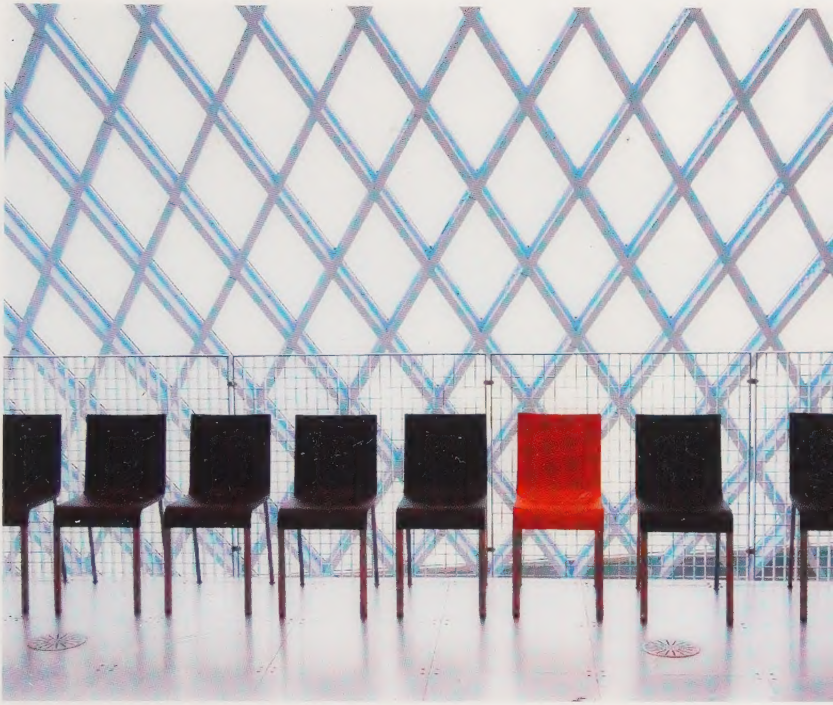

Manual of Mineralogy and Geology

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MANUAL

OF

MINERALOGY AND GEOLOGY.

BY

EBENEZER EMMONS, *M. D.*

LECTURER ON CHEMISTRY AND NATURAL HISTORY IN WILLIAMS COLLEGE.

SECOND EDITION.

ALBANY:
WEBSTER AND SKINNERS.
1832.

PREFACE

TO THE SECOND EDITION.

A new edition of the following work having been called for, the author has been induced to remodel it, by the conviction that a method of teaching and studying the science different from, and superior to, that which had formerly been pursued in this country, ought to be adopted. That method is well known to have possessed too much of a traditionary character, and to have obliged the student to depend more upon the *ipse dixit* of his instructor than his own investigation. In preparing this edition it has been the design of the author, so far as it was in his power, to furnish the student with a guide by means of which he might be satisfactorily conducted through the process of examining minerals, to the attainment of correct results. To accomplish this, sufficient information is given in the following pages, to enable him rightly to employ the characters of mineral substances and to trace the relations existing between them.

To make this simple, and at the same time scientific, the classification of Prof. Mohs has been adopted, with his method of treating the principal heads under which a Natural-Historical system is to be developed. In treating of Crystalography, however, it has been deemed proper still to follow the system of Brooke, as the abstruse manner in which Mohs has taught it, (requiring a knowledge of the higher mathematics,) would here preclude its general use.

The author considers the classification of Mohs in its leading features, as perfect as the present state of the science will admit, and he entertains no doubt but that the student will ultimately adopt the same opinion. To test its advantages, he is advised to exercise himself in carrying known minerals through the different classes and orders; he will thus also acquire a confidence in the practical part of the science, and be fully prepared to enter into the investigation of unknown substances. He, however, who wishes to obtain a knowledge of the Mineral Kingdom, must make himself familiar with Terminology, as it in fact contains the rudiments of the science, and is the groundwork of the whole. If he neglects this, he may be assured that all his investigations will be uncertain and unsatisfactory, and lead to no well determined results.

To illustrate the crystaline forms, a few figures have been introduced; and although a greater number might have been employed with advantage, it is hoped that they will be sufficient to give the student general and correct ideas of the relations existing between the primary and secondary forms. In the course of the work, it will be found that occasionally where the figure is not given, the dimensions of forms are referred to. The mode of expression in these cases is explained by stating that crystalographers employ certain letters to designate the different planes, angles and edges of crystals. Thus the letters, P M T, always refer to the primary faces or planes of a crystal; the vowels, A E I O, are used to denote the solid angles; and the consonants, B C D F G H, the primary edges. They are arranged in the ordinary mode of writing, beginning at the upper part of the figure and proceeding from left to right. When the planes, &c. are similar, the same letter is made use of, and they are distinguished from each other by adding the mark ′ or ″ to the letter employed. For example, in figure 10, the letter P stands upon the terminal plane, and the letter M on the lateral planes; this is intended to show, that whilst the terminal and lateral planes are dissimilar, the lateral ones are similar to each other. In figure 11, the letters, P M T, being made use of, shew that the planes are dissimilar, whilst A A and E E, being placed upon the solid angles, shew that those designated by the same letter are similar, and those by different letters dissimilar.

In compiling the description of a species, it is very important to express the properties of the collective individuals composing it. The description of an individual, however accurate and full, would not convey a notion of the species, but only of a single variety. While, therefore, we abandon the description of each individual variety, we should at the same time avoid giving it a distinct epithet or name. This practice has already retarded the advance of the science, and should be discountenanced.

Some errors have unavoidably escaped correction, owing as well to the indisposition of the author, as to the distance of his residence from the place of publication. They are, however, it is hoped, all noticed in the errata, and are such as may generally be corrected with the pen.

E. EMMONS.

Williamstown, August, 1832.

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INTRODUCTION.

§ 1. *The Mineral Kingdom.*

The mineral kingdom embraces those natural productions which are unorganized.

Natural productions are obviously divisible into two great classes, organized and unorganized. The differences between these are so plain, that a mere glance at them will be sufficient for our purpose. Organized bodies are composed of different parts and organs, and each organ performs a distinct function. The power which controls the organs is a vital power, and is commonly termed VITAL AFFINITY. Organized bodies increase in size by the assimilation of matter to the internal parts. They cease to grow and naturally or *necessarily* die; and the particles which compose them being no longer under the control of vital affinity, are separated and form new combinations, which are not organized. On the other hand, in unorganized bodies, the particles composing their parts are homogeneous; the power which unites them is physical attraction: they increase in size, not by the *assimilation* of matter, but by the apposition of similar particles to their external surfaces: they do not necessarily cease to exist.

Organized bodies may be distinguished into *animals* and *vegetables.* These are properly denominated the Animal and Vegetable Kingdoms. No such distinction can, from the nature of the bodies composing it, be made in the Mineral Kingdom. A proposed division, viz.: that of bodies into *atmospherilia* and *fossils*, cannot be considered as philosophical, since it respects merely the state of bodies as they are gaseous or solid, and hence it has not received the approbation of a majority of naturalists. Besides, the term *fossil* is applied to the remains of organized bodies found in the earth.

§ 2. *Advantages of a Knowledge of the Mineral Kingdom.*

Experience has already taught us that a knowledge of the mineral bodies is important in the arts; the more perfect our knowledge is, the more extensive will be their application to useful purposes. Besides it is rational and wise to study the properties of bodies aside from their immediate application to the arts, since they illustrate those interesting laws which produce regular forms and structure, and exhibit electrical, magnetical and optical properties, not only interesting in themselves, but which may be useful in explaining other phenomena in the great field of nature.

§ 3. *Design of Mineralogy.*

Mineralogy considers the inorganic productions as they are, and not how they have been formed.

The inquiry how natural productions have been formed, does not come within the province of natural history. The restricting of the design of mineralogy to the consideration of the natural historical properties, will serve to promote greatly the real interests of science, as it will not involve the study of principles foreign to this department of knowledge.

§ 4. *Heads under which a System of Mineralogy is to be developed.*

Natural history in general, and mineralogy in particular, is developed under the following heads. 1. Terminology. 2. Theory of the system. 3. Nomenclature. 4. Characteristic. 5. Physiography.

§ 5. *Terminology.*

Terminology explains those natural properties which are employed in recognizing and describing natural bodies.

§ 6. *Theory of the System.*

Theory of the system fixes the principles of classification. It contains the reasoning or philosophical part of the subject.

§ 7. *Nomenclature.*

Nomenclature furnishes the names of natural productions, and explains the principles by which those names are selected.

§ 8. *Characteristic.*

The characteristic teaches the use of the natural properties in such a way that the student may be led to the name which any natural production has received.

§ 9. *Physiography.*

Physiography teaches the arrangement of those marks or properties by which natural bodies are distinguished, in a way best calculated to impress the mind with an image of the object described.

§ 10. *Objects which Mineralogy considers.*

The objects which mineralogy considers are Individuals.

An individual in the mineral kingdom is a single body. It may exist in an *isolated* state, or in connection with others. A crystal of quartz, garnet or diamond is an individual. It is common, however, for individuals to be connected together. Examples of individuals in this state are furnished in masses of granular limestone, granular quartz, &c. the particles of which they are composed are individuals. An individual is also a simple mineral, but in a sense different from that which is understood in chemistry; the term being used to distinguish *simple* from *compound* minerals; the latter embracing those masses in which we can discover two or more individuals of the same kind. The term *mixed mineral* is used to designate compound masses which contain two or more individuals of different kinds, as granite, mica slate, &c.

§ 11. *Method of obtaining a Knowledge of Mineralogy.*

The student may acquire a knowledge of the mineral kingdom by making himself acquainted with the natural properties of inorganic bodies, and the terms which are used in describing them. He ought to commence at once by collecting every thing within his reach, if he has not access to a cabinet, and apply to them the characteristic. This process, so far as other sciences are concerned, requires some knowledge of the elements of geometry. The first object is, to become familiar with a majority of the species in the natural system, after which the more interesting study, the "affinities of inorganic bodies," may be pursued with profit and great satisfaction.

§ 12. *Natural Historical Properties.*

They are those properties which nature has conferred on inorganic bodies, and which are invariable during the natural state of the body.

Those properties which are observed, in consequence of some change which has been wrought upon the substance, or which it has suffered from exposure to the elements, are unfit to be used in the determination of mineral bodies; they are therefore excluded from occupying a place in the characteristic. Those properties are treated of in other branches of science, which, in respect to their principles, differ entirely from those of natural history.

§ 13. *Division of the Natural-Historical Properties.*

The natural-historical properties of minerals are considered under three heads. 1. Such as relate to *simple* minerals, § 10. 2. Such as relate to *compound* minerals. 3. Such as are common to both.

The natural-historical properties are their colour; lustre, hardness, specific gravity, form, structure, &c. They include the greater part of the characters which are called external characters. These characters will be considered in the following order: *First.* Such as relate to the individual itself, or a fragment of the individual: they are such as relate to space, or the form it has received, the structure, surface, and the effect which it produces on light, so far as regularity of form is concerned. *Second.* Those characters which belong to compound minerals, as their *composition*, the *forms* of compound minerals, and the mode of junction of individuals. *Third.* Those characters will be considered which are common both to simple and compound minerals, as colour, lustre, transparency, hardness, state of aggregation, &c.

The principles of Terminology will, therefore, be considered in three sections.

TERMINOLOGY.

PART I.

PROPERTIES WHICH BELONG TO SIMPLE MINERALS.

SECTION I.

§ 14 *Regular Forms.*

In mineralogy a regular form is termed a *crystal.* It consists of continuous and homogeneous matter, and occupies a regular space.

The science which treats of regular forms or crystals is termed *crystalography ;* it has for its object the determination of the form and dimensions of crystaline bodies, with a view to discover the differences which exist among them.

§ 15. *Limits of Crystals.*

Crystals are limited by regular surfaces, which are termed their *planes* or *faces.*

The planes or faces appear under different shapes and receive certain names according to these shapes : thus, some are triangular, others rhombic, &c. and are termed *triangular faces,* rhombic faces respectively. Faces may not be perfectly plane and smooth, yet in crystalography they are considered as perfect planes.

§ 16. *Edges.*

The lines which are formed by the meeting of planes are termed edges.

§ 17 *Angles.*

The meeting of two edges forms a *plane* angle.

§ 18. *Solid Angle.*

A solid angle is formed by the meeting of three or more edges or lines.

§ 19. *Value of Angles.*

The value or measure of angles is the number of degrees and minutes of which they consist.

§ 20. *Similar Planes.*

The planes of crystals are similar when their corresponding edges are proportional and their corresponding angles are equal.

§ 21. *Similar Edges.*

Edges are similar when they are produced by the meeting of planes respectively similar, at equal angles.

§ 22. *Similar Angles.*

Angles are similar when they are equal and contained within similar edges, respectively.

§ 23. *Similar Solid Angles.*

Solid angles are similar when they are formed of an equal number of plane angles, of which the corresponding ones are similar.

The student should be informed that there are some irregularities in crystals in the length of their edges and the dimensions of their faces. Some faces are more extended than others, their similarity is then infered from their situation. Irregularities in the length of edges and the extension of faces, are not noticed in crystalography as they are accidental variations.

CONSIDERATIONS ARISING FROM THE DIFFERENT FORMS WHICH DIFFERENT MINERALS ASSUME.

§ 24. *Primary and Secondary Forms.*

Of the different forms which crystaline bodies assume or under which they appear, some one is selected as the *primary form*, the remainder of the forms of the same species are called *secondary forms.*

The primary form is the parent or original form, from which all the secondary forms are supposed to arise, from certain symmetrical changes which the primary has undergone, and these changes are supposed to take place according to certain laws, being based upon the relations which are observed to exist among the different forms of the same mineral species.

§ 25. *Number and Kinds of Primary Forms.*[*]

There are fifteen *primary forms.* 1. The Cube. 2.

---

[*] See Note A.

The regular Tetrahedron. 3. The regular Octahedron. 4. Rhombic Dodecahedron. 5. The Octahedron with a square base. 6. Octahedron with a rectangular base. 7. Octahedron with a rhombic base. 8. The right square Prism. 9. The right rectangular Prism. 10. The right rhombic Prism. 11. The right oblique angled Prism. 12. The oblique rhombic Prism. 13. The doubly oblique Prism. 14. The Rhombohedron or Rhomboid. 15. The regular hexahedral Prism.

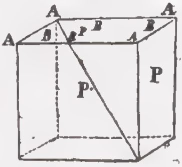
The primary form will be observed under different circumstances. Sometimes a mineral appears under the primary form without any modification of its edges or angles; in other instances the primary is entirely concealed under the secondary faces of the crystal and must be developed by cleavage, or its form infered from the known relations which exist between the primary and secondary forms of crystaline bodies. The primary is never an imaginary form.

§ 26. *Cube.*

The *cube* (Fig. 1.) is a solid contained under six square faces.

The angles of the cube are right angles. From the perfect symmetry of its form the cube has a similar axis* in four directions, which pass through the centre of each pair of solid angles.

Fig. 1.



§ 27. *Tetrahedron.*

The regular *tetrahedron* (Fig. 2.) is a solid contained within four equilateral triangular planes.

The inclination of its planes as P on P′ 70° 31′ and 43″. Its plane angles 60°. It possesses a similar axis in four directions.

Fig. 2.

---

* An axis of a crystal is an imaginary line passing through the solid, and through two opposite solid angles. See (Fig. 3.) the line a b represents an axis.

§ 28. *Regular Octahedron.*

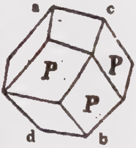
Fig. 3.

The regular *octahedron* (Fig. 3.) is a solid, bounded by eight equilateral triangles, or it is formed of two four sided pyramids united base to base, which base is a square.

The plane angles of the regular octahedron 60°. The inclination of their faces as P on P′ or P″ 109° 28′ 16″.

§ 29. *Rhombic Dodecahedron.*

Fig. 4.



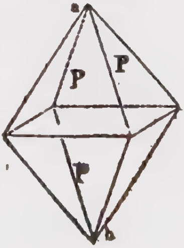
The *rhombic dodecahedron* (Fig. 4) is contained within twelve equal rhombic faces, having six solid angles, consisting each of four acute plane angles, the opposite ones as, a b, being sometimes called the summits, and eight solid angles, consisting each of three obtuse plane angles.

The mutual inclination of two adjacent faces on each other, as P on P″ 120°. Its planer angles 109° 28′ 16″ and 70° 31′ 43′.

This solid has two dissimilar sets of axis which pass through its centre. One set passes through the acute solid angles as the angles a b, the other as c d pass through the obtuse solid angles.

§ 30. *Octahedron with a Square Base.*

Fig. 5.



The *octahedron with a square base* (Fig. 5.) is a solid bounded by light isosceles triangular planes; the bases of the triangles constitute the edges of the base of the octahedron.

When the angles at the summits as a b, measure less than 60° the octahedron is called acute. When the same angles are greater than 60° the octahedron is obtuse.

This form may present a great variety of angles, and the individuals will differ from each other in the inclination of P on P″ and of P on P′.

The square base distinguishes this solid from the two succeeding forms, and the isosceles triangular faces distinguish it from the regular octahedron.

§ 31. *Octahedron with a Rectangular Base.*

Fig. 6.

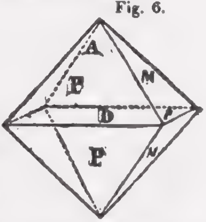
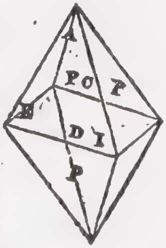


Fig. 6, is an *octahedron with a rectangular base.* The planes are isosceles triangles but unequal.

In this form the broad planes P P′, meet at the edge of the base at a more obtuse angle than the narrow planes M M′. The edge D is therefore the obtuse edge, and the meeting of the planes M M′ the acute edge of the base. The individuals belonging to this class of forms will differ from each other in the inclination of P on P′ or of M on M′.

§ 32. *Octahedron with a Rhombic Base.*

Fig. 7.

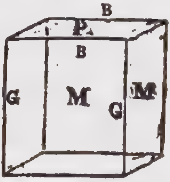


The *octahedron with a rhombic base* (Fig. 7.) is contained within eight equal scalene triangular planes.

This form is in position when the greater diagonal of the base is horizontal, hence the planes which meet in the edge B form a more acute angle than those which meet in C, the former is therefore denominated the acute and the latter the obtuse edge of the pyramid. The solid angle at E is the acute lateral solid angle, and that at I the obtuse lateral solid angle. The individuals of this class will differ from each other in the inclination of P on P′ and on P″.

