, corresponding to *P*, are more easily obtained than the rest, but all of them are imperfect, and interrupted by conchoidal fracture. Fracture conchoidal, sometimes highly perfect, sometimes less distinct.† Surface, P + 1, sometimes also P + 2 and $\frac{(\mathrm{P})^{1\frac{1}{3}}}{2}$ are rough, $\frac{(\mathrm{P})^{5}}{2}$ is streaked parallel to the edges of combination with R, R sometimes parallel to the same line. P + ∞ horizontally streaked, sometimes parallel to the edges of combination with R. The rest of the faces generally smooth.

Lustre vitreous, inclining in some varieties to resinous. Colour, white prevalent; among the brightest colours are violet-blue, rose-red, clove-brown, and apple-green. Dark brown and green colours generally owing to foreign admixtures.

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[*] A splendid crystal of this variety, of considerable size, is in the cabinet of Mr ALLAN. H.

[†] The fracture perpendicular to the axis, often possesses the appearance of velvet, particularly in transparent varieties, as has been first observed by Dr BREWSTER.

Streak white. Transparent ... translucent, frequently even opake, particularly when impure.
Hardness = 7·0. Sp. Gr. = 2·690, of a snow-white crystallised variety.

Compound Varieties. 1. Faces of composition parallel, axis of revolution perpendicular to a face of $P + \infty$; the individuals being continued beyond the face of composition. 2. Individuals joined in a face of $P - \infty$; this is as it were the supplemental mode of composition to the preceding one. Frequently larger crystals are made up of alternating laminæ of two individuals, and often faces of composition assume the appearance of cleavage.

Implanted globules, reniform, stalactitic shapes: surface smooth, granulated, or drusy; composition columnar, generally impalpable; often a second time composed into granular or curved lamellar masses. Massive: composition granular or columnar, and often impalpable, and then the fracture becomes conchoidal and splintery. Sometimes a second composition produces indistinct granular or thick lamellar masses. Certain very thin columnar compositions, if cut *en cabochon* parallel to the fibres, shew an opalescent light. Pseudomorphic crystals, in the shape of hexahedrons and octahedrons, derived from octahedral Fluor-haloide, of rhombohedrons and prisms derived from rhombohedral Lime-haloide, of lenticular forms from prismatoidal Gypsum-haloide.

Globular and tuberose masses formed in vesicular cavities. Plates. Pebbles.

OBSERVATIONS.

1. There are several modes of occurrence among the crystals of rhombohedral Quartz, hitherto entirely confined to this species, which becomes evident on an inspection of the combinations quoted above, and depends chiefly upon their hemi-rhombohedral and hemi-di-rhombohedral character. The scalene six-sided pyramids are the most remarkable forms in this respect. Their faces appear only to the right, or only to the left of the faces of R. Two individuals, differing in regard to the right or left situation of these faces, cannot be brought in any such position that all their faces become parallel, and they are different, therefore, like the right hand and the left. This difference extends even to the action of the individuals on light, as has been first shewn by Mr HERSCHEL. Dr BREWSTER found that Amethyst, particularly that from Brazil, of various colours, consists of thin films, shewing an opposite action upon light. These films belong to individuals in a parallel position, but differing from each other as to right and left.

2. The species of rhombohedral Quartz is by no means one of those which contain many different simple forms, and various combinations depending upon them; and yet there are none in the whole order Gem which occur in so many varieties, bearing at first sight so slight a degree of resemblance to each other. This, however, depends upon mechanical composition and the admixtures of different substances foreign to the species. No less than *thirteen* different species are distinguished in the Wernerian system, to which those of other systems more or less correspond. *Quartz* contains most of its simple or crystallised varieties, and may be said to represent the species most perfectly. It contains five sub-species, *Amethyst*, including violet-blue varieties; *Rock-crystal*, composed of the most perfectly crystallised, and some transparent or semi-transparent

massive varieties; *Rose Quartz*, confined to translucent rose-red and milk-white massive varieties; and *Prase*, which is only of a dark leek-green colour; *Common Quartz* at last comprehends all those varieties not included in any of the preceding subspecies. There are several massive varieties of common quartz, which consist of granular particles of composition. If these diminish so much in size as to become impalpable, also their transparency and lustre is somewhat diminished, and several kinds of conchoidal and splintery fracture appear, if specimens of these varieties be broken. This gives rise to new species, according to the old acceptance of the word. *Hornstone* is always compound, translucent on the edges, and either of a splintery dull fracture, or glistening and glimmering and conchoidal. Thus *splintery* Hornstone and *conchoidal* Hornstone are formed, and either of them may produce *Woodstone*, if it appears in the shape of petrified wood. The varieties of *common Flinty slate* are most like Hornstone, but shew on a large scale an imperfect slaty fracture and various dirty grey colours; those of *Lydian stone*, which forms the second kind of Flinty slate, possess an even, glimmering fracture, and a greyish-black colour. *Flint* is a compound mineral like the two preceding ones, but translucent at least on the edges, and possesses a perfect, flat conchoidal, glimmering fracture. *Float-stone*, a variety of rhombohedral Quartz, which has likewise been considered as a particular species, consists of a delicate tissue of minute crystals, visible under a powerful magnifier, and demonstrates hornstone and flint, into which it insensibly passes by having its grain closer, and of which it often contains nodules, to be varieties of the same natural-historical species. Common Quartz is sometimes found in reniform and stalactitic shapes, consisting of granular particles of composition, sufficiently large to be observed and separated from each other. If the thickness of these individuals be so much diminished that at last they become impalpable, the different varieties of *Calcedony* are formed, occurring in the above mentioned external shapes. The difference in the colours of these has given occasion to the distinction of *common* Calcedony and of *Carnelian*, the former of which comprehends greyish colours, or in general such as do not possess bright tints of colours, while the latter refers to red varieties. *Common* Carnelian moreover occurs in globular and irregular tuberose shapes; *fibrous* Carnelian is found in reniform masses, and generally shews very distinctly the above mentioned composition. The rhombohedron-like crystals of a smalt blue colour from Transylvania, are also enumerated among the varieties of common Calcedony, probably because there exist reniform varieties of Calcedony possessing the same colour, though they are more nearly related to common Quartz. Common Quartz also occurs in massive varieties, shewing columnar composition. If these be thin, parallel, strongly coherent, and more or less bent, *Fibrous Quartz* a particular species is formed, and *Cat's eye*, another species of those systems, if they are nearly impalpable, and almost solely to be observed in the opalescent light, which they exhibit when cut with a convex surface. Cat's eye is generally greenish-grey, but there are varieties of various yellowish, red, and brown colours, all of them inclining to grey, and sometimes even nearly black. It possesses a small conchoidal fracture, and is more or less translucent. If several of the preceding varieties are distinctly coloured by some foreign mineral substance, or intimately mixed with it, various other pretended species are formed. *Chrysoprase* is a variety of common Quartz, consisting of small granular particles of composition, coloured apple-green by oxide of nickel; *Plasma* is a variety of Calcedony, coloured leek-green, and almost grass-green, by some substance, which is not exactly ascertained. *Heliotrope*, likewise a variety of Calcedony, but mixed and coloured by green-earth, containing blood-red spots of Jasper. The brownish-red colour of the commonly so called Hyacinth from Compostella is produced by an admixture of oxide of iron. If the same thing takes place in compound varieties, the individuals of which are still recognizable, *Iron-Flint* is produced, and *Jasper* with its various kinds is formed, if, besides the oxide of iron, clay enters into the mixture, and if moreover the individuals can, on account of their diminutive size, no longer be recognized. *Striped Jasper* probably contains a good deal of clay, and is distinguished on account of its striped delineations. The varieties of *Egyptian* Jasper, both *Red* and *Brown*, occur in globular shapes, the latter of which are beyond a doubt formed in open spaces, as appears from the concentric layers of which they consist, and the drusy cavities lined with crystals of quartz, often found in their interior. *Agate* Jasper, being less impure, is more properly referred to Hornstone. *Opal-Jasper* may be said to be a jasper of uncleavable Quartz, and does not belong to the present species, nor does *Porcelain-Jasper*, which is nothing else but burnt clay.

3. The most perfect varieties of rhombohedral Quartz are pure Silica, $\dddot{\mathrm{Si}}$, which contains 49·70 silicium and 50·30 oxygen. Bucholz obtained 99.375 of silica from Rock-crystal, with traces of iron and alumina. Hornstone, Flint, and Calcedony agree with it, according to various analyses of the ablest chemists. Several varieties contain small quantities of alumina, lime, oxide of iron, &c. Chrysoprase contains 0·01 of oxide of nickel, according to Klaproth. Rhombohedral Quartz is infusible before the blowpipe, and shews itself to be pure silica. It is dissolved by soda easily and with effervescence. According to Vauquelin, it colours an infusion of violets green, if reduced to powder. Two pieces rubbed together emit an empyreumatic odour, and a phosphorescent light. Crystals of rhombohedral Quartz may be obtained as deposits from a solution of silica in fluoric acid, or in potash diluted with water. The fluid from which crystals of this species are formed in geodes and other natural cavities of rocks, has been observed to be chiefly water, and often leaving behind it a mass resembling opal on desiccation, when suddenly exposed to the air.

4. The varieties of rhombohedral Quartz are of the

greatest frequency in nature. Those of common Quartz enter into the regular mixture of various rocks, of granite, gneiss, mica slate, topaz rock, &c. In others, they occur in single crystals, and in grains, as, for instance, in porphyry, and are frequently met with in vesicular cavities, particularly of amygdaloidal rocks. Here also are found the finest varieties of Calcedony, Carnelian, of the brown, and probably also the red Egyptian Jasper, the agate balls, &c. Hornstone frequently forms globules in compact limestone, and Flint globular and tuberose concretions in chalk, often disposed in beds, and including petrifactions. Many varieties occur in irregular nodules and large massive concretions in various rocks. Thus, common Quartz occurs in all those rocks, of which it forms besides a regular ingredient; hornstone and chrysoprase in serpentine, fibrous Quartz and Cat's eye probably in some shistose rock. Sometimes these masses are open in their interior, and lined with crystals, and this seems to be the case in the crystal vaults of the Alps, from whence the largest and most transparent Rock-crystals have been brought. Rhombohedral Quartz also forms beds by itself, of which we have examples in quartz-rock, and even in the different kinds of sandstone; they may be considered either as produced by crystalline formation, or as conglomerated pebbles. Striped Jasper and Flinty slate form particular beds; in other beds, as those of Iron-ore, Iron-pyrites, it likewise occurs, generally the varieties called common Quartz, but also Prase, Hornstone, and Calcedony. It is very frequent in all kinds of veins. In these localities are found Amethyst, several varieties of Rock-crystals, Hornstone, Calcedony, particularly the blue one, but chiefly common Quartz, constituting the greater part, and sometimes the whole body of the vein. The agate veins are among these; they consist of different kinds of rhombohedral Quartz, particularly Calcedony, and of uncleavable Quartz, alternating in various stripes with each other. Rock-crystal, Amethyst, Flinty slate, but particularly common Quartz, are found in pebbles. The river sand, and that of many extensive plains, consists of the latter, and is often so fine as to be drifted by the winds. Rhombohedral Quartz frequently fills up the space of petrified bodies, as, for instance, echinites in chalk, and petrified wood in sandstone and in alluvial deposits.

5. The numerous varieties of the present species are spread all over the globe, but some of the most distinguished varieties are found only in a few localities. The finest and largest Rock-crystals of high degrees of transparency are found in the alps of Salzburg, the Tyrol, Switzerland, Dauphiny, Piedmont, and Savoy, also in the isle of Madagascar, Ceylon, and Brazil. Several varieties from Hungary and Siberia are pale violet-blue, some called *Smoky topaz*, from Bohemia, brown and yellow. The Scottish Cairngorm sometimes possesses several bright tints of these colours, in one and the same specimen. Amethysts of various colours are brought from Brazil, but he finest violet-blue colours come from Ceylon, India, and Persia, where some of them are found in pebbles. Less transparent or well coloured, they occur in original repositories at Porkura, and other places in Transylvania, in Hungary, Siberia, &c. Some varieties are also found in Scotland, in Saxony, in the Hartz, in Bohemia, in Silesia, &c.; and they are met with in veins, in agate balls, or in secondary deposits. Rose-quartz occurs at Rabenstein near Zwiesel in Bavaria, and in Siberia; the milk-white varieties of it are known from Norway, Spain, France, &c. The locality of Prase is Breitenbrunn, in the mining district of Schwarzenberg in Saxony. Smalt-blue calcedony sometimes crystallised, occurs at Tresztyan in Transylvania, the stalactitic and reniform shapes occur in fine varieties in Iceland and the Faroe islands in amygdaloid, at Hüttenberg and Loben in Carinthia, in beds of ironstone: also in Hungary, Transylvania, in Scotland, and other countries. Most beautiful and elegant specimens have been found in Trevascus mine in Cornwall. Carne-

lian is brought from Arabia, India, Surinam, and Siberia; it is met with also in Bohemia, Saxony, &c.; fibrous Carnelian in Hungary; Chrysoprase at Kosemütz in Silesia, and at New Fane in Vermont, North America, in both places in serpentine. It is not known from whence the ancients received the Plasma found among the ruins of Rome, but several varieties resembling it have been recently discovered in Moravia and Bavaria. It occurs in India, from whence it is occasionally brought in the shape of beads and other ornaments. Flint is a common mineral in England, France, the islands of Rügen and Seeland, in Poland, Spain, &c. Near Gratz in Stiria it occurs as one of the ingredients of gneiss. Splintery Hornstone produces the remarkable pseudomorphic crystals from Schneeberg in Saxony; it also occurs in veins in Hungary and other mining countries; in beds it is found in Norway, and in spheroidal masses in limestone in the Tyrol. The locality of conchoidal Hornstone is the isle of Cyprus. Flinty slate forms beds, and occurs also in pebbles in Bohemia, Silesia, Saxony, Hungary, in the Hartz, in France, &c.; fibrous Quartz in the Hartz; Cat's eye in Ceylon, the coast of Malabar, and it is said also in the Hartz. Heliotrope used formerly to be brought from Ethiopia, but is now generally obtained from Bucharia, from Tartary, and Siberia. Iron flint is frequent in the ironstone veins of Saxony, Bohemia, Hungary, Transylvania, &c., and along with it often also common Jasper. Striped Jasper occurs in Siberia, at Gnandtstein in Saxony, at Ivybridge in Devonshire; the brown Egyptian Jasper comes from the banks of the Nile; the red variety from Baden. The petrifactions, still preserving the rings of wood in the shape of trunks, branches and roots, are met with in many countries.

6. Several varieties of rhombohedral Quartz are of important use in the arts and manufactures. Some of those of good transparency, or fine colours and delineations, as Rock-crystal, Amethyst, Rose-quartz, Chrysoprase, several varieties of Calcedony, called Onyx, Sard, Sardonyx, &c.

are cut and polished into ring-stones and seals, and for various other ornamental purposes. Agate is also used for the same thing. The most important applications, however, made of rhombohedral Quartz, are those depending upon its consisting of silica. It enters into the composition of glass, both white and coloured, as, for instance, smalt. It is added to the mass of porcelain in the state of an impalpable powder, and forms part of the paste also in other kinds of pottery. It is used as a flux in the melting of several kinds of ores, particularly copper ores, and in other metallurgical processes. The use of flint in gun-locks is well known. Lydian-Stone is employed for trying the contents of mixtures of gold and silver. Sand-stone yields various applications for architectural and other purposes, as the construction of melting furnaces, mill-stones, &c. As a peculiar variety of it, the flexible sandstone from Villa Ricca in Brazil deserves to be noticed, which probably owes its flexibility to scales of mica dispersed throughout its mass. Sand with slaked lime forms mortar. It is also used for the improvement of roads, as in some countries also flint.

3. UNCLEAVABLE QUARTZ.

Indivisible Quartz (excepting subsp. 1. 6. 7. 8. and 9.). JAM. Syst. Vol. I. p. 283. Uncleavable Quartz. Man. p. 208. Hyalite. Muller's Glass. Opal. Hydrophane. Menilite. Cacholong. Siliceous Sinter. PHILL. p. 8. 10. 12. 13. 16. 22. Opal. Hialith. Menilit. Opaljaspis. WERN. Hoffm. H. B. II. 1. S. 131. 134. 156. 177. Opal. Eisenopal. HAUSM. II. S. 421. 428. Opal. LEONH. S. 131. Quarz hyalin concrétionné. Quarz résinite. HAÜY. Traité, T. II. p. 416. 433. Tabl. comp. p. 25. 27. Traité, 2de Ed. T. II. p. 270.

Regular forms and cleavage unknown.

Fracture conchoidal, of various degrees of perfection, sometimes highly perfect.

Lustre vitreous, in some varieties inclining to resinous. Colour white, yellow, red, brown, green, grey; none of them lively, except some red and green ones, and generally pale; dark colours, owing to foreign admixtures. Streak white. Transparent ... translucent, sometimes only on the edges, or even opake, if the colours be very dark. Lively play of light observable in some varieties; others shew different colours by reflected and refracted light.

Hardness = 5·5 ... 6·5. Sp. Gr. = 2·091, a milk-white variety; = 2·060 a brownish-red variety.

Compound Varieties. Small reniform, botryoidal, and stalactitic shapes, and large tuberose concretions: surface of the former smooth, of the latter rough; composition impalpable, fracture conchoidal. Massive, composition impalpable; fracture conchoidal, even. Pseudomorphoses of rhombohedral Lime-haloide.

OBSERVATIONS.

1. The phenomenon of the play of colour of precious Opal has not been hitherto satisfactorily explained. According to HAÜY, it is the consequence of fissures in the interior filled with thin films of air, which reflect coloured light according to the law of NEWTON's coloured rings. If this were the fact, Opal would present nothing else but a kind of iridescence, and the beauty of Opal would be owing, as HAÜY expresses it, only to its imperfections. But these colours often keep constant directions within single parts of the mass; and in specimens not cut in the usual convex form, but presenting even faces, it is often possible to observe distinct images reflected, exactly as in the Moonstone, which is a crystallised variety of prismatic Feld-spar, or in prismatic Corundum. The play of colour seems therefore

to be connected with the regular structure, and deserves the attention of all those who may have occasion to observe the mineral in this point of view*.

2. The species of uncleavable Quartz is altogether united by HAÜY with the preceding one of rhombohedral Quartz. In the Wernerian system the great differences in the appearance of its varieties have been the cause of its distinction into a number of species, of subspecies and kinds, many of which have been adopted by mineralogists at large. By far the greatest part of the varieties is contained within the species of *Opal*, excluding from it the *Hyalite*, in small reniform, botryoidal, and sometimes stalactitic shapes, white, and generally of considerable degrees of transparency, and the *Menilite*, in tuberose forms, and for the rest possessing almost the opposite properties of Hyalite. Menilite has been subdivided into *brown* and *grey* Menilite, according to colour: some of the

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* There is a specimen in Mr ALLAN's cabinet actually presenting traces of cleavage in one direction, reflecting a most beautiful green colour, which is collected into a faint image, if brought sufficiently near the eye. The colour of the specimen itself is a dark wax-yellow; it is translucent, and presents by refracted light a nearly hyacinth-red colour. The play of light is interrupted and re-appears, alternating in lines, similar to he effect of regular composition in Labradorite. There is apparently one cleavage in each individual; the cleavages from two individuals meet at angles of about 109°. In the cabinet of Mr VON MORGENBESSER at Vienna, there is a white specimen, of a similar description, but consisting of larger individuals, and without the alternation of particles indicative of regular composition. From a great number of observations, Dr BREWSTER concludes that the play of light depends upon openings in the interior of the mass of Opal, which are not fissures, but of a uniform shape, aud reflecting the tints of NEWTON's scale. In some varieties of Hydrophane they are so large that these colours cannot be any longer reflected by the included air; but they appear when filled with water, and of still higher tints if filled with fluids possessing a high refractive power. Other varieties, in this case, only become transparent, but do not shew any colours. H.

varieties generally exhibited among the latter do not, however, belong to the present species, but to the preceding one, being Hornstone. Opal itself is subdivided into *Precious Opal*, containing the varieties which shew the play of light; into *Wood Opal*, which appears in the shape of trunks, branches, and roots of trees; into *Common Opal* and *Semi-Opal*, consisting of the rest of the varieties, and distinguished from one another by the higher or lower degrees of transparency and lustre, and of the perfection of their conchoidal fracture. *Opal-Jasper* evidently also belongs to the species of uncleavable Quartz, for it contains varieties that are in the same relation to it, as Jasper is to the species of rhombohedral Quartz. *Hydrophane* is nothing but a variety of Opal without transparency, but assuming it if thrown into water or another transparent fluid. *Siliceous sinter* is a deposit from hot springs, &c. and according to its specific gravity, seems to belong to the present species.

3. Three varieties of uncleavable Quartz, 1. Hyalite, analysed by BUCHOLZ, 2. Precious Opal, and 3. Menilite, both analysed by KLAPROTH, have yielded

Silica	1. 92·00	2. 90·00	3. 85·50.
Water	6·33	10·00	11·00.

The last contains, like several other varieties, a small proportion of oxide of iron, alumina, lime, and carbon. Opal Jasper contains so much as 47 per cent. of oxide of iron. The contents of water are considered by BERZELIUS foreign to the mixture of the mineral, and to change with the hygrometric state of the atmosphere. Before the blowpipe, water is disengaged, the mineral decrepitates and becomes opake, and shews besides the properties of pure silica. Two pieces rubbed together give a phosphorescent light, like rhombohedral Quartz.

4. Uncleavable Quartz is less frequently met with in nature than the preceding species. Generally it forms short irregular veins, strongly connected with the matrix, which in most cases is porphyry, or is imbedded in it in amorphous masses of various dimensions. If they be large, they sometimes assume the shape of more or less regular

beds. Uncleavable Quartz often accompanies Calcedony, in the vesicular cavities of amygdaloidal rocks, and even in agate balls. Thus also Menilite is found in adhesive slate. Some varieties are met with in metalliferous veins, along with hexahedral Lead-glance, dodecahedral Garnet-blende, &c. It occurs in petrifactions in sandstone.

5. Uncleavable Quartz is, in its different varieties, more plentiful in Hungary than in any other country in the world. It has for a long time been the only locality of precious Opal, which is found at Czerwenitza near Caschau, along with common and semi-opal in a kind of porphyry. Traces of it have been met with at Hubertsburg in Saxony. Fine varieties have been lately discovered in the Faroe islands, and most beautiful ones, sometimes quite transparent, near Gracias a Dios in the province of Honduras, America. Common opal occurs in great quantities at Telkobanya near Eperies, and in other parts of Hungary, in the Faroe isles, in Saxony, &c. An apple-green variety is found at Kosemütz in Silesia with Chrysoprase; and the red and yellow, bright coloured varieties of *Fire-opal*, near Zimapan in Mexico. Semi-opal occurs in several of the countries mentioned above; also near Frankfort on the Maine, in Austria, Moravia, Poland, Siberia, &c. In Saxony, Bohemia, and Cornwall, it is met with in metalliferous veins. Hyalite is found in amygdaloidal rocks, near Frankfort, in irregular veins; near Schemnitz in Hungary, in porphyry; also in Bohemia, and various other countries. Brown Menilite occurs at Menil Montant near Paris; the grey variety has also been discovered in that neighbourhood. Opal Jasper is formed wherever uncleavable Quartz happens to be mixed with oxide of iron, as at Telkobanya in Hungary, near Almas and Tököró in Transylvania, &c. Wood opal is frequently found at Kremnitz and Telkobanya in Hungary, and in many districts of Transylvania, sometimes in very large trees.

6. Precious opal is considered as a gem, and generally cut with a convex surface. It is of considerable value, if large, pure, and possessing vivid colours.

4. EMPYRODOX* QUARTZ.

Indivisible Quartz, 6th—9th subsp. JAM. Syst. Vol. I. p. 283. Fusible Quartz. Man. p. 214. Pearlstone. Pitchstone. Pumice. Obsidian. PHILL. p. 112. 130. 133. 135. Obsidian. Pechstein. Perlstein. Bimstein. WERN. Hoffm. H. B. II. 1. S. 191. 202. 208. 213. Pechstein. Obsidian. Perlstein. Bimstein. HAUSM. II. S. 430. 431. 433. 435. Pechstein. Obsidian. Perlstein. Bimsstein. LEONH. S. 137. 138. 141. 143. Petrosilex résinite. Lave vitreuse obsidienne, perlée, pumicée. HAÜY. Traité, T. IV. p. 386. 494. 495. Feldspath résinite. Traité, 2de Ed. T. III. p. 101.

Regular forms unknown. Grains.†

Cleavage none. Fracture conchoidal, sometimes highly perfect, sometimes less distinct. Surface, the larger grains uneven and rough, the smaller ones smooth.

Lustre vitreous and resinous. Colour, black, brown, red, yellow, green, grey, white; none of them bright. There occurs a distinct velvet-black. Streak white. Faintly transparent ... translucent on the edges.

Hardness = 6·0 ... 7·0. Sp. Gr. = 2·395, Obsidian from Iceland; = 2·212, Pitchstone from Meissen.

Compound Varieties. Massive: composition gra-

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[*] From ἔμπυρος, belonging to fire, and δόξα, the opinion; according to the opinion of many, produced by fire.

[†] In the Phil. Trans. 1816, p. 77. Dr BREWSTER has shewn that the rounded masses of obsidian from Ascension, and from Japan, possess the structure of unannealed glass, and therefore appear to have been cooled from a red heat. H.

nular, strongly connected, so as to be scarcely recognizable; fracture more or less perfectly conchoidal, uneven and splintery. The whole mass is often traversed with separating faces, which may be considered as rudiments of the faces of lamellar composition: often the composition is granular, thick or thin, and generally bent; the faces of composition being smooth, and possessing pearly lustre. Small grains of Obsidian are often enveloped in a number of successive thin coats, several of these again are surrounded by other coats, and so on several times, which produces a very remarkable composition. Vesicular; the cavities often elongated in one direction, parallel and in such number, that the mass appears fibrous and of a pearly lustre.

OBSERVATIONS.

1. The varieties of empyrodox Quartz are intimately connected by transitions. These transitions are particularly important in the determination of the species in Natural History, when there are no regular forms or faces of cleavage. Yet they require to be carefully treated, and, as in the present case, it is necessary to give proper attention to hardness and specific gravity. Though in most mineralogical systems the four species of Obsidian, Pitchstone, Pearlstone, and Pumice, which must be comprised within that of empyrodox Quartz, are placed immediately following each other, yet they are not brought into that connexion which evidently takes place in nature, if we consider their properties. As an empirical demonstration of the correctness of this view, we may take the difficulty of an accurate distinction of these species. *Obsidian* possesses the most perfect conchoidal fracture, and high degrees of a

pure vitreous lustre. Agreeably to the degrees of transparency, it is divided into *transparent* and *translucent* Obsidian, in which the paler and darker shades of colour likewise correspond to the degrees of transparency. Transparent Obsidian is sometimes called *Marekanite.* If the high perfection of the conchoidal fracture is lost, and we meet with uneven or coarse splintery fracture, the lustre at the same time diminishing and passing into resinous, the passage is formed from Obsidian to *Pitchstone.* Pitchstone is faintly translucent, generally only on the edges. It contains often those faces which are usually called the faces of distinct concretion, and which no doubt arise from composition. If there are many of them, variously curved, and containing but little matter between them, a transition into *Pearlstone* is formed, the distinguishing mark of which consists of those roundish masses into which it may be separated, and that generally allow themselves to be resolved into thin films, not unfrequently including a grain of Obsidian. The Obsidian itself is often vesicular, the cavities being small, and keeping a constant direction. If there are a great many of them of larger sizes, the whole mass becomes apparently very light, the original colour disappears, and there is pearly or silky lustre in one direction. Thus *Pumice* is generally formed; but there are also transitions from Pearlstone into it. The subspecies of Pumice are the *glassy*, *common*, and *porphyritic* Pumice. The glassy kind still betrays its connexion with Obsidian by its small and imperfectly conchoidal cross-fracture. This is no longer the case in the second kind; but the whole mass seems to consist of a delicate tissue of glassy fibres; the third kind contains imbedded crystals and grains of prismatic Feld-spar, and hence assumes a porphyritic appearance. All these transitions may be easily observed in nature in almost every collection made on a somewhat larger scale, if the artifice has not been used to remove those varieties by which they are produced.

2. According to an analysis of Obsidian by DESCOTILS, one of Pitchstone, one of Pearlstone, and one of Pumice by KLAPROTH, the empyrodox Quartz consists of

	Obsidian.	Pitchstone.	Pearlstone.	Pumice.
Silica	72·00	73·00	75·25	77·50.
Alumina	12·50	14·50	12·00	17·50.
Potash	10·00	0·00	4·50	3·00.
Soda		1·75	0·00	
Oxides of Iron and Manganese	2·00	1·10	1·60	1·75.
Lime	0·00	1·00	0·50	0·00.
Water	0·00	8·50	4·50	0·00.

Before the blowpipe these varieties melt with more or less facility, according to the fusibility of their ingredients, into a vesicular glass, or they yield an enamel.

3. The geological relations of the present species are very remarkable. Pitchstone forms mountain masses, and is generally in close connexion with porphyry. Many of the other varieties occur in similar circumstances. It is often itself the paste of certain kinds of porphyry, containing imbedded crystals of other minerals; and in a similar manner obsidian, pearlstone, and pumice, form each their porphyry, denominated after the kind of paste which contains the crystals. All these varieties occur also in beds in sandstone, in which that remarkable fact has been observed, that in some places they lie regularly between the strata, and abruptly assume another situation, interrupt the strata, and then appear in the shape of veins. Several of the pitchstone veins in red sandstone seem to have the same origin; but it cannot be observed whether this also be the case in similar veins in granite, where they likewise occur. Obsidian frequently occurs in grains, like those mentioned above in Pearlstone. Several of the varieties of empyrodox Quartz, and more particularly Pumice, are products of active volcanoes.

4. Some countries are rich in varieties of the present species. Considerable masses of very distinct Pitchstone occur on the foot of the Saxon metalliferous mountains at Meissen, also at Planitz near Zwickau, passing into Obsidian in the isle of Arran. Pearlstone, including grains of Obsidian, is found between Tokay and Keresztur, and at Glashütte near Schemnitz in Hungary, at Cabo de Gata in

Spain, near Ochotzk in Siberia, &c. Obsidian is very frequent in Iceland, where it occurs in grains, angular pieces and beds; it is also found at Schemnitz and Glashütte in Hungary, of a green colour at Moldauthein in Bohemia, and shewing every stage of the passage into Pumice in the Lipari islands, also in Teneriffe, Peru, and New Spain. Pumice occurs at Vesuvius, in Ischia, the Lipari islands, and several islands of the Grecian archipelago, in Teneriffe; near Tokay, Schemnitz, and other places in Hungary; near Andernach and the lake of Laach on the Rhine; in Quito and Mexico, &c.; in several of these countries it is met with also in conglomerates.

5. Obsidian is employed for mirrors, vases, snuff-boxes, &c.; in Mexico and the island of Ascension very sharp edged fragments are used as tools and weapons. Pumice yields a well known material for grinding and polishing, and is also employed as a filtering stone.

GENUS VII. AXINITE.

1. PRISMATIC AXINITE.

Prismatic Axinite. JAM. Syst. Vol. I. p. 127. Man. p. 218. Axinite. PHILL. p. 43. Axinit. WERN. Hoffm. H. B. I. S. 678. Axinit. HAUSM. II. S. 626. Axinit. LEONH. S. 404. Axinite. HAÜY. Traité, T. III. p. 22. Tabl. comp. p. 37. Traité, 2de Ed. T. II. p. 559.

Fundamental form. Scalene four-sided pyramid, the axis of which is inclined probably in the planes of both diagonals. Vol. I. Fig. 42.

Simple forms. $\begin{matrix} r \\ l \end{matrix}\frac{P}{4}\begin{Bmatrix} t \\ t' \end{Bmatrix}$; $-\begin{matrix} r \\ l \end{matrix}\frac{(\bar{P}r)^3}{4}\begin{Bmatrix} n \\ x \end{Bmatrix}$; $-l\frac{(\breve{P})^3}{4}(u)$; $-l\frac{(\breve{P}r)^7}{4}(l)$; $-\frac{\frac{3}{4}P+2}{4}(s)$;

$\genfrac{}{}{0pt}{}{r}{l}\dfrac{(\breve{\mathrm{P}}\mathrm{r}+\infty)^3}{2}\left\{\begin{matrix}P\\M\end{matrix}\right\}$; $l\dfrac{(\bar{\mathrm{P}}\mathrm{r}+\infty)^5}{2}(z)$; $\pm\dfrac{\breve{\mathrm{P}}\mathrm{r}}{2}\left\{\begin{matrix}v\\T\end{matrix}\right\}$; $\dfrac{\frac{3}{4}\breve{\mathrm{P}}\mathrm{r}+2}{2}(y)$; $\bar{\mathrm{P}}\mathrm{r}+\infty\ (r)$.