§ 33. *The Right Square Prism.*

Fig. 8.

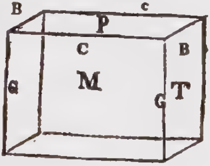


The *right square prism* (Fig. 8.) is a quadrilateral solid whose edges B and G are unequal.

The bases of this class of forms are square and the lateral faces equal rectangles. The form would be a cube if the edges B and G were equal. The individuals will differ from each other in the comparative length of the edges B and G.

§ 34. *Rectangular Prism.*

Fig. 9.



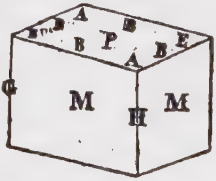
The *right rectangular prism* (Fig. 9.) is a quadrilateral solid, whose bases are equal rectangles, and whose edges C G and B are unequal.

Individuals of this class of forms differ from each other in the comparative length of the edges C G and B.

The right square and right rectangular prisms have the same axis as the cube, besides which, they have an imaginary line passing through the centres of their bases which is called a *prismatic axis.*

§ 35. *The Right Rhombic Prism.*

Fig. 10.

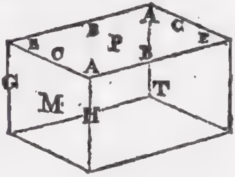


The *right rhombic prism* (Fig. 10.) is a quadrilateral solid, whose bases are equal rhombs and whose lateral planes are either equal squares or equal rectangles.

The solid angles A are the obtuse and those at E the acute solid angles. The edge G is the acute and H the obtuse lateral edges. The individuals of this class will differ from each other in the inclination of M on M′, or in the ratio of the edge H to the edge B.

§ 36. *The Right Oblique-Angled Prism.*

Fig. 11.



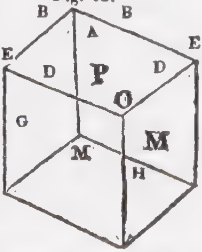
The *right oblique-angled prism*, (Fig. 11.) is a quadrilateral solid, whose bases are *oblique-angled parallelograms*, and whose adjacent lateral planes are unequal, one of which must be rectangular, the other may be either a square or rectangle.

The angles and edges of this class are denominated as in the right rhombic prism.

The individuals of this class will differ from each other in the inclination of M on T, and on the relative lengths of the edges, C, B and H.

§ 37. *The Oblique-Rhombic Prism.*

Fig. 12.



The *oblique rhombic-prism*, (Fig. 12.) is a quadrilateral solid, whose bases are rhombs, and whose lateral planes are equal oblique-angled parallelograms.

The figure is supposed to be oblique in the direction of O A, so that the terminal plane P forms an obtuse angle with the edge H. The planes M and M′ may meet at an acute or an obtuse* angle. The solid angle at A will, in either case, be called the acute solid angle; that at O the obtuse solid angle; and those at E the lateral solid angles.

The edges B are the acute terminal edges; those at D the obtuse terminal edges. The edge H and its opposite are the oblique edges of the prism, and G and its opposite the lateral edges of the prism. The individuals of this class will differ in the inclination of M on M′, and in the ratio of the edge H to the edge D.

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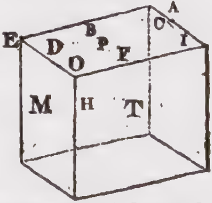
* When the planes M M′ meet at an acute angle, the prism is said to be *oblique from an acute edge*. When they meet at an obtuse angle, they are said to be *oblique from an obtuse edge*.

The oblique-rhombic prism has a greater and lesser, and two transverse axes, besides a prismatic axis. The first passes through the *acute solid angles*, the second passes through the *obtuse solid angles*, and the two transverse pass through the *lateral solid angles*.

§ 38. *The Doubly Oblique Prism.*

Fig. 13.



The *doubly oblique prism*, (Fig. 13.) is a quadrilateral solid, whose bases and whose lateral planes are generally oblique-angled parallelograms. The only equality which subsists is between the opposite and parallel planes.

This class of prisms differ from the oblique rhombic prisms in the angles A, E, I and O, which are dissimilar, and also in the acute terminal angles B, C, and obtuse terminal edges D, F.

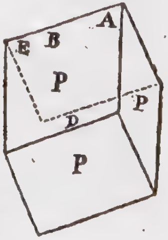
The edges and angles of this class are designated by the same terms as have been used for the corresponding ones of the oblique rhombic prism. The figure is supposed to stand oblique in the direction O A, so that the terminal plane forms an obtuse angle with the edge H.

The *doubly oblique prism* has four unequal axes passing through the pairs of opposite solid angles, and also a prismatic axis, which inclines from a perpendicular.

Individuals belonging to this class will differ from each other in the inclination of P on M, P on T, and M on T, also in the ratios of the edges D, H, F.

§ 39. *The Rhombohedron*, or *Rhomboid.*

Fig. 14.



The *rhombohedron* (14) is a solid contained within *six equal rhombic planes*, having two of its solid angles composed of three equal plane angles, which are sometimes called the summits.

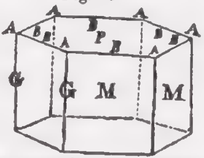
The angle A is the superior, and O the inferior angle of the plane P; those at E are the lateral angles; the edges B the superior, and those at D the inferior lateral edges. The solid angle at A is called the summit.

The individuals of this class differ from each other in the inclination of P on P′; when P on P′ measures more than 90° the rhomboid is obtuse; when less, it is acute.

The angle P on P′ is limited between 180° and 60°, but can never reach those limits, for the planes P P′ would become one plane, and its axis would vanish; or in other words, become infinite, and the figure would cease to be a rhomboid.

§ 40. *The Regular Hexagonal Prism.*

Fig. 15.



The *regular hexagonal prism,* (Fig. 15.) is a solid whose bases are regular hexagons, and whose lateral planes are parallelograms.

The adjacent planes M M′ incline on each other at an angle of 120°.

The prism has as many axes as it has opposite solid angles, but the line generally regarded as the axis passes through the centre of the bases.

The only difference which will exist between individuals of this class will be in the ratio of the edge G to the edge B.

(For remarks on Isomorphism, see Note I.)

RELATIONS SUBSISTING BETWEEN PRIMARY AND SECONDARY FORMS.

§ 41. *Secondary Forms.*

The *secondary forms* are those which are produced by modifications, which take place either on the solid angles or edges of the primary forms.

Whenever a plane appears in the place of an edge or angle which does not belong to the primary form, the edge or angle suffers a modification, which is called a *replacement.* It is scarcely necessary to say that a replacement is something different from a *change in the dimensions* of a form. The latter can have no effect to alter the shape of a solid. The secondary forms, therefore, embrace all those varieties of form which differ in any respect from the primary, and though they are numerous and complicated, yet they are capable of being reduced to a few classes, and become intelligible to most students.

§ 42. *Transformation of Primary into Secondary Forms.*

Forms may be conceived to pass into each other by the replacement of the edges or solid angles.

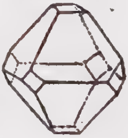
The change spoken of in the proposition may be understood by reference to Fig. 16, the general form of which is a cube; the triangular planes which appear in the place of the solid angles modify but slightly the original square faces of the cube. If these planes should be enlarged by any cause, the square faces would disappear, either wholly or in part, and the form of the cube would pass into the regular octahedron; (Fig. 17.) a result which may be verified by shaving down cubical pieces of wax, or any soft substance.

Fig. 16.

Fig. 17.

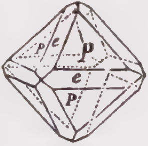
Again, the small quadrangular planes which appear in place of the solid angles of the regular octahedron, (Fig. 18,) if enlarged until the original faces of the octahedron disappear, would transform it into the cube.

Fig. 18.



Other forms may be conceived to be produced in the same manner: thus, if the regular octahedron (Fig. 19.) has its edges replaced by tangent* planes, the figure will be bounded by twenty planes, eight of which are triangular and twelve hexahedral. If the latter are enlarged until the triangular or primary faces disappear, the rhombic dodecahedron will be produced. The inclination of the planes *e* on P or P′ 144° 44′ 8″.

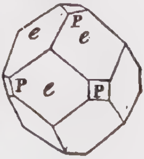
Fig. 19.



Again, the rhombic dodecahedron may be transposed into the octahedron, by removing the obtuse solid angles, § 30, and enlarging them until the other faces disappear.

Or, the cube will be the result of a modification of the rhombic dodecahedron, by replacing the acute solid angles by tangent planes, as may be shown by inspecting Fig. 20.

Fig. 20.



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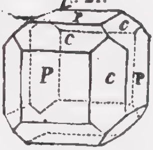
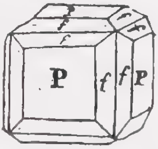
* A *tangent* plane inclines equally on the adjacent planes.

Fig. 21.



Or, supposing the cube to be the primary form, the rhombic dodecahedron will result from tangent planes, when applied to the edges of the cube, which is illustrated by Figs. 20 and 21. The inclination of the plane *c* on P or P′=135°.

Fig. 22.



If the edges of the cube, (Fig. 22.) are replaced by two planes, a series of four-sided pyramids will be produced. The planes of the cube on the one side and those of the rhombic dodecahedron on the other side, will evidently limit this series of figures.

The following remarks will serve to illustrate summarily what is taught by the figures belonging to this section. 1. The replacement of the twelve edges of the cube and of the regular octahedron by tangent planes, produce the Dodecahedron. 2. The replacement by tangent planes of eight solid angles of the cube, or the eight obtuse angles of the dodecahedron, produce the regular Octahedron. 3. The replacement of the six acute solid angles of the dodecahedron, (and it may be added though the figure is not given,) the six edges of the tetrahedron by tangent planes, produce the Cube.

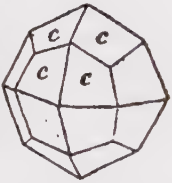
The student will meet with numerous examples of the above transitions among minerals. Thus fluor, the sulphurets of *lead*, *silver* and *zinc*, diamond, red oxide of copper, &c., are found crystalized under the forms of the cube, octahedron and rhombic dodecahedron; and, as has been shown, those solids are transformed into each other by tangent planes, applied either to the edges or solid angles.

The following are instances of transformation by unequal inclination of the secondary on the primary planes. Thus if the cube suffers a replacement or truncation of its edges by single planes, inclining unequally on the primary, a solid will be produced which is bounded by twelve pentagonal faces. (Fig. 23.)

Fig. 23.

Fi *ansformation &c.*

Fig. 24.



Another solid which is frequently met with among crystals is produced from the cube by the replacement of its solid angles by three planes, resting on the primary planes. The new form is denominated the Trapezoedron, and is contained under twenty-four trapezoidal planes.

§ 43. *Molecules.*

The minute particles of which crystals are composed are called molecules. They are homogeneous, symmetrical, solid particles, and contained within plane surfaces.

The term *molecule,* or which is synonymous, *integrant particle,* is to be distinguished from the elementary particle of chemists. The former are the smallest particles of any body which can exist without decomposition; the latter are the elements which combine together to form the particle. For instance, the carbonic acid and lime, which together form limestone, are the elementary particles, the single atom which their union produces is a molecule or integrant particle.

§ 44. *Kinds* of Molecules.*

The different classes of Primary forms are supposed to be formed of molecules of different kinds, so arranged as to fill all the vacuities and occupy the least space.

There are seven kinds of molecules which enter into the structure of the different classes of primary forms: they are conveniently exhibited at one view in the following table.

The cube . . . . regular tetrahedron . . ——— octahedron . . rhombic dodecahedron.	molecule a cube.
all quadrangular prisms...	molecules similar prisms.

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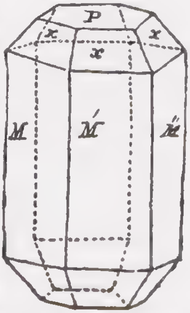
[*] The late Dr. Wollaston (Phil. Trans. 1813,) has proposed to consider the primitive particles or molecules as spheres, or oblate or oblong spheroids. This ingenious theory explains very satisfactorily the structure of the different classes of regular solids, as it is very easy to understand the production of cubes, octahedrons, tetrahedrons, &c. on the supposition that these ultimate particles are spherical. The student is advised to verify the hypothesis by arranging a series of balls so as to produce the different primary forms.

octahedron with a square base.	molecule a square prism:	Proportional in dimensions to the edges of the base and to the axis of each particular octahedron respectively.
———— rectangular base.	molecule a rectangular prism.	
———— rhombic base. . .	molecule a rhombic prism.	
rhomboid or rhombohedron..........	molecule a similar solid.	
hexagonal prism.	molecule an equilateral triangular prism.	

It is scarcely necessary to remark, that the molecules of bodies are infinitely small in relation to our senses; hence the view which is taken of them is to be considered as theoretical, and it is necessary to divest ourselves of notions which would make them *real*, from the absolute manner in which they are spoken of. By their assistance, however, we are enabled to demonstrate the relations between primary and secondary forms, and to understand the manner in which the edges and solid angles of crystals may be replaced or suffer modification.

§ 45. *Formation of Crystals from Molecules.*

Fig. 25.



Crystals are supposed to commence their formation by the aggregations of a few homogeneous molecules which constitute the primary form, which on farther increase in size may suffer an abstraction of rows of molecules either from the edges or solid angles.

If we suppose that the first molecules are arranged in the form of a plate, and their successive plates of the same size to be formed upon each other, it is evident no alteration in the shape of the plate will ensue; it will merely increase in size. If, however, after two or three plates were brought together, each succeeding deposit should be diminished on one side by a single row of particles, it is evident that in the place of an edge a plane would appear, and if these abstractions should take place all round the solid, the area of the surface would constantly diminish until a pyramid was formed, which would terminate in a single molecule or point. In Fig. 25, the pyramid is incomplete, a portion of the primary plane remains on which the letter P is placed.

§ 46. *Of Decrements.*

The term *decrement* is used to express the omitted rows of molecules spoken of in §45.

§ 47. *Simple Decrement.*

A *simple decrement* is said to take place when any number of rows of molecules are omitted, belonging to plates of two or more molecules in thickness, either on the edges or angles of primary forms.

§ 48. *Mixed Decrement.*

A *mixed decrement* is said to take place when unequal numbers of molecules in height and breadth are omitted, neither of the members being multiples of the other, such as three in height and two in breadth, or four in breadth and three in height.

§ 49. *Intermediary Decrements.*

Intermediary decrements may be conceived to take place when rows of compound molecules are abstracted from successively superimposed plates, each compound molecule containing unequal numbers of single rows in *length*, *breadth* and *heighth.*

The effect of decrement is always to produce a plane. When the decrement is on a solid angle and an equal number of molecules are abstracted on each side of the angle, a tangent plane is formed, and the direction will be parallel to the diagonal of the plane on which the new plane rests.

Intermediary decrements always affect the angles, but the direction in which they proceed is never parallel to a diagonal or an edge. It is evident that the inclination of the secondary planes produced by decrement is increased or diminished by the number of omitted rows either in height* or breadth, for instance, the inclination of a plane produced by the abstraction of a single row of molecules from an edge will be greater than

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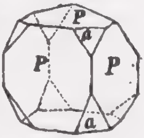
*Decrement in height relates to the thickness of the plate, and decrement in breadth to the width of the plate from which molecules are abstracted.

if two rows were subtracted in breadth; if a row of molecules of the thickness of two plates is subtracted and only one in breadth, the inclination will be greater than in the first instance mentioned, and a pyramid which is formed by this decrement would be acute, but by the second instance given it would be obtuse or a low pyramid.

§ 50. *The effect of Decrement on edges or angles is regulated by Symmetrical Laws.*

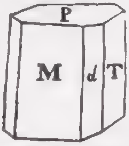
Fig. 26.



Decrements, or in other words replacements, take place on the similar edges or angles of primary forms.

When a solid angle of the cube is replaced, all the angles are similarly affected, as is represented in Fig. 26.

Fig. 27.



The modification of the rectangular prism, (Fig. 27.) represents a decrement on the similar edges.

The replacements which are exhibited in Figs. 18, 19, 20, 21, 22, are instances which conform to the law expressed in the proposition at the head of this paragraph.

The above law is not however universal. Boracite and Tourmaline are instances of exceptions to it: in the latter mineral, the planes which are formed at the extremities of the prism are dissimilar, whereas, if the law of symmetry had operated, they would have been similar planes.

§ 51. *Imperfections of Crystals.*

Crystals frequently exhibit irregularities in their external forms, which may arise from contact with other bodies, or from a disturbance of the molecular attraction during their formation.

Instances of irregularities which are common to individuals may be noticed in the undue extension of similar faces of crystals, as in quartz, garnet, beryl, &c. Irregularities of this kind do not affect the inclination of those faces on the primary planes, a fact which is quite remarkable. Faces are sometimes curved, as those of the Diamond, Fluor, Pearl-spar, &c.

Another instance of irregularity occurs where only a part of the crystal appears, the other part being implanted in the supporting mineral, a situation in which most crystaline bodies are formed. These individuals may however be considered as perfect, since we may complete the planes at the defective extremity according to the law of symmetry.

§ 52. *Structure and Cleavage.*

Crystals generally possess a regular structure which may be demonstrated by cleavage. By the latter term is meant the separation of laminæ in certain directions.

If we apply a knife to the solid angle of a cube of fluor, in a direction to produce a tangent plane, we shall find that it will yield, and a portion of the corner will be removed and a surface more or less bright will appear. This plane will be parallel to the primary plane of the regular octahedron. Again, if we apply a knife to the face of a cubic crystal of common salt, in a direction parallel to a plane, it will yield readily and present a smooth and even surface parallel to the faces of the cube. Instances of regular structure which may be developed by cleavage are numerous, as *sulphate of lime, rhomb-spar, strontia, barytes, galena, mica, &c.*

§ 53. *Direction of Cleavage.*

The direction in which a crystal can be split is called the *direction of cleavage.*

The direction of cleavage may depend upon the comparative force of molecular attraction in different directions, and may be so proportioned as to admit of cleavage in other directions than parallel to the primary planes. In instances of this kind, the crystal is said to possess two sets of cleavage; that which is parallel to the primary planes, is called the *primary set,* and that which is not parallel to the primary planes, the *supernumerary set.*

§ 54. *Cleavage of similar Planes.*

In primary forms whose faces are similar, the *primary cleavages* are usually effected, with equal facility, in the direction of those planes; and the new planes developed by cleavage will be similar in lustre and general character. Galena and carbonate of lime are instances.

When the planes are dissimilar, the primary cleavage is not effected with equal facility, neither are the cleavage planes similar. *Feldspar, Kyanite, Sulphate of Lime,* are instances. This enables us sometimes to determine what is a primary plane.

The terms *single*, *double* and *triple*, *fourfold* or *sixfold* cleavage, have reference to the primary form, and are used to express the number of directions in which a crystal can be cleaved. It is plain that a single solid only can be obtained from a triple cleavage;[*] but from a four-fold or six-fold cleavage more than a single solid can result.

§ 55. *Nomenclature of Cleavage.*

The nomenclature of cleavage is expressed by terms which indicate its direction in relation to the axes of primary forms.

Conformably to this proposition, a cleavage is *axotomous* when it is single, and takes place in a direction perpendicular to the axis of the primary form. It is *monotomous* if it is single, and is either *parallel*, *perpendicular* or *inclined* to the axis. It is *peritomous* if it takes place in two directions parallel to the axis. This form of cleavago will result in the production of four-sided prisms. Again, cleavage is *paratomous* if the number of faces are indeterminate, and the direction is neither parallel nor perpendicular to the axis. This form of cleavage produces tetrahedrons and octahedrons, or pyramids generally.

§ 56. *Goniometer.*

The goniometer is an instrument which is used for measuring the angles at which the planes of crystals meet. There are two kinds, the *common* and *reflecting* goniometer. (For description and manner of using, see Note B.)

§ 57. *Determination of Primary Forms.*

Primary forms may sometimes be determined by the direction of cleavage, the character of cleavage planes, and by analogy; and also, in the absence of cleavage, by the character of secondary planes.

In case a mineral possesses a cleavage which leads to a regular form, that form, in general, is to be considered as the primary form, especially if those cleavages are equally perfect.

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[*] To cleave neatly, some practice is necessary. The student will need a small light hammer, several knives, whose edges are even but not very thin, cutting pincers, and an anvil of iron, lead or block of wood, on which to rest the mineral. Persevering trials in the way of cleaving will be worth more than any directions which can be given.

Thus Galena possesses a cleavage in three directions, equally perfect and leading to the cube; the cube is therefore, to be considered as the primary form. For farther remarks on this subject see, Note C.

§ 58. *Fracture.*

Fracture is the mechanical separation of the particles of a mineral, so as to show its irregular structure; and the surfaces thus produced are called faces of fracture.

The faces of fracture preserve no constant direction; in this particular they differ from faces of cleavage. It is useful to distinguish several kinds of fracture. When the face of fracture resembles the inside of a shell, it is said to have a *conchoidal* fracture. If the face is smooth, it has an *even* fracture. If the face presents numerous and small irregular projections, it is said to have an *uneven* fracture. When the face presents the appearance of a separation produced by tearing, it is called a *hackly* fracture.

§ 59. *Surface.*

There are four kinds of surface, viz: 1. Faces of crystalization. 2. Faces of cleavage. 3. Faces of fracture. 4. Faces of composition. For account of these surfaces see Note D.

SECTION II.

COMPOUND MINERALS.

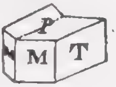
THE NATURAL-HISTORICAL PROPERTIES OF COMPOUND MINERALS.

§ 60. *Regular Composition.*

The composition of two or more bodies is regular if the form produced by their connexion is regular, and joined in one crystaline form. Such a composition is designated by the name of *twin crystal*, or sometimes by the term *hemitrope crystal.*

The property peculiar to twin crystals consists in the close and exact connexion of the face of composition with the series of crystalization of the species. To obtain a conception of the situation of the individuals, we first suppose them to be in parallel position, and then one of them to turn round a certain line, in a determined direction, under an angle of 180°, while the other remains unmoved. This line is the *axis of revolution*, and is either perpendicular to the face of composition, or it coincides with this face, and which is parallel to the crystalographical axis of the individual. The angle of 180° is the *angle of revolution.*

Fig. 28.



The character commonly taken for twin crystals is the presence of a re-entering angle. Fig. 28, represents a twin crystal of the green carbonate of copper.

Another method of explaining the mode of composition in crystals of this kind, is to imagine the crystal to be bisected by a plane passing through it in a determined direction, and one of the halves to be turned through a certain number of degrees, or a number equal to half the circumference, or 180°. Hence the term *hemitrope crystals.*

§ 61. *Irregular Composition.*

When a number of crystals are aggregated together so that one becomes the support of the others, while there exists no general support, the assemblage is termed a Groupe of crystals. If several crystals are fixed to a common basis, the assemblage is termed a Geode of crystals.

§ 62. *Imitative Shapes.*

A compound mineral is said to have an imitative shape if it bears some resemblance to the shape of a natural or artificial body.

Imitative shapes sometimes result from the groupes of crystals which assume globular or spheroidal forms. Reniform and botryoidal shapes may be formed when globular or spheroidal masses are attached together. When the individuals are very small their surfaces are said to be drusy.

§ 63. *Imitative Shapes arising out of the Geodes of Crystals.*

There are three kinds of shapes which result from geodes of crystals. 1. Those in which the individuals spring from or are attached to a common point of support. 2. Those in which the individuals form one in the support of the other. 3. Those in which the support is cylindrical, sometimes a line, and sometimes a tube. . Examples of the first are furnished in prismatic Kouphone-spar, prismatic Hal-baryte, rhombohedral Iron-ore. Fruticose and dendritic shapes likewise belong to this kind. In the second division are included the *dentiform, filiform* and *capillary* shapes. These arise from rows of crystals which mutually support each other. Sometimes the individuals are so extended laterally as to produce leaves or membranes. The striæ on their surfaces indicate their composition.

The third division comprehends the stalactitic and coralloidal shapes. Examples of individuals under these shapes are found in rhombohedral Lime-haloide, rhombohedral Iron-ore; also in the Gibbsite, Flos-ferri, &c.

§ 64. *Amorphous Compositions.*

When the mass, formed by the junction of several individuals, presents no resemblance to any particular shape, and is also irregular, it is said to be massive.

Massive minerals are usually composed of individuals of the same species which are in contact on all sides. When massive minerals are subdivided according to the size of the individuals, they are called *disseminated.*

§ 65. *Accidental Imitative Shapes.*

When a mineral is deposited in a space which has once been occupied by another mineral, it assumes the shape of the latter, and not from any property peculiar to *it.* Such shapes are considered as accidental.

The space in which such minerals are lodged may be regular or irregular. Those shapes which are regular must be deposited in regular spaces, which have been produced by crystalization. Forms produced in those spaces are termed *pseudo-morphous.*

§ 66. *Particles of Composition.*

The individuals forming the masses of compound minerals are the particles of composition.

The differences to be noticed among them arise from their shape, arrangement, size, and the strength with which they are held together. They are always the result of crystalization, but are prevented from assuming regular forms, from the limited space they occupy. The shape depends on their length, breadth and thickness. Those whose dimensions are equal in every direction are termed *granular.* Where the individuals are much extended in length, they are said to be *columnar*, and they may be either parallel or diverging. Where their breadth exceeds the thickness, the composition is called *lamellar.* The latter may be likewise parallel or diverging. The size of the individuals also vary. They may be large, and gradually diminish until the size is no longer perceptible, when the composition is said to be *impalpable*. Individuals of some species are always strongly connected; of others but feebly. The mineral is then said to be friable.

§ 67. *Structure of Compound Minerals.*

The structure of compound minerals differs materially from that of simple ones. If broken they present only what is termed *faces of fracture*.

Some of the kinds of faces of fracture have been sufficiently explained (§ 58.) The following kinds are still to be noticed. 1. *Splintery fracture*, which is produced by the appearance of thin scaly particles on the face of fracture, which are attached to the mass by their thicker ends. 2. *Slaty fracture*, which resembles imperfect faces of cleavage. It is common to the different kinds of slate. 3. *Earthy fracture* resembles the uneven fracture, but belongs to decomposed minerals.

SECTION III.

CONSIDERATION OF THE PROPERTIES WHICH BELONG BOTH TO SIMPLE AND COMPOUND MINERALS.

§ 68. *Division.*

Those natural-historical properties which are common to both the simple and compound minerals may be divided into the *optical properties*, and into the *physical properties* of minerals.

The optical properties are those which depend upon light, and which are not observable except in its presence. They are *lustre*, *colour* and *transparency*. The physical properties are those which belong to matter in the mass, excluding *colour*, *lustre*, *transparency*, and those which relate to the regular forms of bodies. They are as follows: *Hardness, specific gravity, state of aggregation, magnetism, electricity, taste* and *odor*.

OF THE OPTICAL PROPERTIES OF MINERALS.

§ 69. *Colour, Lustre and Transparency.*

The phenomena observable in minerals with respect to reflected and transmitted light, are comprehended under the heads of *Colour*, *Lustre* and *Transparency*.

§ 70. *Colour and Streak.*

It is necessary to distinguish between the colour of the entire mineral and that of its powder. The former is properly the colour of the mineral, while the latter has been designated as that of the *streak.*

§ 71. *Division of Colours.*

Colours are divided into metallic and non-metallic colours.

This distinction depends more on the lustre connected with the colour than on the colours themselves. Hence the distinction is not, strictly speaking, correct; but is useful, as it serves to distinguish what is merely useful from that which is indispensible in discriminating minerals.

§ 72. *Metallic Colours.*

The metallic colours are: 1. *Copper-red.* 2. *Bronze-yellow.* 3. *Brass-yellow.* 4. *Gold-yellow.* 5. *Silver-white.* 6. *Tin-white.* 7. *Lead-gray.* 8. *Steel-gray.* 9. *Iron-black.*

As the colours which are here enumerated are selected from objects which are well known, and of which the student can scarcely fail of obtaining a correct notion, it seems unnecessary to describe them more particularly.

§ 73. *Non-Metallic Colours.*

In the non-metallic colours there is a series of colours under each characteristic colour, which is expressed by a compound term. They will be considered in the consecutive order of the principal kinds, which represent the general series of colours. (See Note L.)

Colours vary in intensity though they belong to the same variety. Differences of this kind are expressed by *pale, light, deep, dark.* And where there are shades or varieties in the series, they are said to incline and pass into one another.

§ 74. *Peculiarities in the Occurrence of Colours.*

The peculiarities which occur in colours which are worthy of notice, are the *Play of Colours, Change of Colours, Opalescence, Iridescence, Tarnish,* and *Dichroism.*

The *play of colours* is that property which minerals possess of exhibiting coloured points of great intensity, which change with the position of the mineral, or with the direction of the rays of light. Examples are found in the Diamond and Opal.

Change of colour consists in the reflection of bright hues of colour in certain directions. The Labrador feldspar is a remarkable instance.

Opalescence consists in a kind of milky-white light, which is reflected from natural and artificial faces. This property may be seen in the Cats-eye and Moonstone. In the former it depends on composition, and in the latter on regular structure.

Iridescence is the reflection of the, coloured rays of light similar to the rainbow. It is generally produced by fissures, and depends on accidental circumstances.

Dichroism is a property of showing different colours in transmitted light, in different determined directions. It depends on form and structure. Rhombohedral Tourmaline and prismatic Quartz are among the most distinct examples. Of the former some varieties are opake when viewed in the direction of the axis, but in directions perpendicular to it they possess considerable transparency, and show the different colours, as green, brown and blue.

The *tarnish* consists in the alteration of the colour of a mineral on the surface. It ought not to be confounded with the real colour of the mineral. Metallic minerals are most liable to suffer this change.

§ 75. *The Streak.*

If a mineral is scratched with a hard instrument, either a powder will be produced or the surface will assume a higher degree of lustre. Both these effects are comprehended under the expression, the *streak.*

The streak is said to be unchanged when the powder retains the colour of the mineral. A white or gray streak is said to be uncoloured.

§ 76. *Degrees of Transparency.*

The degrees of transparency depend on the quantity of light which is transmitted through minerals.

These degrees may be noticed as follows:

1. *Transparent*, if sufficient light is transmitted to enable us to see small objects placed behind the mineral.
2. *Semi-transparent*, if it is possible to distinguish the general outline of bodies placed behind them.
3. *Translucent*, when a small quantity of light only falls into the mineral, but not sufficient to enable us to discover objects behind them.
4. *Translucent on the edges*, when only the acute edges transmit a feeble quantity of light.
5. *Opake*, if the mineral transmits no light at all. The minerals of the orders Metal, Glance and Pyrites are usually opake.

§ 77. *Lustre.*

The lustre of a mineral arises from the reflection of light from its surfaces, and is to be considered as to its *kind* and to its *intensity*.

The kinds of lustre are *metallic, adamantine, resinous, vitreous* and *pearly*.

Metallic lustre is divided into perfect and imperfect metallic lustre. The perfect occurs in all the species of the orders *Metal, Pyrites* and *Glance*, and is the same as occurs in brass, silver, copper and gold. The second is found in the ores, as in prismatic Scheelium-ore, octahedral Copper-ore, &c.

Adamantine lustre is divided into metallic adamantine and common adamantine lustre. Examples of the first are found in the order *Blende*, especially those species which have a dark colour. The common adamantine lustre is peculiar to octahedral Diamond, the pale coloured varieties of Ruby-blende and Garnet-blende, and to some varieties of di-prismatic Lead-baryte.

Resinous lustre is that which a mineral presents when it resembles that of *resin*. It occurs in pyramidal Garnet, and in the varieties of empyrodox Quartz, or Pitchstone.

Vitreous lustre is that of common glass, and may be observed in common Quartz.

Pearly lustre is divided into common and metallic pearly. Examples of the first may be observed in prismatic Disthene-spar, and in some species of the order *Mica ;* the second in the species of Schiller-spar.

The following are the degrees of lustre. 1. *Splendent.* 2. *Shining.* 3. *Glistening.* 4. *Glimmering.* 5. *Dull.*

Splendent surfaces possess the highest degree of lustre and resemble polished steel.

Shining is a less degree but is still lively, but not sufficiently strong to exhibit the distinct image of an object from its surface.

Glistening surfaces reflect light disorderly and rather in defined patches. Common to many compound minerals when the particles of composition are discernable.

Glimmering does not reflect light in defined patches, but a mass of defined light seems spread over the glimmering surface. This degree belongs to compound minerals, whose particles of composition are very small.

Dull possesses no lustre at all, and is mostly confined to decomposed minerals.

In general the kind and degree of lustre which crystalized bodies present are pretty uniform. The gradation which may sometimes be observed presents a continuous series, which allows of the same application as the series in the varieties of colours. In crystals similar faces agree as to the kind and intensity of lustre, and *vice versa*, such faces which do not agree in lustre are not similar. (For an account of Double Refraction and Polarization of Light, see Note E.)

OF THE PHYSICAL PROPERTIES OF MINERALS.

§ 78. *Explanation.*

The properties of minerals which are termed physical, comprehend all those which neither depend upon form, nor upon the presence or absence of light.

Among these are the *State of Aggregation, Hardness*, *Specific Gravity, Magnetism, Electricity, Taste* and *Odour.*

§ 79. *State of Aggregation.*

Minerals, in regard to their state of aggregation, are distinguished into solid and fluid minerals.

A solid mineral may be *brittle, malleable, sectile, ductile, flexible* and *elastic.*

A fluid mineral may be *liquid, viscid* and *expansible.* All these properties may pass into each other by insensible gradations.

§ 80. *Hardness.*

Hardness is the resistance which solid minerals offer to the displacement of their particles. The magnitude of this resistance is termed their *degree of hardness.*

Hardness is one of the most useful properties in the natural history of the mineral kingdom, particularly in the determinative part. The existence of different degrees of hardness is easily ascertained; but to form an accurate scale of hardness is very difficult. A scale of hardness which shall answer the purposes of mineralogy may be formed by choosing a certain number of minerals, of which every preceding one is scratched by the one which follows it, taking care that the intervals between every two members of the scale be not so disproportionate as to render its employment uncertain or difficult. The following minerals have been selected to represent the degrees of hardness, and the numbers which are affixed to them express respectively their comparative degrees of hardness. 1. *Prismatic talc-mica.* 2. *Prismatoidal gypsum-haloide*, which is the same as hexahedral rock-salt. 3. *Rhombohedral lime-haloide.* 4. *Octahedral fluor-haloide.* 5. *Rhombohedral fluor-*

haloide. 6. *Prismatic feldspar.* 7. *Rhombohedral quartz.* 8. *Prismatic topaz.* 9. *Rhombohedral corundum.* 10. *Octahedral diamond.*

This scale is employed by endeavoring to find the place which a mineral occupies in it, by scratching the different numbers, and the degree is expressed by saying that the mineral equals a particular number. Thus, in speaking of the hardness of hexahedral rock salt, it is said that its hardness =2 or is 2.

§ 81. *Specific Gravity.*

If we suppose the absolute weight of one of two bodies which possess the same volume to be =1, the ratio of the absolute weight of the other to this unit is termed its *specific gravity.*

As we cannot secure sufficient accuracy merely by sight or by estimate, it is necessary that we use appropriate instruments to ascertain the specific gravities of bodies. (For the description and use of an instrument of this kind, see Note F.)

§ 82. *Magnetism.*

Some minerals, on being brought within a certain distance of a magnetic needle, act upon it. Others become magnets themselves. Both of these phenomena are used as characters under the name of *magnetism.* (See Note G.)

§ 83. *Electricity.*

The different relations which different bodies sustain to the electric fluid, may be usefully applied as characters of minerals.

Some minerals become electric by friction, some by pressure, and others by heat. Vitreous electricity is produced by friction in most minerals which belong to the orders Spar, Gem, Mica and Baryte. And resinous electricity is produced in the same way in the orders Sulphur, Resin and Coal. The conductors of electricity belong mostly to the orders Metal, Pyrites and Glance.

§ 84. *Taste.*

Several minerals, solid as well as fluid, produce a sensible taste. The different kinds of taste are, 1. *Astringent.* 2. *Sweetish.* 3. *Saline.* 4. *Alkaline.* 5. *Cooling.* 6. *Bitter.* 7. *Urinous.* 8. *Sour.*

§ 85. *Odor.*

Some minerals when rubbed or warm, emit some odor which may afford useful characters.