Char. of Comb. Tetarto-prismatic.

Combinations. 1. $-l\dfrac{(\breve{\mathrm{P}})^3}{4}$. $r\dfrac{(\breve{\mathrm{P}}\mathrm{r}+\infty)^3}{2}$. $\bar{\mathrm{P}}\mathrm{r}+\infty$. Fig. 90. Dauphiny.

2. $-l\dfrac{(\bar{\mathrm{P}}\mathrm{r})^3}{4}$. $-l\dfrac{(\breve{\mathrm{P}})^3}{4}$. $-l\dfrac{\frac{3}{4}\mathrm{P}+2}{4}$. $-l\dfrac{(\breve{\mathrm{P}}\mathrm{r})^7}{4}$. $r\dfrac{(\breve{\mathrm{P}}\mathrm{r}+\infty)^3}{2}$. $\bar{\mathrm{P}}\mathrm{r}+\infty$. Fig. 89. Dauphiny.

3. $\dfrac{\breve{\mathrm{P}}\mathrm{r}}{2}$. $r\dfrac{\mathrm{P}}{2}$. $l\dfrac{\mathrm{P}}{2}$. $\dfrac{\frac{3}{4}\breve{\mathrm{P}}\mathrm{r}+2}{2}$. $-\dfrac{\breve{\mathrm{P}}\mathrm{r}}{2}$. $-r\dfrac{(\bar{\mathrm{P}}\mathrm{r})^3}{4}$. $-l\dfrac{(\bar{\mathrm{P}}\mathrm{r})^3}{4}$. $-l\dfrac{(\breve{\mathrm{P}})^3}{4}$. $-l\dfrac{\frac{3}{4}\mathrm{P}+2}{4}$. $-l\dfrac{(\breve{\mathrm{P}}\mathrm{r})^7}{4}$. $r\dfrac{(\breve{\mathrm{P}}\mathrm{r}+\infty)^3}{2}$. $l\dfrac{(\breve{\mathrm{P}}\mathrm{r}+\infty)^3}{2}$. $l\dfrac{(\bar{\mathrm{P}}\mathrm{r}+\infty)^5}{2}$. $\bar{\mathrm{P}}\mathrm{r}+\infty$. Fig. 91. Cornwall.

Cleavage. $r\dfrac{\mathrm{P}}{4}$, $-\dfrac{\breve{\mathrm{P}}\mathrm{r}}{2}$; traces of $\genfrac{}{}{0pt}{}{r}{l}\dfrac{(\breve{\mathrm{P}}\mathrm{r}+\infty)^3}{2}$, one of them more distinct, and also of $\bar{\mathrm{P}}\mathrm{r}+\infty$, altogether indistinct and interrupted. Fracture conchoidal, uneven. Surface, *v* rough, *M* irregularly streaked, parallel to the edges of combination with *y*; *r*, but particularly *z*, deeply streaked parallel to their common intersections; *u* and *l*, sometimes also *T* and *P*, streaked parallel to their edges of combination. In general they are smooth and shining.

Lustre vitreous. Colour clove-brown, various shades inclining to plum-blue and pearl-grey. Green from an admixture of Chlorite. Streak white. Transparent ... translucent, sometimes only on the edges. The deepest shades of violet-blue tints appear if the mineral is viewed in the direction perpendicular to $\bar{P}r + \infty$ (r).

Hardness = 6·5 ... 7·0. Sp. Gr. = 3·271, the crystallised variety from Cornwall.

Compound Varieties. Massive: composition lamellar, generally a little bent; faces of composition irregularly streaked. Sometimes the composition is granular and impalpable.

OBSERVATIONS.

1. From the angles given by **Haüy**, the inclination of the axis in the plane of the long diagonal would be = 0° 8′, and in the plane of the short diagonal = 8° 13′. He considers as the primitive form the combination of $-\frac{\breve{P}r}{2}$ and $r\,l\,\frac{(\breve{P}r + \infty)^3}{2}$, supposing at the same time the transverse section of $(\breve{P}r + \infty)^3$, to be = 90°, the inclination of $-\frac{\breve{P}r}{2}$ on $r\,\frac{(\breve{P}r + \infty)^3}{2}$ also = 90°, and on $l\,\frac{(\breve{P}r + \infty)^3}{2}$ = 78° 27′ 47″. These quantities, however, should be first exactly ascertained, before, on account of their very simplicity, they be adopted as the effective dimensions of the forms, as there is nothing in experience which confirms the existence of such simple relations. The incidences of the faces, and the plane angles are, according to **Haüy**,

u on P = 140° 11′[*]
u on r = 116° 54′[*]
P on r = 135° 0′[*]
n on s = 154° 3′
s on P = 150° 7′
M on P = 90° 0′
P on T = 90° 0′
s on r = 142° 51′.
x on s = 166° 7′.
z on P = 116° 34′.
M on T = 78° 28′.
z on r = 161° 34′.
x on P = 136° 14′.
l on P = 153° 26′.

Plane angles t = 129° 2′.
n = 135° 18′.
f = 78° 28′.

2. According to **Klaproth**, the present species consists of

Silica	50·50.
Lime	17·00.
Alumina	16·00.
Oxide of Iron	9·50.
Oxide of Manganese	5·25.
Potash	0·25.

Before the blowpipe it melts easily, and with intumescence, into a dark-green glass, which becomes black in the oxidating flame. Some varieties are differently electrified by heat, contiguous to opposite ends of the crystals, and in these also a difference in the form has been observed by **Haüy**.

3. Prismatic Axinite occurs in beds and veins in primitive countries. It is accompanied in the former by rhombohedral Lime-haloide, dodecahedral Garnet-blende, &c.; in the latter chiefly by several species of Augite-spar, Asbestus, rhombohedral Quartz, &c. also by various metallic minerals. Several of these veins belong to the class of those supposed to be of cotemporaneous origin with the rocks which they traverse.

4. It is found in beds at Thum near Ehrenfriedersdorf, in Saxony, from whence it derived its first name of *Thumite* or *Thumerstone*. At Kongsberg in Norway, it occurs in veins

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[*] Mr **Phillips** gives these measurements as follows: u on P = 135° 10′; u on r = 115° 17′; P on r = 134° 40′. H.

with hexahedral Silver. Beautiful crystals are met with in the veins of various places near Bourg d'Oisans in Dauphiny, at Barèges in the Pyrenees, in Savoy, in the county of Gömör in Hungary, and in large well defined crystals at Botallack in Cornwall. In the latter place it is found in a massive state, and forms a peculiar kind of rock, with dodecahedral Garnet and rhombohedral Tourmaline. It is found, besides, in several places in the Hartz, &c.

GENUS VIII. CHRYSOLITE.

1. PRISMATIC CHRYSOLITE.

Prismatic Chrysolite. JAM. Syst. Vol. I. p. 117. Man. p. 219. Chrysolite. Olivine. PHILL. p. 95. 96. Krisolith. Olivin. WERN. Hoffm. H. B. I. S. 429. 437. Chrysolith. Olivin. HAUSM. II. S. 680. 681. Chrysolith. LEONH. S. 514. Péridot. HAÜY. Traité, T. III. p. 198. Tabl. comp. p. 52. Traité, T. II. p. 465.

Fundamental form. Scalene four-sided pyramid. $P = 107° 46', 101° 31', 119° 41'$. Vol. I. Fig. 9. R. G.

$$a : b : c = 1 : \sqrt{0{\cdot}7263} : \sqrt{0{\cdot}6306}.$$

Simple forms. $P - \infty$ (*P*); P (*p*); $P + \infty$ (*s*) $= 94° 3'$; $(\bar{P}r - 1)^3$ (*e*); $(\bar{P}r + \infty)^3$ (*n*) $= 130° 2'$; $(\breve{P}r + \infty)^3$ (*z*) $= 56° 26'$; $\breve{P}r - 1$ (*h*) $= 119° 12'$; $\breve{P}r$ (*k*) $= 80° 53'$; $\bar{P}r$ (*d*) $= 76° 54'$; $\breve{P}r + \infty$ (*T*); $\bar{P}r + \infty$ (*M*).

Char. of Comb. Prismatic.

Combinations. 1. $\bar{P}r.\ (\bar{P}r - 1)^3.\ (\bar{P}r + \infty)^3.\ \bar{P}r + \infty.$

2. $\bar{P}r.\ (\bar{P}r - 1)^3.\ P.\ (\bar{P}r + \infty)^3.\ (\bar{P}r + \infty)$. Fig. 20.

3. $P - \infty.\ \bar{P}r.\ (\bar{P}r - 1)^3.\ \breve{P}r - 1.\ \breve{P}r.\ P.\ (\bar{P}r + \infty)^3.\ \breve{P}r + \infty.\ \bar{P}r + \infty.$

Irregular forms, grains.

Cleavage, $\breve{P}r + \infty$, pretty easily obtained, sometimes traces of $\bar{P}r + \infty$. Fracture conchoidal. Surface, $P - \infty$ generally rough, so is also $\breve{P}r + \infty$. The faces of the vertical prisms streaked parallel to the axis, those of the rest of the faces smooth and even. The grains possess an uneven surface.

Lustre vitreous. Colour various shades of green, as pistachio-green, olive-green, nearly asparagus-green and grass-green, sometimes passing into brown. Streak white. Transparent ... translucent.

Hardness = 6·5 ... 7·0. Sp. Gr. = 3·441, a crystallized variety.

Compound Varieties. Irregular spheroidal masses, imbedded in rocks: composition granular, individuals easily separated, faces of composition uneven and rough.

OBSERVATIONS.

1. The two species, *Chrysolite* and *Olivine*, generally distinguished among the varieties of the present species, do not yield any decisive character by which they might be separated. Chrysolite are called the varieties in perfect crystals, or such varieties as possess bright colours and pretty high degrees of transparency. Yet there are some crystals and imbedded grains by no means inferior to them, which are exhibited among the varieties of Olivine, which, for the greater part, however, contain only compound varieties of inferior degrees of transparency, and less lively colours. The varieties found in the meteoric iron discovered by PALLAS in Siberia, in fact belong to the present species, as not only their forms, but also the rest of their properties, agree with those enumerated above.

2. According to **Klaproth**, the present species consists of

	Chrysolite.	*Chrysolite* From the meteoric Iron.	*Olivine.*
Silica	39 00	41·00	50·00.
Magnesia	43·50	38·50	38·50.
Oxide of Iron	19·00	18·50	12·00.
Lime	0·00	9·00	0·25.

According to some recent researches of Professor **Stromeyer**, the Chrysolite from the meteoric Iron from Siberia, and Olivine also, contain some oxide of nickel. Before the blowpipe, prismatic Chrysolite assumes a darker colour, but does not melt, nor lose its transparency. Olivine loses its colour in heated nitric acid. Varieties of the present species may be artificially produced by mixing the constituent parts in the required proportions, and exposing them to a high temperature. The silicate of the protoxide of iron which possesses the same form of the prismatic Chrysolite, is an important agent in the process of melting copper ores and refining pig-iron.

3. The original repository of the implanted crystals of Chrysolite is not known: they are said to come from Upper Egypt, and are frequently brought to Europe by way of Constantinople. Less distinct crystals and imbedded grains are found in lava, in various kinds of basalt, &c.; so in the neighbourhood of Vesuvius, in Saxony, Bohemia, Silesia, Hungary, &c. It occurs in large spheroidal masses, which are not pebbles, mixed with paratomous Augite-spar, in the rock called Traptuff, as at Kapfenstein in Lower Stiria, and at the Habichtswald in Hessia.

4. It is used as a gem of inferior value.

GENUS. IX. BORACITE.

1. TETRAHEDRAL BORACITE.

Hexahedral Boracite. Jam. Syst. Vol. I. p. 335. Octahedral Boracite. Man. p. 220. Boracite. Borate of Magnesia. PHILL. p. 181. Borazit. WERN. Hoffm. H. B. III. 1. S. 138. Borazit. HAUSM. III. S. 821. Borazit. LEONH. S. 509. Magnésie boratée. HAÜY. Traité, T. II. p. 337. Tabl. comp. p. 16. Traité, 2de Ed. T. II. p. 56.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. $\overset{*}{H}$ (*P*) Segeberg, Holstein ; $\frac{O}{2}$ (*s*) Vol. I. Fig. 13. ; $-\frac{O}{2}$ (*s'*) Vol. I. Fig. 14 ; D (*n*) Vol. I. Fig. 31. ; $\frac{C_1}{2}$ (*r*) Vol. I. Fig. 16. ; $\frac{T_3}{2}$ (*x*) Vol. I. Fig. 35.

Char. of Comb. Semi-tessular with inclined faces.

Combinations. 1. $\frac{O}{2}$. D. 2. H. $\frac{O}{2}$. D. Fig. 159 and 160. 3. H. $\frac{O}{2}$. D. $-\frac{C_1}{2}$. 4. H. $\frac{O}{2}$. $-\frac{O}{2}$. D. $-\frac{C_1}{2}$. $\frac{T_3}{2}$. All of them from Lüneburg.

Cleavage, traces parallel to the faces of the octahedron. Fracture conchoidal, uneven. Surface, smooth and shining, only the inverse halves $-\frac{O}{2}$ and $-\frac{C_1}{2}$ are sometimes rather rough and uneven.

Lustre vitreous, inclining to adamantine. Colour white, inclining to grey, yellow, and green. Streak white. Semi-transparent, translucent.

Hardness = 7·0. Sp. Gr. = 2·974 of an isolated crystal.

OBSERVATIONS.

1. This substance has been hitherto found always in crystals, remarkably well pronounced. According

to the optical researches of Dr **Brewster**, tetrahedral Boracite possesses one axis of double refraction, *positive* like that of Quartz, and coinciding with one of its principal rhombohedral axes. This is one of the remarkable exceptions to the otherwise almost general law, that bodies, whose forms are tessular, do not possess any double refraction. Our present knowledge of the connexion of these two phenomena is as yet insufficient to account for the anomaly of this case.

2. Tetrahedral Boracite consists, according to **Pfaff**, of

Boracic Acid	54·55.
Magnesia	30·68.
Oxide of Iron	0·57.
Silica	2·27.

Before the blowpipe upon charcoal it intumesces, and melts into a glassy globule, which becomes white and opake on cooling. It becomes electric by heat, four alternating terminal points of its rhombohedral axes being positive, and those which are opposite to them negative.

3. The varieties of tetrahedral Boracite are found in crystals terminated on all sides, imbedded in compound varieties of prismatoidal, in a few instances also of prismatic Gypsum-haloide, and have been hitherto found only at Lüneburg in Brunswick, and at Segeberg in Holstein.

GENUS X. TOURMALINE.

1. RHOMBOHEDRAL TOURMALINE.

Rhomboidal Tourmaline. **Jam.** Syst. Vol. I. p. 104. Man. p. 221. Tourmaline. **Phill.** p. 139. Turmalin. Schörl. **Wern.** Hoffm. H. B. I. S. 627. 647. Schörl. Aphrit. **Hausm.** II. S. 640. 642. Turmalin. **Leonh.** S. 397. Tourmaline. Tourmaline apyre. **Haüy.** Traité, T. III. p. 31. T. IV. p. 401. Tourmaline. Tabl. comp. p. 38. Traité, 2de Ed. T. III. p. 14.

Fundamental form. Rhombohedron. R = 133° 26′. Vol. I. Fig. 7. **Haüy.**

$$a = \sqrt{0{\cdot}5921}.$$

Simple forms. $R - \infty\ (k)$; $R - 1\ (n) = 155^\circ\ 9'$; $R\ (P)$; $R + 1\ (o) = 103^\circ\ 21'$; $R + 2\ (r) = 76^\circ\ 50'$; $R + \infty\ (l)$; $P + \infty\ (s)$; $(P - 1)^3\ (x)$; $(P)^{\frac{5}{3}}$; $(P)^5\ (u)$; $(P + 1)^2$; $(P + \infty)^5\ (h)$.

Char. of Comb. Hemi-rhombohedral, with different faces contiguous to opposite ends of the crystals. Of the prism $R + \infty$, there are generally only the alternating faces, of $(P + \infty)^m$ the alternating pairs to be met with in the combinations.

Combinations. 1. $R.\ \frac{[R + \infty]}{2}.\ P + \infty.\ R.$ Sim. Fig. 136. Colour black. Greenland.

2. $R.\ (P)^{\frac{5}{3}}.\ \frac{[R + \infty]}{2}.\ P + \infty.$ Red. Catherinenburg, Siberia.

3. $R.\ R + 1.\ P + \infty.\ R - \infty.$ Fig. 137. Green. St Gothard.

4. $R - \infty.\ R - 1.\ R.\ \frac{R + \infty}{2}.\ P + \infty.\ R.$ Brown. Ceylon.

5. $R - \infty.\ R - 1.\ R.\ \frac{[R + \infty]}{2}.\ R - 1.\ R - \infty.$ Fig. 138. Red. Ceylon. This variety occurs along with dodecahedral Corundum, and is remarkable for the face $R - \infty$, which occurs on both ends of the crystal.

6. $R - 1.\ R.\ \frac{5}{4}R.\ (P - 1)^3.\ R + 1.\ R + \infty.\ P + \infty.$ Black. Penig, Saxony. Observed only on one end.

Cleavage. R, P + ∞, difficult. Fracture imperfect conchoidal, uneven. Surface, the prisms deeply striated parallel to the axis; the rest of the faces generally smooth, and of pretty much the same physical quality.

Lustre vitreous. Colour, brown, green, blue, red, white, frequently black; generally dark, and scarcely ever bright. Streak white. Transparent ... almost opake, agreeably to the colour. Less transparent if viewed in a direction parallel to the axis, than perpendicular to it, and generally different colours in these directions.

Hardness = 7·0 ... 7·5. Sp. Gr. = 3·076, of a deep pistachio-green ringstone.

Compound Varieties. Massive: composition seldom granular, of various sizes of individuals; generally columnar, of various sizes of individuals, often very thin, straight, and parallel or divergent; sometimes again aggregated into larger granular or wedge-shaped masses; faces of composition smooth and longitudinally streaked.

OBSERVATIONS.

1. *Tourmaline* and *Schörl*, which have been formerly distinguished as two particular species, differ in nothing but their colours and transparency. The varieties of green, blue, red, brown or white colour, in general, such as are not perfectly black, though of occasionally very dark tints, and not absolutely opake, form Tourmaline, while the perfectly black and opake ones are comprised within the name of Schörl. Yet even among the latter varieties there are some which are translucent in thin splinters.

2. Among the various kinds of rhombohedral Tourmaline, analysed by chemists, we notice the following :

	Red Tourmaline from Siberia.	Green Tourmaline from Brazil.	Blue Tourmaline from Uton.	Black Tourmaline from Eubenstock.
Silica	42·00	40·00	40·30	36·75.
Alumina	40·00	39·00	40·50	34·50.
Soda	10·00	0·00	0·00	0·00.
Lithia	0·00	0·00	4·30	0·00.
Potash	0·00	0·00	0·00	6·00.
Lime	0·00	3·84	0·00	0·00.
Oxide of Iron	0·00	12·50	4·85	21·00.
Oxide of Manganese	7·00	2·00	1·50	with Manganese. 0·00.
Magnesia	with a little iron	0·00	0·00	0·25.
Water	0·00	0·00	3·60	0·00.
Boracic Acid	0·00	0·00	1·10	0·00.
	VAUQUELIN.	VAUQUELIN.	ARFVEDSON.	KLAPR.

GRUNER discovered, in a variety from Greenland, 9 per cent. of boracic acid, a substance which has since been found also in several other varieties. Those which contain lithia intumesce before the blowpipe, and assume a slaggy appearance, but do not melt ; those which contain soda intumesce still more, but likewise do not melt, except on the edges ; those containing lime intumesce very much, and melt into a white slag. Rhombohedral Tourmaline assumes by heat opposite kinds of electricity on the opposite apices, which is in connexion with similar phenomena in the crystallisation of the species.

3. Rhombohedral Tourmaline is frequently met with in rocks, particularly in granite, but without forming a regular ingredient of any, and is found imbedded in them in larger or smaller masses, or crystallised in the drusy cavities, as, for instance, in the topaz rock of Saxony. It occurs in beds with different species of Augite-spar, Garnet, Iron-ore, &c. The red varieties in columnar compositions from Siberia, are described as occurring with rhombohedral Quartz, in veins traversing a fine grained granite. It is also met with in the shape of pebbles in the stream-works, and in the sand of many rivers.

4. In Saxony, Cornwall, and other countries, compound varieties of Schörl are very frequent, but simple well pronounced crystals are rare; in these two countries it occurs in the stream-works with ores of tin, &c. The largest and most remarkable crystals of a black colour occur in Greenland, in the mountain called Hörlberg near Bodenmais in Bavaria; near Bovey in Devonshire in England, where they are found along with rhombohedral Fluor-haloide. The red varieties are brought from the government of Permia in Siberia. Less beautiful varieties of the same colour occur at Rozena in Moravia, with Lepidolite in rhombohedral Quartz. They were formerly called *crystallized Lepidolite*. Of the same, and of various other, pale and dark green, blue, &c., colours, rhombohedral Tourmaline occurs in Quartz and Albite at Goshen and Chesterfield in Massachusetts. Pale green crystals are engaged in the dolomite from St Gothard, various transparent deep green, red, brown, and blue colours, occur in the crystals and pebbles from Brazil and Ceylon. Yellowish-brown perfect crystals, imbedded in pale green prismatic Talc-mica, have been lately discovered at Windisch-Kappel in Carinthia. The blue varieties called *Indicolite* are found in the isle of Utön in Sweden, where it also occurs in red and various other colours. Some white specimens have been found at St Gothard and in Siberia. It occurs besides in various parts in Spain, France, Scotland, Norway, Piedmont, Salzburg, Tyrol, &c., in more or less curious varieties.

5. Rhombohedral Tourmaline, if fit for it on account of colour and transparency, is used as a gem. The green varieties from Brazil, formerly called *Brazilian emeralds*, fetch the highest price; but they are inferior in value to real emeralds. Plates of particularly the brown Tourmaline, if cut parallel to the axis, absorb one of the polarized pencils, which renders them useful instruments in the examination of the structure of minerals in polarized light.

GENUS XI. GARNET.

1. PYRAMIDAL GARNET.

Pyramidal Garnet (excepting Gehlenite). JAM. Syst. Vol. I. p. 131. Pyramidal Garnet or Vesuvian. Man. p. 228. Idocrase. PHILL. p. 33. Vesuvian. Egeran. WERN. Hoffm. H. B. I. S. 472. Syst. S. 34. Idokras. (excepting Kaneelstein). HAUSM. II. S. 622. Idokras. LEONH. S. 434. Idocrase. HAÜY. Traité, T. II. p. 574. Tabl. comp. p. 34. Traité, 2de Ed. T. II. p. 544.

Fundamental form. Scalene four-sided pyramid. P = 129° 29′, 74° 14′. Vol. I. Fig. 8. R. G.

$$a = \sqrt{0{\cdot}5726}.$$

Simple forms. P − ∞ (*P*); $\frac{2\sqrt{2}}{3}$ P − 3 (*n*) = 160° 5′, 28° 19′; P − 1 (*o*) = 141° 1′, 56° 8′; P (*c*); P + 1 = 117° 47′, 93° 53′; P + 2 (*b*) = 107° 41′, 113° 6′; $\frac{3}{2\sqrt{2}}$ P + 3 = 99° 21′, 132° 27′; P + 4 (*r*) = 95° 39′, 143° 26′; P + ∞ (*d*); [P + ∞] (*M*); (P − 2)^3 (*a*) = 146° 25′, 156° 26′, 80° 28′; (P − 1)^3 (*z*) = 139° 54′, 151° 55′, 100° 14′; (P)^3 (*s*) = 134° 45′, 148° 24′, 118° 50′; (P + 1)^3 (*e*) = 131° 16′, 146° 4′, 134° 39′; (P + ∞)^3 (*h*) = 126° 52′ 12″, 143° 7′ 48″; [(P + ∞)^3] (*f*) = 143° 7′ 48″, 126° 52′ 12″; (P)^4 (*x*).

Char. of Comb. Pyramidal.

Combinations. 1. P − ∞. P. P + ∞. [P + ∞]. Sim. Fig. 101., having the apex replaced. Siberia.

2. P − ∞. P. P + ∞. [P + ∞]. P + ∞. [(P + ∞)^3]. Vesuvius.

3. P − ∞. P − 1. P. P + ∞. [P + ∞]. [(P + ∞)^3]. Orawitza, Bannat.

4. $P-\infty$. $P-1$. P. $(P-2)^3$. $(P-1)^3$. $P+2$. $(P)^3$. $(P)^4$. $(P+1)^3$. $P+4$. $(P+\infty)^3$. $[(P+\infty)^3]$. $P+\infty$. $[P+\infty]$. Fig. 96. Vesuvius.

Cleavage, $P+\infty$ and $[P+\infty]$ not very distinct, still less so $P-\infty$. Fracture imperfect conchoidal, uneven. Surface, $P-\infty$ sometimes uneven and curved; the prisms striated parallel to their common intersections, the rest of the faces smooth.

Lustre vitreous, inclining to resinous, sometimes very distinctly the latter. Colour, various shades of brown, passing into leek-green, pistachio-green, olive-green and oil-green. Streak white. Semi-transparent ... faintly translucent on the edges. If viewed in the direction of the axis, the colours inclined more to yellow, perpendicular to it more to green.

Hardness = 6·5. Sp. Gr. = 3·399, a perfectly pure fragment of a crystal of Egerane.

Compound Varieties. Massive: composition granular, of various, sometimes considerable sizes of individuals, often strongly connected. There occurs also columnar composition, generally of thin individuals, straight and divergent or irregular, faces of composition irregularly streaked.

OBSERVATIONS.

1. The first varieties of pyramidal Garnet, which attracted the notice of mineralogists, were those found among the minerals ejected by Mount Vesuvius. With

these, the varieties discovered at successive periods, were almost all united. Those found near Egra in Bohemia, were, however, considered as a particular species, and from their locality they received the name of *Egerane*, while that of *Vesuvian* was retained for the other; both have been comprised under the name of *Idocrase.* The only difference that seems to exist between these varieties consists in the relative length of the crystals, which is much greater in Egerane, and the crystals more deeply streaked and altogether less perfectly formed, than those of Vesuvian, which appear in shorter prisms, bounded by a greater number of brilliant planes. The composition of massive varieties is granular in the latter, and columnar in the former. All the colours, however, of Vesuvian and Egerane form a continuous series, in which no constant limits can be fixed. A variety resembling Egerane has been called *Loboïte*, and *Frugardite;* another from Tellemarken in Norway, of a blue colour, and containing copper, which is supposed to belong to the present species, has been termed *Cyprine.*

2. Pyramidal Garnet has yielded by analysis the following results: the two first were obtained by KLAPROTH, the third by Count DUNIN BORKOWSKY.

	Vesuvian, from Vesuvius.	*Vesuvian,* from Siberia.	*Egerane,* from Bohemia.
Silica	35·50	42·00	41·00.
Alumina	33·00	16·25	22·00.
Lime	22·25	34·00	22·00.
Magnesia	0·00	0·00	3·00.
Oxide of Iron	7·50	5·50	6·00.
Oxide of Manganese	0·25	a trace	2·00.
Potash	0·00	0·00	1·00.

The varieties from Vesuvius and from Fassa in the Tyrol, easily melt into a dark coloured globule, which is pale green in Egerane, and the formation of it accompanied with effervescence. The blueish-grey eight-sided prisms, formed in the iron-slag from Merthyr Tydvil, are considered by Professor MITSCHERLICH as belonging to the present species.

3. Some of the varieties of pyramidal Garnet occur in imbedded crystals in a kind of serpentine, containing also decomposed crystals of an unknown mineral in the shape of trigonal dodecahedrons; others are found massive in rocks and mountain masses, in the cavities of which they appear in a crystallised state. They also occur in veins, but the second kind of their repositories is the most frequent. Pyramidal Garnet is accompanied by rhombohedral Lime-haloide, rhombohedral Talc-mica, various species of the genera Kouphone-spar, Augite-spar and Feld-spar, frequently by dodecahedral Garnet and rhombohedral Quartz, and sometimes by ores of iron and copper, &c.

4. The imbedded crystals, presenting less complicated varieties of crystallisation, have been found on the banks of the Wilui river, and Lake Baikal in Siberia; the implanted complicated crystals occur at Monte Somma, among the fragments ejected by Vesuvius, and have been originally formed in those cavities of the rock in which they are found. At Haslau near Egra in Bohemia, it occurs in crystals imbedded in rhombohedral Quartz, also in massive varieties of a columnar composition; in similar circumstances in Finland, where, among others, they are accompanied by prismatic Titanium-ore. In beds in limestone it occurs at Orawitza in the Bannat of Temeswar, and at Mount Monzoni near Fassa in Tyrol, also near Christiania in Norway, and in magnificent crystals in veins traversing primitive rocks, in the valley of Brozzo and other places in Piedmont. It is found besides in Spain, in Ireland, America, &c.

2. TETRAHEDRAL GARNET.

Tetrahedral Garnet or Helvine. JAM. Man. p. 224. Helvin. PHILL. p. 244. Helvin. WERN. Hoffm. H. B. IV. 2. S. 112. Helvin. LEONH. S. 430. Helvine. HAÜY. Traité, 2de Ed. T. II. p. 333.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. $\frac{O}{2}$ (*P*) Vol. I. Fig. 13.; $-\frac{O}{2}$ (*e*) Vol. I. Fig. 14.

Char. of Comb. Semi-tessular with inclined faces. Combination. $\frac{O}{2}. -\frac{O}{2}.$ Fig. 158.

Cleavage, traces of the octahedron. Fracture uneven. Surface, of one of the tetrahedrons smooth, a little rounded and uneven, sometimes streaked parallel to its edges, of the other rough but even.

Lustre vitreous, inclining to resinous. Colour wax-yellow, inclining to honey-yellow and yellowish-brown, or also to siskin-green. Streak white. Translucent on the edges.

Hardness = 6·0 ... 6·5. Sp. Gr. = 3·100, of a very small quantity.

OBSERVATIONS.

1. According to VOGEL, it consists of

Silica	39·50.
Alumina	15·65.
Oxide of Iron	37·75.
Oxide of Manganese	3·75.
Lime	0·50.

Before the blowpipe upon charcoal, it melts in the reducing flame with effervescence into a globule of almost the same colour as the mineral. In the oxidating flame the colour becomes dark, and the fusion more difficult. With borax it yields a transparent glass, often coloured by manganese.

2. Tetrahedral Garnet has been hitherto found only at Schwarzenberg in Saxony, in beds in gneiss. It is accompanied with dodecahedral Garnet-blende, rhombohedral

Quartz, octahedral Fluor-haloide, and rhombohedral Lime-haloide.

3. DODECAHEDRAL GARNET.

Dodecahedral Garnet (excepting subsp. 8. and 9.). Jam. Syst. Vol. I. p. 139. Dodecahedral Garnet. Man. p. 224. Garnet. Phill. p. 26. Grossular. Melanit. Granat. Allochroit. Pirop. Pirenäit. Kolophonit. Wern. Hoffm. H. B. I. S. 479. 488. 491. 512. 521. II. 1. S. 371. 373. Almandin. Pyrop. Granat. Braunsteinkiesel. Kolophonit. Melanit. Hausm. II. S. 595. 596. 599. 602. 603. 604. Granat. Leonh. S. 426. Grenat. Haüy. Traité, T. II. p. 540. Tabl. comp. p. 32. Traité, 2de Ed. T. II. p. 313.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. H; $\overset{*}{D}_1$ (*P*) Vol. I. Fig. 31., Fahlun, Sweden; A_2 (*c*) Vol. I. Fig. 32; $\dot{C}_1$ (*n*) Vol. I. Fig. 34., Botallack, Cornwall; $\dot{T}_1$ (*s*) Vol. I. Fig. 35.

Combinations. 1. H. D. Fig. 151. the faces of the hexahedron much smaller. Cziklowa, Bannat.