The black mineral resins possess a bituminous odor; the species of the genus Iron-pyrites emit a sulphureous odor, and the arsenical Iron-pyrites emits the odor of garlic. Other kinds might be mentioned, but it is unnecessary.

§ 86. *Chemical Characters.*

Chemical characters are those which are observed in bodies after some essential change has been wrought upon them.

The chemical characters which are made use of are confined to the use of the blow-pipe and the action of acids. These characters have no place in a treatise of this kind, as they do not belong to the natural-historical properties. But that the student may be furnished with every aid in the investigation of minerals, a particular account of these characters is given in Note H.

PART II.

THEORY OF THE SYSTEM.

§ 87. *Identity.*

Natural productions which do not differ in their natural-historical properties are *identical.*

The consideration of this proposition supposes a separation of all accidental differences in two bodies; such as the size of two individuals and the disproportional enlargement of their faces, and their junction with other individuals. By considering two bodies as identical, is meant that every one of them may be substituted in the place of the other in every natural-historical respect. So that if *one* belongs to a particular species the *other* must necessarily belong to it.

§ 88. *Difference.*

Individuals which do not agree in their natural-historical properties are not identical.

If two individuals differ as to crystaline form, hardness or specific gravity, or in only one of these properties, they will not be identical. The same *degree* of difference, cannot be said to exist between every two individuals. Thus there is less difference between epidote and zioisite than between epidote and quartz. There is a less difference between two crystals of garnet, one of which is a rhombic dodecahedron, and the other a trapezoedron—than between either of them and a crystal of gold: which is sufficient to show that the *degrees* of difference are not the same in every two individuals.

§ 89. *Species.*

An assemblage of individuals which are brought under the idea of identity constitutes a *species:* and the individuals belonging to it are *homogeneous* individuals.

Under this definition, the idea of a species becomes the foundation of scientific mineralogy, and is the starting point from which to obtain some knowledge of all the productions of the mineral kingdom, when we wish to preserve a certain unity in the acquirement of our information.

Individuals which constitute a species often possess a series of characters by which they pass or graduate into each other; but individuals belonging to two species never pass into each other, as individuals connected by transitions are homogeneous, and belong to one and the same species.

The continuity which exists in the series of the characters of individuals is such, that all their differences may be joined into a whole. This enables us to comprehend all the varieties under one species, and also in the mineral kingdom; so that it is not for the interest of mineralogy that the species should be subdivided, or distinguished into sub-species and varieties. The species itself is the proper object of classification, or the thing to be classed. The idea of the species is not produced by classification.

§ 90. *Genus.*

An assemblage of species connected by the highest degree of resemblance is termed a *genus.*

The resemblance which shall constitute a genus is not arbitrarily fixed, and it is impossible to express it in one or in a certain number of characters. A resemblance is, however, manifest by occular inspection. Striking examples are furnished in the genera *Garnet, Iron-pyrites, Kouphone-spar, Hal-baryte, Lead-baryte, &c.*

§ 91. *Order.*

The *order* is an assemblage of similar genera.

The orders in the mineral kingdom are the same as the natural families of the vegetable kingdom, and their reception and determination in one and the other, depend upon the same principles. Where can be found in the vegetable kingdom families more natural than are the group of genera in the orders Spar, Ore and Pyrites? Where the principles of natural history are applied in conformity to its proper objects, the result will always be happy, and the employment of characters under the guidance of those principles can never fail of developing the system intended. Thus, a chemical system of mineralogy would require for its developement principles and characters peculiar to that science. When a mixed method is followed, confusion and obscurity must be the prominent features.

§ 92. *Class.*

The *class* is an assemblage of similar orders.

The inspection of the three classes in mineralogy will prove the orders in each class to resemble each other in their natural-historical properties, more closely than those in the other classes. For instance, the order Spar has a greater resemblance to the order Gem, than to the order Coal or Resin, proving that the idea of class depends also upon natural-historical relations, and does not admit of foreign principles, and is not produced by mere division.

PART III.

NOMENCLATURE.

§ 93. *Definition.*

The systematic nomenclature is the assemblage of those denominations which natural history applies to natural productions, and which refer to a natural-historical system.

The systematic nomenclature provides every natural production with a denomination, and represents by these denominations the natural-historical resemblance by which these bodies are connected in the system. The species is the *foundation*, and the systematic nomenclature the *verbal expression* of the system. The species therefore is the object to which the systematic denomination refers.

§ 94. *Object of the Names.*

The ideas expressed by the names are the higher unities of classification, immediately preceding that of the species.

The name is to be applied to an assemblage of natural productions, and belongs to a single species or individuals only so far as the one or other belongs to the assemblage in virtue of their natural-historical properties. This points out the difference between the *systematic* nomenclature and the *trivial* nomenclature. The latter applies the name directly to the object, without expressing the connexion of bodies. The trivial nomenclature is wholly arbitrary in the selection of its names.

§ 95. *Name of the Order.*

In the natural history of the mineral kingdom, the *order* is the highest idea expressed in the systematic nomenclature. The order consequently will bear the simple name.

§ 96. *Selection and Signification of the Names of the Orders.*

The simple names are the foundation of the whole nomenclature, and receive their signification in agreement with the ideas of the orders.

The names are *Gas, Water, Acid, Salt, Haloide, Baryte, Kerate, Malachite, Spar, Gem, Ore, Metal, Pyrites, Glance, Blend, Sulphur, Resin* and *Coal.*

§ 97. *Name of the Genus.*

In the genus the name of the order is restricted by connecting another word with the name of the order; and thus a compound word is formed, which is the generic name.

The generic name refers to the natural-historical properties of the genus. It is therefore intended to express by it some striking feature of its resemblance with other bodies. Thus the name *Garnet-blende* indicates that it belongs to the order Blende, and that the individuals it contains have a Garnet-like appearance.

§ 98. *Denomination of the Species.*

The denomination of the species is effected by the use of an adjective.

The adjective which is employed for this purpose is selected from the natural-historical properties, and if possible is one which is the most useful in distinguishing it from other species. The most desirable are those which relate to form and cleavage. Examples are *hexahedral, prismatic, rhombohedral* Iron-pyrites; or *peritomous* and *pyramidal rhombohedral* Titanium-ore; *prismatic rhombohedral, macrotyphus, paratomous* Lime-haloide. In this way the student is furnished in the denomination of the species with an image or representation of it, which indeed will not answer in the place of the characteristic or general description.

§ 99. *Trivial Nomenclature.*

In the trivial nomenclature the name is fixed upon the species.

The trivial nomenclature does not express the connexion among bodies which it provides with names. Any name which does not express this connexion is a *trivial name*, which rests upon the lowest idea of the system, that is, upon the species.

The natural-historical determination of natural productions, does not go beyond the species. The systematic nomenclature stops therefore at the denomination; the trivial nomenclature at the name of the species.

PART IV.

CHARACTERISTIC.

§ 100. *Definition.*

The characteristic is an assemblage of certain natural-historical properties, arranged according to a certain system, for the purpose of distinguishing the unities contained in the system.

A single property or collection of these, if subservient to the distinction of the several species of a genus, or of the genera of an order, or the orders of a class, &c. is termed a character, and the single properties it contains, characteristic marks or terms. According to this definition, the existence of a character presupposes the existence of a system to which it applies.

§ 101. *Properties of the Characters.*

The characters must be sufficient to a precise distinction within their respective spheres, and as short as the necessary degree of evidence in the determination of the species will allow. It may be remarked that characters are entirely useless, if they are ambiguous or apply equally well to two distinct natural productions. The characters require both *conciseness* and *uniformity*: hence the character should not contain any thing, but what is required for the distinction and the evidence of the determination of the species.

§ 102. *Absolute and Conditioned Characteristic Marks.*

A characteristic mark is absolute if it is by itself distinctive in its sphere; a conditioned mark is only distinctive under certain circumstances or restrictions.

In illustration of the proposition, if a solid mineral shall belong to the first class, it must be sapid, the character of this class is *therefore solid: taste*, where solidity is the condition under which the property of exciting taste *must necessarily* take place. If the mineral is not solid it is no matter whether it has taste or not; hence the marks or characters must be taken literally, and they admit of no other signification than that expressed by the words.

§ 103. *Base of a Perfect Characteristic.*

The perfection of the characteristic depends upon the perfection and accuracy of our natural-historical knowledge of natural productions.

Our ideas of a system of nature will advance towards perfection, the more we inquire into the nature of bodies, and study their relation towards each other, and as our knowledge increases the more correct will be our views, and the nearer to perfection shall we be able to construct a characteristic.

§ 104. *Use of the Characteristic.*

The use of the characteristic is to determine the name of a natural production.

(For process in determining minerals, &c., see Note K.)

PART V.

PHYSIOGRAPHY.

§ 105. *Definition.*

Physiography means a description of natural productions

Physiography is not fitted to the purpose of distinguishing minerals or other natural productions. 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 natural connexion among bodies upon which systems are founded. A description is not a character, since the peculiarity of a character consists in its being composed of a smaller number of characteristic terms than may be observed in the objects characterised.

The description presupposes nothing but Terminology. It is perfectly indifferent what *nomenclature* is made use of, provided the names serve to keep separate the objects which really differ from each other.

§ 106. *Objects of Physiography.*

The object which physiography serves in the mineral kingdom, is the description of the individual.

Individuals are described by indicating all the natural-historical properties. In enumerating these a certain order should be fixed upon for the sake of perspicuity, which should not be altered. All prolixity should likewise be avoided, and every thing foreign to the purpose rejected.

§ 107. *General Description of the Species.*

In order to represent the natural-historical species in the mineral kingdom, it is necessary to construct a general description which shall give a correct idea of all, or at least all known varieties of a species in their proper connexion. The method of constructing a general description is as follows. First, any suitable variety of the species is chosen and described with all possible accuracy. The description will contain only single characters, consisting of a certain colour and lustre; a certain degree of hardness; a certain form, &c. all of which are 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.

§ 108. *Arrangement of the General Descriptions.*

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

The characters which depend on the presence of light serve very much to create and enliven the image of the species, such as the colour, lustre and transparency, all of which should be particularly noticed next to the form and cleavage, together with the character of the different faces, and will contribute to fill up in our minds, a notion of the individuals described. These are to be followed by the hardness and specific gravity, after which the compound forms, their composition, &c. will serve to complete a perfect representation of the species.

§ 109. *The Collective Descriptions do not depend on the Systems.*

The natural-historical species itself is the basis of every method, and in fact of every science; it is the object, not the product of classification. The descriptions are applicable therefore in every system, even though the principles upon which it is framed should not agree with those of Natural History. Thus the collective description is raised to a high degree of importance, since it becomes the link between Natural History and other sciences, referring likewise to the Mineral Kingdom. When the collective descriptions are completed, Natural History has fulfilled its duty, and the species is now prepared to be the subject of farther investigation in other sciences. The classifiable unity itself may be clearly designated and distinguished from every other object.

MANUAL

OF

MINERALOGY AND GEOLOGY.

CLASS I.

ORDER I. GAS.

GENUS I. MARSH GAS.

1. EMPYREUMATIC HYDROGEN GAS.

Carburetted Hydrogen Gas. Jam.

Amorphous. Transparent and expansible. Odor slightly empyreumatic. Sp. gr. 0.570. *Berzelius.*

1. The colour of litmus paper when exposed to the influence of this gas, is unchanged. It is highly inflammable, and burns with a yellow flame. It detonates powerfully when mixed with atmospheric air, and fired with the electric spark. It is composed by weight of

Carbon	6, or	one p.
Hydrogen	2,	two p.

2. Carburetted hydrogen is formed abundantly in stagnant pools, from which it escapes in bubbles when the mud at the bottom is stirred or agitated.

It is likewise developed in coal mines, and is identical with that dangerous compound known among miners as the *fire-damp*. Accidents arising from the explosion of this gas are much less frequent since the invention of the *safety lamp* by Sir Humphrey Davy.

2. SULPHURETTED HYDROGEN GAS. *Jam.*

Colourless and transparent. Odor of putrid eggs. Taste offensive. Sp. gr. 1.18. *Berzelius.*

1. Sulphuretted hydrogen is not a supporter of combustion, as a flame is extinguished when immersed in it. When in-

flamed, it burns with a pale blue light. It is found to possess acid properties, for it reddens litmus paper, and forms salts with alkalies; hence it is sometimes called hydro-sulphuric acid.

From its affinity for the metallic oxides, it is a chemical agent of great importance. It tarnishes gold and silver, forming with them sulphurets. It instantly blackens the carbonate of lead; for this reason it is often used as a test of its presence. It consists of

Sulphur 16, one p.
Hydrogen 1, one p.

2. This substance is a poison of considerable energy, as it is fatal to small animals, if it constitutes only a small proportion of the air which they inhale.

3. Sulphuretted hydrogen is mostly found in connexion with those rocks which abound in pyrites and coal; thus it is found issuing from the western bank of. Niagara river, a mile south of the Falls: the rock is the shelly limestone, which contains thin seams of coal and iron pyrities. It occurs also under the same circumstances near the Otsquaga creek. *Eaton.*

GENUS II. ATMOSPHERIC GAS.

1. PURE ATMOSPHERIC GAS.

Pure Atmospheric Air. Jam.

Colourless and transparent. Without odor or taste. Sp. gr. 1.00.

1. Pure atmospheric air consists of 80 nitrogen, 20 oxygen, and 0.001 carbonic acid.

Or of Nitrogen 4 p.
Oxygen 1 p.

The proportions of oxygen and nitrogen are constant; but that of carbonic acid is variable. This compound constitutes the atmosphere, and surrounds the whole globe.

2. Atmospheric air is compressible and elastic. One hundred cubic inches at the temperature of 60° of F. and when the mercury of the barometer stands at 30 inches, weigh 30.5 grs. It is 828 times lighter than pure water, and near 11260 times lighter than mercury. The height of the atmosphere above the level of the sea is supposed to be about 45 miles, and its pressure on every square inch of surface, is equal to 15lbs. hence it is capable of supporting a column of mercury 30 inches high, and one of water of 34 feet. It is well known

that as we recede from the surface of the earth and ascend into the higher regions, the pressure decreases; this may be shown by the barometer, and by boiling water on elevated situations.

2. NITROGEN GAS.

Colourless and transparent. Without odor or taste. Expansible. Not a supporter of combustion or combustible. Sp. gr. 0.972.

1. One hundred cubic inches at the mean temperature and pressure, weigh 29.65 grs. *Turner.*

It issues from many springs in the valley of the Hoosic, and in some of them, in considerable quantities. It contains usually oxygen in mixture, not, perhaps, varying much from 10 per cent.

ORDER II. WATER.

GENUS I. METEORIC WATER.

1. PURE METEORIC WATER.

Colourless and transparent. Without odor or taste. Amorphous. Liquid. Sp. gr. 1.00.

Water when heated to 212° F. passes into the form of vapor, and when it cools to 32° F. congeals, or becomes solid. It is composed of

Oxygen 88.94.
Hydrogen 11.06. *Berzelius.*

As found in springs and fountains it usually contains an admixture of the alkaline and earthy salts, as lime, magnesia and soda. These impurities are removed by distillation. Water when crystallized usually assumes the form of a star, with six radii. The primary form appears to be a *prism*, but its dimensions have not yet been satisfactorily determined.

ORDER III. ACID.

GENUS I. CARBONIC ACID.

1. ÆRIFORM CARBONIC ACID.

Colourless and transparent. Taste slightly acid. Odor pungent. Amorphous. Sp. gr. 1.51. *Biot and Arago.*

1. Carbonic acid reddens the vegetable blues, and forms a turbid compound when agitated with lime water. It extinguishes all burning bodies, and destroys life if inhaled into the lungs, by its poisonous qualities, as well as by excluding oxygen. When absorbed by water it communicates an acidulous taste. It consists of

Carbon	6,	one p.
Oxygen	16,	two p.

2. Carbonic acid is always present in the atmosphere; even at the summits of the highest mountains. It is formed by the combustion of substances which contain carbon, and by the respiration of animals. When it is formed in low situations, it is likely to accumulate and form an atmosphere which is commonly known as the *choke-damp*. This is almost instantly fatal to every animal placed in it. At the *Grotto del Cane*, in Italy, it issues directly from the earth.

3. This gas, when in solution in water, forms a pleasant and useful stimulant to the stomach. Many mineral waters owe their efficacy, in part, to this substance; this too imparts that liveliness to the different fermented liquors.

GENUS II. MURIATIC ACID.

1. LIQUID MURIATIC ACID.

Amorphous and transparent. Colour green or greenish. Taste strongly acid. Odor pungent and suffocating. Sp. gr. 1.27.

1. The natural form of this substance is a gas, which is colourless and transparent. It has a strong affinity for water, which causes it to appear like a white cloud when disengaged from its combinations. It consists of

Chlorine	37,	one p.
Hydrogen	1,	one p.

2. It usually occurs in the vicinity of active volcanoes, as Mount Ætna and Vesuvius.

GENUS III. SULPHURIC ACID.

1. LIQUID SULPHURIC ACID. *Jam.*

Colourless. Taste strongly acid. Sp. gr. 1.850. *Berz.*

1. It reddens litmus and the other vegetable blues. It acts strongly on vegetable and animal matter, even when greatly diluted.

It has a strong affinity for water. The sulphuric acid of commerce freezes at —15° F. It is composed by weight of

Sulphur 16, one p.—Oxygen 24, three p.

2. The sulphuric acid as found in nature is far from being pure. Those acidulous springs which are found in the neighborhood of volcanic mountains, contain free sulphuric acid. Sulphuric acid is sometimes produced also by the decomposition of iron pyrites, and vegetable matter—as the trunks of trees, leaves, &c. with which it comes in contact, are converted into *coal*, (or what is commonly called *lignite.*) This effect may be observed on the lignite beds, a few miles south of South-Amboy.

GENUS IV. BORACIC ACID.

1. PRISMATIC BORACIC ACID.

Sasoline, or Native Boracic Acid. *Jam.*

Colour grayish and yellowish-white. Streak white. Feebly translucent. Taste acidulous, afterwards bitter and cooling—lastly sweetish. Sp. gr. 1.48. *Berzelius.* Primary form an octahedron, whose dimensions have not been accurately determined.

1. Boracic acid fuses in the flame of a candle and yields a glassy globule, which acquires resinous electricity by friction on being insolated. *Mohs.* It dissolves freely in hot alcohol, and when the solution is set on fire it tinges the flame green. It consists of

Boron	8,	one p.
Oxygen	16,	two p.
Water	18,	two p.

2. It is deposited from the water of the hot springs, near Sasso, in Tuscany; it occurs likewise at Volcano, one of the Lipari Islands. When crystallized it is pure, except an accidental admixture of sulphur.

GENUS V. ARSENIOUS ACID.

1. OCTAHEDRAL ARSENIOUS ACID.

Oxide of Arsenic. Jam. Arsenious Acid.

Colour white. Often inclining to yellow. Streak white. Lustre vitreous-adamantine. Semi-transparent...opake. Sp. gr. 3.69. Taste sweetish. Astringent. *Mohs.* Cleavage parallel to the planes of the regular octahedron. Cross fracture conchoidal.

1. When exposed to heat it volatilizes and emits the odour of garlic. The vapor may be condensed by cold, when the acid appears again in the form of an octahedron. It is soluble in water. It is well known to be the most poisonous substance in nature. It is usually associated with the ores of cobalt, lead, bismuth, &c. It frequently occurs in reniform, botryoidal and stalactitic forms, or in thin crusts or scales, of a pearly lustre. It occurs in most of the mining districts of Europe.

ORDER IV. SALT.

GENUS I. NATRON-SALT.

1. HEMI-PRISMATIC NATRON-SALT.
Prismatic Natron. Jam.
Carbonate of Soda. Phil.

Taste mildly alkaline. Colour white. When gray or yellow it is owing to foreign admixture. Lustre vitreous. Hardness 1.0—1.5. Sp. gr. 1.2—2.9. Massive and crystallized. Primary form a rhombic octahedron.

1. Natron effervesces with the mineral acids. When exposed to air it effloresces. It is composed of

Carbonic acid	22,	one p.
Soda	32,	one p.
Water	90,	ten p.

2. The native carbonate of soda occurs abundantly in Egypt, near certain lakes called Natron Lakes. Their waters containing this salt in solution, during the summer evaporate and deposite it in a solid form. This deposite is broken and packed in casks and sent to the European markets. It is likewise found on the surface of the soil on the plains of Debreczin in Hungary; also in Bohemia, Italy, and other European countries. It is found too in the ashes of most sea-weeds, particularly the Salsola and Salicornia.

3. This salt is chiefly employed in the manufacture of hard-soap and glass. It is useful in dyeing and bleaching.

GENUS II. GLAUBER-SALT.

1. PRISMATIC GLAUBER-SALT.
Prismatic Glauber-Salt. Jam.
Sulphate of Soda. Phil. C.

Colour white, grayish or yellowish-white. Lustre vitreous. Streak white. Transparent. Taste bitter and saline. Hardness 1.5—2.0. Sp. gr. 2.2—2.3. Primary form a rhombic octahedron.

1. Sulphate of soda effloresces on exposure to air. It is very soluble in warm or cold water. When exposed to heat it readily undergoes watery fusion. It is composed of

Sulphate of soda	72,	one p.
Water	90,	ten p.

2. This salt is found in many lakes in Austria, Lower Hungary, Siberia, Russia and Switzerland. It sometimes occurs in efflorescences on old plastered walls. It is used principally as a cooling purgative.

GENUS III. NITRE-SALT.

1. PRISMATIC NITRE SALT.

Prismatic Nitre. Jam.
Nitre, Nitrate of Potash. Phil. & C.

Colour white. Transparent...translucent. Streak white. Lustre vitreous. Taste slightly saline, cool, and lastly alkaline. Brittle. Hardness 2.0. Sp. gr. 1.93.

1. Nitre deflagrates when thrown on burning coals and burns with a pink-red flame. It dissolves easily in water and is but little altered on exposure to air. It forms a detonating compound with combustible substances.

2. This useful substance occurs in many places in the United States; in the caves where animal matter has undergone decomposition. In Kentucky, Madison county, there is a cave 1936 feet long and 40 feet broad, which contains nitre in mixture with earthy matter and nitrate of lime. The nitre is obtained pure by mixing the compound with wood-ashes and then subjecting it to lixiviation. From one bushel of earth is obtained from three to ten pounds of nitre. It is said to be found in some parts of Kentucky, in loose masses, which weigh several pounds.

3. Nitre does not occur in sufficient abundance to meet the demands for it in the purposes of life. It is employed in the manufacture of gun-powder, and for making nitric acid. Besides this, it is used in medicine, and for preserving meat and other perishable articles.

GENUS IV. ROCK-SALT.

1. HEXAHEDRAL ROCK-SALT.

Common Salt. Phil.
Muriate of Soda. C.

Colour generally white, passing into yellow, flesh-red and ash-gray. Transparent...translucent. Lustre vitreous, somewhat inclining to resinous. Streak white. Rather brittle. Hardness 2.0. Sp. gr. 2.25. Taste saline. It yields a perfect cleavage parallel to all the planes of the cube. The solid angles are sometimes replaced by tangent planes.

1. The rock salt of Cheshire, England, contains in 1000 parts, 983$\frac{1}{4}$ muriate of soda, 6$\frac{1}{2}$ sulphate of limo, 0.3-16 of muriate of magnesia, 0.3-16 of muriate of lime, and 10 of insoluble matter. *Henry.* Muriate of soda consists of

Muriatic acid 37, one p.
Soda 32, one p.

Rock-salt is usually massive, but sometimes occurs in imitative forms, as columnar, dentiform, &c. Fracture usually presents granular concretions.

2. This substance is abundant. It forms about one-thirtieth part of the waters of the ocean. It occurs too in beds and veins in the earth, which are associated pretty constantly with gypsum. These beds are sometimes superficial, as those of Africa, or at very great depth, as those of Poland. In Spain, large isolated masses occur on the surface of the earth.

3. As yet no beds of salt are known within the limits of the United States. Numerous salt-springs however exist, from which are made more than a million of bushels of salt annually. It is worthy of notice, that these springs are situated in the interior of the country, at a distance from the sea-coast and from the ordinary course of navigation. Salt-springs are found in the states of New-York, Virginia, Kentucky, Ohio and Illinois.

4. The uses of common salt are too well known to require a particular notice.

GENUS V. BORAX-SALT.

1. PRISMATIC BORAX-SALT.

Prismatic Borax. Jam. *Borax. Borate of Soda.* P.
Bi-Borate of Soda. Turner.

Colour white, inclining to blue or green. Transparent, or translucent. Streak white. Taste alkaline. Hardness 1.5. Sp. gr. 1.71. Cleavage parallel to the planes of an oblique rhombic prism of 86° 30′ and 93 °30′, and indistinct, in directions parallel to both its diagonals.

1. Before the blow-pipe borax intumesces and melts into a transparent colourless bead. When dissolved in sulphuric acid and alcohol it burns with a green flame.

According to Thompson, pure borax consists of

Soda	32, one p.
Boracic acid	48, two p.
Water	72, eight p.

2. Borax is brought principally from Thibet, in an impure state. It is procured from the borders of certain lakes whose waters are impregnated with this salt. It is brought to Europe in the form of brown or grayish masses, in which state it is called Tincal. It is said also to occur in Ceylon, and in Potosi, South America.

3. Borax is used as a flux in the production of artificial gems; in the process of soldering, and in medicine as an external application.

GENUS VI. EPSOM-SALT.

1. PRISMATIC EPSOM-SALT.

Sulphate of Magnesia. Phil. C.

Colour white. Streak white. Transparent...translucent. Lustre vitreous. Brittle. Hardness 2.0. Sp. gr. 1.75. Taste saline and bitter. Slightly efflorescent on exposure to air; crystallizes in irregular six-sided prisms. Primary form a right rhombic prism, the angles of which are 90° 30′ and 89° 30.′ *Brooke.*

1. Epsom-salt is soluble in an equal weight of water at 60°.

When exposed to heat, it undergoes watery fusion. The composition of the pure salt may be stated thus:

Sulphate of magnesia	60,	one p.
Water	63,	seven p.

2. It is generally the product of decomposition, as it is found in efflorescences on rocks in their original repositories, or on the exterior of plastered walls. It forms a principal ingredient in certain mineral waters.

GENUS VII. AMMONIAC-SALT.

1. OCTAHEDRAL AMMONIAC SALT.

Octahedral Sal Ammoniac. Jam.
Muriate of Ammonia. Phil. C.

Colour generally white, inclining to gray, yellow or green. Transparent...translucent. Lustre vitreous, faint. Hardness 1.5—2.0. Sp. gr. 1.52. Taste sharp and pungent. Yields to mechanical division parallel to the planes of a cube.

The massive varieties occur in the form of stalactites, or botryoidal, globular or reniform concretions, and sometimes in the form of a mealy efflorescence.

1. The composition of this substance, from Mount Vesuvius, was found to be

Muriate of ammonia,	99.5.	
Muriate of soda,	0.5.	*Klaproth.*

Sal ammoniac occurs in cracks and fissures in the immediate vicinity of active volcanoes, and is the product of sublimation. Its localities are Mount Ætna, Vesuvius, the Solfateras, and the Lipari Islands.

2. This salt occurs only sparingly in nature. It is therefore principally formed artificially by various chemical processes. It is employed in dyeing, medicine, and in several operations in metallurgy.

2. MASCAGNIN. *Karsten.*

Sulphate of Ammonia.

Colour yellowish inclining to gray. Taste sharp and bitter. Regular forms unknown.

When triturated with lime, it is decomposed, and the ammonia escapes in the form of a pungent gas. It consists of

Ammonia	17,	one p.
Sulphuric acid	40,	one p.
Water	27,	three p.

It occurs in the vicinity of volcanoes, forming yellowish crusts on the lava and ejected stones.

GENUS VIII. ALUM SALT.

1. OCTAHEDRAL ALUM-SALT.

Octahedral Alum. Jam. *Alum.* P.
Sulphate of Alumine and Potash. C.

Colour white. Streak white. Transparent...translucent. Lustre vitreous. Hardness 2.0—2.5. Sp. gr. 1.75. Taste sweetish, astringent. Pure alum crystallizes in regular octahedrons, the solid angles of which are often replaced. Fracture conchoidal with smooth surfaces.

1. In nature, alum is never pure. It is usually formed from the decomposition of aluminous rocks, which contain pyrites, hence it contains iron and other impurities. It consists of

Sulphuric acid and water,	77.00.	
Potash,	0.25.	
Oxide of iron,	7.50.	*Klaproth.*

It dissolves easily in water ; and melts before the blow-pipe in its water of crystallization, and is converted into a spungiform mass.

2. NATIVE SODA-ALUM.

Colour white. Transparent...translucent. Lustre pearly. Structure fibrous. Sectile. Brittle. Hardness 2.0. Sp. gr. 1.88. Form prismatic.

1. One hundred parts of water at 62° dissolve 377.3 parts. Boiling water dissolves an indefinite quantity. When exposed to air, it loses its water of crystallization and becomes opake. Under the influence of heat it appears like common alum. It consists of

Sulph. acid,	4	atoms.	
Alumina,	3	do.	
Soda,	1	do.	
Water,	20	do.	*Thompson.*

The difference between the *native* soda alum and the *artificial* soda alum is, that the former contains only 20 atoms of water, and the latter 25. This is supposed to occasion a difference in the shape of the crystalline forms. *Thompson.*

3. DAVITE.

Sulphate of Alumine.

Colour white, greenish, or yellowish-white. Taste nauseous and highly astringent. Lustre, as observed on a recent fracture, pearly. Regular forms unknown.

1. This substance, on being subjected to the action of the blow-pipe, first gives off its water of crystallization, and afterwards its sulphuric acid, which may be known by its suffocating odour. It changes the vegetable blues to red. It is composed of

Sulphate of alumine,	38.0.
Sulphate of iron,	2.4.
Free sulph. acid,	4.6.
Water,	51.8.

GENUS IX. BRYTHENE[*] SALT.

1. PRISMATIC BRYTHENE SALT.

Glauberite. Jam. Phil. C.

Colour yellowish or grayish-white. Semi-transparent... translucent. Brittle. Hardness 2.5.—3.0. Sp. gr. 2.80. Taste saline, feeble. Lustre vitreous. Fracture conchoidal. Cleavage perfect, parallel to the planes of an oblique rhombic prism. P on M or M′, 104° 15′. M on M′ 83° 30′. *Brooke.*

1. Prismatic brythene salt consists of

Sulphate of lime,	49.0.
Sulphate of soda,	51.0. *Brogniart.*

It consists of one atom of anhydrous sulphate of lime, and one atom of anhydrous sulphate of soda. If immersed in water it loses its transparency and is partly dissolved.

2. It occurs imbedded in rock-salt at Villarubia, Spain; likewise in Aussee, in Upper Austria.

The following earthy and alkaline salts are but little known.

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[*] From *brithus* dense (heavy.)

1. SULPHATE OF POTASH.

Colour white, yellowish or grayish. Streak white. Transparent...translucent. Rather brittle. Lustre vitreous, inclining to resinous. Hardness 2.5.—3.0. Sp. gr. 1.73. Taste saline, bitter, disagreeable.

1. It consists of

Sulphuric acid,	45.93.	
Potash,	54.07.	*Berzelius.*

It occurs at Mount Vesuvius.

2. BLŒDITE. *Leonhard.*

Sulphate of Magnesia and Soda.

Colour between flesh-red and brick-red. Translucent, becoming white by decomposition. Lustre vitreous, faint. Structure fibrous. Fracture splintery, soft, massive, composed of thin columnar concretions.

1. It is composed of

Sulphate of magnesia,	36.66.	
Sulphate of soda,	33.34.	
Muriate of soda,	22.00.	
Water,	0.34.	*Johns.*

It occurs at Ischel, in Upper Austria, along with prismatic gypsum, and polyhalite.

3. POLYHALITE.[*] *Stromeyer.*

Colour smoky and pearl-gray, brick or flesh-red, from the presence of iron. Lustre resinous or pearly. Brittle. Fracture splintery. Structure columnar, compact. Hardness 3.5.—4.0. Sp. gr. 2.77. The compact variety yields a cleavage parallel to the planes of a cube. Taste saline and bitter.

1. In the flame of a candle it melts into an opake globule. When exposed to air it is slightly efflorescent. It consists, according to Stromeyer, of

Sulphate of potash,	27.70.
Anhydrous sulph. lime,	44.74.
Do. magnesia,	20.63.
Muriate of soda,	0.19.
Water,	5.96.
Peroxide of iron,	0.33.

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[*] From the Greek, signifying many salts.

4. NITRATE OF SODA.

Nitrate of Soda. Mariano de Rivero. Ann. des Mines.

Colour white. Streak white. Transparent. Rather sectile. Fracture conchoidal. Surface smooth. Lustre vitreous. Hardness 1.5.—2.0. Sp. gr. 2.09. Taste bitter and cooling. It has a perfect cleavage parallel to the planes of the rhombohedron of 106° 33′.

1. When thrown on burning coals it deflagrates, but not so actively as prismatic Nitre-salt. By friction it acquires strong negative electricity. Efflorescent when exposed to air. It is soluble in three times of its weight of water at 60°.

2. It occurs, according to Mariano de Rivero, in beds of clay, in Peru, near the seaport of Yquique, which are said to extend more than fifty miles. It sometimes appears in efflorescences on the surface of the earth.

5. GAY LUSSITE. *Boussingault.*

Colour white. Transparent...translucent. Opake by decomposition. Brittle, and easily reduced to powder. Lustre vitreous. Hardness 1.5.—2.0. Sp. gr. 1.92.—1.95. Fracture conchoidal. It possesses double refraction in an eminent degree. Taste alkaline, mild.

1. Gay Lussite decrepitates before the blow-pipe and melts into an opake globule. In nitric acid it dissolves with effervescence, and if left to partial spontaneous evaporation, crystals of nitrate of soda are formed which float in a solution of nitrate of lime. It occurs disseminated in clay in several places in Colombia, S. A. It resembles Selenite.

6. NITRATE OF LIME.

Colour white, yellowish-white or grayish-white. Taste bitter and pungent. Form prismatic, or undetermined.

1. It occurs in silken tufts, or in delicate needles, or in a pulverulent form. Deliquescent. When thrown on burning coals it emits slight detonations somewhat similar to nitre. Soluble. It is found on old walls from decomposition, or on calcareous rocks in the vicinity of which animal matter has decomposed.

GENUS X. VITRIOL-SALT.

1. RHOMBOIDAL VITRIOL. *Jam.*

Green Vitriol. Sulphate of Iron. Phil. C.

Colour green, yellowish-green. By partial decomposition it becomes yellowish-white. Streak white. Brittle. Hardness 2.0. Taste astringent, metallic. Primary form an oblique rhombic prism. P on M, or M′ 99° 20′. M on M′ 82° 20′. *Brooke.*

The compound varieties are stalactitic, botryoidal and reniform, and sometimes pulverulent.

1. It consists of

Protoxide of iron	36, one p.
Sulphuric acid	40, one p.
Water	54, six p.

Those varieties which are of a yellowish-white, are anhydrous. Green vitriol is easily soluble in water, and the solution becomes black on being mixed with a solution or tincture of galls.

2. This salt, in most cases, is the product of decomposition; hence it occurs in connexion with iron pyrites. The sulphur of the pyrites taking oxygen from the atmosphere is converted into sulphuric acid, and acting on the oxide of iron produces the salt in question.

This fact has taught us to manufacture this article extensively in those places where its elements are found.

2. PRISMATIC VITRIOL. *Jam.*

Blue Vitriol. Sulphate of Copper. Phil. C.

Colour sky-blue, in different degrees or shades. Streak white. Semi-transparent...translucent. Opake by partial decomposition. Fracture conchoidal. Primary form an oblique rhombic prism. Cleavage imperfect, in the direction of the planes M and T. Hardness 2.5. Sp. gr. 2.21. Taste astringent and metallic.

Blue vitriol, like the preceding salt, is the result of decomposition, and of course occurs in the vicinity of those metallic deposits which contain its elements, as the pyramidal Copper pyrites. It consists of

Oxide of copper,	32.14.	
Sulphuric acid,	31.30.	
Water,	36.30.	*Berzelius.*

This salt when moistened and rubbed on polished iron leaves a trace of metallic copper.

It is used in dyeing and in printing cotton and linen, &c.

3. PYRAMIDAL VITRIOL. *Jam.*

White Vitriol. Prismatic Vitriol-Salt. Mohs.
Sulphate of Zinc. Phil. C.