2. D. C_1. Fig. 154. Fracati, near Rome.

3. D. C_1. T_1. Arendal, Norway.

4. D. C_1. A_2. T_1. Ala, Piedmont.

Irregular forms, grains.

Cleavage, dodecahedron, indistinct. Fracture conchoidal, more or less perfect, generally uneven. Surface of the hexahedron rough; the tetragonal icositetrahedron, and the tetraconta-octahedron frequently streaked parallel to the edges of combination with the dodecahedron; the dodecahedron itself sometimes streaked parallel to its edges of combination with the hexahedron. The surface of the grains is uneven, rarely granulated.

Lustre vitreous, inclining to resinous in some varieties, more nearly the latter. Colour red, brown, yellow, white, green, black; except some red colours, none of them are bright. Streak white. Transparent ... translucent.

Hardness = 6·5 ... 7·5. Sp. Gr. = 3·615, Grossular; 3·701, Melanite; 3·769, brown, common Garnet; 3·788, Pyrope; 4·098, crystals of precious Garnet, Tyrol; 4·125 grains of precious Garnet, Ohlapian; 4·179, crystals of Almandine; 4·208, crystals of precious Garnet, Haddam.

Compound Varieties. Massive: composition granular, of various sizes of individuals, and often even impalpable, easily separated or strongly coherent; faces of composition irregularly streaked, uneven or rough. If the composition be impalpable, the fracture becomes uneven and splintery. The composition is sometimes thick lamellar, and bent, the faces of composition being pretty smooth.

OBSERVATIONS.

1. The numerous and manifold varieties of those minerals which are at present united within the species of dodecahedral Garnet, present such properties as render it likely, that they will be at some future period distinguished into several really distinct species. Particularly the limits of hardness and of specific gravity are more distant than we are accustomed to find it in one and the same species. Those inquiries, however, which have been hitherto instituted into their natural-historical properties, are not sufficient to establish clear and constant limits, and in

the present state of Mineralogy we must therefore leave them in that connexion with each other. The distinction introduced among those species which have received particular names and denominations, does not correspond to those properties, for it depends almost entirely upon accidental circumstances. Of these species, *Grossular* occurs only in imbedded crystals of the forms of icositetrahedrons, and combinations of it with the dodecahedron. Its colours are confined to asparagus-green and mountain-green. *Pyreneite* also occurs only in small imbedded crystals in limestone; these are dodecahedrons, and generally greyish-black, but sometimes so pale as to be greyish-white and semi-transparent. *Melanite* possesses nearly the same forms as Grossular, generally imbedded, and of a velvet-black colour. *Pyrope* occurs only in grains, and is remarkably distinct by its pure translucency and blood-red colour, which is not found in any other variety, though they approach very near to it. Among the gems commonly considered by jewellers as Spinel, there are some which, in colour, hardness, and specific gravity, agree much more with Pyrope than with dodecahedral Corundum, and therefore very likely belong to the same species. Among the varieties called *Garnet*, we find every simple form and combination noticed above among the crystalline varieties, also grains and massive varieties; it contains likewise every shade of the series of colours, &c., and it is therefore only in the particular union of several of these properties, that we must look for the distinction of the above-mentioned species. The colour of *precious Garnet* is always red, its crystals are formed imbedded, it is the only variety that occurs in grains, and if compound, it presents lamellar composition. *Common Garnet* seldom occurs in red colours, and these are of dirty tinges; its crystals are generally implanted, and the composition granular, but not impalpable. *Colophonite* is a compound variety of yellowish-brown and reddish-brown, or oil-green and honey-yellow colours, consisting of roundish particles of composition, which may be separated with great facility. It should be observed, however, that frequently varieties of paratomous Augite-spar are called Colophonite in collections. If the composition be impalpable, or the particles of a granular composition so intimately connected that they cannot be distinguished from each other, *Allochroite* is formed, a variety which is often mechanically mixed with minerals foreign to the species.

2. The ingredients of dodecahedral Garnet have been found as follows:

	Grossular.	Melanite.	Precious Garnet.	Colophonite.	Allochroite.	Pyreneite.	Pyrope.
Silica	44·00	35·50	35·75	37·00	35·00	43·00	40·00
Alumina	8·50	6·00	27·25	13·50	8·00	16·00	28·50
Lime	33·50	32·50	0·00	29·00	30·00	20·00	3·50
Ox. of Iron	12·00	24·25	36·00	7·50	17·00	16·00	16·50
Ox. of Man.	a trace.	0·40	0·25	4·75	3·50	0·00	0·25
	Klap.	Klap.	Klap.	Simon.	Vauq.	Vauq.	Klap.

Besides these, Colophonite contains 6·5 per cent. of magnesia, 0·5 oxide of titanium, and 1·0 water, Allochroite 6·0 of carbonate of lime, Pyreneite 4·0 of water, and Pyrope 10·0 of magnesia and 2·0 chromic acid. In general the varieties of the present species present great differences in regard to their mixture, only a few of which have been indicated above. Before the blowpipe they melt pretty uniformly without effervescence into a black globule presenting a vitreous fracture. Some varieties present a slight effervescence, but finally yield the same result. The bead obtained by melting is frequently attracted by the magnet.

3. Though dodecahedral Garnet cannot be said with propriety to enter into the composition of rocks, it occurs in many of them in grains and imbedded crystals, as in granite, gneiss, but particularly in mica-slate, chlorite-slate, white-stone, serpentine, in various kinds of rocks considered as lava, more sparingly in limestone. Precious Garnet occurs in slaty primitive rocks; Grossular and Pyrope are found in serpentine, the latter also in other rocks, through the decomposition of which it is brought into the

soil. Melanite is imbedded in a kind of lava, but occurs also implanted in the geodes ejected by Vesuvius, and Pyreneite in limestone. Common Garnet is likewise one of those species occurring at Mount Vesuvius, along with pyramidal Garnet, several species of the genus Feld-spar, &c.: much more frequently, however, it is found in beds, consisting either wholly or for the greater part of its varieties, accompanied by octahedral Iron-ore, several species of Augite-spar, &c. Thus also are found Allochroite and Colophonite. Some varieties occur in veins traversing serpentine and other rocks.

4. Several of the varieties mentioned above have been found only in a few localities. Grossular occurs along with pyramidal Garnet in Kamtschatka, in a kind of serpentine; Melanite at Frascati and Albano near Rome; Pyrope near Bilin in Bohemia, and in the serpentine of Zöblitz and the forest of Zell in Saxony; Pyreneite near Barèges in the Pyrenees. Precious Garnet, sometimes in large but not very transparent crystals, and often covered with a coat of chlorite, occurs at Fahlun in Sweden, and in many localities of the Tyrol, Carinthia, Stiria, Switzerland, Hungary, &c. The varieties presenting lamellar compositions are found in Greenland, common Garnet in large quantities at Breitenbrunn, Berggiesshübel, Geyer, and other places in Saxony, at Drammen and Arendal in Norway, Fahlun, Longbanshyttan, &c. in Sweden, at Orawitza in the Bannat, at Dobschau and Rezbanya in Hungary, at Saldenhofen in Stiria, in Siberia, and many other places. Colophonite is known from Arendal, Allochroite from Drammen, and curious varieties of the latter of yellowish-white and grass-green colours also from the valley of Zem in Salzburg. The transparent crystals of precious garnet, called *Almandine*, are chiefly brought from Ceylon and Pegu, where they occur in the sand of rivers. A fine variety approaching in colour to Pyrope, is found at Elie in Fifeshire.

5. Transparent varieties of dodecahedral Garnet are used as gems, but are not highly prized. Among these, how-

ever, Pyrope is preferred to the rest, if pure and of considerable magnitude. Common Garnet is useful as a flux of iron-ores, and is in some countries called Green Iron-stone.

6. From the species of dodecahedral Garnet two substances are distinguished by Haüy, which may be here shortly noticed.

i. *Aplome.*

Haüy. Traité, 2de Ed. T. II. p. 538.

Form tessular. Combinations observed, 1. H. D. Fig. 151, the faces of the hexahedron small; 2. D. C_1. Fig. 154. Cleavage, traces of the hexahedron. Fracture uneven. Surface of the dodecahedrons streaked parallel to the edges of combination with the hexahedron, which, however, is not the case in the cleavable varieties. Lustre vitreous, inclining to resinous; high degrees upon faces of crystallisation, low degrees in the fracture. Colour brown, sometimes yellowish. Streak white. Translucent on the edges ... opake. Brittle. Hardness = 7·0 ... 7·5 (it scratches rhombohedral Quartz). Sp. Gr. = 3·444, Haüy. It has also been found massive.

According to Laugier, Aplome consists of

Silica	40·0.
Alumina	20·0.
Lime	15·5.
Oxide of Manganese	2·0.
Ferriferous Silica	2·0.

There was a loss of 7·0. Before the blowpipe it melts into a black globule. The localities are, the banks of the river Lena in Siberia, Schwarzenberg in Saxony and Bohemia. Small brilliant, cleavable crystals are found in England.

ii. *Essonite.*

Dodecahedral Garnet, subsp. 8th. Jam. Syst. Vol. I. p. 162. Prismatic Garnet or Cinnamon-Stone. Man. p. 228. Cinnamon-Stone. Phill. p. 32. Kaneelstein. Wern. Hoffm. H. B. I. S. 417. Idokras. Hausm.

II. S. 622. Hessonit. Leonh. S. 433. Kaneelstein. Haüy. Tabl. comp. p. 62. Essonite. Traité, 2de Ed. T. II. p. 541.

The forms are said by Haüy to be prismatic, and traces of cleavage parallel to a prism of 102° 40′. It is generally found in grains. Fracture imperfect and small conchoidal, uneven. Surface uneven and gibbous. Lustre vitreous, inclining to resinous. Colour intermediate between hyacinth-red and orange-yellow. Streak white. Transparent ... translucent. Hardness = 7·0 ... 7·5. Sp. Gr. = 3·636. It also occurs massive, presenting granular composition.

It will depend upon the investigations of the regular forms of cinnamon-stone, whether or not it is to be considered as a species of its own. If these belong to the prismatic system, as is indicated by Haüy, no doubt can exist in regard to the propriety of his erecting it into a particular species. But the close agreement of all its properties with those of dodecahedral Garnet, and the tessular forms inferred from the optical observations of M. Biot and Dr Brewster, which are not contradicted by Haüy, who quotes *simple* refraction among the characters, render it extremely probable, that it is a variety of dodecahedral Garnet.

Cinnamon-stone consists, according to Klaproth, of

Silica	38·30.
Alumina	21·20.
Lime	31·25.
Oxide of Iron	6·50.

It does not at first assume a darker colour before the blowpipe but melts easily into a brownish-black globule. It occurs in the sand of rivers and in primitive rocks with prismatic Augite-spar in Ceylon. It is found massive at Kincardine in Ross-shire. But it is difficult to quote localities, as the varieties can be hardly distinguished from others of dodecahedral Garnet. It is used as a gem, which fetches a good price, if large, well coloured and transparent, and goes generally by the name of *Hyacinth*.

5. PRISMATOIDAL GARNET.

Prismatic Garnet or Grenatite. JAM. Syst. Vol. I. p. 166. Prismatoidal Garnet or Grenatite. Man. p. 229. Staurolite. Grenatite. PHILL. p. 82. Staurolith. WERN. Hoffm. H. B. I. S. 515. Staurolith. HAUSM. II. S. 629. Staurolith. LEONH. S. 424. Staurotide. HAÜY. Traité, T. III. p. 93. Tabl. comp. p. 43. Traité, 2de Ed. T. II. p. 338.

Fundamental form. Scalene four-sided pyramid. $P = 104° 49', 99° 22', 125° 33'$. Vol. I. Fig. 9. HAÜY.

$$a : b : c = 1 : \sqrt{0{\cdot}5625} : \sqrt{0{\cdot}5}.$$

Simple forms. $P - \infty$ (P); $\bar{P}r$ (r) $= 70° 32'$; $(\bar{P}r + \infty)^3$ (M) $= 129° 31'$; $\breve{P}r + \infty$ (o).

Char. of Comb. Prismatic.

Combinations. 1. $P - \infty$. $(\bar{P}r + \infty)^3$. Sebes, Transylvania.

2. $P - \infty$. $(\bar{P}r + \infty)^3$. $\breve{P}r + \infty$. Spain.

3. $P - \infty$. $\bar{P}r$. $(\bar{P}r + \infty)^3$. $\breve{P}r + \infty$. Fig. 12. St Gothard.

Cleavage, $\breve{P}r + \infty$ perfect, but interrupted, traces of $(\bar{P}r + \infty)^3$. Fracture conchoidal, uneven. Surface, $P - \infty$ sometimes very rough and corroded, hollowed out in the centre. The rest of the faces generally of the same quality, either rough or smooth.

Lustre vitreous, inclining to resinous. Colour reddish-brown, or brownish-red, very dark. Streak white. Translucent, frequently only on the edges.

Hardness $= 7{\cdot}0 \ldots 7{\cdot}5$. Sp. Gr. $= 3{\cdot}724$, crystals from St Gothard; that of the common twin-crystals from Spain, the substance of which is less homogeneous, is between 3·3 and 3·4.

Compound Varieties. Twin-crystals. 1. Face of composition parallel, axis of revolution perpendicular to a face of $\frac{3}{4}\breve{P}r = 90°$; 2. Face of composition parallel, axis of revolution perpendicular to a face of P. The individuals in both cases are continued beyond the face of composition, and produce cruciform groupes, the crystals crossing each other in the first case at right angles, in the second at angles of 60° and 120°. By the addition of a third individual to the latter, groupes resembling stars, with six radii are forms. There are examples of composition, parallel to both kinds of faces at once.

OBSERVATIONS.

1. According to an analysis by Vauquelin, of the variety from Brittany, and another by Klaproth, of the variety from St Gothard, prismatoidal Garnet consists of

Silica	33·00	37·50.
Alumina	44·00	41·00.
Lime	3·84	0·00.
Magnesia	0·00	0·50.
Oxide of Iron	13·00	18·25.
Oxide of Manganese	1·00	0·50.

It assumes a dark colour before the blowpipe, but does not melt.

2. This species occurs in imbedded crystals in primitive rocks, particularly in mica-slate, in simple and compound crystals, accompanied by prismatic Disthene-spar, dodecahedral Garnet, &c.

3. Simple crystals occur in St Gothard in Switzerland, and the Greiner Mountain in Zillerthal in the Tyrol, sometimes curiously aggregated with crystals of prismatic

Disthene-spar, into a continuous mass with parallel axes. Mr **Rose** first observed that the perfect planes of cleavage of the two crystals always coincide. Less perfect are the varieties from Sebes in Transylvania. Twin-crystals occur at St Jago de Compostella in Spain, and Oporto in Portugal. There occur likewise several varieties in France, in Aberdeenshire, and several of the isles in Scotland; in Brazil; and near Philadelphia in North America.

GENUS XII. ZIRCON.

1. PYRAMIDAL ZIRCON.

Pyramidal Zircon. JAM. Syst. Vol. I. p. 29. Man. p. 230. Zircon. PHILL. p. 99. Zirkon. Hiazinth. WERN. Hoffm. H. B. I. S. 396. 407. Zirkon. HAUSM. II. S. 618. Zirkon. LEONH. S. 391. Zircon. HAÜY. Traité, T. II. p. 465. Tabl. comp. p. 28. Traité, 2de Ed. T. II. p. 291.

Fundamental form. Isosceles four-sided pyramid. $P = 123° 19'$, $84° 20'$. Vol. I. Fig. 8. R. G.

$$a = \sqrt{0{\cdot}8204}.$$

Simple forms. $P - \infty$; $P - 1$ (t) $= 135° 10'$, $65° 17'$; $\overset{*}{P}$ (P), Expailly, France; $P + 2 = 103° 31'$, $122° 12'$; $\frac{3}{2\sqrt{2}} P + 3$ (u) $= 96° 51'$, $139° 35'$; $P + \infty$ (l); $[P + \infty]$ (s); $(P)^3$ (x) $= 132° 43'$, $147° 3'$, $127° 27'$; $(P)^4$ (y); $(P)^5$ (z).

Char. of Comb. Pyramidal.

Combinations. 1. P. $P + \infty$. St Gothard, Switzerland.

2. P. $[P + \infty]$. Sim. Fig. 97. Ceylon.

3. P. $(P)^3$. $P + \infty$. $[P + \infty]$. Ohlapian.

4. P. $(P)^3$. $\frac{3}{2\sqrt{2}} P + 3$. $P + \infty$. $[P + \infty]$. Vol. I. Fig. 68. Frederiksvärn, Norway.

5. $P - 1.\ P.\ (P)^3.\ (P)^4.\ P + \infty.\ [P + \infty].$ Saualpe, Carinthia.

6. $P - 1.\ P.\ (P)^3.\ (P)^4.\ (P)^5.\ P + \infty.\ [P + \infty].$ Fig. 99. Saualpe.

Irregular forms, grains.

Cleavage, P and $P + \infty$; the latter more distinct, but none of them of high degrees of perfection. Fracture conchoidal, uneven. Surface; $P - \infty$ very rough; $P - 1$ also rough, though less so than $P - \infty$; $[P + \infty]$ often both rough and uneven. The other faces are nearly all alike in respect to their physical qualities, often particularly smooth and shining; the grains and pebbles are uneven and often rough, but sometimes also very smooth.

Lustre, more or less perfectly adamantine. Colour red, brown, yellow, grey, green, white; with the exception of some red tints, none of them are bright. Streak white. Transparent ... translucent, sometimes but faintly.

Hardness = 7·5. Sp. Gr. = 4·505, of a crystallised variety from the Saualpe, Carinthia.

OBSERVATIONS.

1. The reason why Hyacinth and Zircon have so long been separated from each other as distinct species, we find in the circumstance, that the specific gravity of Essonite (p. 364.), to which the name of *Hyacinth* likewise had been applied, was supposed to refer to those varieties of pyramidal Zircon, which possess the same colour, while the specific gravity of the rest was known, and constituted one of the characters of the species *Zircon*. But even after

this error had been discovered, several mineralogists yet continued to divide those varieties, and grounded the differences upon forms of crystallisation, colour, &c. all of which can be of no avail, if we rightly consider the species in Mineralogy. Hyacinth possesses the brightest colours, least inclining to grey, and such combinations, in which the regular four-sided prism, in combination with the fundamental pyramid, is in a diagonal position, as in Fig. 97., either alone, or at least presents broader faces than the other prism, in parallel position with P, and which replaces the lateral edges of the pyramid, and of the other prism. Both, crystals and grains of Hyacinth are smooth and shining, those of Zircon are frequently rough. Zircon besides possesses tints of colour, that incline much more to grey. The differences in cleavage, supposed to take place between the two varieties, do not exist, at least they are not greater than we are accustomed to find them in other species. Hence it is evident that all the varieties must be necessarily included within one and the same species, which then appears as one of the most remarkable in the whole mineral kingdom.

2. Zircon and Hyacinth consist, according to KLAPROTH, of

Zirconia	69·00	70·00.
Silica	26·50	25·00.
Oxide of Iron	0·50	5·00.

Before the blowpipe it loses its colour, but does not melt.

3. The varieties of this species have always been found in imbedded crystals in mountain masses, or in beds included in them. They seldom form small masses, consisting of several crystals. From these repositories it is washed into the sand of rivers, where it is not unfrequently met with.

4. In the Saualpe in Carinthia, pyramidal Zircon occurs in a bed of Albite and of prismatoidal Augite-spar, called Zoisite, in gneiss; the varieties from New Jersey and other localities in North America, from Greenland, from Ceylon, &c. occur likewise in gneiss or in talcose rocks; those from Frederiksvärn in Norway, in zircon-syenite. Near Puy

in France it occurs in amygdaloid. In Ceylon, in France, at Bilin in Bohemia, at Ohlapian in Transylvania, &c. pyramidal Zircon occurs in the sand of rivers; it is commonly found with the native Platina. Among the residue from the gold stream works in Transylvania, they are frequently of a white colour; but there are likewise bright hyacinth-red ones of the elegant form $(P)^3$. $[P + \infty]$, the eight-sided pyramid not being modified by any faces contiguous to its apices. Similar varieties are found among the *Scorza*, or arenaceous Epidote (prismatoidal Augite-spar) from Muska on the Aranyos in the same country. They are very small.

5. Pyramidal Zircon is used as a gem, but of no high value. Several varieties from Ceylon used formerly to be called *Jargon de Ceylon*, and sold as an inferior kind of diamonds, on which account they were denominated Jargoon of diamond.

GENUS XIII. GADOLINITE.

1. PRISMATIC GADOLINITE.

Prismatic Gadolinite. JAM. Syst. Vol. I. p. 170. Man. p. 231. Gadolinite. PHILL. p. 105. Gadolinit. WERN. Hoffm. H. B. III. 2. S. 303. Gadolinit. HAUSM. II. S. 608. Gadolinit. LEONH. S. 500. Gadolinite. HAÜY. Traité, T. III. p. 141. Tabl. comp. p. 47. Traité, 2de Ed. T. II. p. 440.

Fundamental form. Scalene four-sided pyramid. $P = 156° \; 55', 111° \; 6', 73° \; 44'$. Inclination of the axis $= 0$. Vol. I. Fig. 41. HAÜY.

$$a : b : c : d = 1 : 4 : \sqrt{2} : 0.$$

Simple forms. $\frac{P}{2}\,(l) = 156° \; 55'$; $(\breve{P}r + \infty)^3\,(M) = 109° \; 28'$; $(\breve{P} + \infty)^4\,(u) = 70° \; 32'$; $\frac{\bar{P}r}{2}\,(s) = 54° \; 44'$; $\breve{P}r + \infty\,(r)$.

Char. of Comb. Hemi-prismatic.

Combination. $1. \frac{\bar{P}r}{2} \cdot \frac{P}{2} \cdot (\check{P}r+\infty)^3 \cdot (\check{P}+\infty)^4 \cdot \check{P}r+\infty.$

Cleavage, so imperfect, that its direction has not been ascertained. Fracture conchoidal.

Lustre vitreous, inclining to resinous. Colour greenish-black, very dark. Streak greenish-grey. Translucent on the edges, almost opake.

Hardness = 6·5 ... 7·0. Sp. Gr. = 4·238.

Compound Varieties. Massive: composition impalpable, fracture conchoidal.

OBSERVATIONS.

1. The above mentioned forms are given on the authority of Haüy, but, according to his own statement, they are only approximations.*

2. According to Berzelius, prismatic Gadolinite consists of

Yttria	45·00.
Protoxide of Iron	11·43.
Protoxide of Cerium	17·92.
Silica	25·80.

Before the blowpipe it decrepitates, if it has not been heated with the necessary precaution; and does not melt, except in very small splinters. If heated with precaution upon charcoal, it incandesces at once, and its colour becomes paler. In nitric acid it loses its colour, and is converted into a jelly.

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* Mr Phillips describes an oblique rhombic prism of 115°, the terminal plane of which is inclined to the obtuse edge at an angle of 98°. It is combined with a horizontal prism of 120° in the direction of the short diagonal of the oblique prism, and two faces of a pyramid to which the horizontal prism belongs, meeting at an angle of 120°; they replace the obtuse edges of combination in the oblique prism. H.

3. Prismatic Gadolinite occurs in gneiss and granite, in repositories that have been considered as beds and as veins. It is chiefly accompanied by prismatic Feld-spar and Albite, rhombohedral Quartz, &c. Its localities are Ytterby near Stockholm, and Finbo and Broddbo near Fahlun in Sweden. It is likewise found in Greenland.

ORDER VIII. ORE.

GENUS I. TITANIUM-ORE.

1. PRISMATIC TITANIUM-ORE.

Prismatic Titanium-Ore or Sphene. JAM. Syst. Vol. III. p. 121. Man. p. 232. Sphene. PHILL. p. 262. Braun-Menakerz. Gelb-Menakerz. WERN. Hoffm. H. B. IV. 1. S. 260. 263. Sphen. HAUSM. II. S. 613. Titanit. LEONH. S. 596. Sphène. Titane silicéo-calcaire. HAÜY. Traité, T. III. p. 114. T. IV. p. 307. Titane silicéo-calcaire. Tabl. comp. p. 116. Titane calcaréo-siliceux. Traité, 2de Ed. T. IV. p. 353.
G. ROSE. De Sphenis atque Titanitae systemate crystallino. Berol. 1820.

Fundamental form. Scalene four-sided pyramid. $P = \left\{\begin{matrix}113^\circ\ 37' \\ 106^\circ\ 40'\end{matrix}\right\}$, $89^\circ\ 46'$, $131^\circ\ 8'$. Inclination of the axis $= 8^\circ\ 18'$ in the plane of the short diagonal. Vol. I. Fig. 41. ROSE.

$a : b : c : d = 6{\cdot}35 : 4{\cdot}05 : 4{\cdot}97 : 1.$

Simple forms. $P - \infty\ (v)$; $\frac{P}{2}\ (r) = 113^\circ\ 37'$; $-\frac{\frac{4}{3}P - 2}{2}\ (l) = 133^\circ\ 48'$; $-\frac{(\check{P}r)^3}{2}\ (s) = 67^\circ\ 46'$; $(\bar{P}r + \infty)^3\ (n) = 136^\circ\ 8'$; $\frac{(\frac{4}{3}\bar{P} - 2)^3}{2}\ (o) = 155^\circ\ 25'$; $-\frac{(\frac{4}{3}\check{P} - 2)^3}{2}\ (M) = 76^\circ\ 1'$;

$(\bar{\mathrm{P}} + \infty)^4\ (d) = 157^\circ\ 8'$; $(\check{\mathrm{P}}\mathrm{r} + \infty)^5\ (u) = 79^\circ\ 12'$; $\pm \frac{\check{\mathrm{P}}\mathrm{r}}{2} \left\{ \begin{matrix} P \\ y \end{matrix} \right\} = \left\{ \begin{matrix} 28^\circ\ 6' \\ 32^\circ\ 18' \end{matrix} \right\}$; $-\frac{\bar{\mathrm{P}}\mathrm{r} + 1}{2}$? $(x) = 16^\circ\ 50'$; $\check{\mathrm{P}}\mathrm{r} - 1\ (t) = 110^\circ\ 51'$; $\check{\mathrm{P}}\mathrm{r} + \infty\ (q)$.

Char. of Comb. Hemi-prismatic. Inclination of $\mathrm{P} - \infty$ on $\bar{\mathrm{P}}\mathrm{r} + \infty = 98^\circ\ 18'$.

Combinations. 1. $\frac{\bar{\mathrm{P}}\mathrm{r}}{2}. - \frac{\bar{\mathrm{P}}\mathrm{r}}{2}. (\check{\mathrm{P}}\mathrm{r} + \infty)^3$. Sim. Fig. 1. Arendal, Norway.

2. $\frac{\bar{\mathrm{P}}\mathrm{r}}{2}. - \frac{\bar{\mathrm{P}}\mathrm{r}}{2}. - \frac{\bar{\mathrm{P}}\mathrm{r} + 1}{2}. - \frac{(\check{\mathrm{P}}\mathrm{r})^3}{2}$. Passau.

3. $\frac{\bar{\mathrm{P}}\mathrm{r}}{2}. \frac{\mathrm{P}}{2}. - \frac{\bar{\mathrm{P}}\mathrm{r}}{2}. (\bar{\mathrm{P}}\mathrm{r} + \infty)^3$. Fig. 47. Arendal.

4. $\frac{\bar{\mathrm{P}}\mathrm{r}}{2}. - \frac{\bar{\mathrm{P}}\mathrm{r}}{2}. - \frac{\bar{\mathrm{P}}\mathrm{r} + 1}{2}. - \frac{\frac{4}{3}\mathrm{P} - 2}{2}. \frac{(\frac{4}{3}\check{\mathrm{P}} - 2)^3}{2}. \check{\mathrm{P}}\mathrm{r} + \infty$. St Gothard, Switzerland.

Cleavage; sometimes distinct in the direction of $\frac{\mathrm{P}}{2}$; less distinct in that of $\frac{\bar{\mathrm{P}}\mathrm{r}}{2}$ and $-\frac{\frac{4}{3}\mathrm{P} - 2}{2}$. Fracture imperfect conchoidal, uneven. Surface, $\frac{\bar{\mathrm{P}}\mathrm{r}}{2}$ and $-\frac{\frac{4}{3}\mathrm{P} - 2}{2}$ almost always faintly streaked parallel to the edges of combination with $\frac{\mathrm{P}}{2}$; $-\frac{(\check{\mathrm{P}}\mathrm{r})^3}{2}$ at the same time parallel to those with $\check{\mathrm{P}}\mathrm{r} - 1$, with $(\bar{\mathrm{P}}\mathrm{r} + \infty)^3$, and with its own edges; $-\frac{\bar{\mathrm{P}}\mathrm{r} + 1}{2}$ is often rounded, sometimes also $-\frac{\bar{\mathrm{P}}\mathrm{r}}{2}$. The remaining faces are smooth, and often possess high degrees of lustre.

Lustre adamantine, sometimes inclining to resinous.

Colour brown, yellow, grey, green; they are not lively, some pistachio-green ones excepted. Streak white. Transparent ... translucent on the edges.

Hardness = 5·0 ... 5·5. Sp. Gr. = 3·468, of a massive yellowish-grey variety from Norway.

Compound Varieties. Twin-crystals: faces of composition parallel, axis of revolution perpendicular to $-\frac{\bar{P}r}{2}$; sometimes the individuals are continued beyond the face of composition. Massive: composition granular or lamellar; the first are very strongly connected.

OBSERVATIONS.

1. The preceding regular forms are given entirely on the authority of Mr G. Rose. Most of the forms depend upon the parallelism and situation of some of their edges of combination, yet some doubt still remains in regard to the best position to be chosen for the crystals of the species, which may be probably brought to a still higher degree of simplicity. The two species of the Wernerian system, the *Brown* and the *Yellow Menachine-ore*, or *Titanite* and *Sphene*, differ chiefly in their colours, and the degrees of transparency connected with them. The first is brown, and almost entirely opake, while the last is of various pale brown, yellow, green, and grey colours, and at least translucent. These two species, like Hyacinth and Zircon, or Beryl and Emerald, are fragments of the intimately connected series of varieties which together form the natural-historical species of prismatic Titanium-ore.

2. The varieties of the present species consist of

Lime	33·00	32·20.
Oxide of Titanium	33·00	33·30.
Silica	35·00	28·00.
Oxide of Manganese	a trace. Klaproth.	0·00. Cordier.

Before the blowpipe the yellow varieties do not change their colour; all the rest become yellow. They intumesce a little, and melt on the edges into a dark-coloured enamel. They are soluble in heated nitric acid, and leave a siliceous residue.

3. Prismatic Titanium-ore occurs in small nodules or crystals imbedded in gneiss, and beds of syenite and other trap-rocks, belonging to them, or also to more recent classes of mountains. It is met with in metalliferous beds with ores of iron, several species of Augite-spar and Feld-spar, &c., and likewise in those veins which traverse primitive rocks, and which are considered as the most ancient productions of that kind, as they consist of the same species as these rocks themselves.

4. Prismatic Titanium-ore occurs in several districts of the Saualpe in Carinthia, imbedded in coarse-grained gneiss. At Hafnerzell in the district of Passau it occurs in a bed in gneiss, consisting almost entirely of Augite-spars and Feld-spars, at Windisch-Kappel in Carinthia, and near Dresden in Saxony, in similarly compound rocks of a newer date. In beds of iron-ore it occurs particularly at Arendal in Norway; in veins at St Gothard in Switzerland, in the Felberthal in Salzburg, and in many other places in the Alps. It is found, besides, in many countries, as almost every syenite contains small crystals of it; for instance, the variety from Strontian and other places in Scotland.

2. PERITOMOUS TITANIUM-ORE.

Prismato-Pyramidal Titanium-Ore. Jam. Syst. Vol. III. p. 128. Man. p. 234. Titanite. Nigrine. Phill. p. 258. 259. Rutil. Nigrin. Wern. Hoffm. H. B. IV. 1. S. 252. Syst. p. 26. Eisentitan? Rutil. Hausm. I. S. 318. 319. Rutil. Leonh. S. 147. Titane oxydé. Haüy. Traité, T. IV. p. 296. Tabl. comp. p. 115. Traité, 2de Ed. T. IV. p. 333.

Fundamental form. Isosceles four-sided pyramid. $P = 117° 2', 95° 13'$. Vol. I. Fig. 8. HAÜY.

$a = \sqrt{1{\cdot}2}$.

Simple forms. $P - 1 = 128° 41', 67° 58'$; P (c); $P + \infty$ (l); $[P + \infty]$ (M); $(P + \infty)^3$ (h) $= 126° 52' 12'', 143° 7' 48''$.

Char. of Comb. Pyramidal.

Combinations. 1. $P.\ (P + \infty)^3$. Grisons.

2. $P.\ P + \infty.\ [P + \infty]$. Sim. Fig. 101. Teinach, Stiria.

3. $P - 1.\ P.\ P + \infty.\ [P + \infty]$. Sim. Fig. 101. Saualpe, Carinthia.

Cleavage, $P + \infty$ and $[P + \infty]$, perfect, but very much interrupted. Fracture conchoidal, uneven. Surface, P and $P - 1$, either smooth or rough, but both of the same physical quality: the prisms vertically streaked.

Lustre metallic adamantine. Colour reddish-brown, passing into red, sometimes yellowish. Streak very pale brown. Translucent ... opake, sometimes in a strong light transparent.

Hardness = 6·0 ... 6·5. Sp. Gr. = 4·249, the dark coloured variety from Ohlapian.

Compound Varieties. Twin crystals very frequent, axis of revolution perpendicular, face of composition parallel to a face of $P - 1$. The composition produces geniculated groupes, and is often repeated in several geniculations. Thin and long individuals produce after this law a reticulated composition. Massive: composition granular, the individuals being of various sizes and strongly connected.

OBSERVATIONS.

1. If pure, it is entirely composed of oxide of titanium, $\overset{:}{\mathrm{T}}$, containing, according to Mr H. Rose, 66·05 of metal, and 33·95 of oxygen. By itself it is infusible before the blowpipe, but gives with borax in the reducing flame a yellow glass, which assumes an amethyst colour when farther reduced.

2. It occurs generally in imbedded crystals, either in the masses of rhombohedral Quartz engaged in gneiss, mica-slate, and other rocks, or in beds, consisting of rhombohedral Quartz, dodecahedral Garnet, several species of Augite-spar, &c. It is sometimes found massive in metalliferous beds. It is likewise a production of ancient veins, and often inclosed in transparent crystals of rhombohedral Quartz. It occurs in the shape of pebbles in some gold stream works.

3. Imbedded crystals in Quartz have been found at Rosenau in Hungary, Teinach on the Bacher in Stiria, and various localities along the chain of the Alps, also at Crianlarich in Perthshire, and other places in Scotland, &c. Very perfect crystals occur in the Saualpe, and in the neighbourhood of Windisch-Kappel in Carinthia; massive varieties in the metalliferous beds of Arendal in Norway. Switzerland and Savoy include many localities where it occurs in veins, sometimes in reticulated shapes. Pebbles have been found at Ohlapian in Transylvania, and called *Nigrine* on account of their dark colour. At St Yrieix in France and in the province of Guadalaxara in Spain, the well known twin-crystals occur, often of very considerable dimensions. St Gothard is the locality of some finely crystallized varieties, associated with rhombohedral Iron-ore. The present species occurs in greater or smaller quantities in many countries, as in Germany, Bohemia, Salzburg, Piedmont, Siberia, America, &c. Beau-

tiful varieties of it, engaged in transparent Quartz, have been brought from Brazil.

4. The oxide of Titanium has been used in painting upon porcelain.

3. PYRAMIDAL TITANIUM-ORE.

Pyramidal Titanium-Ore or Octahedrite. JAM. Syst. Vol. III. p. 137. Man. p. 235. Anatase. Octahedrite. PHILL. p. 257. Oktaedrit. WERN. Hoffm. H. B. IV. S. 249. Anatas. HAUSM. I. S. 322. Anatas. LEONH. S. 145. Anatase. HAÜY. Traité, T. III. p. 129. Titane anatase. Tabl. comp. p. 116. Traité, 2de Ed. T. IV. p. 344.

Fundamental form. Isosceles four-sided pyramid. P = 97° 56′, 126° 22′. Vol. I. Fig. 8. R. G.

$$a = \sqrt{6{\cdot}240}.$$

Simple forms. P — ∞ (*o*); $\frac{5}{4}$ P — 4 (*r*) = 148° 50′, 53° 6′; P — 1 = 104° 3′, 120° 58′; $\overset{*}{\mathrm{P}}$ (*P*) Dauphiny; P + 1 (*q*) = 94° 15′, 148° 23′; P + ∞; $(\frac{4}{5}\,\mathrm{P} - 7)^{4}$? (*s*).

Char. of Comb. Pyramidal.

Combinations. 1. P — ∞. P. Sim. Fig. 92.

2. $\frac{4}{5}$ P — 4. P. Sim. Fig. 105.

3. P — ∞. P — 1. P. P + 1.

4. P — ∞. $\frac{4}{5}$ P — 4. $(\frac{4}{5}\,\mathrm{P} - 7)^{4}$. P. P + 1. Fig. 100. All of them from Dauphiny.

Cleavage, P — ∞ and P, both perfect. Fracture conchoidal, scarcely observable. Surface smooth and shining, P + ∞ and sometimes also P, horizontally streaked.

Lustre metallic adamantine. Colour, various shades of brown, more or less dark, also indigo-blue. Streak white. Semi-transparent … translucent.

Hardness = 5·5 ... 6·0. Sp. Gr. = 3·826.

OBSERVATIONS.

1. The present species consists of oxide of titanium, like the preceding one, but it is purer itself, and also the colours of the fluxes, as obtained by the action of the blowpipe, are purer.

2. The only mode of occurrence of pyramidal Titanium-ore in nature is in narrow irregular veins, consisting of those species which constitute the rocks themselves, and it is accompanied by Albite, rhombohedral Quartz, several species of Talc-mica and Augite-spar, prismatic Axinite, and Crichtonite. Its chief localities are Bourg d'Oisans in Dauphiny and Switzerland; but it has been found also in Cornwall, in Norway, in Spain, and Brazil.

GENUS II. ZINC-ORE.

Red Zinc or Red Oxide of Zinc. JAM. Syst. Vol. III. p. 447. Prismatic Zinc-Ore. Man. p. 235. Red Oxide of Zinc. PHILL. p. 353. Zinkoxyd. LEONH. S. 312. Zinc oxidé ferrifère lamellaire brun rougeâtre. HAÜY. Traité, 2de Ed. T. IV. p. 179.

Fundamental form. Scalene four-sided pyramid. Vol. I. Fig. 9.

Cleavage, $P + \infty = 125°$* (about), distinct; less distinct, $\breve{P}r + \infty$ and $\bar{P}r + \infty$, traces of $(\breve{P}r + \infty)^3$. Fracture conchoidal.

Lustre adamantine. Colour red, inclining to yellow. Streak orange-yellow. Translucent on the edges.

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[*] According to Messrs BREITHAUPT and PHILLIPS, this angle is = 120°, and the prism in combination with $\breve{P}r + \infty$ a regular one. H.

Brittle. Hardness = 4·0 … 4·5. Sp. Gr. = 5·432.

Compound Varieties. Massive: composition granular, individuals strongly connected.

OBSERVATIONS.

1. According to an analysis by **Bruce**, and another by **Berthier**, the prismatic Zinc-ore consists of

Oxide of Zinc	92·00	88·00.
Oxide of Iron and Manganese	8·00	12·00.

It becomes dull on being exposed to the air, and is covered with a white coating. Alone it is infusible before the blowpipe, but yields a yellow transparent glass with borax. It is soluble without effervescence in nitric acid.

2. It occurs massive, mixed with rhombohedral Lime-haloide and dodecahedral Iron-ore, probably in beds, and is found in large quantities in several localities in Sussex county, New Jersey. It bids fair to become very useful in extracting zinc. It is set free in several metallurgical processes, and occurs crystallised in six-sided prisms of a yellow colour in the founderies of Königshütte in Silesia, according to **Mitscherlich**.

Genus III. COPPER-ORE.

1. OCTAHEDRAL COPPER-ORE.

Octahedral Copper-Ore. **Jam.** Syst. Vol. III. p. 140. Octahedral Red Copper-Ore. Man. p. 236. Red Oxide of Copper. Oxydulated Copper. **Phill.** p. 306. Roth-Kupfererz. Ziegelerz. **Wern.** Hoffm. H. B. III. 2. S. 89. 98. Kupferroth. Kupferbraun. **Hausm.** I. S. 237. 240. Roth-Kupfererz. **Leonh.** S. 267. Cuivre oxidé rouge. **Haüy.** Traité, T. III. p. 555. Cuivre oxidulé. Tabl. comp. p. 83. Traité, 2de Ed. T. III. p. 462.
Phillips. Trans. Geol. Soc. Vol. I. p. 23.

Fundamental form. Hexahedron. Vol. I. Fig. 1.
Simple forms. $\dot{\text{H}}$ (*i*); $\dot{\text{O}}$ (*P*), Vol. I. Fig. 2.; $\dot{\text{D}}$

(r) Vol. I. Fig. 31.; A_2, Vol. I. Fig. 32.; B, Vol. I. Fig. 33.; C_1, Vol. I. Fig. 34.; T_1, Vol. I. Fig. 35.

Char. of Comb. Tessular.

Combinations. 1. H. O. Vol. I. Fig. 3 and 4. 2. H. D. Fig. 151. 3. H. O. D. 4. H. O. D. B. Fig. 155. 5. H O. D. C_1. 6. H. O. D. A_2. B. C_1. T_1.

Cleavage, octahedron, with smooth faces, but very much interrupted. Fracture conchoidal, uneven. Surface generally very smooth and shining, and everywhere the same.

Lustre adamantine, sometimes metallic adamantine or imperfect metallic. Colour between cochineal-red and lead-grey; also pure cochineal-red, and in capillary crystals almost carmine-red. Streak several shades of brownish-red, shining. Semi-transparent ... translucent on the edges.

Brittle. Hardness = 3·5 ... 4·0. Sp. Gr. = 5·992, crystals from Chessy.

Compound Varieties. Massive: composition granular, individuals of various sizes, or even impalpable. In the latter case, fracture becomes flat conchoidal or even, the surface of the fracture glimmering. Sometimes earthy.

OBSERVATIONS.

1. Those varieties which consist of friable particles, and present an earthy fracture, and which are besides often mixed with oxide of iron, or several Malachites, &c., constitute the *Tile-ore*, which was formerly considered as a particular species, and divided into *earthy* and *indurated* Tile-

ore. *Red Copper-Ore* itself, the remaining varieties of the present species, was divided into three subspecies, the *foliated*, which contains those crystallised varieties which are not capillary, and compound cleavable ones ; the *capillary*, which comprehends very thin filiform crystals, reticulated or in velvety groupes ; and the *compact*, which refers to impalpable compositions, and is to the foliated varieties in the same relation as compact limestone is to calcareous spar, or compact Lead-glance to common Lead-glance.

2. Octahedral Copper-ore consists of

Copper 91·00 88·50.
Oxigen 9·00 KLAPROTH. 11·50. CHENNEVIX.

It is the protoxide of copper, $\dot{\mathrm{C}}\mathrm{u}$, which contains 88·78 copper and 11·22 oxygen. In the reducing flame of the blowpipe, it is reduced upon charcoal into a globule of copper. It is soluble with effervescence in nitric acid, but without effervescence in muriatic acid.

3. Octahedral Copper-ore is found in beds and veins in several rocks. It is accompanied by various other ores of copper and iron, and rhombohedral Quartz.

4. Very fine varieties of this species have been found in the Bannat of Temeswar, particularly the vicinity of Moldawa ; near Catharineburgh in Siberia, at Chessy near Lyons in France ; and these occur in beds, at least those of France, in sandstone, and those of Hungary in gneiss. Not inferior to any of the preceding ones, and in considerable quantity, the present species is met with in the well known tin and copper veins of Cornwall. The chief localities of capillary groupes are Cornwall and Rheinbreitbach on the Rhine. Octahedral Copper-ore also occurs in Saxony, in the district of Siegen in Prussia, in Norway, in Peru and Chili. Tile-ore is found among others in the Bannat, and at Camsdorf and Saalfeld in Thuringia. It is frequently produced in the slags formed in the last process of melting copper, as has been observed by Professor MITSCHERLICH. Copper vessels and other objects made of that metal, and long exposed to the action of the weather, are, to a great

extent, converted into a tissue of crystals of the present species, while the outside is covered with chloride of copper, sometimes crystallized.

5. The varieties of the present species, wherever they occur in considerable quantity, are highly valuable as ores of copper.

GENUS IV. TIN-ORE.

1. PYRAMIDAL TIN-ORE.

Pyramidal Tin-Ore. JAM. Syst. Vol. III. p. 155. Man. p. 238. Oxide of Tin. PHILL. p. 250. Kornisch Zinerz. Zinstein. WERN. Hoffm. H. B. IV. 1. S. 53. 56. Zinnstein. HAUSM. I. S. 314. Zinnerz. LEONH. S. 218. Etain oxydé. HAÜY. Traite, T. IV. p. 137. Tabl. comp. p. 101. Traité, 2de Ed. T. IV. p. 152.

PHILLIPS. Trans. Geol. Soc. Vol. II. p. 336.

Fundamental form. Isosceles four-sided pyramid. $P = 133^\circ\ 26'$, $67^\circ\ 59'$. Vol. I. Fig. 8. R. G.

$$a = \sqrt{0{\cdot}4547}.$$

Simple forms. $P - \infty$ (i); P (P); $P + 1$ (s) $= 121^\circ\ 35',\ 87^\circ\ 17'$; $P + \infty$ (l); $[P + \infty]$ (g); $(P)^5$ (z) $= 159^\circ\ 6',\ 118^\circ\ 16,\ 135^\circ\ 17'$; $(P + \infty)^3 = 126^\circ\ 52'\ 12'',\ 143^\circ\ 7'\ 48''$; $(P + \infty)^5$ (r) $= 112^\circ\ 37'\ 12'',\ 157^\circ\ 22'\ 48''$.

Char. of Comb. Pyramidal.

Combinations. 1. $P + 1$. $P + \infty$. Cornwall.

2. $P + 1$. $P + \infty$. $[P + \infty]$. Fig. 101; the prisms very short, Goshen, Massachusetts.

3. P. $P + 1$. $P + \infty$. $[P + \infty]$. Fig. 102. Cornwall.

4. P. $P + 1$. $(P)^5$. $[P + \infty]$. Cornwall.

5. $P - \infty$. P. $P + 1$. $P + \infty$. $[P + \infty]$. Ehrenfriedersdorf, Saxony.

6\. P. $P + 1$. $(P)^5$. $[P + \infty]$. $(P + \infty)^5$.
Fig. 103. Cornwall.

Cleavage, $P + \infty$ and $[P + \infty]$ not very distinct, traces of P. Fracture imperfect conchoidal, uneven. Surface, $P - \infty$ rough, $[P + \infty]$ often uneven; $P + 1$ sometimes irregularly striated parallel to the edges of combination with P, and the latter pyramid parallel to those with $P + 1$. The prisms are sometimes vertically streaked.

Lustre adamantine. Colour various shades of white, grey, yellow, red, brown, black. Streak pale grey, in some varieties it is pale brown. Semi-transparent, sometimes almost transparent ... nearly opake.

Brittle. Hardness $= 6{\cdot}0 \ldots 7{\cdot}0$. Sp. Gr. $= 6{\cdot}960$, a crystallised variety; $= 6{\cdot}519$, thin columnar composition.

Compound Varieties. Twin-crystals: Axis of revolution perpendicular, face of composition parallel to one, or sometimes to several faces of P. Small reniform, rarely botryoidal shapes: original surface rough, composition very thin columnar, divergent from common centres, strongly connected, and often forming a second curved lamellar composition. Massive: composition granular, sometimes almost impalpable, strongly connected, fracture uneven. The hardness of very thin columnar compositions is often found as low as 5·5, owing probably to the delicacy of the individuals in this composition.

OBSERVATIONS.

1. According to the same principles which require us to consider Red Hematite or fibrous Red Iron-Ore, as a variety of rhombohedral Iron-ore, we must also unite within one and the same species, the *Wood-tin* of Cornish miners, with the rest of the varieties of pyramidal Tin-ore. The distinction of the two species, *Tin-stone* and *Cornish Tin-Ore* in the Wernerian system, rests only upon the state of mechanical composition, and must therefore be abandoned, as has been already done by several mineralogists.

2. The following ingredients were found by KLAPROTH in a simple variety, by DESCOTILS in a compound one:

Oxide of Tin	99·00	95·00.
Oxide of Iron	0·25	5·00.
Silica	0·75	0·00.

In its greatest purity it contains nothing but oxide of tin, $\ddot{\mathrm{S}}$n, composed of 78·67 metal, and 21·33 oxygen. Alone it does not melt before the blowpipe; but is reducible when in contact with charcoal. It is insoluble in acids.

3. This ore occurs disseminated in rocks, particularly in granite, also in beds and veins, and in those large irregular masses called *Stockwerke.* It is frequently accompanied by prismatic Scheelium-ore and pyramidal Scheelium-baryte, rhombohedral Molybdena-glance, also by rhombohedral Quartz and other species. It occurs in pebbles, and is extracted in this shape from stream-works. The varieties called *Wood-tin* have been hitherto found only in these repositories.

4. There are but few countries in which the present species is met with in any notable quantities. These are Saxony, Bohemia, Cornwall in Europe, and the peninsula of Malacca and the island of Banca in Asia. Small quantities occur in Galicia in Spain, in the department of Haute Vienne in France, and in the mountain chains called the

Fichtel and Riesengebürge in Germany. Disseminated through the rocks, it is found at Zinnwald in Bohemia and Saxony and in Cornwall, in beds in granite at Zinnwald, in mica-slate in Galicia, in the *Stockwerke* it is found at Schlaggenwald in Bohemia, at Altenberg, Geyer, &c. in Saxony, in veins at Ehrenfriedersdorf, Marienberg, Altenberg, and other places in Saxony, in Bohemia, but particularly in great profusion in Cornwall. Tin stream-works are likewise opened in Saxony, and still more so in Cornwall. The columnar compositions of pyramidal Tin-ore from Mexico and Chili, are also products of stream-works. The finest and most remarkable simple varieties are found in Cornwall, twins and regular compositions in general in Saxony and Bohemia. Small groupes of black twin-crystals have been lately discovered in the albite-rock of Chesterfield in Massachusetts, and are accompanied by red and green varieties of rhombohedral Tourmaline.

5. The pyramidal Tin-ore is used for extracting tin.

GENUS V. SCHEELIUM-ORE.

1. PRISMATIC SCHEELIUM-ORE.

Prismatic Wolfram. JAM. Syst. Vol. III. p. 170. Man. p. 240. Wolfram. Tungstate of Iron. PHILL. p. 255. Wolfram. WERN. Hoffm. H. B. IV. 1. S. 242. Wolfram. HAUSM. I. S. 308. Wolfram. LEONH. S. 377. Scheelin ferruginé. HAÜY. Traité, T. IV. p. 314. Tabl. comp. p. 118. Traité, 2de Ed. T. IV. p. 366.

Fundamental form. Scalene four-sided pyramid. $P = \left\{\begin{matrix}117^\circ\,2'\\117^\circ\,2'\end{matrix}\right\}$, 105° 49′, 105° 49′. Inclination in the plane of the short diagonal = 0. Vol. I. Fig. 41. HAÜY.

$$a : b : c : d = 1 : \sqrt{1{\cdot}333} : 1 : 0.$$

Simple forms. $\pm\frac{\mathrm{P}}{2}=\left\{\begin{matrix}117°\ 2'\\117°\ 2'\end{matrix}\right\}$; $\mathrm{P}+\infty\ (r)=98°\ 12'$; $\frac{(\breve{\mathrm{P}}\mathrm{r})^3}{2}\ (s)$; $(\bar{\mathrm{P}}\mathrm{r}+\infty)^3=133°\ 10'$; $\pm\frac{\bar{\mathrm{P}}\mathrm{r}-1}{2}\left\{\begin{matrix}t\\t'\end{matrix}\right\}=\left\{\begin{matrix}63°\ 26'\\63°\ 26'\end{matrix}\right\}$; $\bar{\mathrm{P}}\mathrm{r}+\infty\ (M)$; $\breve{\mathrm{P}}\mathrm{r}\ (u)=98°\ 12'$; $\breve{\mathrm{P}}\mathrm{r}+\infty\ (T)$.[*]

Char. of Comb. Hemi-prismatic.

Combinations. 1. $\frac{\bar{\mathrm{P}}\mathrm{r}-1}{2}$. $\mathrm{P}+\infty$. Fig. 44. Ehrenfriedersdorf, Saxony.

2. $\frac{\bar{\mathrm{P}}\mathrm{r}-1}{2}$. $\breve{\mathrm{P}}\mathrm{r}+\infty$. $\bar{\mathrm{P}}\mathrm{r}+\infty$. Fig. 46. Cornwall.

3. $\frac{\bar{\mathrm{P}}\mathrm{r}-1}{2}$. $-\frac{\bar{\mathrm{P}}\mathrm{r}-1}{2}$. $\breve{\mathrm{P}}\mathrm{r}$. $\mathrm{P}+\infty$. $\bar{\mathrm{P}}\mathrm{r}+\infty$. Fig. 49. Zinnwald, Bohemia.

4. $\frac{\bar{\mathrm{P}}\mathrm{r}-1}{2}$. $\frac{\mathrm{P}}{2}$. $\frac{(\breve{\mathrm{P}}\mathrm{r})^3}{2}$. $\breve{\mathrm{P}}\mathrm{r}$. $-\frac{\mathrm{P}}{2}$. $\mathrm{P}+\infty$. $(\breve{\mathrm{P}}\mathrm{r}+\infty)^3$. $\bar{\mathrm{P}}\mathrm{r}+\infty$. Zinnwald.

Cleavage, $\breve{\mathrm{P}}\mathrm{r}+\infty$, perfect. Fracture uneven. Surface, streaked parallel to the axis; the rest of the forms smooth, $\frac{\bar{\mathrm{P}}\mathrm{r}-1}{2}$ often curved.

Lustre metallic adamantine, or imperfect metallic.

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[*] Mr PHILLIPS gives the following angles: $\frac{\mathrm{P}}{2}=117°\ 45'$, incidence of $\frac{\bar{\mathrm{P}}\mathrm{r}-1}{2}$ on $\mathrm{P}-\infty=152°\ 40'$; on $\bar{\mathrm{P}}\mathrm{r}+\infty=117°\ 22'$, $\mathrm{P}+\infty=101°\ 5'$, the inclination of $\mathrm{P}-\infty$ on $\mathrm{P}+\infty$ being $=90°$. H.

Colour dark greyish- or brownish-black. Streak dark reddish-brown. Opake.

Not very brittle. Hardness = 5·0 ... 5·5. Sp. Gr. = 7·155, of a crystallised variety from Zinnwald.

Compound Varieties. Twin-crystals: 1. Face of composition parallel, axis of revolution perpendicular to $\bar{P}r + \infty$; 2. Face of composition parallel, axis of revolution perpendicular to a face of $\breve{P}r$. There is often a curious composition in the interior of crystals parallel to all their faces. Massive: composition irregularly lamellar, easily separated, faces of composition irregularly streaked; also columnar, the individuals being generally of a considerable size, straight and divergent, and often rather strongly coherent. Pseudomorphoses in the shape of pyramidal Scheelium-baryte.

OBSERVATIONS.

1. According to **Berzelius**, the varieties of the present species consist of

Tungstic Acid	78·77.
Protoxide of Manganese	6·22.
Protoxide of Iron	18·32.
Silica	1·25.

When pure it is expressed by $\ddot{Mn}\,\dddot{W}^2 + 3\,\ddot{Fe}\,\dddot{W}^2$, and the proportion of its ingredients = 77·27 : 5·84 : 16·89. It decrepitates before the blowpipe, but may be melted in a sufficiently elevated temperature into a globule, having its surface covered with crystals possessing a metallic lustre. It is pretty easily soluble in borax.

2. This ore occurs very frequently along with pyramidal Tin-ore, in veins and beds. It is met with, however, also

without the Tin-ore, in veins traversing greywacke with ores of lead, rhombohedral Quartz, &c.

3. It occurs almost in every one of the Saxon and Bohemian tin-mines, as at Schlaggenwald, Zinnwald, Ehrenfriedersdorf, and Geyer; also in many places in Cornwall. It is thus likewise found in France. In the principality of Anhalt it occurs in veins in greywacke. In the island of Rona, one of the Hebrides, it was discovered in a vein of graphic granite in gneiss. It is found in Siberia, accompanying rhombohedral Emerald, and in the United States of North America.

GENUS VI. TANTALUM-ORE.

1. PRISMATIC TANTALUM-ORE.

Prismatic Tantalum-Ore. JAM. Syst. Vol. III. p. 147. Man. p. 241. Columbite. PHILL. p. 269. Tantalit. BREITH. Hoffm. H. B. IV. 2. S. 191. Tantalit. HAUSM. I. S. 310. Tantalit. LEONH. S. 379. Tantale oxidé. HAÜY. Tabl. comp. p. 120. Traité, 2de Ed. T. IV. p. 387.

Fundamental form. Scalene four-sided pyramid. $P = 145° 8', 99° 8', 91° 12'$. Vol. I. Fig. 9. LEONH.

$a : b : c = 1 : \sqrt{5{\cdot}4545} : \sqrt{1{\cdot}1636}$.

Simple forms. $P - \infty$; P; $(\breve{P}r + \infty)^5 = 46° 50'$; $\bar{P}r - 1 = 56° 41'$; $\breve{P}r + \infty$; $\bar{P}r + \infty$.

Char. of Comb. Prismatic.

Combinations. 1. $P - \infty$. $\breve{P}r + \infty$. $\bar{P}r + \infty$. Bodenmais, Bavaria.

2. $P - \infty$. P. $\breve{P}r - 1$. $(\breve{P} + \infty)^5$. $\breve{P}r + \infty$. $\bar{P}r + \infty$. Bodenmais.

Cleavage, $\breve{P}r + \infty$ rather perfect, $\bar{P}r + \infty$ less distinct. Traces of $P - \infty$. Fracture imperfect conchoidal, uneven. Surface, $\breve{P}r + \infty$ vertically streaked.

Lustre imperfect metallic. Colour greyish- and brownish-black. Streak dark brownish-black, on the file a little shining. Opake.

Brittle. Hardness = 6·0. Sp. Gr. = 6·038.

Compound Varieties. Massive: composition granular.

OBSERVATIONS.

1. The synonymes quoted above refer also to all those minerals which have been hitherto indiscriminately designated by the names of *Tantalite*, *Columbite*, *Tantale oxidé*, &c. and which occur in other localities than Bodenmais in Bavaria. Several of these varieties, however, differ so much from those included in the general description, that they cannot be all comprehended within one and the same species. Our information in regard to their regular forms is still very defective; it is not certain, whether the variety from Skogböhle in the parish of Kimito in Finland, possesses prismatic or hemi-prismatic forms. The colour of this variety is brownish-black, the streak between hair-brown and clove-brown, hardness = 6·0, and sp. gr. = 7·075. Of another variety, having a degree of hardness = 6·0, and a specific gravity between 7·8 and 8·0, the forms seem to be hemi-prismatic. The Tantalite from Broddbo, which agrees very nearly with that from Finbo, both in Sweden, is described as having a black colour, brown streak, a specific gravity of 6·291, when purified as much as possible, and other properties which coincide with those of prismatic Tantalum-ore. It is probable that some of these varieties will form in future, one, or even several species, distinct from that to which the above description refers; but it would be impossible, from the little we know of their natural-historical properties, to decide whether these will be comprehended within the genus Tantalum-ore, or whether

they will perhaps form new genera. The description has been drawn up from several not crystallised varieties from Bodenmais, and the ratios of the axes of the crystalline forms are those given by **Leonhard**.

2. According to **Vogel** and Count **Borkowsky**, the prismatic Tantalum-ore from Bodenmais, consists of

Oxide of Tantalum	75·00	74·00.
Oxide of Tin	1·00	0·40.
Oxide of Iron	17·00	20·00.
Oxide of Manganese	5·00	4·60.

Its chemical formula is $\ddot{M}n^2\,\ddot{T}a + 3\,\ddot{F}e^2\,\ddot{T}$. Upon charcoal it suffers no change before the blowpipe, but it melts with borax, and is partly soluble in heated sulphuric acid.

The Tantalite from Broddbo consists, according to **Berzelius**, of

Oxide of Tantalum	67·586.
Oxide of Manganese	5·902.
Oxide of Iron	7·560.
Lime	1·504.
Oxide of Scheelium	8·690.
Oxide of Tin	8·750.

The two last of these ingredients **Berzelius** considers as accidental. It is likewise unchanged by itself before the blowpipe, and is slowly but perfectly soluble in borax.

3. Prismatic Tantalum-ore is found at Bodenmais in Bavaria, with rhombohedral Emerald, pyramidal Euchlore-mica, rhombohedral Quartz, &c., and is said to occur there in very large and distinct crystals. The variety from Haddam in Connecticut, where it is accompanied by prismatic Corundum, &c., likewise belongs to the present species. The other varieties occur at Finbo and Broddbo near Fahlun in Sweden, with prismatic Topaz, Albite, and rhombohedral Quartz. In several other places in Sweden and in Finland, it is imbedded in granite.

GENUS VII. URANIUM-ORE.

1. UNCLEAVABLE URANIUM-ORE.

Indivisible Uranium or Pitch-Ore. JAM. Syst. Vol. III. p. 178. Uncleavable Uranium-Ore. Man. p. 241. Uran-Ochre. Pitch-blende. PHILL. p. 267. Pecherz (Uranpecherz). WERN. Hoffm. H. B. IV. 1. S. 271. Pechuran. HAUSM. I. S. 325. Uran-Pecherz. LEONH. S. 308. Urane oxydulé. HAÜY. Traité, T. IV. p. 280. Tabl. comp. p. 113. Traité, 2de Ed. T. IV. p. 316.

Regular forms and cleavage unknown. Fracture conchoidal, uneven.

Lustre imperfect metallic. Colour greyish-black, inclining sometimes to iron-black, also to greenish- and brownish-black. Streak black, a little shining. Opake.

Brittle. Hardness = 5·5. Sp. Gr. = 6·468.

Compound Varieties. Reniform: composition columnar, impalpable; aggregated into a second curved lamellar composition, the faces of composition being smooth and shining. Massive: composition granular, individuals not distinguishable.

OBSERVATIONS.

1. The analysis of a variety of the present species yielded to KLAPROTH,

Protoxide of Uranium	86·50.
Protoxide of Iron	2·50.
Silica	5·00.
Sulphuret of Lead	6·00.

Alone it is infusible before the blowpipe, but it melts with borax into a grey scoria. If reduced to powder, it is slowly soluble in nitric acid.

2. The uncleavable Uranium-ore chiefly occurs in silver

veins, and is accompanied by various ores of silver and lead, and often intimately mixed with pyramidal Copper-pyrites and hexahedral Lead-glance. Also rhombohedral and macrotypous Lime-haloide and pyramidal Euchlore-mica occur along with it.

3. Its chief localities are Johanngeorgenstadt, Marienberg, Annaberg and Schneeberg in Saxony, and Joachimsthal and Fribus in Bohemia. In Cornwall it has been found in the tin-mines of Tincroft and Tolcarn near Redruth.

4. It is used in painting upon porcelain, and yields a fine orange colour in the enamelling fire, and a black one in that in which the porcelain itself is baked.

GENUS VIII. CERIUM-ORE.

1. UNCLEAVABLE CERIUM-ORE.

Indivisible Cerium-Ore, or Cerite. JAM. Syst. Vol. III. p. 183. Uncleavable Cerium-Ore. Man. p. 241. Cerite. PHILL. p. 263. Cerinstein. WERN. Hoffm. H. B. IV. 1. S. 286. Cererit. HAUSM. S. 303. Cererit. LEONH. S. 388. Cerium oxydé silicifère. HAÜY. Tabl. comp. p. 120. Cerium oxidé siliceux rouge. Traité, 2de Ed. T. IV. p. 393.

Regular forms and cleavage unknown.

Lustre adamantine. Colour, intermediate between clove-brown and cherry-red, passing into grey. Streak white. Translucent on the edges.

Brittle. Hardness = 5·5. Sp. Gr. = 4·912.

Compound Varieties. Massive: composition granular, individuals not distinguishable; fracture uneven and splintery.

OBSERVATIONS.

1. According to HISINGER, it consists of

Oxide of Cerium	68·59.
Silica	18·00.
Oxide of Iron	2·00.
Lime	1·25.
Water and Carbonic Acid	9·60.