Colour white. Streak white. Transparent...translucent. Brittle. Lustre vitreous. Hardness 2.0—2.5. Sp. gr. 2.03. Taste astringent, metallic. It crystalizes in four-sided rectangular prisms. Primary form, right rhombic prism.

Compound varieties are reniform, botryoidal and stalactitic. Sometimes granular, passing into an impalpable powder.

1. It consists of

Oxide of zinc,	27.5.	
Sulph. acid,	20.0.	
Water,	50.	*Klaproth.*

The sulphate of zinc, or white vitriol of commerce, is produced in the same way as the sulphates of iron and copper. It is employed as an active emetic in medicine; but its principal use is in dyeing.

4. RED VITRIOL.

Sulphate of Cobalt. Phil.

Colour pale rose-red. Semi-transparent...translucent. Lustre vitreous. Form prismatic. Taste astringent.

Compound varieties are coralloidal and stalactitic; friable.

It is soluble in water. To borax, before the blow-pipe, it communicates a blue colour. It consists of

Oxide of cobalt,	38.71.	
Sulph. acid,	19.74.	
Water,	41.55.	*Kopp.*

It occurs in the rubbish of old cobaltic mines.

5. SULPHATE OF URANIUM. *John.*

Colour emerald-green. Lustre vitreous, transparent... opake. Brittle. Soluble in water, and is said to crystalize in flat prisms.

6. SUB-SULPHATE OF URANIUM. *John.*

Colour bright sulphur-yellow. Friable and partly soluble in water.

The two last species occur in the Uranium mines at Joachimsthal, in Bohemia.

CLASS II.

ORDER I. HALOIDE.

GENUS 1. GYPSUM-HALOIDE.

1. PRISMATOIDAL GYPSUM-HALOIDE.

Axifrangible Gypsum. Jam.
Sulphate of Lime. Phil. C.

Colour generally white, sometimes inclining and passing into flesh-red, ochre-yellow, smalt-blue, and gray of different shades. Impure varieties, dark-gray, brick-red and tinged brownish-red. Streak white. Transparent... translucent. Sectile. Hardness 1.5.—2.0. The lowest degree on the plane P. Sp. gr. 2.31. Thin laminæ flexible but not elastic. Lustre pearly. Primary form a right oblique angled prism. Cleavage perfect, parallel to the plane P. Inclination of P on M or T 90°. M on T 113°.08′.

Compound varieties numerous; consisting of granular, fibrous, compact and earthy forms. The white compact variety is the alabaster; the fibrous variety possesses a pearly lustre, and passes into coarse columnar.

1. Gypsum before the blow-pipe exfoliates and melts into a white enamel, which after a few hours falls to powder. With a smaller particle of fluor than of gypsum, it fuses easily and

combines, and the compound is converted into a colourless transparent bead, which on cooling assumes the appearance of a white enamel. *Berzelius.*

Gypsum is composed of

Lime	28, one p.	
Sulph. acid	40, one p.	
Water	18, two p.	*Thompson.*

The compound varieties sometimes contain a few per cent of carbonate of lime, iron, &c.

2. The crystalized varieties occur mostly disseminated in argillaceous deposites; they are thus found near Hudson, in the state of New-York.

3. The compound varieties of this species form beds in secondary deposites. These beds are quite limited in length and breadth. Its associations are with the compact limestone and sandstone, as principal deposites; and with rock salt and marly clay as accompanying deposites. These deposites contain organic remains of extinct species of terrestrial quadrupeds, as at Montmartre, near Paris.

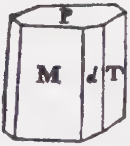
4. Gypsum is found abundantly in Nova-Scotia, large quantities of which are imported into the United States; it occurs also at Niagara, near the falls, and at Manlius and Lockport, in the state of New-York.

5. Gypsum is employed in the manufacture of artificial marble, stucco work, and hard mortar or finish. The finest white variety is employed in sculpture, under the name of alabaster. Ground and spread on certain soils it is highly valuable as a manure.

2. PRISMATIC GYPSUM-HALOIDE.

Prismatic Gypsum, or Anhydrite. Jam.
Anhydrous Sulphate of Lime. C.

Colour generally white, sometimes ash-gray, flesh-red, violet, smalt, and pale sky-blue. Streak grayish-white. Translucent...opake. Brittle. Lustre of the crystalized varieties more distinctly pearly than vitreous. Hardness 3.0.—3.5. Sp. gr. 2.89. Cleavage parallel to the planes of a rectangular prism, differing but little from the cube. Most distinct and easy parallel to P.



P on M or T	90°	0'.	H.
M on T	90	0	
M on d	140	4	
T on d	129	56	

Compound varieties.—These admit of the same distinctions as those under axifrangible gypsum. The confused crystalized variety is usually called *sparry* anhydrite. It is composed of plates either parallel or contorted. Others are *fibrous*, *granular* and *compact*—in the latter the fracture is splintery.

1. The anhydrite before the blow-pipe does not melt distinctly, but becomes coated with a white friable enamel. It consists, according to Thompson, of

Lime	28, one p.
Sulphuric acid	40, one p.

It sometimes contains one per cent of muriate of soda, from which circumstance it has been called *muriacite.*

2. The geological relations of the anhydrite are the same as in the preceding species. The different varieties may be found at Lockport, in the state of New-York; and generally in the geodiferous lime-rock, associated with calc. and pearl spar, yellow blende, &c. The varieties which are compact, possess a firm composition, and are polished for various ornamental purposes. It is sometimes called *vulpinite;* a small per cent of silex is usually found in it.

GENUS II. CRYONE-HALOIDE.

1. PRISMATIC CRYONE-HALOIDE.

Cryolite. Phil.
Prismatic Cryone. Jam.

Colour white, sometimes verging upon red or yellowish-brown. Translucent...opake. Hydrophanous. Lustre vitreous, inclining to pearly. Brittle. Hardness 2.5.—3.0. Sp. gr. 2.96. Cleavage perfect, parallel to all the planes of a rectangular prism.

Compound varieties.—Massive. Composition coarsely granular.

Cryolite consists of

Alumine,	21.0.
Soda,	32.0.
Fluoric acid and water,	47.

Before the blow-pipe on charcoal, this mineral fuses into a transparent globule, which becomes opake on cooling. With borax it fuses into a transparent glass, and when cold it becomes milk-white.

It occurs at West-Greenland, and is yet a scarce substance. It is geologically connected with gneiss, or slaty granite.

GENUS III. ALUM-HALOIDE.

1. RHOMBOHEDRAL ALUM-HALOIDE.

Rhomboidal Alum-Stone. Jam.
Alum-Stone. Phil.

Colour white, sometimes reddish or grayish. Streak white. Transparent...translucent. Brittle. Hardness 5. Sp. gr. 2.64. Lustre vitreous, inclining to pearly, upon the more distinct faces of cleavage. Primary form an obtuse rhomboid of the following dimensions:

P on P′ 92°50′. P on P′ or P″ 87°11′.

The obtuse solid angles are sometimes replaced.

1. Before the blow-pipe it first decrepitates: by a continuance of the blast a sulphurous gas is emitted. If it is now placed on the tongue it imparts a strong taste of alum. If the heat is continued till the sulphurous odour ceases, it does not melt, but becomes insipid.

It consists of alumine, 39.65; sulphuric acid, 35.49; potash, 10.02; water and loss, 14.83.

It occurs in a secondary rock at Tolfa.

It is used in the manufacture of alum, and the superior quality of that produced at Tolfa is ascribed to the employment of this mineral. *Mohs.*

GENUS IV. FLUOR.

I. OCTAHEDRAL FLUOR. *Jam.*

Fluor. Fluate of Lime. Phil. C.

Colour generally violet-blue or emerald and pistachio-green, rose-red and crimson-red; rarely white or black. Streak white. Transparent...translucent. Brittle. Hardness 4.0. Sp. gr. 3.14. Lustre vitreous. Cleavage perfect, parallel to the planes of the regular octahedron.

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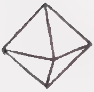

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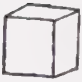

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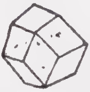

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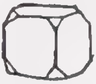


Compound varieties.—Massive. Composition columnar or coarsely fibrous, passing into compact, with a flat conchoidal fracture. Columnar varieties rarely curved. Colours often appear in zones.

1. Octahedral fluor consists of

Lime	28, one p.
Fluoric acid	18, one p.

or a compound of 1 atom of fluorine 10.+1 atom of calcium 20.

Before the blow-pipe *fluor* decrepitates and melts into an opake globule. Its powder effervesces when thrown into warm sulphuric acid, and the vapour which escapes possesses the property of corroding glass.

Most varieties phosphoresce when placed on a hot shovel. Those specimens which exhibit a bright-green colour, are called *chlorophanes*.

2. Fluor never forms a part of the rocky strata. It is usually associated with deposites of lead, zinc and silver, both in beds or veins. It is found in all the rock formations, as primitive, transition and secondary. Most of the countries in Europe produce the different varieties of fluor.

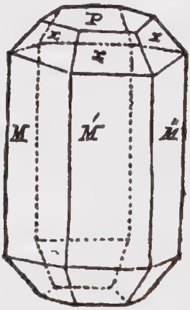
3. It is found green at Putney, Vt. ; purple at Southampton, Mass. and white or colourless at various places in the geodiferous lime rock in New-York, and perfectly black in the county of Genessee, N. Y.

2. RHOMBOHEDRAL FLUOR-HALOIDE.

Rhombohedral Apatite. Jam.
Apatite. Phosphate of Lime. Phil. C.

Colours white, yellow, gray, red and brown. Frequently violet-blue, mountain-green, or asparagus-green.

Transparent...translucent. Lustre vitreous, inclining to resinous. Brittle. Hardness 5.0. Sp. gr. 3.22. Cleavage imperfect and difficult, parallel to the planes of a regular hexahedral prism, which is considered as the primary form. This prism is often terminated by six-sided pyramids. In the annexed figure the pyramid is incomplete.



M on P	90°	
M on M	120	
x on P	140 47′	
x on M	129 13	*Troost.*

Compound varieties.—These belong in part to the imitative forms, as the globular, reniform and the imperfectly columnar. It is sometimes massive, and then the composition is granular, either coarse or fine, and passing into an impalpable powder.

1. Rhombohedral Fluor consists of

Lime	28, one p.
Phosphoric acid	28, one p.

It dissolves slowly in nitric acid without effervescence. Some varieties phosphoresce on hot coals. When exposed to a strong heat on charcoal, the corners of the fragment are rounded, but it does not melt without addition.

2. This substance belongs to the older rocks, as granite gneiss and mica slate. The hexahedral prism truncated on the terminal edges, as in the figure, occurs at Chester, Ms. and at St. Anthony's nose, near New-York. It may also be found, though it is scarce, in most of the granitic veins in N. England.

Phosphate of lime occurs too at Topsham, Me. West

Marlborough, Chester co. Pa. at West Farms, at Warwick, Orange co. N. Y. and at Milford Hills, Ct.

3. PRISMATIC FLUOR-HALOIDE.

Herderite. Haidinger.

Colour yellow or greenish-white. Streak white. Translucent. Lustre vitreous, inclining to resinous. Brittle. Hardness 5.0. Sp. gr. 2.98.

1. Prismatic fluor occurs in the tin mines of Saxony, associated with octahedral fluor. (Rare.)

GENUS V. LIME-HALOIDE.

1. PRISMATIC LIME-HALOIDE.

Prismatic Limestone. Arragonite. Jam.
Arragonite. Phil. C.

Colour white, sometimes passing into gray, yellow, mountain-green and violet-blue. Lustre vitreous, as observed on cleavage-planes, or cross-fracture. Transparent... translucent. Streak grayish-white. Brittle. Hardness 3.5—4.0. Sp. gr. 2.93. Doubly refractive. Yields to cleavage parallel to the planes of a right rhombic prism of 116° 5′ and 63° 55′

Compound varieties.—They are commonly composed of individuals, disposed in coralloidal and columnar forms; the former are beautifully white, and come principally from Eisenerz in Stiria, and Hüttenberg in Carinthia. The latter occur not only in parallel columns, but likewise in radiated masses; in both cases the individuals vary much in size. Some are large while others are so small as to be discerned with difficulty.

1. Arragonite is composed, according to Stromeyer, of

Carbonate of lime,	95.29—99.29.
Carbonate of strontian,	0.50— 4.10.

The latter substance is not constant, but it is remarked that the purest varieties contain it in the greatest proportions. To the presence of carbonate of strontian is attributed the peculiar crystalline form of arragonite. But it appears from recent investigations in crystallography, that simple bodies are capable of assuming at least two distinct forms; hence it may be inferred that the presence of strontian does not modify the dimensions of the simple forms of this substance. Notwithstanding the relation which prismatic lime-haloide bears to rhombohedral lime in chemical composition, it is still, for good reasons, considered a distinct species. Its form, hardness, and specific gravity, vary essentially from rhombohedral lime.

2. Prismatic Lime-haloide occurs at Weir's cave, Va. Suckasunny mine, N. J. Ball's cave, and Foxe's creek, Schoharie co. N. Y. The coralloidal variety is sometimes found in the geodiferous lime rock in the state of N. Y.

2. RHOMBOHEDRAL LIME-HALOIDE.

Limestone. Jam. *Carbonate of Lime.* Phil. C.

Colour of the pure varieties, white. Impure and mixed varieties, different shades of gray, red, green, yellow, and sometimes dark-brown and black. Streak white and grayish-white. Transparent...translucent. Lustre vitreous. Double refraction very distinct and easily observed. Brittle. Hardness 3.0. Sp. gr. 2.72. Cleavage perfect, parallel to the planes of a rhomboid of the following dimensions: Obtuse angles, or P on P′ or P″ 105° 5′. Acute angles 74° 55′.

Fig. 1.

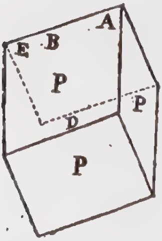


Fig. 2.

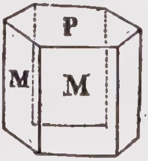


Fig. 3.

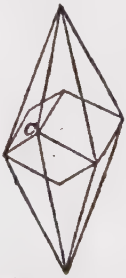


Fig. 1. The primary form, which is an obtuse rhomboid.

Fig. 2. A regular hexahedral prism formed by the omission of a single row of particles along the lower edges of the rhomb.

Fig. 3. is a dodecahedral crystal, formed by the omission of two rows of particles along the same edges as in the preceding figure.

Count Bournon has described 56 modifications of the rhomboid of carbonate of lime, and other mineralogists have greatly increased the number.

Compound massive varieties.—They have a composition both granular and compact. Individuals, in some instances, are sufficiently large to exhibit the internal structure of the species. In others, they are so small as to become imperceptible ; the mass then assumes a compact structure, and is known under the name of *compact limestone*. Other compositions are columnar. When the individuals are thin and closely aggregated, the mineral is known under the name of *satin spar*, or fibrous carbonate of lime. Under favorable circumstances the external forms are imitative, as *stalactical*, *tuberose*, *botryoidal*, and *coralloidal* : surfaces rough and dull, frequently drusy, and internally they are made up of distinct layers, either parallel, curved or divergent.

1. Carbonate of lime burns to quick-lime before the blowpipe, and effervesces with the mineral acids. It consists of

Carbonic acid	22,	one p.
Lime	28,	one p.

2. Rhombohedral Lime-haloide is distributed extensively in nature, and in such great quantities that it composes 1-5th of all the rock formations. Sometimes it forms considerable masses or beds in other rocks. The white granular varieties belong to primitive formations, while the dark compact belong to the transition and secondary formations. Several other varieties of limestone form extensive deposites, and are distinguished by particular names—thus, *Oolite* or *roe-stone*, consists of roundish grains which internally exhibit columnar individuals, disposed like the radii of a sphere. *Pea-stone*, or *pisolite*, resembles in form and composition the oolite, but each globule is formed around a particle of sand. *Chalk* is a species of compact limestone whose particles possess only a feeble coherence. *Rock milk*, or *agaric mineral*, has considerable resemblance to chalk, but the particles are much more loose and friable. *Calcareous tufa*, is a recent deposite from the water of springs, which contain carbonate of lime in solution. *Swinestone*, *marl* and *bituminous limestone*, are mixed and impure varieties of rhombohedral Lime.

3. Several of the preceding varieties are extensively used for various purposes. Those employed in sculpture and orna-

mental architecture, are called *marbles*. These are prized and valued according to pureness, colour, translucency, and the size and aggregation of their particles. When polished they form the most durable of all materials for sculpture and building. A peculiar fine grained variety is employed in forming plates for lithographic printing. Carbonate of lime when free from intermixture of siliceous particles, forms good quick-lime by burning. It is likewise useful as a flux, for smelting the ores of iron. When burned into quick-lime it enters into the composition of mortar. It forms for some soils a valuable manure.

1. *Sub-Species.* ARGENTINE.

Colour pure white; sometimes greenish or reddish. Translucent...opake. It is composed of thin slaty individuals which are generally undulating or curved. Surfaces smooth, or drusy. The slaty particles often intersect each other so as to form cavities, which are often studded with crystals of rhombohedral quartz. Lustre pearly, eminent.

It occurs in beds and veins in primitive rocks. In Goshen and Southampton, Mass. it is found in granite.

2. APHRITE. *Jam.*

Colour white. Streak white. Lustre pearly. Cleavage monotonous. Composition granular, scaly, slightly coherent. Opake. Feels soft. Soils a little. Hardness 0.5.—1.0. Sp. gr. 2.53.

1. Effervesces in the mineral acids and completely dissolves. When friable, it absorbs water readily.

It consists of	lime,	51.50.
	Carbonic acid,	39.00.
	Silex,	5.71.
	Oxide of iron,	3.28.
	Water,	1.00.

3. MACROTYPOUS[*] LIME-HALOIDE.

Bitter Spar. Pearlspar. Dolomite.
Magnesian Limestone. Phil. C.

Colour seldom pure white except the compound granular varieties, but generally inclines to red or green. Streak grayish-white. Semi-transparent...opake. Brittle. Hard-

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[*] From *makros*, long, and *typos*, the form.

ness 3.5.—4.0. Sp. gr. 2.88. Cleavage perfect, parallel to the planes of a rhomboid of 106° 15′.