Alone it is infusible before the blowpipe, but forms with borax an orange-yellow globule, which becomes paler on cooling. This rare mineral occurs in a bed in gneiss, at the copper mine of Nya Bastnaes near Riddarhyttan in Westmanland in Sweden. It is accompanied by prismatic Bismuth-glance, rhombohedral Talc-mica, &c.

2. Among the minerals which accompany the uncleavable Cerium-ore, there exists still another mineral belonging to the order Ore, but which is too imperfectly known to allow of being received in the system. It is the *Cerine* of BERZELIUS (*Cerium oxidé siliceux noir.* HAÜY. Traité, 2de Ed. T. IV. p. 395.). Its forms seem to belong to the prismatic system, its cleavage being pretty distinct in a longitudinal direction. Its colour is brownish-black, streak yellowish-grey inclining to brown ; hardness = 5·5 ... 6·0 ; sp. gr. = 4·173. According to HISINGER, it consists of

Silica	30·17.
Alumina	11·31.
Lime	9·12.
Oxide of Cerium	28·19.
Oxide of Iron	20·72.
Copper (accidental)	0·87.
Volatile ingredients	0·40.

Before the blowpipe it froths and melts easily into an opake, shining, black globule, which acts upon the magnetic needle. Also with borax it melts easily, and forms a reddish- or yellowish-brown ; with a small proportion of soda, a dark greenish-grey globule. It agrees very nearly in several of its properties with *Allanite*.

GENUS IX. CHROME-ORE.

1. OCTAHEDRAL CHROME-ORE.

Prismatic Chrome-Ore. JAM. Syst. Vol. III. p. 185. Prismatic Chrome-Ore or Chromate of Iron. Man. p. 243. Chromate of Iron. PHILL. p. 240. Chromeisenstein. WERN. Hoffm. H. B. III. 2. S. 226. Chromeisenstein. HAUSM. I. S. 252. Eisenchrom. LEONH. S. 354. Fer chromaté. HAÜY. Traité, T. IV. p. 129. Tabl. comp. p. 99. Traité, 2de Ed. T. IV. p. 130.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple form. $\overset{*}{O}$, Vol. I. Fig. 2. St Domingo. Fracture uneven, imperfect conchoidal.

Lustre imperfect metallic. Colour between iron-black and brownish-black. Streak brown. Opake. Brittle. Hardness = 5·5. Sp. Gr. = 4·498, a variety from Stiria.

Compound Varieties. Massive: composition granular, the individuals being of various sizes, and generally firmly connected; they are often enveloped in a talcose stratum.

OBSERVATIONS.

1. The octahedral Chrome-ore consists, according to VAUQUELIN and KLAPROTH, of

Oxide of Chrome	43·00	55·50.
Protoxide of Iron	34·70	33·00.
Alumina	20·30	6·00.
Silica	2·00	2·00.

Alone it is infusible before the blowpipe, but acts upon the magnetic needle, after having been exposed to the reducing flame. It is difficultly but entirely soluble in borax, and imparts to it a beautiful green colour.

2. The varieties of the present species frequently occur in

a compound state. The hexahedral crystals from Stiria, occasionally combined with the octahedron, and which have been considered as belonging to it, are in fact octahedral Iron-ore. But crystals in the form of regular octahedrons are quoted from Hoboken in New Jersey, and from the Bare-hills near Baltimore in Maryland. This is also the form in which the Chrome-ore occurs in St Domingo, and in Shetland. The Stirian has not yet been found crystallised, but there are indications of cleavage or composition in its interior apparently in only one direction, which deserve very well the attention of mineralogists. The varieties of the present species have been hitherto found only in serpentine, in irregular veins and beds, which seem to be of contemporaneous formation with the rock itself.

3. The first varieties of octahedral Chrome-ore were discovered in the department du Var in France, where they form nodules and kidney-shaped masses. In Stiria it occurs in the Gulsen mountain near Kraubat, in serpentine in very irregular veins, traversing the rock in all possible directions. It is found also near Portsoy in Banffshire, and at Buchanan in Stirlingshire, in Scotland, in the latter place imbedded in limestone. It is met with in large masses in the Shetland isles, Unst and Fetlar, in the Bare-hills near Baltimore, and in the Uralian mountains. At Hoboken in New Jersey, octahedral crystals of it are imbedded, both in serpentine and in limestone. It has also been met with in Silesia and in Bohemia.

4. The octahedral Chrome-ore is a highly valuable mineral for extracting the oxide of chrome, which is employed either alone or in various combinations with the oxides of other metals, as cobalt, lead, mercury, &c. both for painting on porcelain, and for painting in oil. It yields green, yellow, and red pigments.

GENUS X. IRON-ORE.

1. AXOTOMOUS IRON-ORE.

Titanitic Iron, from Gastein in Salzburg.

Fundamental form. $R = 85° 59'$. Vol. I. Fig. 7. R. G.

$$a = \sqrt{5{\cdot}6}.$$

Simple forms. $R - \infty\ (a)$; $\frac{3}{4} R - 2 = 127° 40'$; $R - 1\ (c) = 115° 8'$; $R\ (R)$; $R + 1\ (d) = 68° 42'$; $P + 1\ (b) = 128° 1', 122° 28'$.

Char. of Comb. Hemi-rhombohedral with parallel faces. $\frac{P+1}{2} = 91° 20'$.

Combinations. 1. $R - \infty.\ R.\ \frac{P+1}{2}$. Fig. 141. 142.

2. $R - \infty.\ \frac{3}{4} R - 2.\ R - 1.\ R.\ \frac{P+1}{2}$.

3. $R - \infty.\ R - 1.\ R.\ \frac{P+1}{2}.\ R + 1$. Fig. 144.

Irregular forms, grains.

Cleavage, perfect parallel to $R - \infty$, less distinct R, not always observable. Fracture conchoidal. Surface, $R - 1$ streaked parallel to its edges of combination with $R - \infty$; the other faces generally more rough than smooth, and all of them alike.

Lustre imperfect metallic. Colour dark iron-black. Streak black. Opake.

Brittle. Hardness = 5·0 ... 5·5. Sp. Gr. = 4·661.

Compound Varieties. Twin-crystals: axis of revolution perpendicular, face of composition parallel to $R - \infty$, Fig. 143. The compositions of this kind, as hitherto observed, are not quite regularly formed, but consist generally of several alternating laminæ. The situation of the individuals is, however, recognizable from the direction of their faces.

OBSERVATIONS.

1. The chemical composition of axotomous Iron-ore has not been exactly ascertained. It is likely to consist of the oxides of iron and titanium.

2. It occurs in imbedded crystals and grains in several varieties of prismatic Talc-mica, and macrotypous Lime-haloide, in the valley of Gastein in Salzburg, and frequently along with the crystals of peritomous Titanium-ore, over which it often forms a black coating, as at Klattau in Bohemia, in the gold stream-works at Ohlapian in Transylvania, &c.

3. The mineral most nearly resembling axotomous Iron-ore, if we compare the descriptions published, is the *Crichtonite* of Count BOURNON (*Fer oxidulé titané*. HAÜY. Traité, 2de Ed. T. IV. p. 98), at least, as to the general nature of its forms, and the other properties, which, however, are not ascertained in the Crichtonite with sufficient accuracy. According to Count BOURNON, the primitive form of this substance is an acute rhombohedron, whose plane angle at the apex is $= 18°$. The Abbé HAÜY from this observation deduces the ratio of the diagonals $= \sqrt{40} : 1$, from which the axis follows $= \sqrt{267{\cdot}75}$, and the terminal edge $= 60° \, 50'$. Its most common crystalline forms are combinations of this rhombohedron with $R - \infty$, similar to Fig. 113., or also flat twelve-sided prisms, which have never been accurately described. Its only locality is the department of the Isère in France, where it occurs in narrow veins along with pyramidal Titanium-ore. It consists, according to BERZELIUS, of oxide of iron and oxide of titanium.

2. OCTAHEDRAL IRON-ORE.

Octahedral Iron-Ore. JAM. Syst. Vol. III. p. 188. Man. p. 244. Oxydulated Iron. PHILL. p. 221. Magneteisenstein. WERN. Hoffm. H. B. III. 2. S. 216. Magneteisenstein. HAUSM. I. S. 245. Magneteisenstein.

Leonh. S. 349. Fer oxydulé. Haüy. Traité, T. IV. p. 10. Tabl. comp. p. 93. Traité, 2de Ed. T. III. p. 560.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. $\overset{*}{H}$, Gulsen, Stiria; $\overset{*}{O}$ (*P*), Vol. I., Fig. 2., Fahlun, Sweden; $\overset{*}{D}$ (*l*), Vol. I. Fig. 31., Traversella, Piedmont; A_2, Vol. I. Fig. 32.; $\overset{*}{B}$, Vol. I. Fig. 33., Zillerthal, Salzburg; C_2, Vol. I. Fig. 34.; T_1, Vol. I. Fig. 35.

Char. of Comb. Tessular.

Combinations. 1. H. O. Vol. I. Fig. 3 & 4. Gulsen. 2. O. D. Sweden. 3. H. O. D. Piedmont. 4. O. D. C_2. Vesuvius. 5. O. D. A_2. B. Zillerthal. 6. O. D. A_2. C_2. T_1. Zillerthal.

Irregular forms, grains.

Cleavage, octahedron, in some varieties perfect and easily obtained, in others entirely obliterated by conchoidal fracture. Fracture conchoidal, uneven. Surface, the dodecahedrons commonly streaked parallel to their edges of combination with the octahedron; of the octahedral trigonal-icositetrahedron smooth, though curved; the surface of all the other forms is smooth.

Lustre metallic, in some varieties imperfect. Colour iron-black. Streak black. Opake.

Brittle. Hardness = 5·5 … 6·5. Sp. Gr. = 5·094, octahedrons imbedded in chlorite.

Compound Varieties. Twin-crystals: axis of revolution perpendicular, face of composition parallel to a face of the octahedron. Fig. 156. Massive:

composition granular, of various sizes of individuals, and different degrees of cohesion. If the composition be almost impalpable, fracture becomes flat conchoidal, even or uneven.

OBSERVATIONS.

1. The present species used to be divided into *Common Magnetic Iron-Ore*, and *Granular Magnetic Iron-Ore or Iron-Sand.* The first of these contains almost the whole of what is comprised within the species, except small octahedral crystals and grains, which occur either solitary in sand, or imbedded in basalt, and will be taken more particular notice of afterwards.

2. Hisinger obtained from a variety of the present species

Protoxide of Iron	94·38.
Magnesia	0·16.

The loss is oxygen, as the mineral contains both protoxide and peroxide of iron, according to Berzelius, in the proportion of 30·98 to 69·02, expressed by $\ddot{Fe} + 2\,\dddot{Fe}$; the whole content of oxygen being 28·215. It is infusible before the blowpipe, but assumes a brown colour and loses its attractory power, after having been exposed to a great heat. It is soluble in heated muriatic acid, but not in nitric acid. It may be obtained crystallised, by fusing it; and crystals are likewise often produced in the process of roasting the ore which contains this mineral.

3. The octahedral Iron-ore occurs always in beds, which are sometimes uncommonly extended, both in length and thickness, or imbedded in crystals and grains, in chlorite slate, serpentine, greenstone, &c. The beds are included chiefly in gneiss, mica-slate, clay-slate, hornblende-slate, and chlorite-slate, greenstone, or sometimes limestone. It is accompanied by various species of the genera Augite-spar, Feld-spar, Lime-haloide, &c. also by dodecahedral Garnet, rhombohedral Quartz, rhombohedral Iron-ore, and other species. Those remarkable and extensive beds in the Ban-

nat, which contain so much of copper-ore at Moldawa, Saska, Orawitza, &c. consist in a more northerly direction, at Dognatzka, almost entirely of the present species.

4. Large masses of octahedral Iron-ore are found at Arendal in Norway, the Taberg in Smaland in Sweden, and Chili; also in North America. It occurs at Berggiesshübel and Schmalzgrube in Saxony, at Presnitz in Bohemia, in the Schmalenberg in the Hartz; near the Abbey of Pella in Stiria, along with rhombohedral Iron-ore, at Kahlwang with granular limestone, and in many other places along the chain of the Alps. It is likewise met with in Corsica, in Unst, one of the Shetland isles, in Russia, Silesia, &c. Imbedded crystals are very frequent; among these the rare hexahedron occurs in the Gulsen mountain near Kraubat in Stiria. Well defined crystals occur at Vesuvius, and Traversella in Piedmont.

5. The present species is one of the most important ores of iron, and large quantities of that metal are annually extracted from it in Sweden, Norway, Russia, and other countries.

6. It is highly probable that the *Iron-Sand* will be established in future into a particular species. Its specific gravity never exceeds 4·9, it was found = 4·871 in perfectly pure grains, while that of cleavable varieties of octahedral Iron-ore never is below 5·0. Also several other properties indicate such a difference, as the distinct imperfect metallic lustre, even a slight difference of colour, and the entire want of regular forms, as it cannot be said with perfect security whether the octahedrons quoted, really belong to the present species. According to CORDIER, it consists of

Protoxide of Iron	79·20.
Oxide of Titanium	14·80.
Oxide of Manganese	1·60.
Alumina	0·80.

It occurs in the Bohemian Mittelgebürge, in the mountains of the Rhön, at Andernach on the Rhine; also in

France, in Pomerania, and other countries, sometimes in sufficient quantity for melting.

3. DODECAHEDRAL IRON-ORE.

Franklinite. PHILL. p. 226. Franklinit. LEONH. S. 313.

Fundamental form. Hexahedron, Vol. I. Fig. 1.

Simple forms. $\overset{*}{O}$, Vol. I. Fig. 2.; D, Vol. I. Fig. 31.; B, Vol. I. Fig. 33.

Char. of Comb. Tessular.

Combinations. 1. O. D. 2. O. D. B. Sim. Fig. 155., without the faces marked *P.* Irregular forms, grains.

Cleavage, octahedron very indistinct. Fracture conchoidal. Surface of all the forms smooth.

Lustre metallic. Colour iron-black. Streak dark brown. Opake.

Brittle. Acts upon the magnetic needle, but does not exhibit magnetic poles. Hardness = 6·0 ... 6·5. Sp. Gr. = 5·091.

Compound Varieties. Massive: composition granular, strongly connected.

OBSERVATIONS.

1. The dodecahedral Iron-ore consists, according to BERTHIER, of

Peroxide of Iron	66·00.
Oxide of Zinc	17·00.
Red Oxide of Manganese	16·00.

Its composition is expressed in the formula $\ddot{Zn} + \ddot{Mn} + 4\,\dddot{Fe}$, which corresponds to 17·2 oxide of zinc, 15·7 oxide of manganese, and 67·1 peroxide of iron. It is soluble without effervescence in heated muriatic acid. In a high degree of temperature the zinc is driven off, and a hard compound of iron and manganese remains.

2. The dodecahedral Iron-ore is found imbedded in prismatic Zinc-ore and rhombohedral Lime-haloide in several mines in Sussex county, New Jersey, in North America. Those crystals which present the most distinct forms, are imbedded in the prismatic Zinc-ore, and not those in the Lime-haloide. But already these exhibit rounded faces on the solid angles of the octahedron, which, being enlarged, are the only ones remaining in the irregular grains imbedded in the rhombohedral Lime-haloide.

4. RHOMBOHEDRAL IRON-ORE.

Rhomboidal Iron-Ore. JAM. Syst. Vol. III. p. 199. Man. p. 245. Specular Iron. Red Iron-Ore. PHILL. p. 224. 228. Eisenglanz. Rotheisenstein. Thoneisenstein (in part). WERN. Hoffm. H. B. III. 2. S. 229. 239. 274. Blutstein. HAUSM. I. S. 256. Eisenoxyd. LEONH. S. 336. Fer oligiste. Fer oxydé (in part). HAÜY. Traité, T. IV. p. 38. 104. Fer oligiste. Tabl. comp. p. 94. Traité, 2de Ed. T. IV. p. 5.

Fundamental form. Rhombohedron. $R = 85° 58'$. Vol. I. Fig. 7.

$$a = \sqrt{5{\cdot}6041}.$$

Simple forms. $R - \infty$ (o); $R - 4 = 170° 15'$; $R - 3$ (y) $= 160° 42'$; $R - 2$ (s) $= 142° 56'$; $R - 1 = 115° 7'$; R (P); $R + 1$ (k) $= 68° 42'$; $R + \infty$ (r); $P + 1$ (n) $= 128° 0', 122° 29'$; $\frac{3}{4} P + 3 = 121° 5', 159° 16'$; $P + \infty$ (z); $(P - 2)^5$ (g) $= 117° 58', 139° 49', 118° 21'$.

Char. of Comb. Rhombohedral.

Combinations. 1. $R - \infty$. R. Sim. Fig. 111. and Fig. 119. Vesuvius.

2. R — 2. R. Elba.
3. R — ∞. P + 1. Framont, Lorraine.
4. R — ∞. R. P + 1. Sim. Fig. 143. Altenberg, Saxony.
5. R — 2. R. P + 1. Fig. 124. Elba.
6. R — 3. R — 2. R — 1. R. $(P-2)^5$. P + 1. R + 1. $\frac{3}{4}P + 3$. Elba.

Cleavage, R — ∞. R. In some varieties scarce any traces appear, while in others it seems to be perfect, which, however, must be in a great measure attributed to composition. Fracture conchoidal, uneven. Surface, those rhombohedrons which are in parallel position with R, as R — 4, R — 2, R + ∞, particularly the obtuse ones, are horizontally streaked, sometimes so deeply that they appear rounded; R is sometimes streaked parallel to the edges of combination with P + 1; R — 3 is uneven and often curved, it is striated at the same time parallel to the edges of combination with R — 2; R — 1 is sometimes curved but always smooth.

Lustre metallic. Colour dark steel-grey, iron-black. Streak cherry-red, reddish-brown. Surface frequently tarnished; generally with the exception of R — ∞, which may be useful to beginners in finding the true position of the crystals. Opake; very thin laminæ are faintly translucent, and shew a deep blood-red colour.

Brittle. Sometimes feeble action upon the magne tic needle. Hardness = 5·5 ... 6·5. Sp. Gr. = 5·251, a crystalline variety from Sweden.

Compound Varieties. Twin-crystals: 1. Axis of revolution perpendicular, face of composition parallel to R — ∞; the individuals are continued beyond the face of composition (Altenberg, Saxony). Sometimes two individuals in the same position are joined in a face of R + ∞, and terminate at this face (Stromboli). 2. Axis of revolution perpendicular, face of composition parallel to a face of R, generally observable in the reversed situation of thin films engaged in the mass (Elba). Faces of composition in these directions must not be confounded with faces of cleavage.

Globular, reniform, botryoidal, and stalactitic shapes: surface generally smooth, composition more or less thin columnar, sometimes even impalpable; in this case the lustre becomes imperfect metallic, and the colour red; fracture of impalpable compound varieties even, flat conchoidal, or uneven. Compound varieties often join in a second and third composition, which are curved lamellar and granular; the junction of granular masses produces frequently very smooth faces, while the reniform surface of the curved lamellar compositions is rough, and more difficultly obtained by separating the particles than the first. Massive: composition, 1. Columnar, generally imperfect, thick, and diverging from common centres. 2. Granular, and often impalpable, sometimes very distinct and easily separated; often, however, they are strongly coherent; if they are impalpable, their lustre decreases, their colour becomes red, and the fracture even, uneven, or flat conchoidal. 3. Lamellar, joined in the face of R — ∞, thick and variously bent; sometimes, however, they are so thin that they allow blood-red light to pass; if they are still thinner, their colour becomes red altogether, and their lustre imperfect metallic: the faces of composition are often irregularly streaked. When the cohesion among the particles is diminished, the lamellar varieties become scaly and glimmering, the granular ones earthy and dull. Pseudomorphoses in the shape of rhombohedral Lime-haloide, octahedral Fluor-haloide, &c.

OBSERVATIONS.

1. There can hardly be a more striking example of the necessity of correctly ascertaining the simple and compound state of a mineral, than that afforded in the species of rhombohedral Iron-ore, even in regard to the correct determination of the species itself; for the two species of *Specular Iron-ore* and *Red Iron-ore* entirely depend upon this composition. Its importance extends likewise to the determination of the genus; for the connection between the octahedral, rhombohedral, and prismatic Iron-ore, cannot be rightly understood if we do not pay attention to the simple or compound state of their varieties. Specular Iron-Ore contains all the simple varieties and those of the compound ones, which have not yet lost their metallic appearance by the too small size of their component individuals. Those in thin lamellar compositions have been called *Mi-*

caceous Specular Iron-Ore, while the rest form the *Common Specular Iron-Ore.* Those varieties which have lost the metallic appearance are included within the *Red Iron-Ore*, divided into *Fibrous* Red Iron-Ore or *Red Hematite*, which occurs in reniform and other imitative shapes, and consists of columnar particles of composition; into *Compact* and *Ochrey* Red Iron-Ore, which are massive, and consist of impalpable granular individuals more or less firmly connected; and into *Scaly* Red Iron-ore, or *Red Iron Froth*, consisting of very small scaly lamellar particles, which in most cases are but slightly coherent. This variety is in immediate connexion with the micaceous specular iron-ore, and an uninterrupted transition exists between it and the crystallised specular iron-ore itself. Among the varieties of *Clay Iron-Ore*, the following may be considered as an appendix to the present species, all of which are of a red colour, but more or less impure, and mixed with earthy substances. *Reddle* possesses an earthy, coarse slaty fracture; it soils and writes, and may be used as a drawing material. *Jaspery Clay Iron-Ore* has an even, or large and flat conchoidal fracture, and a hardness which is considerable if compared with other minerals of a similar formation. *Columnar* and *Lenticular Clay Iron-Ore* are distinguished, the first by the columnar form, the latter by the flattish granular form of its particles of composition.

2. The micaceous specular iron-ore, analysed by BUCHOLZ, and the red hematite, analysed by D'AUBUISSON, have been found to consist of

Peroxide of Iron	100·00	90·00 ... 94·00.
Oxide of Manganese	0·00	a trace.
Silica .	0·00	2·00.
Lime	0·00	a trace 1·00.
Water	0·00	2·00 ... 3·00.

Its chemical sign is $\dddot{\mathrm{F}}\mathrm{e}$, the proportion of metal to that of oxygen being = 69·34 : 30·66. The clay iron-ores, being more or less mixed with earthy substances, vary in their contents, and several of their properties are dependent upon the nature of these admixtures. Thus lenticular clay iron-ore is very rich, while the columnar variety contains but little iron, and is produced from nodules of common clay iron-stone originally engaged in common clay, which have been converted by the influence of heat from burning coal seams, the one into columnar clay iron-ore, the other into porcelain jasper. The rhombohedral Iron-ore is infusible before the blowpipe, but melts with borax, and forms a green or yellow glass, like pure oxide of iron. It is likewise soluble in heated muriatic acid.

3. It occurs most commonly in beds and veins in ancient rocks. Clay iron-ore forms either by itself beds in secondary mountains, or it is included in beds of clay in the shape of nodules or irregular masses. Rhombohedral Iron-ore occurs in crystals among the rocks ejected by Vesuvius, and lining the cavities and fissures of lava, where it seems to be a product of sublimation. In beds, it is generally accompanied by other ores of iron, several species of the genera Feld-spar, Augite-spar, and Garnet; rhombohedral Lime-haloide and rhombohedral Quartz; in veins, the compound varieties are chiefly associated with several varieties of rhombohedral Quartz (such as Iron-flint, &c.), the simple ones in narrow veins in primitive mountains, likewise with rhombohedral Quartz, but moreover with prismatic Feld-spar and Albite, with ores of titanium, &c.

4. The most distinct crystals, sometimes of considerable size, are found in the island of Elba, along with hexahedral Iron-pyrites and rhombohedral Quartz; at Framont in Lorraine; at St Gothard in Switzerland; in Dauphiny, where they occur in narrow veins in primitive rocks; in the vicinity of Mount Vesuvius, and in the island of Stromboli. Besides the island of Elba, there occur considerable quantities of this species in Norway and Sweden, in Stiria, &c. frequently mixed with octahedral Iron-ore. Micaceous Iron-ore is very common in the beds of brachytypous Parachrose-baryte in Stiria and Carinthia. Red Iron-ore is found in Saxony, Bohemia, the Hartz, the

Fichtelgebürge, at Ulverstone in Lancashire, and other places in England, and in many other countries. Jaspery clay iron-ore is almost entirely confined to the vicinity of Fischau and Meiersdorf near Wienerisch Neustadt in Lower Austria; the columnar variety occurs in several localities of the north of Bohemia, in the counties of Elbogen and Leitmeritz; the lenticular clay iron-ore forms a bed in the transition district of central Bohemia, in the counties of Pilsen, Beraun, and Rackonitz, &c. The species of rhombohedral Iron-ore is not a rare one, and several of its varieties are met with in different countries.

5. The rhombohedral Iron-ore is a mineral of the highest importance, and yields a considerable proportion of the iron annually produced in the different quarters of the globe. Red Hematite, sometimes also compact Red Iron-ore, are used for polishing metals, and Reddle as a writing material.

5. PRISMATIC IRON-ORE.

Prismatic Iron-ore. Jam. Syst. Vol. III. p. 225. Man. p. 250. Hydrous Oxide of Iron. Brown Iron-ore. Phill. p. 226. 230. Brauneisenstein (excepting Brauneisenrahm). Thoneisenstein (in part). Wern. Hoffm. H. B. III. 2. S. 250. 274. Brauneisenstein. Hausm. I. S. 268. Eisenoxyd-Hydrat. Leonh. S. 342. Fer oxydé (in part). Haüy. Traité, T. IV. p. 104. Fer oxydé (excepting Fer oxydé carbonaté). Tabl. comp. p. 98. Traité, 2de Ed. T. IV. p. 101.

Fundamental form. Scalene four-sided pyramid. Vol. I. Fig. 9.

Combinations, somewhat resembling Fig. 20., but variously modified on the angles, where the pyramids *e* and *p* occur in the figure. They are compressed between *M* and *M*, and elongated in the direction of *n*. Incidence of *d* on *d*

= 117° 30′, of n on M = 117° 50′, according to Phillips, n on n over M = 130° 14′, according to Brooke.

Cleavage, pretty distinct, parallel to the broad faces of the crystals. Surface, deeply streaked in a longitudinal direction.

Lustre adamantine. Colour, various brown shades, of which yellowish-brown, hair-brown, clove-brown, and blackish-brown, are the most common. Streak yellowish-brown. Crystals often semi-transparent, and shewing a blood-red tint. Other varieties are nearly opake.

Brittle. No action on the magnet. Hardness = 5·0 … 5·5. Sp. Gr. = 3·922, of a columnar compound variety.

Compound Varieties. Globular, reniform, stalactitic and fruticose shapes: surface of various descriptions, smooth, granulated, reniform, drusy; composition columnar, individuals very delicate, often impalpable. In the latter case fracture becomes even, flat conchoidal or uneven. The composition is often repeated; granular and curved lamellar masses are formed of columnar compositions, the faces of composition being either smooth, or covered with reniform asperities. Massive: composition columnar or impalpable. Sometimes the particles are so slightly coherent, that the mass appears earthy and dull. Pseudomorphoses of rhombohedral Lime-haloide.

OBSERVATIONS.

1. The division introduced among the varieties of the present species is similar to that which has been given to Red Iron-Ore. We must except, however, the Brown Iron-Froth which this division contains, since it properly does not belong to the present species. Moreover, some of what are generally considered as pseudomorphoses or supposititious crystals, must be excluded, because they are not real pseudomorphoses, consisting of compound varieties of this species, but decomposed varieties of three others, the hexahedral and prismatic Iron-pyrites, and the brachytypous Parachrose-baryte, to which they must be severally referred. The *Fibrous* Brown Iron-ore or *Brown Hematite* contains the real crystals and the compound varieties in stalactitic, reniform, and other imitative shapes, also those massive varieties in which the composition still may be ascertained. *Compact* Brown Iron-ore comprehends those imitative shapes and massive varieties, in which the composition is no longer observable, but which are still firmly connected; while *Ochrey* Brown Iron-ore is applied to those which have an earthy texture, and are friable. As impure varieties of the species we must consider some of the clay Iron-ores, such as the *Granular*, the *Common*, the *Pisiform*, and the *Reniform* clay iron-ore. The granular variety is composed of compact roundish or globular masses, the reniform one of alternating coats of different colour and consistency, disposed in a reniform surface. In the pisiform variety we meet with a similar composition, only in small globules, parallel to the surface of which the lamellæ are disposed. The compact pisiform clay iron-ore, however, does not belong to the present species, but it is decomposed prismatic Iron-pyrites, as is demonstrated not only by the crystalline forms which it presents, and which are described in books, but likewise from the nucleus of undecomposed pyrites, which larger specimens of it often contain.

2. According to D'Aubuisson, the present species consists of

Peroxide of Iron	82·00	84·00.
Water	14·00	11·00.
Oxide of Manganese	2·00	2·00.
Silica	1·00	2·00.

It is a hydrate of peroxide of iron, $2\,\dddot{\mathrm{Fe}} + 3\,\mathrm{Aq}$, the proportions of peroxide of iron and water being as 85·30 to 14·70. The first analysis refers to a hematitic variety, and the second to a compact one. Before the blowpipe it becomes black and magnetic. It melts with borax into a green or yellow glass, and is soluble in heated nitro-muriatic acid.

3. The present species occurs in beds and veins. In the first it is very generally accompanied by brachytypous Parachrose-baryte, sometimes also by prismatic Hal-baryte, rhombohedral and prismatic Lime-haloide, rhombohedral Quartz (often Calcedony), and other species. These beds are included both in ancient and in secondary rocks, the latter of which, though very thick, do not extend to a great distance. It is frequently associated with the species of the following genus, particularly where it occurs in veins. In these repositories also a crystallised variety in thin lamellæ has been found, and has received the name of *Rubinglimmer* or *Göthite*. Another variety in velvety reniform shapes occurs in silver-veins, with hexahedral Lead-glance, &c. Acicular crystals are met with in geodes of rhombohedral Quartz, probably formed in veins, and in agate balls. Those varieties of clay iron-stone which belong to the present species either form beds by themselves in secondary rocks, or they are imbedded in strata of clay in the shape of larger or smaller globular concretions, some of them belonging to the coal measures, others to various kinds of sandstone.

4. Prismatic Iron-ore is very plentiful in some countries. It is found in beds in gneiss along with granular limestone, at Friesach, at Hüttenberg, and in the valley of Lavant in Carinthia, at Turrach and Eisenerz in Stiria; in the last

place, however, it is not very common. Under similar circumstances it is met with at Torotzko in Transylvania, and probably also at Dobschau, Szirk, &c. in Hungary. It likewise occurs in beds at Schneeberg in Saxony, at Kamsdorf and Saalfeld in Thuringia, partly in newer rocks. It is found in veins in various parts of Saxony, Nassau, the Hartz, &c.; and among these are some of the finest varieties in imitative shapes. Göthite is found in the districts of Siegen and Sayn; the velvety varieties at Przibram in Bohemia, several crystallized varieties, sometimes determinable, in the vicinity of Bristol in England, and in the lake of Onega in Russia. Granular clay iron-ore is found in Eichstädt, in Wirtemberg, in Switzerland, in Salzburg, and in the Tyrol. Rich varieties of the common clay iron-ore occur in Bohemia, in Silesia, at Wehrau in Lusatia, in Westphalia, but particularly in England and Scotland. The kidney-shaped variety is met with near Teplitz in Bohemia, Tarnowitz in Silesia, in Poland, in several districts of Lower Stiria, &c. The pisiform clay iron-ore is found in Swabia, Franconia, Hessia, and other countries. In some of them, however, also the compact variety is often found in caves in limestone, as at Wochein in Carniola, or also in several of the highest limestone mountains of Stiria, where it is met with in single specimens, as, for instance, upon the Reichenstein near Eisenerz.

5. The prismatic Iron-ore is by no means less important in the manufactures of cast and wrought iron, than the preceding species. The pig-iron obtained from melting its purer varieties with charcoal in particular may be easily converted into steel.

6. DI-PRISMATIC IRON-ORE.

Lievrite. JAM. Syst. Vol. III. p. 539. Man. p. 324. Lievrite. Yenite. PHILL. p. 24. Lievrit. WERN. Hoffm. H. B. II. 1. S. 376. Ilvait. HAUSM. II. S. 665. Lievrit. LEONH. S. 366. Yenite. HAÜY. Tabl. comp. p. 42. Fer calcaréo-siliceux. Traité, 2de Ed. T. IV. p. 91.