Compound massive varieties.—They are usually granular, individuals often sufficiently large to exhibit the structure of the species. Forms sometimes imitative, as globular, botryoidal and fruticose, whose surfaces are often drusy. Composition rarely columnar; when columnar, the variety is called *miasite.* The granular variety is known under the name of *dolomite*, and is often friable, or only slightly coherent.

1. Macrotypous Lime-haloide, is a carbonate of lime and magnesia. The relative quantity of its elements are found to vary. According to Klaproth it consists of 30.56 lime, 22.18 magnesia, 47.26 carbonic acid; hence it consists of two atoms of carbonic acid, one atom of lime, and one atom of magnesia.

2. The present species is soluble in the mineral acids with effervescence, but not so rapidly as the preceding species. Before the blow-pipe it often assumes a darker colour, and becomes harder. It phosphoresces by friction with hard bodies, with a yellowish-white light.

Dolomite occurs abundantly in nature; it enters extensively into rock-formations and frequently prevails over extensive districts. It is easy to mistake it for the granular variety of rhombohedral lime. It is more frequently associated with *talcose slate, steatite, serpentine, &c.* It occurs in Middlefield, Cummington, Williamstown, Pittsfield, Adams, Windsor, Hinsdale, Sheffield, and Gt. Barrington, Mass.; Newfane and Marlborough, Vt.; Washington, Milford Hills, and Litchfield, Ct.

4. BRACHYTYPOUS* LIME-HALOIDE.

Carbonate of Magnesia and Iron. Phil.

Colour generally inclining to yellow, also white and brown. Streak grayish-white. Translucent...opake. Lustre vitreous, inclining to pearly on the faces of cleavage. Brittle. Hardness 4.0.—4.5. Primary form a *rhombohe-*

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* From *brachus*, short, and *tupos*, form.

dron, whose planes incline to each other at angles of 107° 22′. Cleavage perfect.

1. This mineral is composed of carbonate of magnesia and carbonate of iron. According to H. J. Brooke, Esq. it consists of 1.315 carb. iron, 8.605 carb. magnesia, without a trace of lime.

It is found in the Tyrol, in single crystals of a yellow colour, imbedded in talc or chlorite. *Phil.* This mineral is abundant in New Fane and Marlborough, Vt. imbedded in a grayish-green steatite.

5. PARATOMOUS* LIME-HALOIDE.

Colour white with various tints of gray, red, and brown. Streak white. Translucent, often, only faintly. Brittle. Hardness 3.5.—4.0. Sp. gr. 3.08.

Before the blow-pipe it becomes black, and magnetic. It dissolves with brisk effervescence in the mineral acid. The colour becomes dark on long exposure to the air. The chemical constitution of this species is not well ascertained. The principal constituents are carbonate of lime and carbonate of magnesia. It is deposited on mica slate in the Rathausberg in Salzburg.

It forms an excellent addition in the process of smelting iron ores.

GENUS I. WAVELLINE-HALOIDE.

1. PRISMATIC WAVELLINE-HALOIDE.

Wavellite. Sub-phosphate of Alumine. Phil.

Colour white, passing into several shades of green, gray, brown and black. Translucent. Hardness 3.5. Sp. gr. 2.3. Primary form a right rhombic prism, M on M′ about 122° 15′.. Cleavage perfect, parallel to the planes M and M′ and to the longer diagonal. Lustre of those planes intermediate between pearly and vitreous.

Compound varieties consist of implanted globules composed of thin columnar individuals radiating from a common centre.

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* From *para* about, and *temno*, I cleave.

1. Before the blow-pipe on charcoal it intumesces, loses its crystaline form, and becomes snow-white. With boracic acid and iron it gives a fused product of phosphuret of iron. *Berz.*

Wavellite is composed of alumina 35.35, phosphoric acid 33.40, fluoric acid 2.06, lime, oxides of iron and manganese 1.75, water 26.80. It was first discovered by Dr. Wavel, in or near Barnstable, in Devonshire, Eng.

GENUS I. ORTHOKLASE-HALOIDE.

1. PRISMATOIDAL ORTHOKLASE-HALOIDE.

Hopeite. Brewster. *Trans. R. Soc. Ed.*

Colour grayish-white. Streak white. Transparent... translucent. Lustre vitreous. Surface often striate. Refraction double. Sectile. Hardness 2.5.—3.0. Sp. gr. 2.76.

1. Before the blow-pipe it melts easily into a clear colourless globule, which tinges the flame green. Fused with soda, it gives a yellow scoria while hot, and copious floccoli of zinc and some cadmium are deposited near the scoria. The melted mineral forms a fine blue glass, with a solution of cobalt.

2. Hopeite resembles stilbite, for which it had been mistaken. It is considered as a compound of some of the stronger acids, as phosphoric or boracic acid, zinc and an earthy base, with a little cadmium and a large quantity of water.

It has been found only at the calamine mines of Altenberg, near Aix-la-chapelle. (Rare.)

The following species have not as yet received scientific names; their places in the systematic arrangement of minerals are not satisfactorily determined, and some of them are but little known.

1. MAGNESITE.

Carbonate of Magnesia.

Colour white, grayish or yellowish white. Opake, or only feebly translucent. Lustre pearly or dull. Hardness ranges between 1.—3.9. Sp. gr. 2.8.

Compound varieties.—Long capillary crystals, either parallel or diverging; sometimes in mamillary concretions, whose surfaces are covered with delicate crystaline tufts. Massive varieties are *granular* and *compact*, often passing into pulverulent, impalpable.

1. In the mineral acids it dissolves with effervescence and forms soluble compounds, which are usually bitter.

It consists of	Magnesia	20, one p.
	Carbonic acid	22, one p.
	Water	27, three p.

It is found at Hoboken, N. J. in horizontal veins, traversing a soft serpentine.

2. ROSELITE.

Roselite Levy. Ann. of Phil. xlvii. p. 4, 39.
Edinburgh Jour. of Science, vol. ii. p. 177.

Colour deep rose-red. Streak white. Translucent. Hardness 3.0. Primary form a right rhombic prism. Cleavage perfect, parallel to the plane P.

1. Before the blow-pipe, it gives off water and becomes black. To borax and salt of phosphorus it imparts a fine blue colour. In muriatic acid it dissolves without residue.

Roselite is composed of cobalt, lime, arsenic acid and magnesia, in proportions not well determined.

3. FLUELLITE.

Fluellite of Wallaston. Levy. Ann of Phil. Oct. 1824, p. 241.

Colour white. Transparent.

1. It occurs in minute crystals which affect the form of a scaline four-sided pyramid, with most of its acute solid angles replaced. It is associated with the Wavellite from Cornwall.

4. CHILDRENITE.

Childrenite. Brooke. Brande's Q. J. v. xvi. p. 274.

Colour yellowish-white, wine-yellow, ochre-yellow and pale yellowish-brown. Streak white. Translucent. Lustre vitreous, inclining to resinous. Fracture uneven. Hardness 4.5—5.0. According to Dr. Wollaston, it is a compound of phosphoric acid, alumina and iron. (Rare.)

5. PHARMACOLITE. *Jam.*

Arseniate of Lime. Phil.

Colour white. Translucent...opake. Lustre vitreous. Pearly in the thin columnar particles. Sectile. Very soft. Sp. gr. 2.64 *Klaproth.*

Compound varieties occur in globular, reniform and botryoidal masses, which are composed usually of thin columnar particles. Sometimes it occurs in the form of an impalpable powder.

1. Before the blow-pipe it emits an arsenical odour, and melts with difficulty into a white enamel. It dissolves with effervescence in nitric acid. It consists of

Lime,	25.00.
Arsenic Acid,	50.54.
Water,	24.46.

2. It is found at Andreasberg in the Hartz. The *picropharmacolite* of Stromeyer, differs from the above in containing about three per cent of magnesia and a trace of cobalt.

ORDER II. BARYTE.

GENUS I. PARACHROSE*-BARYTE.

H.=3.5—4.5.
G.=3.3—3.9.

1. BRACHYTYPOUS PARACHROSE-BARYTE.

Sparry Iron. Jam.
Spathose Iron. *Carbonate of Iron.* Phil. C.

Colour various shades of yellow, passing into ash and yellowish-gray, also into several kinds of yellow, white, red and brown, and by long exposure, into black. Streak white. Translucent in different degrees. Lustre vitreous, inclining to pearly. Brittle. Hardness 3.5.—4.5. Sp. gr. 3.82. It yields to cleavage parallel to the planes of a rhomboid of 107° and 73°. It often occurs massive, in which form there exists a regular composition.

1. Carbonate of iron consists of

Carbonic acid	22, one p.
Protox. iron	36, one p.

Before the blow-pipe it becomes black and magnetic, but does not melt. It dissolves slowly and with a feeble effervescense in nitric acid. When exposed to air it changes colour and disintegrates, diminishes in hardness, and finally passes into the form of a dark-brown or blackish powder.

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* From *parachrosis*, change of colour.

2. It is found accompanying rhombohedral Lime-haloide in primitive formations. It occurs abundantly at New-Milford, Ct. chiefly in foliated masses, but sometimes in the primary form of the species.

3. Carbonate of iron is a valuable mineral; large quantities of wrought and cast iron are obtained from it. Its greatest value however, as an ore of iron, arises from the facility of converting it directly into steel.

2. MACROTYPOUS PARACHROSE-BARYTE.

Rhomboidal Red Manganese. Jam.
Carbonate of Manganese. Phil. C.

Colour rose red, reddish-white and brownish. Lustre vitreous, inclining to pearly. Streak white. Translucent in different degrees. Brittle. Hardness 3.5. Sp. gr. 3.59. Cleavage parallel to the planes of a rhomboid of 107°. Occurs massive with a granular composition. The individuals in this case are sometimes small and even imperceptible.

1. Carbonate of manganese consists of

Protoxide of manganese	36,	one p.
Carbonic acid	22,	one p.

The native carbonate often contains silex, oxide of iron and lime. It effervesces with the mineral acids. Before the blowpipe its colour is changed into gray, brown and black, and it decrepitates strongly, but does not melt without addition. It dissolves in borax, which becomes violet-blue or purple. The rose-red varieties on exposure to light and air become paler.

It occurs in metalliferous veins, associated with the ores of copper, silver and lead.

GENUS II. ZINC-BARYTE.

H.=5.0
G.=3.3—4.5.

1. PRISMATIC ZINC-BARYTE.

Prismatic Calamine or *Electric Calamine.* Jam.
Siliceous Oxide of Zinc. Phil. C.

Colour yellowish, or grayish-white and light-brown, and sometimes greenish and bluish. Transparent...translucent. Lustre vitreous, inclining to pearly on the faces of cleavage. Brittle. Hardness 5.0. Sp. gr. 3.37. Cleavage perfect, parallel to the planes of a right rhombic prism, which is the primary form. M on P 172° 30′. M on M′ 132° 35′.

Compound varieties occur in botryoidal and stalactical forms; composition often granular and columnar. Sometimes it is compact.

1. When reduced to powder it dissolves in warm sulphuric or muriatic acids, and when cold, it forms a jelly. Before the blow-pipe alone in the matrass, decrepitates slightly, gives off water, and becomes milk-white. Infusible without addition. With borax it fuses into a colourless glass. The silica may be made perceptible with a large quantity of salt of phosphorus. Phosphorescent by friction. Remarkably electric by heat.

2. Siliceous oxide of zinc consists of

Oxide of zinc	42, one p.
Silex	16, one p.
Water	9, one p.

This mineral belongs principally to calcareous rocks; it is usually associated with blende, carbonate of zinc and sulphuret of lead. It occurs at the Perkiomen lead mines, Pa. and at Franklin, N. J.

2. RHOMBOHEDRAL ZINC-BARYTE.

Rhombohedral Calamine. Jam. *Carbonate of Zinc. Calamine.* Phil. C.

Colour white, rarely pure; frequently gray, green or brown. Streak white. Semi-transparent...opake. Lustre vitreous, inclining to pearly. Brittle. Hardness 5.0. Sp. gr. 4.44. Cleavage perfect parallel to the planes of a rhombohedron of 107° 40′.

The compound varieties occur in reniform, botryoidal and stalactitic forms. It appears in crystaline coats investing other minerals. By decomposition it becomes friable.

1. Carbonate of zinc consists of

Oxide of zinc	42, one p.
Carbonic acid	22, one p.

It dissolves with effervescence in the mineral acids. Before the blow-pipe in the reducing flame, it covers the charcoal with zinc fumes, but does not fuse.

2. It accompanies the preceding species, and occurs at the same localities. It is found at Franklin, N. J.

GENUS III. SCHEELIUM-BARYTE.

H.=4.0—4.5.
G.=6.0—6.1.

1. PYRAMIDAL SCHEELIUM-BARYTE

Pyramidal Tungsten. Jam.
Tungstate of Lime. Phil. C.

Colour generally white, or passing into yellowish-gray, orange-yellow, or reddish-brown. Streak white. Semi-transparent...translucent. Lustre vitreous, inclining to adamantine. Brittle. Hardness 4.0.—4.5. Sp. gr. 6.07. Yields to cleavage parallel to the planes of an octahedron with a square base. P on P′ 100° 40′. P on P″ 129° 2′. *Brooke.* Fracture imperfect conchoidal.

The *compound massive variety* resembles the carbonate and sulphate of lead or barytes.

1. Pyramidal scheelium-baryte consists of

Lime,	19.40
Oxide of scheelium,	80.42

Alone on charcoal it is infusible. With borax it gives a white glass. It generally occurs in those repositories (?) which contain tin, topaz, fluor, quartz, &c. It is found at Huntington, Ct.

GENUS IV. HAL-BARYTE.

H.=3.0—3.5.
G.=3.6—4.7.

1. PERITOMOUS* HAL-BARYTE.

Strontian. Carbonate of Strontian. Phil. C.

Colour asparagus-green, or yellowish-white. Translu-

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* From *peri*, round, and *temno*, I cleave.

cent. Fracture splintery. Lustre resinous, pearly and vitreous. Streak white.. Brittle. Hardness 3.5. Sp. gr. 3.60. Cleavage perfect, parallel to the lateral faces of a right rhombic prism ; less perfect parallel to the plane P. M on M′ 117° 32′.

Compound varieties have a fibrous structure both parallel and divergent. Lustre pearly. Seldom granular.

1. Before the blow-pipe it is infusible except on the surface, but the mass becomes white and opake. It intumesces and exhibits a brilliant light. During the blast the flame is tinged faintly of a purplish-red ; taste of the fragment alkaline. Dissolves with effervescence in the mineral acids. It consists of

Protoxide of strontium	52, one p.
Carbonic acid	22, one p.

2. This mineral occurs in metallic veins traversing primitive and transition mountains, in company with hexahedral Lead-glance, prismatic Hal-baryte, arsenical pyrites, quartz, &c. (Rare.)

2. DI-PRISMATIC HAL-BARYTE.

Rhomboidal Baryte or *Witherite*. Jam.
Carbonate of Barytes. Phil. C.

Colour generally yellowish-white, approaching orange-yellow, grayish, greenish and rarely reddish-white. Semi-transparent...translucent. Streak white. Lustre vitreous and shining. Brittle. Hardness 3.0.—3.5. Sp. gr. 4.30. Fracture uneven. Cleavage imperfect. Primary form is supposed to be a right rhombic prism. M on M′ 118° 30′. The ordinary hexagonal prisms probably result from the intersection of three of the primary crystals. *Brooke.*

Compound varieties are stalactitic and fibrous, or thin columnar, passing into crystals of a bladed form.

1. Before the blow-pipe it decrepitates slightly and melts easily into a transparent bead, which becomes opake on cooling. It dissolves with effervescence in the mineral acids.

Di-prismatic barytes consists of

Prot. oxide of barium	78, one p.
Carbonic acid	22, one p.

It occurs in veins traversing the metalliferous limestone and the primitive formations, and most generally associated with lead, silver, tin, &c.

The carbonates of strontian and barytes are violent poisons.

3. PRISMATIC HAL-BARYTE.

Prismatic Baryte or *Heavy Spar.* Jam.
Sulphate of Baryte. Phil. C.

Colour generally white, sometimes inclining to gray, yellow, blue, red, and brown. Transparent...opake. Streak white. Lustre vitreous, inclining to resinous. Brittle. Hardness 3.0.—3.5. Sp. gr. 4.44. Cleavage parallel to the planes of a right rhombic prism, and to the short diagonal. M on M′ 101° 42′.

Compound varieties occur of various imitative shapes, as globular, reniform and stalactical. Composition often lamellar, sometimes fibrous or thin columnar. The former variety is known as the *lamellar* sulphate of barytes and the latter as the *fibrous* sulphate of barytes. It is sometimes granular, which graduate into impalpable. Less important varieties have been described.

1. Prismatic Hal-baryte consists of

Protoxide of baryum	78, one p.
Sulphuric acid	40, one p.

Before the blow-pipe it fuses with difficulty and decrepitates if heated suddenly. It decomposes in the interior flame and gives sulphuret of barytes, which when moistened, exhales a slight hepatic odour. Taste hepatic and pungent.

2. It accompanies the ores of lead and iron, and frequently octahedral fluor.

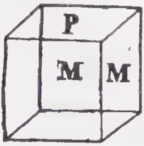
The localities of this mineral are numerous. Southhampton, Hatfield, Greenfield, Mass.; Berlin, Farmington, Hartford, Southington, Ct.; Little Falls, on the Mohawk, Livingston's lead mine, and Watertown, N. Y. At the latter place, in large flesh coloured masses.

4. PRISMATOIDAL HAL-BARYTE.

Axifrangible Baryte. Jam.
Celestine. Sulphate of Strontian. Phil. C.

Colour usually white, passing into blueish-gray, sky-blue and smalt-blue. Also reddish-white and flesh-red. Transparent...opake. Brittle. Hardness 3.0.—3.5. Sp. gr. 3.85. Cleavage perfect, parallel to the planes of a right rhombic prism,

1.



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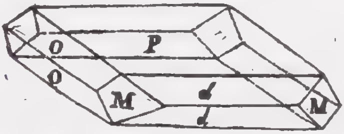


Fig. 1.Primary form. Fig. 2. Sulphate of Strontian, *epointée.*

M on M	104° 48′
O on P	128 3
O on O	77 2
d on d	101 32

Compound varieties have a structure both *lamellar* and *fibrous*, thus forming two distinct varieties.

1. Before the blow-pipe it decrepitates and melts without colouring the flame, into a white friable enamel. It consists of

Protoxide of strontium	52, one p.
Sulphuric acid	40, one p.