Fundamental form. Scalene four-sided pyramid. $P = 139° 37', 117° 38', 77° 16'$. Vol. I. Fig. 9. HAÜY.

$$a : b : c = 1 : \sqrt{5{\cdot}1428} : \sqrt{2{\cdot}2857}.$$

Simple forms. $P - \infty$; P (*o*); $P + \infty$ (*M*) $= 112° 37'$; $(\breve{P}r + \infty)^3 = 78° 28'$; $\bar{P}r$ (*P*) $= 113° 2'$; $\breve{P}r + \infty$.

Char. of Comb. Prismatic.

Combinations. 1. P. $P + \infty$. 2. $\bar{P}r$. $P + \infty$. 3. $\bar{P}r$. P. $P + \infty$. Fig. 4. 4. $\bar{P}r$. P. $P + \infty$. $(\breve{P}r + \infty)^3$. All of them from Elba.

Cleavage, $\bar{P}r$ and $P + \infty$ indistinct, more easily observed $P - \infty$ and $\breve{P}r + \infty$. Fracture imperfect conchoidal, uneven. Surface streaked, of the vertical prisms parallel to the axis, of the rest of the faces very frequently parallel to the edges of combination between $\bar{P}r$ and P.

Lustre imperfect metallic. Colour intermediate between iron-black and dark greyish-black, passing into greenish-black. Streak black, sometimes inclining to green or brown. Opake.

Brittle. Hardness = 5·5 ... 6·0. Sp. Gr. = 3·994, a crystalline variety from Elba.

Compound Varieties. Massive: composition columnar, thin and straight, sometimes granular, the individuals being scarcely distinguishable.

OBSERVATIONS.

1. According to DESCOTILS, the di-prismatic Iron-ore consists of

Oxide of Iron	55·00.
Silica	28·00.
Lime	12·00.
Oxide of Manganese	3·00.
Alumina	0·60.

After having been exposed to heat, it acts on the magnetic needle. Before the blowpipe it melts easily and without effervescence into an opake glass, which is likewise magnetic. Glass of borax is coloured by it yellowish-green. It is soluble in muriatic acid.

2. The present species is found in beds in primitive rocks, along with paratomous and prismatoidal Augite-spar, with dodecahedral Garnet, rhombohedral Quartz, octahedral Iron-ore, &c.

3. Its chief locality is the island of Elba, where it is found in crystals sometimes of considerable size; but it has been discovered also at Kupferberg in Silesia, at Fossum in Norway, in Siberia, and in North America.

Genus XI. MANGANESE-ORE.

1. PYRAMIDAL MANGANESE-ORE.

Foliated Black Manganese-Ore. Jam. Syst. Vol. III. p. 263. Black Manganese. Phill. p. 381. Schwarzer Braunstein. Wern. Hoffm. H. B. IV. 1. S. 149. Blättriger Schwarz-Braunstein. Hausm. I. S. 293. Manganèse oxydé hydraté. Haüy. Traité, 2de Ed. T. IV. p. 264.

Fundamental form. Isosceles four-sided pyramid. $P = 105° 25', 117° 54'$. Vol. I. Fig. 8. Ap.

$$a = \sqrt{2{\cdot}76}.$$

Simple forms. $\frac{4}{3}P - 4\ (a) = 139° 56', 58° 46'$; $P - 1 = 114° 51', 99° 11'$; $\overset{*}{P}\ (P)$.

Char. of Comb. Pyramidal.

Combinations. 1. $\frac{4}{3}$P — 4. P. Fig. 105.
2. $\frac{4}{3}$P — 4. P — 1. P.

Cleavage, P — ∞ rather perfect; P — 1 and P less distinct, and interrupted. Fracture uneven. Surface, $\frac{4}{3}$P — 4, very smooth and shining, P horizontally streaked and often dull.

Lustre imperfect metallic. Colour brownish-black. Streak dark reddish- or chestnut-brown. Opake.

Hardness = 5·0 ... 5·5. Sp. Gr. = 4·722, of a crystallised variety.

Compound Varieties. Twin-crystals: Axis of revolution perpendicular, face of composition parallel to a face of P — 1. Fig. 106. The composition is often repeated parallel to all the faces of the pyramid. Fig. 107. Generally small particles only of the surrounding individuals are joined to the central one. Massive: composition granular, firmly connected.

OBSERVATIONS.

1. The pyramidal Manganese-ore consists of oxide of manganese, but no analysis of it has yet been published. Perhaps the variety from Piedmont, analysed by BERZELIUS, which yielded oxide of manganese 75·80, silica 13·17, oxide of iron 4·14, and alumina 2·80, may belong to the present species. In the oxidating flame of the blowpipe it yields a fine amethyst coloured glass. It is soluble in heated sulphuric acid.

2. It has been found in veins in porphyry, along with other ores of manganese at Oehrenstock, near Ilmenau in Thuringia, and at Ihlefeld in the Hartz. From these localities at least it seems to be a rare mineral.

2. UNCLEAVABLE MANGANESE-ORE.

Compact and fibrous Manganese-Ore or Black Hematite. JAM. Syst. Vol. III. p. 261. 262. Prismatic Manganese-Ore or Black Manganese-Ore (in part). Man. p. 255. Black Iron-ore (in part). Compact Grey Oxide of Manganese. PHILL. p. 232. 244. Schwarzeisenstein. WERN. Hoffm. H. B. III. 2. S. 270. Fasriger and dichter Schwarzbraunstein. HAUSM. I. S. 293. 294. Dichtes Schwarz-Manganerz. LEONH. S. 374. Manganèse oxydé noir-brunatre? HAÜY. Tabl. comp. p. 110. Manganèse oxydé hydraté concretionné. Traite, 2de Ed. T. IV. p. 267.

Regular forms and cleavage unknown. Fracture not observable.

Lustre imperfect metallic. Colour, blueish-black and greyish-black, passing into dark steel-grey. Streak brownish-black, shining. Opake.

Brittle. Hardness = 5·0 ... 6·0. Sp. Gr. = 4·145, a botryoidal variety.

Compound Varieties. Reniform, botryoidal, fruticose: composition columnar, impalpable; fracture flat conchoidal, even; in a second composition it is curved lamellar, the faces of composition being smooth, rough, or granulated. Massive: composition granular, impalpable, strongly connected, fracture flat conchoidal, even.

OBSERVATIONS.

1. The two subspecies of *Black Iron-Ore*, the *Fibrous* Black Iron-Ore, or *Black Hematite*, and the *Compact* Black Iron-Ore, differ from each other like the analogous varieties of rhombohedral and prismatic Iron-ore, or as Red and Brown Hematite differ from compact Red and Brown Iron-ore.

2. The mixture of the uncleavable Manganese-ore has

not been exactly ascertained. It is supposed to contain a considerable proportion of oxide of iron. It colours glass of borax violet-blue, like other ores of manganese.

3. It occurs, sometimes accompanied by prismatic Iron-ore, but generally along with other ores of manganese, in veins in ancient rocks, or also in porphyry. It has been found in several districts of Saxony, as at Spitzleite near Schneeberg, at Schimmel near Johanngeorgenstadt, at Schlegelsberg near Ehrenfriedersdorf, &c. It occurs, besides, in the Hollert mines in the district of Siegen, at Schmalkalden in Hessia, at Ilefeld and other places in the Hartz. It has been found in various localities in Cornwall, Devonshire, &c. in England.

3. PRISMATOIDAL MANGANESE-ORE.

Prismatic Manganese-Ore (excepting the second subspecies). JAM. Syst. Vol. III. p. 251. Prismatoidal Manganese-Ore, or Grey Manganese-Ore. Man. p. 256. Grey Oxide of Manganese. PHILL. p. 243. Grauer Braunstein. WERN. Hoffm. H. B. IV. 1. S. 137. Grau-Braunstein. HAUSM. I. S. 258. Grau-Manganerz. LEONH. S. 371. Manganèse oxydé (excepting the appendix). HAÜY. Traité, 2de Ed. p. 243. Tabl. comp. p. 110. Traité, 2de Ed. T. IV. p. 261.

Fundamental form. Scalene four-sided pyramid. $P = 130°\,49', 120°\,54', 80°\,22'$. Vol. I. Fig. 9. AP.

$$a : b : c = 1 : \sqrt{3{\cdot}37} : \sqrt{2{\cdot}4}.$$

Simple forms. $P - \infty\ (o)$; $P\ (P)$; $P + \infty\ (M) = 99°\,40'$; $(\breve{P}r - 1)^5\ (y)$; $(\breve{P}r + \infty)^5\ (s) = 76°\,36'$; $(\bar{P} + \infty)^{\frac{5}{2}} = 142°\,42'$; $\bar{P}r\ (d) = 114°\,19'$; $\bar{P}r + \infty$; $\breve{P}r + 1 = 85°\,6'$; $\breve{P}r + \infty$.

Char. of Comb. Prismatic.

Combinations. 1. $P - \infty$. $P + \infty$. Granam, Aberdeenshire.

2. $\bar{P}r$. $P + \infty$. Sim. Fig. 1.

3. $\bar{P}r$. P. $P + \infty$. Figs. 3. and 4.
4. $P - \infty$. $\bar{P}r$. P. $(\breve{P}r - 1)^5$. $P + \infty$. $(\breve{P}r + \infty)^5$. Fig. 27. The three last varieties from Ihlefeld in the Hartz.

Cleavage, $\breve{P}r + \infty$ highly perfect, less distinct $P + \infty$ and $P - \infty$. Fracture uneven. Surface of the vertical prisms streaked parallel to their edges of combination, often deeply furrowed; $\bar{P}r$ streaked parallel to the edges of combination with P; $P - \infty$ parallel to those with $\bar{P}r$; $\bar{P}r$ is often rough, the remaining faces generally smooth.

Lustre metallic. Colour dark steel-grey, iron-black. Streak brownish-black. Opake.

Brittle. Hardness $= 2{\cdot}5 \ldots 3{\cdot}0$. Sp. Gr $= 4{\cdot}626$, crystals from Ihlefeld.

Compound Varieties. Twin-crystals: face of composition parallel, axis of revolution perpendicular to a face of $\breve{P}r = 122° 50'$. Reniform, botryoidal, and other imitative shapes: surface generally rough and drusy; composition columnar, of various sizes of individuals, often forming a second granular composition. Massive: composition granular or columnar, the individuals of the latter of various sizes, and often impalpable. In this case fracture becomes uneven, or earthy.

OBSERVATIONS.

1. *Grey Manganese-Ore* has been divided into several subspecies, chiefly in regard to its mechanical composition. *Radiated* Grey Manganese-Ore comprises long acicular, or

reed-like prisms, and such massive varieties as consist of columnar particles of composition, while the *foliated* one refers to short prisms and granular compositions. *Compact* Grey Manganese-Ore contains varieties, composed of impalpable granular individuals; and *Earthy* Grey Manganese-Ore, such as have lost their coherence, and appear in the state of an earthy powder.

2. The composition of some varieties, belonging to prismatoidal Manganese-ore, has been found by KLAPROTH to be

Black Oxide of Manganese	90·50	89·00.
Oxygen	2·25	10·25.
Water	7·00	0·50.

It is infusible before the blowpipe, and colours glass of borax violet-blue. It is insoluble in nitric acid. In heated sulphuric acid it disengages oxygen, and chlorine is disengaged, if it is brought in contact with muriatic acid. Also before the blowpipe, or alone in a strong heat, it gives out oxygen.

3. The present species frequently accompanies prismatic and rhombohedral Iron-ore; sometimes its earthy varieties constitute beds by themselves. It occurs often in veins, particularly in porphyry, along with prismatic Hal-baryte.

4. Several varieties of the species generally occur together. They occur in abundance and great beauty at Ihlefeld in the Hartz, and at Oehrenstock near Ilmenau in Thuringia. But they are found likewise at Johanngeorgenstadt and Eubenstock in Saxony, at Platten in Bohemia, in several places in Hungary, in Moravia, Silesia, and France. They are met with also in different localities in England and Scotland.

5. The prismatoidal Manganese-ore is a useful mineral in the manufacture of glass, and painting in enamel. It is likewise essential in several chemical operations. If found along with iron-ores, it is said to be favourable to the quality of the iron extracted from the latter.

6. *Black Wad*, to which probably *Brown Iron-Froth* will be found to belong, deserves to be mentioned in the present place as a very remarkable mineral among those which

contain manganese. It occurs in reniform, botryoidal, fruticose, and arborescent shapes, in froth-like coatings on other minerals, &c., or also massive. Its composition is columnar, generally impalpable, and often curved lamellar, the fracture flat conchoidal, even, or earthy. Some varieties possess imperfect metallic lustre. The colour is brown, in various shades, the streak corresponding to the colour, only shining. It is opake, very sectile, soils and writes; the hardness is about 0·5, specific gravity = 3·706. It must be observed here, that although the varieties seem to be very light when lifted with the hand, yet they imbibe water with violence, as soon as they have been immersed into it, and they sink immediately; from which it appears that those indications of the specific gravity which state it as being below 1·0, must be erroneous. Black Wad mixed with lint-seed oil undergoes a spontaneous combustion. According to KLAPROTH, a variety from the Hartz consists of

Oxide of Manganese	68·00.
Oxide of Iron	6·50.
Water	17·50.
Carbon	1·00.
Baryta and Silica	9·00.

Brown Iron-froth is frequently found in various imitative shapes in geodes of prismatic Iron-ore. Black Wad probably occurs under similar circumstances. Very fine varieties of the first are met with at Hüttenberg, Friesach, Loben, and other places in Carinthia, also at Kamsdorf in Thuringia. The localities of Black Wad are particularly Devonshire and Cornwall, but also the Hartz and Piedmont. This is probably also the colouring matter in the dendritic delineations upon steatite, limestone, and other substances.

ORDER IX. METAL.

GENUS I. ARSENIC.

1. NATIVE ARSENIC.

Native Arsenic. JAM. Syst. Vol. III. p. 104. Man. p. 257. Native Arsenic. PHILL. p. 275. Gediegen Arsenik. WERN. Hoffm. H. B. IV. 1. S. 207. Gediegen Arsenik. HAUSM. I. S. 120. Gediegen-Arsenik. LEONH. S. 164. Arsenic natif. HAÜY. Traité, T. IV. p. 220. Tabl. comp. p. 108. Traité, 2de Ed. T. IV. p. 236.

Regular forms and cleavage unknown.

Lustre metallic. Colour tin-white, a little inclining to lead-grey, very soon tarnished dark-grey on being exposed to the air. Streak unchanged, rather shining.

Brittle. Hardness = 3·5. Sp. Gr. = 5.766, a Saxon variety. According to BERGMANN, that of the melted arsenic is = 8·308.

Compound Varieties. Reticulated, reniform and stalactitic shapes: composition granular, small and often impalpable; it is sometimes columnar, forming a second curved lamellar composition; the individuals being generally impalpable, and the faces of the second composition reniform or uneven. In columnar particles of composition we may often observe cleavage in a direction perpendicular to the axis of the individuals. Massive, sometimes with impressions.

OBSERVATIONS.

1. Native Arsenic is the pure metal as produced by nature. Two varieties yielded to JOHN,

Arsenic	96·00	97·00.

Antimony	3·00	2·00.
Oxide of Iron and Water	1·00	1·00.

Upon ignited charcoal, or before the blowpipe, it emits a strong garlick smell, and copious white fumes, and at last disappears altogether. It is the volatilized metal, and not the white fumes of arsenious acid, which possess that odour.

2. It is most generally found in veins, seldom in beds, and is accompanied by hemi-prismatic Sulphur, rhombohedral Ruby-blende, and various species of the orders Metal, Pyrites, Glance, &c. Rarely it is met with along with hexahedral Gold and prismatic Tellurium-glance.

3. Native Arsenic is not uncommon in several of the mines of Annaberg, Schneeberg, Marienberg, and Freiberg in Saxony; it occurs at Joachimsthal in Bohemia, at Andreasberg in the Hartz, in the Black Forest, in Alsace, at Allemont in Dauphiny, at Kongsberg in Norway, at Kapnik in Translyvania, and in beds at Orawitza in the Bannat of Temeswar.

4. It is variously employed in metallurgical processes, it enters into the composition of certain kinds of glass and of many colours, and has been introduced even among the pharmaceutical preparations. It is a violent poison.

Genus II. TELLURIUM.

1. NATIVE TELLURIUM.

Hexahedral Tellurium. Jam. Syst. Vol. III. p. 118. Native Tellurium. Man. p. 258. Native Tellurium. Phill. p. 326. Gediegen Silvan. Wern. Hoffm. H. B. IV. 1. S. 126. Gediegen-Tellur. Hausm. I. S. 129. Gediegen-Tellur. Leonh. S. 180. Tellure natif ferrifère et aurifère. Haüy. Traité, T. IV. p. 325. Tellure natif auro-ferrifère. Tabl. comp. p. 119. Traité, 2de Ed. T. IV. p. 379.

Form rhombohedral. Mr Phillips quotes a combination similar to Fig. 112., the inclination at the base of the isosceles six-sided pyramid being

= 115° 12′. Cleavage in various directions, which have not been ascertained.

Lustre metallic. Colour tin-white. Streak unchanged.

Rather brittle. Hardness = 2·0 ... 2·5. Sp. Gr. = 6·115, Klaproth.

Compound Varieties. Massive: composition distinctly granular, individuals small; sometimes a tendency to columnar composition.

OBSERVATIONS.

1. According to Klaproth, the native Tellurium consists of

Tellurium	92·55.
Iron	7·20.
Gold	0·25.

It melts easily upon charcoal before the blowpipe, burns with a greenish flame, and is volatilised. The odour of horse-raddish, which some varieties exhale, as has been observed by Berzelius, is owing to selenium, and not to tellurium.

2. The native Tellurium occurs in sandstone probably in beds, or in veins which are of contemporaneous formation with the rock. It is accompanied by rhombohedral Quartz and hexahedral Iron-pyrites, also by hexahedral Gold, particularly that variety in dust-like particles which is known among the collectors and mineral dealers in the Austrian states by the name of *Spanish Snuff*.

3. It has been found in pretty considerable quantities in the mine of Maria Loretto at Facebay near Zalathna in Transylvania. It is very rare at present. It was melted in order to extract the proportion of gold which it contains.

GENUS III. ANTIMONY.

1. RHOMBOHEDRAL ANTIMONY.

Dodecahedral Antimony. JAM. Syst. Vol. III. p. 110. Man. p. 259. Native Antimony. PHILL. p. 329. Gediegen Antimon oder Spiesglas. WERN. Hoffm. H. B. IV. 1. S. 99. Gediegen-Spiessglanz. HAUSM. I. S. 125. Gediegen Antimon. LEONH. S. 150. Antimoine natif. HAÜY. Traité, T. IV. p. 252. Tabl. comp. p. 112. Traité, 2de Ed. T. IV. p. 279.

Fundamental form. Rhombohedron. R = 117° 15′. Vol. I. Fig. 7. AP.

$$a = \sqrt{1\cdot273}.$$

Simple forms. $R - \infty$; R; $R + 2 = 69° 28'$; $P + \infty$. Combinations not observed.

Cleavage, $R - \infty$ highly perfect, and possessing a strong lustre; R distinct and easily obtained, but shewing a less degree of lustre; $R + 2$ difficultly obtained and interrupted; faint traces of $P + \infty$. The result of all these cleavages is similar to Fig. 127, only the faces *o* and *z* are enlarged. Surface of $R - \infty$ triangularly streaked, R in a horizontal direction, and parallel also to its own edges. Fracture not observable.

Lustre metallic. Colour tin-white. Streak unchanged.

Rather brittle. Hardness = 3·0 ... 3·5. Sp. Gr. = 6·646, the Swedish variety.

Compound Varieties. Reniform: surface reniform or uneven; composition of flat grains collected into curved lamellæ. Massive: composition granular of various sizes of individuals, easily separated; faces of composition striated agreeably to the faces of cleavage.

OBSERVATIONS.

1. According to **Klaproth**, the rhombohedral Antimony consists of

Antimony	98·00.
Silver	1·00.
Iron	0·25.

Before the blowpipe it melts quickly into a globule, and continues to burn, when heated to redness, even if the blast is suspended. It emits copious white fumes, which are deposited round the globule; first yellowish-white octahedrons, probably of antimonious acid, are formed, and then snow-white prismatic crystals of oxide of antimony, with which at last the whole globule is covered. Some of the varieties leave a globule of silver, when the contents of antimony have been entirely volatilized. It crystallises readily from fusion.

2. The rhombohedral Antimony is found in veins traversing ancient rocks, and is principally accompanied by other species that contain antimony. The *Antimony Ochre*, which also occurs with it, seems to be the product of its decomposition.

3. The present species was first discovered at Sahlberg near Sahla in Sweden, and afterwards at Allemont in Dauphiny, where it occurs in curved lamellar compound varieties, which consist of granular ones, and at Andreasberg in the Hartz.

2. PRISMATIC ANTIMONY.

Octahedral Antimony. **Jam.** Syst. Vol. III. p. 113. Prismatic Antimony or Antimonial Silver. Man. p. 259. Antimonial Silver. **Phill.** p. 286. Spiesglas-Silber. Arsenik-Silber. **Wern.** Hoffm. H. B. III. 2. S. 46. 48. Silberspiessglanz. **Hausm.** I. S. 126. Antimon-Silber. **Leonh.** S. 204. Argent antimonial.

Haüy. Traité, T. III. p. 391. Tabl. comp. p. 74.
Traité, 2de Ed. T. III. p. 258.

Fundamental form. Scalene four-sided pyramid. Vol. I. Fig. 9.

Simple forms. $P - \infty$ (o); $P - 1$ (z); P (y); $P + \infty$ (M) $= 120°$ (nearly); $\breve{P}r$; $\breve{P}r + 1$ (P); $\breve{P}r + \infty$ (h).

Char. of Comb. Prismatic.

Combinations. 1. $P - \infty$. $P + \infty$. $\breve{P}r + \infty$. Andreasberg, Hartz.

2. $P - \infty$. $P - 1$. P. $\breve{P}r + 1$. $P + \infty$. $\breve{P}r + \infty$. Fig. 28.

Cleavage, $P - \infty$ and $\breve{P}r$ distinct, the former streaked parallel to the edges of combination with $\breve{P}r$; imperfect in the direction of $P + \infty$. Fracture uneven. Surface in general smooth.

Lustre metallic. Colour silver-white, inclining to tin-white. Streak unchanged.

Hardness = 3·5. Sp. Gr. = 9·4406, Haüy; = 9·820, Klaproth.

Compound Varieties. Twin-crystals: face of composition parallel, axis of revolution perpendicular to a face of $P + \infty$. It is often repeated in parallel layers, or in layers parallel to both the faces of $P + \infty$. The result is as in prismatic Lime-haloide, di-prismatic Lead-baryte, and other species, and similar therefore to Figs. 38. and 39. Massive: composition granular, individuals of various sizes, and easily separated. Pseudomorphic six-sided prisms.

OBSERVATIONS.

1. The Arsenical Silver is considered by Professor **Hausmann** as a more or less intimate mechanical mixture of native Arsenic or of prismatic Arsenical-pyrites with prismatic Antimony; and several mineralogists have regarded the *Antimonial Silver* and the *Arsenical Silver* as varieties of the same species. Very few of their properties have yet been ascertained; among those which are known, the curved lamellar composition peculiar to Arsenical Silver, and its readiness to assume grey tarnished colours, the last of which, however, is, perhaps not without foundation, ascribed to native Arsenic, perhaps also specific gravity, may serve to distinguish it from Antimonial Silver. It appears, therefore, that an accurate examination of both substances is a thing yet very much wanted.

Antimonial Silver occurs in crystals and massive varieties consisting of granular individuals; Arsenical Silver is found in curved lamellar compositions, consisting of very thin crystalline coats. These are subject to tarnish.

2. According to **Klaproth**, the Antimonial Silver consists of 16·00 to 24·00 of antimony, and 84·00 to 76·00 of silver; the Arsenical Silver, according to the same author, of

Arsenic	35·00.
Antimony	4·00.
Silver	12·75.
Iron	44·25.

Before the blowpipe the pure varieties yield a globule of silver, while the antimony is driven off.

3. It is found in veins, accompanied by hexahedral Silver, native Arsenic, hexahedral Lead-glance, and various other species. Antimonial Silver is found at Altwolfach in Fürstenberg, and Andreasberg in the Hartz; Arsenical Silver, also in the Hartz, and Guadalcanal in Estremadura in Spain.

4. It is a rare mineral, and is highly valuable for extracting silver, wherever it is found in sufficient quantity.

Genus IV. BISMUTH.

1. OCTAHEDRAL BISMUTH.

Octahedral Bismuth. Jam. Syst. Vol. III. p. 107. Man. p. 260. Native Bismuth. Phill. p. 272. Gediegen Wismuth. Wern. Hoffm. H. B. IV. I. S. 65. Gediegen Wismuth. Hausm. I. S. 123. Gediegen-Wismuth. Leonh. S. 211. Bismuth natif. Haüy. Traité, T. IV. p. 184. Tabl. comp. p. 105. Traité, 2de Ed. T. IV. p. 202.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. $\frac{\overset{*}{O}}{2}$, Bieber near Hanau; $-\frac{O}{2}$, Vol. I. Fig. 13. 14.; D, Vol. I. Fig. 31.

Char. of Comb. Semi-tessular, with inclined faces.

Combinations. 1. $\frac{O}{2}$. $-\frac{O}{2}$. Fig. 158.

2. $\frac{O}{2}$. $-\frac{O}{2}$. D.

Cleavage, octahedron, perfect, and easily obtained. Fracture not observable. Surface rough, generally covered with a grey oxide.

Lustre metallic. Colour silver-white, much inclining to red, subject to tarnish. Streak unchanged.

Sectile, almost malleable. Hardness = 2·0 ... 2·5. Sp. Gr. = 9·737, a variety from Altenberg; = 9·612, the melted metal.

Compound Varieties. Imbedded feathery and arborescent shapes. Massive: composition granular, individuals very distinct, though small.

OBSERVATIONS.

1. This is the pure metal, as produced by nature. It is very fusible, and melts even at the flame of a candle. Before the blowpipe it is volatilized, and leaves a yellow coat-

ing upon the charcoal. It is soluble in nitric acid, but the solution yields a white precipitate, if farther diluted. It crystallises easily from fusion.

2. Octahedral Bismuth occurs chiefly in veins in gneiss and clay-slate, and is accompanied by ores of silver, cobalt, tin, &c. The Bismuth-ochre, which in a great measure depends upon the presence of that metal, is likewise often found along with it.

3. Its chief localities are several of the Saxon and Bohemian silver and cobalt mines at Schneeberg, Annaberg, Marienberg, Johanngeorgenstadt, Joachimsthal, &c. Large cleavable varieties have been found in the tin mine of Altenberg. It is found besides at Bieber in the principality of Hanau, in the Sophia mine at Wittichen in Fürstenberg, at Löling in Carinthia, at Fahlun in Sweden, Modum in Norway, in France, &c. It occurs with ores of cobalt in Wheal Sparnon near Redruth, and with prismatic Bismuth-glance at Carrock in Cumberland.

4. It enters into the composition of several metallic alloys used in the arts, and is employed in certain technical or metallurgic operations.

GENUS V. MERCURY.

1. DODECAHEDRAL MERCURY.

Dodecahedral Mercury, or Native Amalgam. JAM. Syst. Vol. III. p. 86. Man. p. 261. Native Amalgam. PHILL. p. 357. Natürlich Amalgam. WERN. Hoffm. H. B. III. 2. S. 21. Amalgam. HAUSM. I. S. 107. Amalgam. LEONH. S. 207. Mercure argental. HAÜY. Traité, T. III. p. 432. Tabl. comp. p. 77. Traité, 2de Ed. T. III. p. 307.

Fundamental form. Hexahedron. Vol. I. Fig. I.

Simple forms. H (*z*); O (*r*), Vol. I. Fig. 2; $\overset{*}{D}$, Vol. I. Fig. 31.; A_3 (*t*), Vol. I. Fig. 32.; C_1 (*s*), Vol. I. Fig. 34.; T_1 (*l*), Vol. I. Fig. 35.

Char. of Comb. Tessular.

Combinations. 1. O. D. 2. H. D. C_1. 3. H. O. D. A_3. C_1. T_1. All of them from Moschellandsberg.

Cleavage, very indistinct traces parallel to the dodecahedron. Fracture conchoidal, uneven. Surface smooth and shining.

Lustre metallic. Colour silver-white. Streak unchanged.

Brittle; it emits a grating noise when cut with a knife. Hardness = 3·0 ... 3·5. Sp. Gr. = 13·755, both observed in crystallised varieties.

Compound Varieties. Massive: individuals scarcely discernible, fracture conchoidal, uneven.

OBSERVATIONS.

1. Two kinds of native Amalgam have been distinguished, in reference to the *solid* or *fluid* state in which it is found. The fluid varieties must be considered as solutions of the solid ones in fluid Mercury.

2. Dodecahedral Mercury consists of

Silver	36·00.		27·50.	
Mercury	64·00.	Klaproth.	72·50.	Cordier.

Before the blowpipe the mercury is driven off, and we obtain a globule of pure silver.

3. The present species is always found in the repositories of peritomous Ruby-blende. It is accompanied by other ores of silver and mercury, and by hexahedral Iron-pyrites.

4. It occurs at Moschellandsberg in the Palatinate, and at Rosenau in Hungary; it is said also to have been met with in France, Spain and Sweden.

2. FLUID MERCURY.

Fluid Native Mercury. Jam. Syst. Vol. III. p. 83. Liquid Native Mercury. Man. p. 260. Native Quick-silver. PHILL. p. 357. Gediegen Quecksilber. WERN. Hoffm. H. B. III. 2. S. 18. Gediegen Quecksilber. HAUSM. I. S. 108. Gediegen-Quecksilber. LEONH. S. 186. Mercure natif. HAÜY. Traité, T. III. p. 423. Tabl. comp. p. 77. Traité, 2de Ed. T. III. p. 297.

Amorphous. Liquid.
Lustre metallic. Colour tin-white.
Hardness = 0·0. Sp. Gr. = 13·581, HAÜY.

OBSERVATIONS.

1. Fluid Mercury is the pure metal, as produced by nature. It is entirely volatile before the blowpipe, and easily soluble in nitric acid.

2. Like the dodecahedral Mercury, it occurs in the repositories of peritomous Ruby-blende, in the shape of small globules or drops. Sometimes it is found in narrow fissures of those rocks, which accompany that mineral.

3. The most important and well known localities of fluid Mercury are Idria in Carniola, and Almaden in Spain. In smaller quantities it is found at Wolfstein and Mörsfeld in the Palatinate, also in some places in Carinthia, in Hungary, in Peru, and other countries.

4. The quantity of fluid Mercury found in nature is too small to allow of its being applied to any useful purposes. The metal obtained from the peritomous Ruby-blende, is employed for making thermometers and barometers, also in various chemical and pharmaceutical preparations, in the amalgamation of gold and silver ores, in the production of artificial cinnabar, in the processes of silvering mirrors, of gilding, and for many other purposes.

GENUS VI. SILVER.

1. HEXAHEDRAL SILVER.

Hexahedral Silver. JAM. Syst. Vol. III. p. 68. Man. p. 261. Native Silver. PHILL. p. 285. Gediegen

Silber. Wern. Hoffm. H. B. III. 2. S. 38. Gediegen-Silber. Hausm. I. S. 105. Gediegen-Silber. Leonh. S. 192. Argent natif. Haüy. Traite, T. III. p. 384. Tabl. comp. p. 73. Traité, 2de Ed. T. III. p. 249.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. $\overset{*}{H}$ (*r*), Kongsberg, Norway; $\overset{*}{O}$ (*n*) Vol. I. Fig. 2., Mexico; $\overset{*}{C}_2$ (*o*) Vol. I. Fig. 34., Kongsberg.

Char. of Comb. Tessular.

Combinations. 1. H. O. Vol. I. Fig. 3. and 4. 2. O. C_2. Kongsberg.

Cleavage, none. Fracture hackly. Surface, the octahedron striated in a triangular direction, parallel to its edges of combination with the hexahedron or the icositetrahedron. The remaining faces often rough, but even.

Lustre metallic. Colour silver-white, more or less subject to tarnish. Streak shining.

Ductile. Hardness = 2·5 ... 3·0. Sp. Gr. = 10·4743, Haüy.

Compound Varieties. Twin-crystals, compound parallel to one of the faces of the octahedron. Dentiform, filiform and capillary shapes, also reticulated, arborescent and in plates. Often the individuals are still discernible, but frequently also their extent can be no longer ascertained. In the latter case the surface of the dentiform and filiform shapes is longitudinally streaked. Massive: composition scarcely observable, fracture hackly. Plates, formed in fissures, also superficial coatings.

OBSERVATIONS.

1. Native Silver has been divided into *common* and *auriferous* native Silver. It is at present impossible to decide whether the latter ought to be united as a variety with the former, or whether it forms a species of its own; as we are not yet sufficiently acquainted with all its physical properties, by which alone this question can be decided. Specific gravity and the yellowish colour form the distinctive marks between them; but as these might be explained by mere mechanical juxtaposition of the two metals, they are not alone sufficient for this purpose.

2. The common varieties present the pure silver, as produced by nature, occasionally alloyed with a small proportion of antimony, arsenic, iron, &c. A variety of the auriferous native silver yielded to **Klaproth**, and another to **Fordyce**, the following ingredients:

Silver	36·00	72·00.
Gold	54·00	28·00.

The hexahedral Silver is soluble in cold nitric acid, but in sulphuric acid only with the assistance of heat. It crystallises from fusion*.

3. Hexahedral Silver occurs principally in veins, traversing gneiss, clay-slate, and other primitive and transition rocks. It is accompanied by numerous species of the orders Kerate, Metal, Pyrites, Glance, and Blende, also by rhombohedral Quartz, rhombohedral and macrotypous Lime-haloide, &c. The auriferous native silver, though it is found in the same repositories, is far more scarce. The formation of *Black Silver*, a black, friable substance, which is very rich in silver, seems to depend chiefly upon the presence of native Silver, or also of hexahedral Silver-glance.

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* A globule of silver melted before the blowpipe, if not too large, forms while crystallising a single individual, in which the faces of the octahedron, the hexahedron, and the dodecahedron may be most distinctly traced, and admit of measurement by the reflective goniometer, but particularly those of the octahedron. The surface of the globule appears reticulated. H.

4. There are but few countries in which hexahedral Silver is found in any considerable quantity. Among these are the mining districts of Saxony and Bohemia, also Norway and Siberia, but particularly Mexico and Peru. It occurs more sparingly in the Hartz, in Hungary, in Swabia and Franconia, and other countries. The Saxon varieties are chiefly known from Freiberg, Schneeberg, Johanngeorgenstadt, &c.; the Bohemian varieties from Joachimsthal, Przibram, Ratiborzitz, &c. Large and well defined crystals were formerly found at Kongsberg in Norway. It is met with at Andreasberg in the Hartz, at Altwolfach in Swabia, in the Dauphiny, in France, at Schemnitz in Hungary, &c.; it is found likewise in Wheal Mexico, Wheal Duchy, and several other mines of Cornwall. The localities of auriferous native Silver are Kongsberg in Norway, and Schlangenberg in Siberia.

5. The employment of silver in coinage, in the manufacture of plate, and of various articles of luxury, is well known. Other metals are frequently covered with a coat of it; it is useful in the construction of several parts of the chemical and philosophical apparatus, for which, however, it is required to be perfectly pure. It is used also in pharmacy.

Genus VII. GOLD.

1. HEXAHEDRAL GOLD.

Hexahedral Gold. Jam. Syst. Vol. III. p. 55. Man. p. 262. Native Gold. Phill. p. 322. Gediegen Gold. Wern. Hoffm. H. B. III. 1. S. 10. Gediegen-Gold. Electrum. Hausm. I. S. 100. 102. Gediegen-Gold. Leonh. S. 177. Or natif. Haüy. Traité, T. III. p. 374. Tabl. comp. p. 73. Traité, T. III. p. 235.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. $\overset{*}{\mathrm{H}}$ (*r*), Transylvania; $\overset{*}{\mathrm{O}}$ (*n*). Vol. I. Fig. 2. Siberia; $\overset{*}{\mathrm{D}}$ (*s*) Vol. I. Fig. 31., Catharinenburg, Siberia; $\dot{A}_2$, Vol. I. Fig. 32., Siberia; C_2 (*o*) Vol. I. Fig. 34., Transylvania.

Char. of Comb. Tessular.

Combinations. 1. H. O. Vol. I. Fig. 3. and 4., Matto Grosso, Brazil. 2. H. D. Fig. 151. 3. H. C_2. Fig. 153. 4. H. O. C_2. The three last from Transylvania.

Cleavage, none. Fracture hackly. Surface; the hexahedron often hollow; the octahedrons either rough or smooth, in combinations generally the latter; the icositetrahedrons streaked parallel to the edges of combination with the hexahedron and the octahedron. These differences in most cases are not distinctly marked.

Lustre metallic. Colour, various shades of gold-yellow. Streak shining.

Ductile. Hardness = 2·5 ... 3·0. Sp. Gr. = 14·857, a rolled mass of a high gold-yellow colour; = 19·2527, melted, HAÜY.

Compound Varieties. Twin-crystals: face of composition parallel, axis of revolution perpendicular to a face of the octahedron; pretty frequent, particularly in the icositetrahedrons, as represented in Fig. 157. If this variety be compressed in the direction of the axis of revolution, Fig. 178 is formed, having the appearance of an isosceles six-sided pyramid combined with a three-sided one, similar to the crystals, which are described in the *Catalogue of the Collection of* MR VON DER NÜLL, *Part III. p.* 42., but without mentioning the regular composition upon which they depend. Filiform, capillary, reticulated, and arborescent shapes, also leaves or membranes. Sometimes the individuals are still discernible, but frequently also they can be no longer recognised. Surface drusy, striated, or smooth. Massive: composition not observable, fracture hackly. Plates, superficial coatings, rolled masses.

OBSERVATIONS.

1. Although the division which has been introduced in the present species into *gold-yellow*, *brass-yellow*, and *greyish-yellow* Native Gold, seems with some slight modifications to agree with the geological relations of its varieties; it is yet as little deserving of acceptance as any other division within a natural-historical species. The gold-yellow varieties comprise the specimens of the highest gold-yellow colours, though there are some among them which have a rather pale colour; they include most of the crystals, and of the imitative shapes, in fact the greater part of the species itself. The brass-yellow native Gold is confined to some of the regular and imitative shapes, of a pale colour, which is generally called brass-yellow, and, as it is said, of a less specific gravity than the preceding one; but this does not seem to have ever been ascertained by direct experiment. The greyish-yellow native Gold occurs only in those small flat grains which are mixed with the native Platina, and possess a yellow colour a little inclining to grey; they are said to have the greatest specific gravity of them all. The real foundation of this distribution seems to be the opinion that the first are the purest, the second mixed with a little silver, and the third with platina. It is not known whether the latter admixture really takes place, but it is certain that several varieties of gold-yellow native Gold contain an admixture of silver. Some mineralogists unite the auriferous native Silver not improperly with the present species.

2. A variety of the brass-yellow native Gold has yielded to Lampadius,

Gold 96·60.
Silver 2·00.
Iron 1·10.

Hexahedral Gold melts pretty easily, and is soluble only in chlorine or nitro-muriatic acid. Gold may be obtained crystallised from fusion. A solution of muriate of gold in sulphuric ether yields hexahedral crystals on evaporation. Brilliant crystals of the compound form of the hexahedron, octahedron, and dodecahedron, have been accidentally formed by exposing for several years an amalgam of gold wrapt up in cotton.

3. The hexahedral Gold is so minutely disseminated in several rocks, that its presence can be discovered only after pounding and washing. It occurs frequently in beds, in small nodules, imbedded in rhombohedral Quartz; it is more rarely met with in imbedded crystals. It occurs in veins traversing various kinds of rocks, sometimes very short and narrow, presenting a great variety of crystals and imitative shapes. In beds it is generally accompanied by rhombohedral Quartz and hexahedral Iron-pyrites, sometimes also by prismatoidal Antimony-glance and pyramidal Scheelium-baryte. In veins it occurs along with nearly the same minerals, but likewise with many others, of the orders Glance, Pyrites, Blende, Baryte, Haloide, Metal, &c. Hexahedral Gold is often found in the sand of rivers, in valleys and plains into which it has been carried from its original repositories, in the shape of larger or smaller, generally flat pebbles, often mixed with rhombohedral Quartz. From the generally high gold-yellow colour of these varieties, it seems probable that they are derived from beds or mountain masses, and not from veins. The greyish-yellow native Gold occurs in a similar manner along with native Platina. In this kind of repositories it is accompanied by octahedral Iron-ore, peritomous Titanium-ore, (for instance, the *Nigrine* from Ohlapian), and several species of gem, among which pyramidal Zircon is not rare.

4. The greatest quantity of hexahedral Gold is found in alluvial soil in Brazil, Mexico, and Peru, sometimes in pebbles of considerable size. The imbedded crystals from Matto Grosso in Brazil indicate a formation in beds, or rocks. Also in Transylvania a considerable quantity of gold is obtained from streamworks, as at Ohlapian near Hermannstadt. At Wicklow in Ireland, near Leadhills, and in Perthshire in Scotland*, in several districts of Germany and in other countries, gold is found in the sand of rivers, or in alluvial deposits from them. It has been observed that the Rhine, the Danube, and others rivers are auriferous only in plains, from whence it should seem, that the gold is engaged in the diluvium. The mountain of Vöröspatak near Abrudbanya in Transylvania, is a remarkable instance of a rock impregnated throughout with a small portion of gold, which occurs crystallised and in various imitative shapes in the numerous short and narrow veins which traverse it in all directions. This mountain has been worked to a considerable extent since the time of the Romans; it consists of a kind of greywacke and porphyry. Gold occurs in beds at Pösing, Botza, Magurka, and other places in Hungary, also in the Bannat with dodecahedral Garnet, but here more rarely. In the same kind of repositories it is found at Schellgaden in Lungau, also in the valleys of Gastein, Rauris, Fusch, &c. in Salzburg, and in many other places along the chain of the Alps; in the Schlangenberg in Siberia, &c. It is met with in veins at Cremnitz and Schemnitz in Lower Hungary, and in many districts of Transylvania, as at Offenbanya, where it is accompanied by prismatic Antimony-glance, at Zalathna, where it is accompanied by native Tellurium, and in several mines between Nagyag and Boitza. At Nagyag it occurs along with the prismatic Tellurium-glance.

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* The variety from Leadhills is of a high yellow colour, that from Turrich in Glen Coich in Perthshire is very pale. A specimen of the latter in Mr Allan's collection weighs upwards of seven guineas. H.

5. The use of hexahedral Gold is in many respects analogous to that of hexahedral Silver, and perhaps even more extensive.

GENUS VIII. PLATINA.

1. NATIVE PLATINA.

Native Platina. JAM. Syst. Vol. III. p. 49. Man. p. 264. Native Platina. PHILL. p. 324. Gediegen Platin. WERN. Hoffm. H. B. III. 2. S. 7. Polyxen. HAUSM. I. S. 97. Gediegen-Platin. LEONH. S. 174. Platine natif ferrifère. HAÜY. Traité, T. III. p. 368. Tabl. comp. p. 72. Traité, 2de Ed. T. III. p. 226.

Irregular forms, grains. Surface uneven, sometimes worn off by attrition (pebbles).

Cleavage none. Fracture hackly.

Lustre metallic. Colour perfect steel-grey. Streak unchanged, shining.

Ductile. Hardness = 4·0 ... 4·5. Sp. Gr. = 17·332, rolled masses.

OBSERVATIONS.

1. Native Platina generally contains a little iron. It is accompanied besides by iridium, osmium, rhodium, palladium, and also by copper, chrome, and titanium. It is very refractory, and soluble only in nitro-muriatic acid.

2. The original repositories of native Platina are not known, it having hitherto been found only in pebbles and grains, generally small, but sometimes upwards of a pound and a half in weight. It is accompanied by pyramidal *Zircon* and some other gems, also by octahedral Iron-ore, hexahedral Gold, and native Iridium and Palladium.

3. Native Platina is principally found in South America, in the provinces of Choco and Barbacoas; also at Matto Grosso in Brazil. It has also been found in St Domingo.

4. The refractory property of this metal, and the circumstance that it is not acted upon by the greater part of the chemical reagents, render it extremely valuable in the construction of philosophical and chemical apparatus. It is used also for covering other metals, for painting on porcelain, and, like gold or silver, for various other purposes.

GENUS IX. IRON.

1. OCTAHEDRAL IRON.

Octahedral Iron (excepting the first subsp.). Jam. Syst. Vol. III. p. 97. Man. p. 264. Native Iron. Phill. p. 213. Gediegen Eisen. Wern. Hoffm. H. B. III. 2. S. 187. Meteoreisen. Hausm. I. S. 114. Gediegen-Eisen. Leonh. S. 319. Fer natif. Haüy. Tabl. comp. p. 93. Traité, 2de Ed. T. III. p. 531.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple form. $\overset{*}{O}$, Vol. I. Fig. 2. Irregular forms, grains.

Cleavage none. Fracture hackly. Surface rough, the grains rough and uneven.

Lustre metallic. Colour pale steel-grey. Streak unchanged, shining. Strong action upon the magnet.

Ductile. Hardness = 4·5. Sp. Gr. = 7·768, the meteoric variety from Elbogen.

Compound Varieties. Small crystals arranged in rows. The composition in large masses becomes visible, if an artificial surface is produced by cutting and polishing, and this surface exposed either to the action of nitric acid, or allowed to tarnish by heat. The surface of the masses is commonly oxidised, and sometimes marked with impressions of prismatic Chrysolite.

OBSERVATIONS.

1. The masses of octahedral Iron, from Agram, Siberia, and Mexico, analysed by KLAPROTH, have yielded

Iron	96·50	98·50	96·75.
Nickel	3·50	1·50	3·25.

It contains sometimes a larger proportion of nickel. Professor STROMEYER has found some cobalt in the variety from the Cape. The octahedral Iron is infusible before the blowpipe, soluble in acids, and resembling pure iron in most of its properties.

2. The octahedral Iron is found in detached masses of various sizes on the surface of the earth. It enters into the composition of several kinds of meteoric stones, along with Iron-pyrites, with which it has been originally produced. Those large masses, which are found without earthy admixtures, must yet be supposed to have had the same origin. It is not decided whether the terrestrial native Iron is a natural production. It agrees pretty nearly in regard to several of its properties with the meteoric Iron. The variety from Kamsdorf in Saxony, besides 92·50 of iron, yielded to KLAPROTH 6·0 of lead, and 1·5 copper. The native steel from La Bouiche in France, engaged in an iron-slag, appears to be of a secondary formation, owing to the combustion of a coal seam.

3. Among the most remarkable of the masses found on the surface of the earth, we notice that discovered by PALLAS in Siberia, which contains crystals and grains of prismatic Chrysolite; that discovered by Don RUBIN DE CELIS in the district of Chaco-Gualamba in South America, one of the largest known; that of Elbogen in Bohemia, and that of Agram in Croatia, which, according to credible witnesses, was seen falling from the sky in two pieces. Many masses are scattered over the continent of North America, as in Louisiana, and still farther north, in the countries inhabited by the Esquimaux; several masses have also been found in Africa, as on the Senegal river, and near the Cape of Good Hope. The greater part of the

mass from Elbogen, and the larger specimen of those which fell at Agram, are preserved in the imperial cabinet at Vienna, which, besides, contains an extensive and interesting collection of meteoric stones. Masses of this kind, containing octahedral Iron, are those from Erxleben, between Halberstadt and Magdeburg, from Ensisheim, from l'Aigle, and others.

4. Octahedral Iron has been worked as an object of curiosity into knives, swords, and other instruments. It forms the substance of the rough shaped knives of some of the Esquimaux tribes in North America.

GENUS X. COPPER.

1. OCTAHEDRAL COPPER.

Octahedral Copper. JAM. Syst. Vol. III. p. 89. Man. p. 265. Native Copper. PHILL. p. 296. Gediegen Kupfer. WERN. Hoffm. H. B. III. 2. S. 84. Gediegen-Kupfer. HAUSM. I. S. 111. Gediegen-Kupfer. LEONH. S. 251. Cuivre natif. HAÜY. Traité, T. III. p. 518. Tabl. comp. p. 85. Traité, 2de Ed. T. III. p. 423.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. $\overset{*}{H}$ (*r*); $\overset{*}{O}$ (*n*), Vol. I. Fig. 2; $\overset{*}{D}$ (*s*), Vol. I. Fig. 31., Lizard, Cornwall; $\overset{*}{A}_2$, Vol. I. Fig. 32., Nalsoe.

Char. of Comb. Tessular.

Combinations. 1. H. O. Vol. I. Fig. 3. and 4., Cornwall. 2. H. D. Fig. 151. 3. H. O. D. 4. H. O. D. A_2. The three last from Siberia.

Cleavage none. Fracture hackly. Surface generally not very smooth, but nearly of the same quality in all the forms, only the dodecahedron is sometimes streaked parallel to the edges of combination with the hexahedron. It is subject to tarnish.

Lustre metallic. Colour copper-red. Streak unchanged, shining.
Ductile. Hardness = 2·5 ... 3·0. Sp. Gr. = 8·5844, HAÜY.

Compound Varieties. Twin-crystals very frequent, composed parallel to a face of the octahedron. If the form of the individuals is the icositetrahedron A_2, and the compound crystal flattened in the direction of the axis of revolution, isosceles six-sided pyramids are formed, which at first sight appear not to belong to the tessular system. Small crystals aggregated in rows; arborescent and filiform shapes. Massive: composition not recognisable. Plates, often consisting of distinct crystals. Superficial.

OBSERVATIONS.

1. The octahedral Copper is the pure metal as produced by nature. Before the blowpipe it melts pretty easily, but is covered on cooling with an oxidised coat. It is easily soluble in nitric acid, and yields under the influence of light and air, a blue solution in ammonia. It crystallises from fusion; crystals, dentiform and capillary shapes, are often produced in the vesicular cavities of copper-slags.

2. It is found in beds and veins, and is associated with various other ores of copper, sometimes with ores of iron, &c.

3. Among the metals, hexahedral Copper is one of those which are not uncommonly found in the native state; and even in our times examples have occurred of large masses that have been met with in several countries. In beds it occurs at Herrengrund, Schmölnitz, and Göllnitz; also at Moldawa, Saska, and Orawitza, in the Bannat of Temeswar; probably in the same manner in Siberia, from whence the largest and most distinct crystals of the general shape of the hexahedron have been brought, for the greater part

engaged in granular limestone. It occurs likewise in beds in bituminous marl-slate at Camsdorf in Thuringia, and in the county of Mansfeld, and in sandstone at Chessy near Lyons. In veins it is met with in considerable quantities in many of the mines near Redruth in Cornwall, in small quantities in several of the Shetland isles, and formerly in the neighbourhood of Freiberg. Octahedral Copper is found along with axotomous Triphane-spar in amygdaloid at Oberstein in the Palatinate and in Transylvania, and in a similar rock with rhombohedral Kouphone-spar in Nalsoe, one of the Faroe islands; in the last place in beautiful icositetrahedrons of the form Vol. I. Fig. 32. It occurs besides in many localities of Germany, Spain, Norway, America, China, &c. It is sometimes formed in the fissures of those rocks which surround the repositories of various ores of Copper, as in the vicinity of Moldawa in the Bannat. What has been called *copper of cementation*, is the metal precipitated from its solution in sulphuric acid, by metallic iron. It is produced at Herrengrund and Schmölnitz in Hungary, and in Cornwall.

4. Copper allows of a very extensive and well known employment in the arts and manufactures, as in roofing houses, coppering ships, coining, and in the fabrication of various utensils. The discovery of Sir HUMPHRY DAVY, that copper may be guarded against the influence of sea-water, by negatively electrifying its surface, will no doubt enlarge its application in the coppering of vessels.

ORDER X. PYRITES.

GENUS I. NICKEL-PYRITES.

1. PRISMATIC NICKEL-PYRITES.

Prismatic Nickel-Pyrites. JAM. Syst. Vol. III. p. 266. Man. p. 266. Copper Nickel. Arsenical Nickel. PHILL. p. 283. Kupfernickel. WERN. Hoffm. H. B. IV. 1. S. 164. Kupfernickel. HAUSM. I. S. 118. Arsenik-Nickel. LEONH. S. 292. Nickel arsenical. HAÜY.

Traité, T. III. p. 513. Tabl. comp. p. 84. Traité, 2de Ed. T. III. p. 417.

Fundamental form. Scalene four-sided pyramid of unknown dimensions. Vol. 1. Fig. 9.

Simple forms and the character of combination not satisfactorily ascertained. The latter seems to be nearly allied to those of prismatic Iron-pyrites, of diprismatic Lead-baryte, &c. particularly in regard to the regular compositions in which their individuals occur.

Cleavage unknown, imperfect. Fracture small conchoidal, uneven. Surface smooth.

Lustre metallic. Colour copper-red. Streak pale brownish-black.

Brittle. Hardness = 5·0 ... 5·5. Sp. Gr. = 7·655.

Compound Varieties. Reniform: composition columnar, generally impalpable. Massive: composition granular, the individuals being small, and strongly connected. Fracture uneven.

OBSERVATIONS.

1. According to two analyses, one by STROMEYER, and another by PFAFF, the prismatic Nickel-pyrites consists of

Nickel with a little Cobalt.	44·206	48·90.
Arsenic	54·726	46·42.
Iron	0·337	0·34.
Lead	0·320	0·56.
Sulphur	0·401	0·80.

It is represented by the chemical formula Ni As, which corresponds to 44·01 of nickel and 55·99 of arsenic. Before the blowpipe it melts upon charcoal, and emits an arsenical smell. The remaining metallic bead is white and brittle. In nitric acid it soon becomes covered with a green coating. It is soluble in nitro-muriatic acid.

2. The prismatic Nickel-pyrites chiefly occurs in veins, in various classes of rocks, and is more rarely met with in beds. It is almost always accompanied by octahedral Cobalt-pyrites, sometimes also by ores of silver and lead. The apple-green friable substance called *Arseniate of Nickel* or *Nickel Ochre* (*Nickel arseniaté*. HAÜY), found investing the prismatic Nickel-pyrites, is produced by the decomposition of this mineral, and consists of 37·35 oxide of nickel and a little cobalt, of 36·97 arsenic acid, and 24·32 of water, together with a little oxide of iron and sulphuric acid, according to STROMEYER.

3. The present species is found in veins at Schneeberg, Annaberg, Marienberg, Freiberg, Gersdorf, and other places in Saxony; at Joachimsthal in Bohemia; at Saalfeld in Thuringia; at Riegelsdorf in Hessia; in the Hartz and the Black Forest; also at Allemont in Dauphiny, and in several of the mines in Cornwall. In beds it occurs at Schladming in Upper Stiria, and in the neighbourhood of Orawitza in the Bannat. Mr DOEBEREINER has observed that the metallic alloy, consisting chiefly of arsenic and nickel, which is obtained from the process of fabricating smalt, often crystallises in four-sided tabular crystals, and is in every respect similar to prismatic Nickel-pyrites.

GENUS II. ARSENICAL-PYRITES.

1. AXOTOMOUS ARSENICAL-PYRITES.

Prismatic Arsenical-Pyrites. JAM. Syst. Vol. III. p. 272.
Axotomous Arsenic-Pyrites. Man. p. 268.

Fundamental form. Scalene four-sided pyramid. $P = 117° 28', 90° 51', 121° 58'$. Vol. I. Fig. 9. AP.

$$a : b : c = 1 : \sqrt{0{\cdot}8747} : \sqrt{0{\cdot}4806}.$$

Simple forms. $\bar{P}r\ (o) = 51° 20'$; $P + \infty\ (d) = 122° 26'$.

Char. of Comb. Prismatic.

Combination. $\bar{P}r$. $P + \infty$. Fig. 1. Schladming, Stiria.

Cleavage, $P - \infty$, perfect; less distinct $\breve{P}r = 86° 10'$; traces of $P + \infty$. Fracture uneven. Surface faintly streaked parallel to the common edges of combination, frequently smooth.

Lustre metallic. Colour between silver-white and steel-grey. Streak greyish-black.

Brittle. Hardness = 5·0 ... 5 5. Sp. Gr. = 7·228, the massive variety from Reichenstein.

Compound Varieties. Massive: composition granular, individuals small, often nearly impalpable, and strongly connected, fracture uneven; composition columnar, rather thick and irregular, and divergent. Faces of composition irregularly streaked.

OBSERVATIONS.

1. The axotomous Arsenical-pyrites contains arsenic and iron, the proportions of which have not been ascertained.

2. As far as our present information goes, the axotomous Arsenical-pyrites has been found only in beds, either along with brachytypous Parachrose-baryte and prismatic Iron-ore, or imbedded in serpentine. With the first it occurs in the valley of Löling near Hüttenberg in Carinthia, in serpentine at Reichenstein in Silesia. It has likewise been met with in beds in primitive mountains, with Nickel-pyrites and Cobalt-pyrites at Schladming in Stiria.

2. PRISMATIC ARSENICAL-PYRITES.

Di-prismatic Arsenical Pyrites. Jam. Syst. Vol. III. p. 272. Prismatic Arsenic-Pyrites. Man. p. 268. Arsenical Iron. Mispickel. Phill. p. 215. Arsenikkies. Wern. Hoffm. H. B. IV. 1. S. 211. Arsenikkies. Hausm. I. S. 153. Arsenikkies. Leonh. S. 332. Fer arsenical. HAÜY. Traité, T. IV. p. 56. Tabl. comp. p. 95. Traité, 2de Ed. T. IV. p. 28.

Fundamental form. Scalene four-sided pyramid. $P = 131^\circ 51', 105^\circ 56', 93^\circ 20'$. Vol. I. Fig. 9. AP.

$$a : b : c = 1 : \sqrt{2{\cdot}83} : \sqrt{1{\cdot}30}.$$

Simple forms. $P - \infty$; $P + \infty\ (M) = 111^\circ 53'$; $\breve{P}r - 1\ (r) = 145^\circ 26'$; $\breve{P}r\ (s) = 118^\circ 32'$; $\breve{P}r + 1 = 80^\circ 8'$; $\breve{P}r + \infty$; $\bar{P}r + 1 = 59^\circ 22'$.

Char. of Comb. Prismatic.

Combinations. 1. $\breve{P}r - 1$. $P + \infty$. Fig. 2. Freiberg, Saxony.

2. $\breve{P}r$. $\bar{P}r + 1$. $P + \infty$. Wheal Maudlin, Cornwall.

3. $\breve{P}r - 1$. $\breve{P}r + 1$. $P + \infty$. Ehrenfriedersdorf, Saxony.

4. $P - \infty$. $\breve{P}r + 1$. $\bar{P}r + 1$. $P + \infty$. Wheal Maudlin.

Cleavage, $P + \infty$ pretty perfect, traces of $P - \infty$. Fracture uneven. Surface, $\breve{P}r - 1$ deeply streaked parallel to its own edges; $\breve{P}r$ sometimes rough, or striated in the direction of its edges of combination with $\breve{P}r - 1$; the remaining faces are smooth.

Lustre metallic. Colour silver-white, inclining and passing into steel-grey. Streak dark greyish-black.

Brittle. Hardness $= 5{\cdot}5 \ldots 6{\cdot}0$. Sp. Gr. $= 6{\cdot}127$, of a crystallised variety.

Compound Varieties. Twin-crystal: 1. Face of composition parallel, axis of revolution perpendicular, to a face of $\bar{P}r + 1$, the individuals being continued beyond the face of composition. 2. Face of composition parallel, axis of revolution perpendicular to a face of $P + \infty$; the composition often takes place parallel to both faces, or is repeated in parallel layers. Massive: composition columnar, individuals of various sizes, generally straight and divergent or irregular. The faces of composition are irregularly streaked. Individuals joined in a granular composition are often very small, or even impalpable, and strongly connected; their fracture is uneven.

OBSERVATIONS.

1. Two subspecies, the *common* Arsenical pyrites and the *argentiferous* Arsenical pyrites, have been distinguished among the varieties of the present species, which, however, differ chiefly in a small proportion of silver which the latter contains, and which has probably been the only reason of this distinction having been introduced. The latter contains only a few varieties in small imbedded acicular crystals and massive nodules, while all the rest rank under the head of common Arsenical pyrites.

2. According to STROMEYER, the prismatic Arsenical-pyrites consists of

Iron	36·04.
Arsenic	42·88.
Sulphur	21·08.

It is considered by BERZELIUS to be $Fe\,As^2 + Fe\,S^4$, which corresponds to 33·5 of iron, 46·5 of arsenic, and 20·0 of sulphur. Before the blowpipe upon charcoal it emits copious arsenical fumes, and melts into a globule, which is nearly pure sulphuret of iron. It is soluble in nitric acid, with the exception of a whitish residue.

3. Prismatic Arsenical-pyrites is a pretty common mineral both in beds and veins. It is accompanied by ores of

silver, lead, and tin, by several species of the order Pyrites, very frequently by rhombohedral Quartz, and it is scarcely ever found without dodecahedral Garnet-blende.

4. Prismatic Arsenical-pyrites is plentiful in several of the mining districts of Saxony; it is found in beds at Breitenbrunn and Raschau, in veins at Freiberg, Munzig, &c., also in the tin-veins and beds of Altenberg, Geyer, Ehrenfriedersdorf, and other places. In Bohemia it is found in the silver mines of Joachimsthal and the tin mines of Schlaggenwald. Reichenstein and Kupferberg in Silesia, which are quoted as localities, are rather doubtful, no attention having hitherto been paid to the difference between the two species of prismatic and axotomous Arsenical pyrites. It occurs at Andreasberg in the Hartz, at Tunaberg in Sweden, at Wheal Maudlin and other mines in Cornwall, and in many other countries. The argentiferous variety is principally found at Bräunsdorf near Freiberg, in quartzy veins in mica-slate. A variety in small acicular crystals, much resembling the preceding one, but containing no silver, is found in sandstone, in a place called Braza, near Zalathna in Transylvania.

5. The accidental admixture of silver renders some varieties of the present species useful as ores of that metal. The common Arsenical pyrites is employed in the manufacture of white arsenic and of realgar. Sometimes it contains a small proportion of gold.

GENUS III. COBALT-PYRITES.

1. OCTAHEDRAL COBALT-PYRITES.

Octahedral Cobalt-Pyrites. JAM. Syst. Vol. III. p. 282. Octahedral Cobalt-Pyrites or Tin-White Cobalt. Man. p. 269. Bright White Cobalt. PHILL. p. 278. Weisser Speiskobold. WERN. Hoffm. H. B. IV. 1. S. 173. Speiskobalt. HAUSM. I. S. 155. Speiskobalt. LEONH. S. 299. Cobalt arsenical. HAÜY. Traité, T. IV. p. 200. Tabl. comp. p. 106. (excepting C. a. gris-noirâtre). Traité, 2de Ed. T. IV. p. 219. (with the same exceptions).

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. Ḣ (*r*), Schladming, Stiria; Ȯ (*n*), Vol. I. Fig. 2., Schneeberg, Saxony; D (*s*), Vol. I. Fig. 31.; C_1 (*o*), Vol. I. Fig. 34.

Char of Comb. Tessular.

Combinations. 1. H. O., Vol. I. Fig. 3 and 4. Dobschau, Hungary. 2. H. D. Fig. 151. 3. H. O. D. 4. H. O. D. C_1. The three last from Schneeberg.

Cleavage, traces in the direction of the octahedron, the hexahedron and the dodecahedron, the first sometimes a little more distinct. Fracture uneven. Surface generally pretty smooth, the faces of the hexahedron often curved. Subject to tarnish.

Lustre metallic. Colour tin-white, inclining to steel-grey.. Streak greyish-black.

Brittle. Hardness = 5·5. Sp. Gr. = 6·466, a cleavable variety.

Compound Varieties. Reticulated and some other imitative shapes; the individuals of them being often discernible. Massive: composition granular, individuals of various sizes, but generally small and strongly connected. Fracture uneven.

OBSERVATIONS.

1. According to STROMEYER, the octahedral Cobalt-pyrites consists of

Cobalt	20·31.
Arsenic	74·21.
Iron	3·42.
Copper	0·15.
Sulphur	0·88.

Its chemical formula is $Co\ As^3$ or $Co\ As^2 + Co\ As^4$, corresponding to 22·30 of cobalt and 77·70 of arsenic. Before the blowpipe it emits copious fumes and odour of arsenic. It melts into a white brittle metallic globule. To borax and other fluxes it imparts a blue colour. It affords a pink solution with nitric acid, leaving a white residue, which is itself dissolved on farther digestion.

2. Octahedral Cobalt-pyrites is principally met with in veins, traversing rocks of various ages, more rarely in beds. It is accompanied by ores of silver, or by ores of copper, and along with the first sometimes by octahedral Bismuth and prismatic Cobalt-mica. In beds it is associated with Arsenical-pyrites and Lime-haloides, and rarely it is found without the prismatic Nickel-pyrites.

3. In veins traversing primitive rocks it occurs at Schneeberg and Annaberg in Saxony; also at Freiberg and Marienberg; likewise at Joachimsthal in Bohemia, and in veins in killas at Wheal Sparnon in Cornwall. The veins of the counties of Sayn and Siegen, which contain it, are included in greywacke, and those of Thuringia and Mansfeld, and of Riechelsdorf in Hessia, in cupriferous shale. It occurs in beds at Schladming in Stiria, at Orawitza in the Bannat, and at Dobschau in Hungary. It has also been quoted from Piedmont and several other countries.

4. It is a valuable mineral for the preparation of blue enamel colours, but particularly for smalt, and forms an important object in some of the mining districts of Saxony.

5. The *Grey Cobalt-Ore* (Jam. Syst. Vol. III. p. 287), which is considered by Haüy as a variety of the present species, and the *Radiated White Cobalt* (Id. ibid. p. 286), will probably require in future to be established into a separate species. They are, however, too imperfectly known at present to enable us to determine their place in the order Pyrites. From several imitative shapes in which it occurs, the regular forms of this species seem to belong to the prismatic system, among which are very thin four-sided

tabular prisms, sometimes disengaged from contact with others. It occurs generally, however, in reniform or globular compositions, consisting of very thin columnar individuals; the individuals of its granular compositions are often impalpable, the fracture being uneven, flat conchoidal, sometimes even. The surface of the imitative shapes is rough, drusy, or granulated, and subject to tarnish; so are also the faces of fracture, which assume in time a dark grey colour. Their metallic lustre is united to a more or less dark steel-grey colour, inclining to tin-white in the radiated varieties, but which becomes blackish in the streak, and assumes a slight degree of lustre. It is brittle, its hardness is = 5·5, and the specific gravity of a radiated variety = 7·280, of a compact variety = 7·064; the latter ought perhaps to be larger, on account of the numerous interstices in the compound mass.

According to JOHN, the radiated white Cobalt consists of

Cobalt	28·00.
Arsenic	65·75.
Iron, with Manganese	6·25.

Its mixture may be expressed by $Fe\ As^2 + 2\ Co\ As + 2\ Co\ As^2$, which gives the ratio among the above mentioned metals = 26·46 : 67·46 : 6·08.

The locality of the radiated variety is Schneeberg in Saxony; the compact ones are found at the same place, but also at Annaberg, Joachimsthal, in the district of Siegen, &c. The Cornish variety probably also belongs to this species. It is preferred to the octahedral Cobalt-pyrites in the smalt manufactures.

2. HEXAHEDRAL COBALT-PYRITES.

Hexahedral Cobalt-Pyrites or Silver-White Cobalt. JAM. Syst. Vol. III. p. 279. Man. p. 269. Bright White Cobalt. PHILL. p. 278. Glanz-Kobold. WERN. Hoffm. H. B. IV. 1. S. 186. Kobaltglanz. HAUSM. I. S. 157. Kobaltglanz. LEONH. S. 297. Cobalt gris. HAÜY. Traité, T. IV. p. 204. Tabl. comp. p. 107. Traité, 2de Ed. T. IV. p. 225.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. $\overset{*}{H}$ (*P*, *M*); $\overset{*}{O}$ (*d*), Vol. I. Fig. 2.; $\frac{\overset{*}{A_2}}{2}$ (*e*), Vol. I. Fig. 19.; $\frac{T_1}{2}$ (*f*), Vol. I. Fig. 27.

Char. of Comb. Semi-tessular with parallel faces.

Combinations. 1. H. O., Vol. I. Fig. 3. and 4.
2. H. $\frac{A_2}{2}$. Fig. 165. 3. O. $\frac{A_2}{2}$. Fig. 166.
4. H. O. $\frac{A_2}{2}$. $\frac{T_1}{2}$. All of them from Tunaberg.

Cleavage, hexahedron, perfect. Fracture imperfect conchoidal, uneven. Surface, the faces of the hexahedron streaked in three directions perpendicular to each other, parallel to the obtuse edges of combination with the pentagonal dodecahedron. The remaining faces smooth.

Lustre metallic. Colour silver-white, inclining to red. Streak greyish-black.

Brittle. Hardness = 5·5. Sp. Gr. = 6·298.

Compound Varieties. Massive: composition granular, generally small, but easily discernible.

OBSERVATIONS.

1. According to the analyses by KLAPROTH, TASSAËRT, and STROMEYER, the hexahedral Cobalt-pyrites consists of

Cobalt	44·00	36·00	33·10.
Arsenic	55·50	49·00	43·46.
Iron	0·00	5·66	3·23.
Sulphur	0·50	6·50	20·08.

The two first of these varieties are from Tunaberg; the last is from Modum, and is expressed by the formula $Co\,S^4 + Co\,As^2$, corresponding to 35·27 of cobalt, 45·27 arsenic, and 19·46 sulphur. Before the blowpipe it gives upon charcoal a large quantity of arsenical fumes, and melts only after having been roasted. It imparts a blue colour to borax and other fluxes, and is acted upon by nitric acid, like the preceding species.

2. Hexahedral Cobalt-pyrites occurs in beds in primitive rocks and in veins. It is accompanied chiefly by Iron-pyrites, Arsenical-pyrites, and Copper-pyrites; in beds it is also associated with octahedral Iron-ore, and several species of the genera Augite-spar, Feld-spar, &c.; in veins it is sometimes found with several species of Haloide and Baryte. The crystals found in beds are terminated from all sides, and are the finest varieties of the species.

3. The hexahedral Cobalt-pyrites occurs in the parish of Modum in Norway, at Tunaberg in Südermanland in Sweden, at Querbach in Silesia, and Bottallack near St Just in Cornwall. It is found also in several of the mines in the district of Siegen.

4. It is highly valued as an ore of cobalt, for painting on porcelain, and manufacturing smalt.

GENUS IV. IRON-PYRITES.

1. HEXAHEDRAL IRON-PYRITES.

Hexahedral Iron-Pyrites or Common Iron-Pyrites. JAM. Syst. Vol. III. p. 291. Hexahedral Iron-Pyrites. Man. p. 271. Iron pyrites (in part). PHILL. p. 217. Gemeiner Schwefelkies. Zelkies (in part). WERN. Hoffm. H. B. III. 2. S. 191. 205. Schwefelkies. HAUSM. I. S. 147. Eisenkies. LEONH. S. 324. Fer sulfuré (in part). HAÜY. Traité, T. IV. p. 65. Fer sulfuré (in part). Tabl. comp. p. 69. Traité, 2de Ed. T. IV. p. 38.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. $\overset{*}{H}$. (*P*, *M*), Val di Brozzo, Piedmont; $\overset{*}{O}$ (*d*), Vol. I. Fig. 2., Akudlek, Greenland; D, Vol. I. Fig. 31.; $\frac{\overset{*}{A}_1}{2}$ (*y*), Stiria; $\frac{\overset{*}{A}_2}{2}$

(*e*), Vol. I. Fig. 19., Elba; B, Vol. I. Fig. 33.; $\overset{*}{C}_1$ (*u*), Vol. I. Fig. 34., Corsica, Haüy; C_2; $\frac{\overset{*}{T}_1}{2}$ (*f*), Vol. I. Fig. 27., Schneeberg, Saxony; $-\frac{T_1}{2}$, Vol. I. Fig. 28.; $\frac{T_2}{2}$ (*n*); $\frac{T_3}{2}$ (*s*); $-\frac{T_3}{2}$ (*o*).

Char. of Comb. Semi-tessular with parallel faces.

Combinations. 1. H.O., Vol. I. Fig. 3. and 4., Tiverton, near Bath.

2. H. $\frac{A_2}{2}$. Fig. 165. Wheal Maudlin, Cornwall.
3. O. $\frac{A_2}{2}$. Fig. 166. Elba.
4. $\frac{A_1}{2}$. $\frac{A_2}{2}$. Kapnik, Transylvania.
5. $\frac{A_2}{2}$. $\frac{T_1}{2}$. Vol. I. Fig. 75. Elba.
6. $\frac{A_2}{2}$. $-\frac{T_1}{2}$. Vol. I. Fig. 76. Choco; it occurs along with the native Platina.
7. $\frac{A_2}{2}$. $\frac{T_3}{2}$. Hüttenberg, Carinthia.
8. O. D. B. $\frac{T_1}{2}$. Salzburg.
9. H. O. A_2. C_1. $\frac{T_3}{2}$. Fig. 167. Coal mines in the valley of Plauen, near Dresden.
10. H. O. $\frac{A_1}{2}$. $\frac{A_2}{2}$. $\frac{T_1}{2}$. $\frac{T_2}{2}$. $\frac{T_3}{2}$. $-\frac{T_3}{2}$. Petorka, Peru. (The variety called *Fer sulfuré parallélique* by Haüy.).

Cleavage, hexahedron, and octahedron, of various degrees of perfection: sometimes highly perfect; often one of them more distinct, or both lost in conchoidal fracture. In some varieties there are traces of $\frac{A_2}{2}$. Fracture conchoidal, uneven. Surface, of the hexahedron streaked parallel to the obtuse edges of combination with the pentagonal dodecahedron; the faces of this dodecahedron are streaked, either parallel to the same edges, or parallel to the edges of combination with $\frac{T_3}{2}$, which are perpendicular upon the former, the faces of that icositetrahedron sometimes are rough, the rest of the faces generally smooth and shining.

Lustre metallic. Colour, very few shades of a characteristic bronze-yellow. Streak brownish-black.

Brittle. Hardness = 5·031, a cleavable variety from Freiberg; = 4·981, a crystallised variety from Littmitz in Bohemia.

Compound Varieties. Twin-crystals: face of composition parallel, axis of revolution perpendicular to a face of the dodecahedron. The individuals continued beyond the face of composition, by which the compound group takes a cruciform appearance (WEISS. *Mag. der Berl. Gesellsch. naturf. Fr.* VIII. 24.). Imbedded and implanted globules: surface drusy; composition indistinctly columnar. Massive: composition granular, sometimes even impalpable, strongly coherent; fracture uneven, or on a large scale flat conchoidal. Cellular.

OBSERVATIONS.

1. Of the species of Iron-pyrites in the system of WER-

NER, which comprehends the hexahedral and the prismatic Iron-pyrites, only the *Common Iron-pyrites* belongs entirely to the present species: the remaining subspecies belong to the following one, except the *Cellular Pyrites*, which is common to both. In regard to the latter, it is necessary to observe, that if the small individuals lining the inside of the cellular walls, which themselves consist of rhombohedral Quartz, are hexahedral Iron-pyrites, the varieties must be referred to the present species, while they enter within the limits of the following one, if these individuals possess a prismatic form. The cellular shape is owing to the form of hexahedral Lead-glance, in the fissures of which, parallel to the cleavage, thin films of quartz have been deposited; and as a shape which is foreign to the essence of either hexahedral or prismatic Iron-pyrites, it can have no influence on the determination of the species.

2. The hexahedral Iron-pyrites consists, according to HATCHETT, of

Iron	47·30	47·85.
Sulphur	52·70	52·15.

It is considered by BERZELIUS to be $Fe\ S^4$, in which the proportion of iron and sulphur is = 45·74 : 54·26. In the oxidating flame of the blowpipe it becomes red upon charcoal, the sulphur is driven off, and oxide of iron remains. At a high temperature in the interior flame it melts into a globule, which continues red-hot for a short time when removed from the blast, and possesses, after cooling, a crystalline fracture and metallic appearance. In heated nitric acid it is partly soluble, and leaves a whitish residue. Some varieties are subject to decomposition, when exposed to the action of the atmosphere.

3. Hexahedral Iron-pyrites is a very common mineral, and occurs in various repositories. It is engaged in imbedded crystals, and in massive nodules in several rocks, the first particularly in clay-slate and greywacke-slate, the second in greenstone and other rocks allied to it, in granular limestone, &c. It constitutes beds by itself included in primitive slate, accompanied by rhombohedral

Iron-pyrites and rhombohedral Quartz, by several Lime-haloides, and other species, and it is often an important ingredient of those beds which contain ores of lead, iron, &c. It is frequently mixed with coal seams and the beds of clay which occur along with them. Here it is generally accompanied by the prismatic Iron-pyrites. In veins, where it is likewise met with in considerable quantities, its principal associates are dodecahedral Garnet-blende, prismatic Arsenical-pyrites, hexahedral Lead-glance, and pyramidal Copper-pyrites. The *auriferous Pyrites* contain a small portion of hexahedral Gold mechanically mixed up with them. Hexahedral Iron-pyrites is also found with ores of silver. It is contained in many organic remains, both of vegetable and animal origin, and is one of the species which can be distinctly traced in the composition of some of the meteoric masses.

4. It would far exceed the limits of the present work to mention more than those localities where particularly remarkable varieties have been found. Some of the crystals, along with their localities, have been mentioned above. The island of Elba is the most conspicuous for large and well defined crystals; very fine crystals are found in Piedmont, and many other interesting crystallised varieties at Freiberg, Johanngeorgenstadt, &c. in Saxony, in Bohemia, in Hungary, in the Hartz, at Kongsberg in Norway, at Fahlun in Sweden, in Derbyshire and Cornwall, and in many other countries in and out of Europe.

5. Hexahedral Iron-pyrites is roasted for extracting sulphur; afterwards having been exposed to the oxidating influence of the atmosphere, it yields sulphate of iron and sulphuric acid. The remaining oxide of iron is used as a coarse pigment. It is an important agent in several metallurgical operations. Formerly it used to be employed instead of flint in gun-locks.

2. PRISMATIC IRON-PYRITES.

Prismatic Iron-Pyrites. JAM. Syst. Vol. III. p. 297. Man.

p. 272. Iron-Pyrites (in part). White Iron-pyrites. Phill. p. 217. 220. Strahlkies. Leberkies. Zelkies (in part). Spärkies. Kamkies. Wern. Hoffm. H. B. III. 2. S. 198. 202. 205. 210. Wasserkies. Hausm. I. S. 149. Strahlkies. Leonh. S. 328. Fer sulfuré (in part). Haüy. Traité, T. IV. p. 65. Fer sulfuré aciculaire radié. Tabl. comp. p. 97. Fer sulfuré blanc. Traité, T. IV. p. 68.

Fundamental form. Scalene four-sided pyramid. P = 125° 16′, 115° 53′, 89° 11′. Vol. 1. Fig. 9. Haüy.

$$a : b : c = 1 : \sqrt{2{\cdot}4} : \sqrt{1{\cdot}8}.$$

Simple forms. P (*h*); P + ∞ (*l*) = 98° 13′*; $(\breve{P}r + \infty)^3$ = 60°; P̆r (*g*) = 114° 19′; P̆r + ∞ (*P*); P̄r (*M*) = 106° 36′.*

Char. of Comb. Prismatic.

Combinations. 1. P̆r. P + ∞. Sim. Fig. 2. Derbyshire.

2. P̆r. P + ∞. P̆r + ∞. Sim. Fig. 9. Schemnitz, Hungary.

3. P̄r. $(\breve{P}r + \infty)^3$. P̆r + ∞. Sim. Fig. 8. Derbyshire.

4. P̆r. P̄r. P + ∞. P̆r + ∞. The individuals of Fig. 43. Littmitz.

5. P̆r. P. P + ∞. P̆r + ∞. Freiberg.

Cleavage P̄r, rather perfect, traces of P + ∞. Fracture uneven. Surface, P̆r streaked parallel to the edges of combination with P, and generally a little rough; $(\breve{P}r + \infty)^3$ and P̆r + ∞ deeply

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* According to measurements by Mr Phillips, these angle are, P + ∞ = 100° and P̄r = 106° 2′.

streaked in a vertical direction, though smooth. The remaining faces smooth.

Lustre metallic. Colour pale bronze-yellow, sometimes inclining to green or grey. Streak, greyish-black or brownish-black.

Brittle. Hardness = 6·0 ... 6·5. Sp. Gr. = 4·678, crystals from Schemnitz; 4·847, crystals from Littmitz.

Compound Varieties. Twin-crystals: 1. Face of composition parallel, axis of revolution perpendicular to a face of $\bar{P}r$; 2. Face of composition parallel, axis of revolution perpendicular to a face of $\breve{P}r$. The first law of regular composition occurs very frequently in the present species, and is often repeated either in parallel layers, or in the directions of both faces of the prism at once. Thus in Fig. 42., two individuals, P^{I} and P^{II} are attached to the individual P, and in a similar manner the composition is continued in the individuals P^{III} and P^{IV}; the whole group, consisting of five individuals, has very much the appearance of a five-sided pyramid with truncated apices, each of the five solid angles at the base shewing a re-entering angle. The second law generally takes place in such varieties as are already compound according to the first. They assume a grooved appearance like Fig. 43. The re-entering angle, formed by the faces $\breve{P}r + \infty$ (P and P^{II}, or P^{I} and P^{III}) is $= 114° 19'$. Globular, reniform, stalactitic and other imitative shapes: surface drusy; composition columnar, individuals straight, and generally small or even impalpable. There is sometimes a second curved lamellar or granular composition, the faces of composition being uneven or rough. Massive: composition as in the imitative shapes; fracture even, flat conchoidal, uneven. Pseudomorphoses in low, nearly regular six-sided prisms, perhaps of prismatic Melane-glance. Cellular.

OBSERVATIONS.

1. The varieties of Iron-pyrites, which belong to the present species, are the *Radiated Pyrites*, the *Spear Pyrites*, the *Cockscomb Pyrites*, the *Hepatic Pyrites*, and some varieties of the *Cellular Pyrites*, as has been observed above. The distinction among these subspecies depends upon the shape and composition of crystals, and upon several accidental circumstances. The crystals of Radiated Pyrites are generally simple ones, not twins, and it occurs besides in numerous imitative shapes and massive varieties, shewing a columnar composition. Spear Pyrites is found only in compound crystals consisting of two, three, or a greater number of individuals, regularly grouped; it does not present any imitative shapes, and hardly any massive varieties. Cockscomb Pyrites occurs both in simple and compound crystals of a particular form, with indentations along their edges, and a colour much inclining to green or grey. The six-sided prisms commonly called crystals of Hepatic Pyrites, are pseudomorphoses, and often consist of hexahedral Iron-pyrites. It is found in some imitative shapes and massive, but generally the grain of the composition is impalpable, the fracture even or flat conchoidal, and the colour greyish. That variety of Cellular Pyrites which belongs to the present species, though disposed in regard to its extraneous form, like that of hexahedral Iron-pyrites, is produced by small crystals of a prismatic form.

2. The mixtures of the prismatic and the hexahedral Iron-

pyrites are identical. Three analyses, two of them by Hatchett and one by Berzelius, have yielded,

Iron	46·40	45·66	45·07.
Sulphur	53·60	54·34	53·35.
Manganese	0·00	0·00	0·70.
Silica	0·00	0·00	0·80.

Like the hexahedral Iron-pyrites, its chemical formula is $Fe\ S^4$. Before the blowpipe it also comports itself like that species. Some of its varieties are particularly subject to decomposition.

3. The prismatic Iron-pyrites is less frequently met with in nature than the hexahedral one, and seldom without it; it seems most plentiful in beds of coal and the accompanying strata of clay. It is found likewise in metalliferous veins with ores of silver, lead, and copper, also with rhombohedral Lime-haloide, octahedral Fluor-haloide, prismatic Hal-baryte, and other species.

4. Radiated, hepatic, and cellular pyrites are found in several parts of Saxony, particularly near Freiberg, Memmendorf, &c., hepatic pyrites at Johanngeorgenstadt, radiated and spear pyrites at Joachimsthal, Littmitz, and Altsattel in Bohemia, the former also at Schemnitz in Hungary and Almerode in Hessia; cockscomb pyrites in Derbyshire. Spear-pyrites and radiated pyrites in beautiful stalactitic groupes are found in Cornwall. Several varieties are besides met with in the Hartz, in the Black Forest, in France and other countries.

5. The varieties of this species are very useful in manufacturing sulphur, sulphate of iron and sulphuric acid.

1. RHOMBOHEDRAL IRON-PYRITES.

Rhomboidal Iron-pyrites or Magnetic Pyrites. Jam. Syst. Vol. III. p. 305. Man. p. 274. Magnetic Iron-Pyrites. Phill. p. 221. Magnetkies. Wern. Hoffm. H. B. III. 2. S. 212. Magnetkies. Hausm. I. S. 144. Leberkies. Leonh. S. 330. Fer sulfuré ferrifère. Haüy. Tabl. comp. p. 98. Fer sulfuré magnétique. Traité, 2de Ed. T. IV. p. 64.

Fundamental form. Rhombohedron. Vol. I. Fig. 7.

Simple forms. $R-\infty$ (*P*); R (*a*); $R+\infty$ (*d*); $P+n$ (*c*); $P+\infty$ (*M*).

Combinations. 1. $R-\infty.\ P+\infty$. 2. $R-\infty.\ P.\ P+\infty$. Sim. Fig. 112. Inclination of *P* on *a* = 135°; of *P* on *c* = 102° 13′, BOURNON.

Cleavage, $R-\infty$ perfect; $P+\infty$ less distinct. Fracture small and imperfect conchoidal. Surface rough, particularly $P+\infty$, sometimes also horizontally streaked. Subject to tarnish.

Lustre metallic. Colour intermediate between bronze-yellow and copper-red. Streak dark greyish-black.

Slight action on the magnet. Brittle. Hardness = 3·5 ... 4·5. Sp. Gr = 4·631, of a cleavable variety.

Compound Varieties. Massive: composition granular, individuals of various sizes, or even impalpable. Fracture uneven.

OBSERVATIONS.

1. The varieties of the present species have been divided into *Foliated* and *Common Magnetic Pyrites*, which are easily distinguished from one another, as their division depends upon one single character, the presence of cleavage in the former, and the want of it in the latter, on account of the too small size of the component individuals.

2. One analysis by HATCHETT, and two by STROMEYER, have yielded the following proportions:

Iron	63·50	59·85	56·37.
Sulphur	36·50	40·15	43·63.

The first of these is expressed by $Fe\,S^2$, which contains 62·77 iron, and 37·23 sulphur; the others are considered as mixtures of the two sulphurets. In other respects it differs little from the two preceding species. It is often formed in slags.

3. It occurs in beds along with other minerals containing iron, with dodecahedral Garnet-blende, &c. It forms an accidental ingredient of several rocks, and crystallises in their fissures. Its presence has also been ascertained in several meteoric stones.

4. The locality of some large and distinct crystals, preserved in some of the Vienna collections, is not known. Small crystals are found at Andreasberg in the Hartz. The compound varieties occur more plentifully. There are cleavable ones at Bodenmais in Bavaria, and various others at Breitenbrunn and Geyer in Saxony, at Gieren and Querbach in Silesia, in the Hartz, in several districts of Stiria, particularly at Obedach, in Cornwall and other countries.

5. It does not seem as if anywhere the rhombohedral Iron-pyrites alone were employed to any use; but as it occurs often along with the hexahedral Iron-pyrites, it is used for the same purposes.

GENUS V. COPPER-PYRITES.

1. OCTAHEDRAL COPPER-PYRITES.

Variegated Copper. JAM. Syst. Vol. III. p. 334. Man. p. 278. Buntkupfererz. Purple Copper. PHILL. p. 299. Buntkupfererz. WERN. Hoffm. H. B. III. 2. S. 110. Bunter Kupferkies. HAUSM. I. S. 163. Bunt-Kupfererz. LEONH. S. 256. Cuivre pyriteux hépatique. HAÜY. Traité, T. III. p. 536. Tabl. comp. p. 86. Traité, 2de Ed. T. III. p. 436.

Fundamental form. Hexahedron. Vol. I. Fig. 1.

Simple forms. $\overset{*}{H}$ (a); O (P). Char. of Comb. Tessular. Combination. H. O., Vol. I. Figs. 3. and 4., Cornwall.

Cleavage, traces in the direction of the octahedron. Fracture small conchoidal, uneven. Surface generally rough, particularly the hexahedron, and often curved, much subject to tarnish.

Lustre metallic. Colour intermediate between copper-red and pinchbeck-brown. Streak pale greyish-black, a little shining.

Rather sectile. Hardness = 3·0. Sp. Gr. = 5·003, from the Bannat.

Compound Varieties. Twin-crystals: axis of revolution perpendicular, face of composition parallel to a face of the octahedron, the individuals being continued beyond the face of composition. Fig. 128. Massive: composition granular, strongly connected, fracture conchoidal and uneven.

OBSERVATIONS.

1. The tessular form of the present species has been first recognised by Mr W. Phillips in very distinct crystals, resembling Fig. 3. (Vol. I.). Generally, however, particularly the larger crystals, are less regularly formed, and grouped in twins resembling those of octahedral Fluor-haloide and rhombohedral Kouphone-spar.

2. According to Mr R. Phillips, it consists of

Copper	61·07.
Sulphur	23·75.
Iron	14·00.
Silica	0·50.

The formula $Fe\,S^2 + 4\,Cu\,S$ agrees very nearly with this analysis, giving the proportions of copper, iron, and sulphur, = 62·67 : 13·44 : 23·89. Before the blowpipe it comports itself very much like pyramidal Copper-pyrites.

3. It occurs in beds and veins, the crystallised varieties

only in veins. It is accompanied chiefly by various other ores of copper.

4. At Orawitza and other places in the Bannat, the octahedral Copper-pyrites occurs in beds, and is very frequently associated with dodecahedral Garnet. It is found likewise in beds in the cupriferous shale of the Mansfeld, included in thin layers in the bituminous marl-slate. Several of the Saxon veins contain varieties of it; but it is particularly found in Cornwall, which contains the only localities where crystals have been discovered, in the vicinity of Redruth. In smaller quantities it is found also in Ireland, Hessia, Silesia, in Norway and Sweden, in Greenland, &c.

5. It is a valuable mineral for extracting copper.

2. PYRAMIDAL COPPER-PYRITES.

Octahedral Copper-Pyrites or Yellow Copper-Pyrites. Jam. Syst. Vol. III. p. 310. Pyramidal Copper-pyrites. Man. p. 275. Copper Pyrites. Yellow Copper Ore. Phill. p. 302. Kupferkies. Wern. Hoffm. H. B. III. 2. S. 113. Gemeiner Kupferkies. Hausm. I. S. 162. Kupferkies. Leonh. S. 258. Cuivre pyriteux. Haüy. Traité, T. III. p. 529. Tabl. comp. p. 85. Traité, 2de Ed. T. III. p. 432.
Haidinger. Mem. Wern. Soc. Vol. IV. p. 1. Phill. Ann. of Phil. Vol. III. p. 296.

Fundamental form. Isosceles four-sided pyramid. $P = 109° 53', 108° 40'$. Vol. I. Fig. 8. R. G.

$$a = \sqrt{1{\cdot}9412}.$$

Simple forms. $P - \infty$ (*a*); $P - 4$ (*d*) $= 155° 6', 38° 25'$; $P - 2 = 132° 19', 69° 44'$; $P - 1$ (*b*) $= 120° 30', 89° 9'$; $\overset{*}{P}$ (*P P'*) Alston, Cumberland; $P + 1$ (*c*) $= 101° 49', 126° 11'$; $P + 2 = 96° 33', 140° 31'$; $P + \infty$; $\frac{2\sqrt{2}}{3} P - 3$ (*e*) $= 145° 20', 49° 50'$; $\frac{2\sqrt{2}}{3} P - 2$ (*g*) $= 134° 19', 66° 36'$; $\frac{3}{2\sqrt{2}} P$ (*h*) $= 108° 18', 111° 50'$; $[P + \infty]$; $(P + \infty)^3 = 126° 52' 12'', 143° 7' 48''$.

Char. of Comb. Hemi-pyramidal with inclined faces.

Combinations. 1. $P - \infty. \frac{P}{2}. - \frac{P}{2}.$ Sim. Fig. 92. Consolidated mines, Cornwall.

2. $P. P + 1.$ Alte Elisabeth mine, Freiberg.

3. $P - \infty. P - 1. \frac{P}{2}. - \frac{P}{2}. P + 1.$ Fig. 109. Kurprinz mine, Freiberg.

4. $P - \infty. \frac{\frac{2\sqrt{2}}{3} P - 2}{2}. \frac{P}{2}. \frac{2\sqrt{2}}{3} P - 2. P - 1. \frac{3}{2\sqrt{2}} P. P + 1. - \frac{P - 4}{2}. - \frac{\frac{2\sqrt{2}}{3} P - 3}{2}. \frac{(\frac{2\sqrt{2}}{3} P - 5)^3}{2}. - \frac{P}{2}.$ Fig. 178.* Inclination of *f* on *f* over *e* = 155° 35′.

Cleavage, P + 1, sometimes very perfect, but interrupted; P − ∞ indistinct. Fracture conchoidal, more or less perfect. Surface P − 1 generally horizontally streaked. The alternating enlarged faces of P are irregularly streaked parallel to the edges of combination with P + 1, and often uneven; the other faces of P are faintly but regularly streaked in the same direction, and much more smooth. The remaining faces are almost all smooth, and often possess a high lustre.

Lustre metallic. Colour brass-yellow. Streak greenish-black, a little shining.

Rather sectile. Hardness = 3·5 ... 4·0. Sp. Gr. = 4·169.

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* A fine crystal of this form is in the cabinet of Mr ALLAN. H.

Compound Varieties. Twin-crystals: face of composition parallel, axis of revolution perpendicular to a face of P, similar to the composition of the octahedron, Fig. 156; 2. Face of composition perpendicular, axis of revolution parallel to a terminal edge of P + 1. This law is complementary to the preceding one; 3. Face of composition perpendicular, axis of revolution parallel to one of the terminal edges of P. These three kinds of regular composition are not only often repeated in parallel layers, and contiguous to the different homologous parts of the crystals, but they are even found to take place at the same time. Globular, reniform, botryoidal, stalactitic, and other imitative shapes: surface generally rough, sometimes also smooth, composition impalpable, fracture flat conchoidal. Massive: composition granular, of various sizes of individuals, often impalpable, and commonly strongly coherent, fracture uneven or flat conchoidal.

OBSERVATIONS.

1. Pyramidal Copper-pyrites has been found to contain

Copper	30·20	30·50	41·00	32·00	34·40	33·12.
Iron	32·30	33·00	17·00	34·00	30·47	30·00.
Sulphur	37·00	35·00	45·00	33·00	38·87	36·52.
Silica	0·00	0·00	0·00	0·00	0·27	0·39.
	Gueniveau.		Lampad.	Breith.	H. Rose.	

Upon charcoal it becomes black before the blowpipe, and red on cooling. It melts into a globule, which becomes magnetic if kept in the blast for some time. With borax it yields a globule of copper. It is partly soluble in dilute nitric acid; the solution is green, and the undissolved part consists of sulphur.

2. Pyramidal Copper-pyrites is equally frequent in beds and veins. In beds it is accompanied by various ores of iron and copper, by hexahedral Lead-glance, dodecahedral Garnet-blende, several species of Augite-spar, &c.; in veins it is found along with a great variety of different species, among which, besides the preceding ones, we notice several ores of silver, as hexahedral Silver-glance, &c. It often occurs accompanying pyramidal Tin-ore and prismatic Scheelium-ore. The black friable substance called *Copper-black*, is the product from the decomposition of pyramidal Copper-pyrites, but also from that of several other species. If pure, it is the peroxide of copper.

3. Pyramidal Copper-pyrites is found in many countries. It occurs in veins in Saxony, particularly in well defined crystals in the mine of Kurprinz near Freiberg, also in Anhalt, in the Hartz, and particularly in very large quantities in Cornwall. In beds it is found in the Bannat of Temeswar, in the county of Gömör, and other districts in Hungary, in Stiria, in Thuringia and Mansfeld, and probably also in Anglesea, where large quantities of it occur. Much pyramidal Copper-pyrites is also met with in Norway, Sweden, Siberia, &c. That from the Rammelsberg near Goslar in the Hartz forms an intimate, and often nearly impalpable mixture with hexahedral Lead-glance, dodecahedral Garnet-blende, and hexahedral Iron-pyrites, and occurs in the shape of a bed in greywacke.

4. Pyramidal Copper-pyrites is a very important mineral for the production of Copper. It is also used for obtaining blue vitriol or sulphate of copper.

END OF THE SECOND VOLUME.

K.