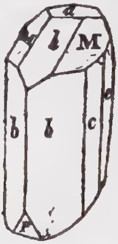
This mineral is more frequently met with in the secondary limestone, sandstone and trap rocks, in globular and laminated masses of various sizes.

2. It occurs at Lockport and Moss Island, N. Y. and at numerous places in the same rock formation, associated with prismatic gypsum, yellow blende and octahedral fluor.

5. BARYTO-CALCITE.

Baryto-Calcite. Brooke. Ann. of Phil. xliv. p. 114.

Colour white, grayish, yellowish or greenish. Streak white. Transparent...translucent. Lustre as observed on a recent fracture vitreous, inclining to pearly. Hardness 4.0. Sp. gr. 3.66. Cleavage not very difficult, parallel to M, perfect parallel to P.



M	on	M	106°	54′
P	on	M	102	54
b	on	b	95	15
c	on	c	145	54

1. It consists of

Carbonate of barytes,	65.9.	
Carbonate of lime,	33.6.	*Children.*

Before the blow-pipe it does not melt. With borax it gives a clear globule. Occurs at Alston Moor, in Cumberland, Eng. both massive and crystalized.

6. STROMNITE.

Bary-Strontianite. Traill. Trans. R. Soc. Ed. vol. ix. p. 81.

Colour white, yellowish-white, grayish-white after disintegration. Lustre inclining to pearly, faint. Translucent. Brittle. Hardness 3.5. Sp. gr. 3.70. Massive. Composition thin columnar.

1. Before the blow-pipe it is infusible. Effervesces with acids. It consists of

Carbonate of strontia,	68.6.	
Sulphate of baryta,	27.5.	
Carbonate of lime,	2.6.	
Oxide of iron,	0.1.	*Traill.*

2. It occurs in clay slate at Stromness, in Orkney. A mineral agreeing in many of the characters of the stromnite is found in Clinton, near Hamilton college, N. Y.

GENUS V. LEAD-BARYTE.

H.=2.5—4.0.
G.=6.0—7.3.

1. DI-PRISMATIC LEAD-BARYTE.

Di-Prismatic Lead-Spar. Jam.
Carbonate of Lead. Phil. C.

Prevailing colour white, passing into yellowish-gray, ash-gray and smoke-gray. Sometimes tinged blue or green by the carbonate of copper. Streak white. Transparent...translucent. Brittle. Lustre adamantine. If the colours are dark, the lustre is often metallic. Fracture conchoidal. Hardness 3.0.—3.5. Sp. gr. 6.46. Primary form a right rhombic prism. Cleavage perfect parallel to the plane P, M & M′ and to the shorter diagonal, but liable to be interrupted by the conchoidal fracture. M on M′ 117°. P on M or M′ 90°.

Compound varieties.—Composition granular, passing into earthy—the latter is known as the earthy lead spar.

1. Before the blow-pipe it decrepitates, becomes yellow and red, and finally yields a globule of lead. It effervesces in the mineral acids and is easily soluble. It consists of

Protoxide of lead	112, one p.
Carbonic acid	22, one p.

2. Occurs abundantly in the different mining districts of Europe. In the United States, at the Perkiomen lead mine, and near Lancaster, Pa. Also, at Southampton, Mass.

2. RHOMBOHEDRAL LEAD-BARYTE.

Rhomboidal Lead-Spar. Jam.
Arseniate of Lead. Phosphate of Lead. Phil. C.

Colour generally green or brown. According to Mohs, there is an uninterrupted series of colours 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, hyacynth-red; pearl-gray and ash-gray. Streak white, sometimes inclining to yellow. Semi-transparent...translucent on the edges. Brittle. Hardness 3.5.—4.0. Sp. gr. 7.09. Fracture imperfect conchoidal. Lustre resinous. Cleavage parallel to all the planes of the regular six-sided prism, and also to the planes C C′ C″, which would give a double six-sided pyramid as the primary form; but the prism, being the most simple solid, is selected as the primary form.

M on M	120° 00′
P on M	90 00
M or M′ on d′	150 00
M on c′	131 45
P on c or c′	138 30
c′ on c or c″	110 5

Compound varieties occur in botryoidal, reniform and fruticose shapes. Internal composition columnar.

1. Before the blow-pipe it melts by itself on charcoal and the bead assumes a polyhedral form of a dark colour. If borax is added to the pulverised globule, it is partially reduced. It dissolves in warm nitric acid without effervescence.

It consists of	
Protoxide of Lead,	112.
Phosphoric acid,	28.

A trace of muriatic acid is usually found.

2. It occurs in the various mining districts of England, in the United States, in the Perkiomen lead mines, Pa. and at Southampton, Mass.

The following analysis of specimens, containing arsenic acid, exhibits the proportions of the elements forming those varieties.

Oxide of lead,	77.50—77.50.
Phosphoric acid,	7.50—00.00.
Arsenic acid,	12.00—19.00.
Muriatic acid,	1.00—01.53.

3. HEMI-PRISMATIC LEAD-BARYTE.

Prismatic Lead-Spar. Jam.
Chromate of Lead. Phil. C.

Colour various shades of hyacinth-red. Streak orange-yellow. Translucent. Sectile. Lustre adamantine. Hardness 2.5.—3.0. Sp. gr. 6.00. Fracture small conchoidal, uneven. Cleavage parallel to all the planes of an oblique rhombic prism of 93° 30′ and 86° 30′.

1. Before the blow-pipe it crackles and melts into a grayish slag. With borax it is partially reduced, and gives to the flux a green colour.

It consists of Protoxide of lead 112, one p.
Chromic acid 52, one p.

2. It is found in Siberia in the gold mine of Beresof, in a vein traversing gneiss and mica slate.

4. PYRAMIDAL LEAD-BARYTE.

Pyramidal Lead-Spar. Jam.
Molybdate of Lead. Phil. C.

Prevailing colour wax-yellow, olive-green, orange-yellow, yellowish-gray and grayish-white. Lustre resinous. Streak white. Translucent on the edges. Structure perfectly lamellar. Brittle. Hardness 3.0. Sp. gr. 6.7. It yields to cleavage parallel to the planes of an octahedron with a square base, and also to the common base of the two pyramids. The angle of one face on the opposite face over the summit is 49° 45′. The inclination of P on P″ or P′ on P‴ 131° 15′. P on P′ 99° 50′.

1. Before the blow-pipe it decrepitates, and fuses on charcoal into a dark gray mass, in which globules of lead are visible. With a little borax it forms a brownish globule; with a large quantity, a blue or greenish-blue glass. It consists of

Protoxide of lead	112, one p.
Molybdic acid, containing oxygen 24	72, one p.

It generally contains 1 or 2 per cent of oxide of iron.

2. It occurs at the Southampton lead mine, Mass. and at the Perkiomen lead mines, Pa.

6. PRISMATIC LEAD-BARYTE.

Tri-Prismatic Lead-Spar. Jam.
Sulphate of Lead. Phil. and C.

Colour yellowish-gray and greenish-white; also yellowish, smoke and ash-gray. Streak white. Transparent...translucent. Lustre adamantine. Brittle. Hardness 2.5.—3.0. Sp. gr. 6.29. Structure perfectly lamellar. It admits of cleavage parallel only to the planes of a right rhombic prism, which is therefore the primary form. M on M′ 103° 42′. P on M or M′ 90°.

Compound varieties often granular, of various sizes of individuals.

1. Before the blow-pipe it decrepitates, then melts, and is soon reduced to a metallic state. It consists of

Protoxide of lead	112,	one p.
Sulphuric acid	40,	one p.

2. It occurs at the Southampton lead mine, Mass., at Huntington, Con., and at the Perkiomen lead mine, Pa.

6. AXOTOMOUS LEAD-BARYTE.

Sulphato-tri-Carbonate of Lead. Brooke. Ed. Phil. Jour.

Colour yellowish-white, passing into various shades of gray, green, brown and yellow. Streak white. Transparent...translucent. Hardness 2.5. Sp. gr. 6.26. Lustre resinous, inclining to adamantine. Cleavage axotomous. Primary form an acute rhomboid of 72° 30′ and 107° 30′.

Composition of the massive varieties lamellar or granular.

1. Before the blow-pipe it first intumesces and then becomes yellow, but reassumes a white colour on cooling. It effervesces briskly in nitric acid, but leaves a white residue.

It occurs at the lead hills, in Scotland, with various other ores of lead.

7. SULPHATO-CARBONATE OF LEAD.

Brooke. Ed. Phil. Jour. vol. 3. p. 117.

Colour greenish or yellowish-white. Streak white. Translucent. Sectile. Lustre adamantine, inclining to pearly on a perfect face of cleavage. Hardness 2.0.—2.5. Sp. gr. 6.8.—7.0. *Brooke.* Cleavage in two directions, in one more distinct than the other. Primary form a right oblique angled prism of 59° 15′ and 120° 45′. Crystals minute and indistinct, and variously aggregated.

1. Before the blow-pipe on charcoal it fuses into a globule which is white when cold, and is nearly reduced to metallic lead. Effervescence in nitric acid scarcely perceptible. It consists of 46.9 of carbonate of lead and 53.1 of sulphate of lead.

2. It occurs at the lead hills in Scotland.

8. CUPREOUS SULPHATO-CARBONATE OF LEAD.

Brooke. Ed. Phil. Jour. vol 3, p. 117.

Colour deep verdigris-green, inclining to mountain-green. Streak greenish-white. Translucent. Lustre resinous. Fracture uneven. Brittle. Hardness 2.5.—3.0. Sp. gr. 6.3. It yields to mechanical division parallel to the planes and shorter diagonal of a right rhombic prism, M on M′ 95°. P on M′ or M 90°.

1. It consists of

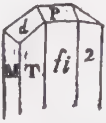
Sulphate of lead,	55.8.
Carbonate of lead,	32.8.
Carbonate of copper,	11.4.

Occurs at the lead hills, Scotland.

9. CUPREOUS SULPHATE OF LEAD.

Brooke. Ann. of Phil. vol. 4, p. 117.

Colour deep blue, resembling the purest varieties of blue carb. of copper. Streak pale, blue. Faintly translucent. Brittle. Hardness 2.5.—3.0. Sp. gr. 5.30.—5.43. Lustre adamantine. Cleavage parallel to the planes M and T of a right rhombic prism; perfect, parallel to the former.



M	on	T	102°	46′
P	on	M	90	00
P	on	T	90	00
—	on	fi	90	00
M	on	d	120	30

1. It consists of

Sulphate of lead,	74.4.	
Oxide of Copper,	18.0.	
Water,	4.7.	*H. J. Brooke.*

Occurs at the lead hills, Scotland.

10. MURIO-CARBONATE OF LEAD. Phil.

Corneous Lead. Jam.

Colour white, exhibiting occasionally pale tints of gray, yellow or green. Streak white. Transparent...translucent. Lustre adamantine. Sectile. Structure said to be lamellar. Hardness 2.0. Sp. gr. 6.05. It yields to cleavage parallel to all the planes of a square prism.

1. Before the blow-pipe it melts quickly into a yellow globule which becomes white, and crystalizes on the surface while cooling. Upon charcoal it is reduced. It consists of

Oxide of lead,	85.5.
Muriatic acid,	8.5.
Carbonic acid,	6.0.

2. It is said to occur at Southampton lead mine, Mass. associated with other ores of lead, fluor and barytes.

11. PERITOMOUS LEAD-BARYTE.

A new ore of Lead. Berzelius. Ann. of Phil. xliv. p. 154.

Colour yellowish-white, straw-yellow, rose-red, pale. Fracture imperfect chonchoidal. Translucent. Lustre adamantine. Brittle. Hardness 2.5.—3.0. Sp. gr. 7.07. *Haidinger*. Cleavage perfect and easily obtained parallel to a four-sided prism of 102° 27′, with traces in the direction of the shorter diagonal.

1. Before the blow-pipe it decrepitates slightly and is easily melted. The globule becomes a deeper yellow than the mineral. On charcoal it is reduced with fumes of muriatic acid. Treated with oxide of copper and salt of phosphorus, the flame assumes an intense blue colour.

2. Occurs near the Mendip hills in Somersetshire, Eng.

12. PLOMBGOMME.

Colour yellowish and reddish-brown, striped. Translucent. Hardness 4.5. Massive; composition thin columnar, impalpable.

1. If rubbed when insulated, it acquires a strong negative electricity. Before the blow-pipe it decrepitates and loses its water, but is infusible per se. With borax it is not reduced, but yields a transparent glass.

It consists of	
Oxide of lead,	40.14.
Alumina,	37.00.
Water,	18.80.
Sulphurous acid,	0.20.
Lime and the oxides of iron and magnesia,	1.80.
Silica,	0.60.

2. Occurs in Brittany in clay slate

13. TUNGSTATE OF LEAD.

Colour yellowish-gray, faintly translucent. Lustre resinous. Crystals acute, four-sided pyramids, much aggregated in bunches.

1. Before the blow-pipe it melts and gives off vapours of lead, leaving a crystaline globule of a dark colour and metallic aspect, which yields a pale-gray powder. With soda it yields a large quantity of globules of lead.
2. Occurs at Zinnwald, in Saxony.

14. VANADIATE OF LEAD.

Colour varies from straw-yellow to reddish-brown. Streak white. Brittle. Fracture conchoidal. Lustre resinous. It is scratched by the knife. Sp. gr. 6.99—7.23. Primary form and cleavage unknown. Crystalizes in six-sided prisms.

1. Heated to redness in a platina crucible, it decrepitates and becomes orange yellow, but becomes pale as it cools. If kept in fusion, mixed with charcoal, it becomes steel-gray and globules of lead soon appear in the mass. Sulphuric and muriatic acids decompose it and form solutions of a green colour. With nitric acid a yellow solution is formed. When the latter acts upon it, the oxide of lead is first dissolved and the remaining fragments are coated with vanadic acid, which is of a reddish colour and in the form of crystaline grains.
2. It occurs in two forms—one, is in the form of mamillated masses, composed generally of microscopic crystals, but sometimes large enough to discover their forms, which are six-sided prisms. In the other it occurs in an impalpable powder, like calamine sprinkled over the surface of other minerals, or forming on them roundish pisiform masses. Both forms somewhat resemble the earthy peroxide of manganese.
3. It is found at the lead mines of Zimapan, in Mexico, and atWanlockhead, Scotland, and at Fahlun, Sweden.

GENUS VI. ANTIMONY-BARYTE.

H=2.5—3.0.
G=5.5—5.6.

1. PRISMATIC ANTIMONY-BARYTE.

Prismatic White Antimony. Jam.
Oxide of Antimony. Phil.

Prevailing colour white, also yellowish or grayish-white, sometimes peach blossom-red. Streak white. Semi-transparent...translucent. Lustre adamantine. Sectile. Brittle. Hardness 2.5.—3.0. Sp. gr. 5.56. It yields to cleavage parallel to the sides of a rhombic prism of 137° 43′ and 42° 17′, but the most distinct cleavage is parallel to the shorter diagonal.

1. Before the blow-pipe it melts very easily and is volatilized in white fumes. It consists of

Antimony,	44.
Oxygen,	8.

It contains both a trace of iron and silex.

2. It occurs at Przibram, Bohemia, and at Braunsdorf, in Saxony.

ORDER III. KERATE.

GENUS I. PEARL-KERATE.

H=1.0—2.0.
S=5.5—6 5.

1. HEXAHEDRAL PEARL-KERATE.

Hexahedral Corneous Silver. Jam.
Muriate of Silver. Horn Silver. Phil. C.

Colour pearl-gray, passing on the one hand into lavender-blue and violet-blue, and on the other into grayish-yellowish and greenish-white, into siskin-green, asparagus-green, pistachio and leek-green. When exposed to the light it becomes brown. Streak shining. Translucent. Lustre resinous, passing into adamantine. Sectile and malleable. Hardness 1.0.—1.5. Sp. gr. 5.55. Cleavage none. Crystalizes in cubes and acicular prisms.

Composition of compound varieties granular, passing into impalpable.

1. It melts in the flame of a candle. Before the blow-pipe on charcoal it is reduced, giving off at the same time the vapours of muriatic acid. When rubbed with a piece of moistened zinc it becomes coated with a film of metallic silver.

2. Occurs chiefly in primitive rocks, accompanying other ores of silver. It is most abundant in the silver mines of Potosi, S. America.

It consists of	Silver,	67.00.
	Oxygen,	8.00.
	Muriatic acid,	14.75.
	Oxide of iron,	6.00.
	Alumina,	1.75.

2. PYRAMIDAL PEARL-KERATE.

Pyramidal Corneous. Mercury. Jam.
Muriate of Mercury. Phil. C.

Colour yellowish-gray or ash-gray, also yellowish and grayish-white. Streak white. Translucent. Lustre adamantine. Sectile. Hardness 1.7—2.0. Sp. gr. 6.48. Crystalizes in quadrangular prisms terminated by pyramids.

1. Before the blow-pipe on charcoal it is perfectly volatilized. Soluble in water, from which it is precipitated by lime water of an orange colour.

2. It consists of	Oxide of mercury,	88.48.
	Muriatic acid,	11.52.

It occurs chiefly at Moschellandsberg, in Deuxponts, and at Almaden, in Spain.

ORDER IV. MALACHITE.

GENUS I. SATPHYLINE[*]-MALACHITE.

H=2.0—3.0.
G=2.0—2.2.

1. UNCLEAVABLE STAPHYLINE-MALACHITE.

Common Copper-green or Chrysocolla. Jam. Phil.

Colour emerald green, pistachio-green, asparagus-green, passing into sky-blue. The appearance of brown indicates impurity. Streak white. Semi-transparent...translucent on the edges. Hardness 2.0.—3.0.

Compound varieties occur in botryoidal and reniform shapes. Structure compact and fibrous, with a choncoidal fracture. Sometimes earthy.

1. Before the blow-pipe it becomes black without melting. With borax it forms a clear green glass, mixed with particles

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[*] From *staphule*, the grape. The varieties hitherto known usually present botryoidal forms.

of reduced copper. It dissolves with effervescence in nitric acid.

It consists of

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.

GENUS II. LIROCONE[*]-MALACHITE.

H=2.0—2.5.
G=2.8—3.0.

1. PRISMATIC LIROCONE-MALACHITE.

Di-Prismatic Olivenite. Jam.
Octahedral Arseniate of Copper. Phil.

Colour sky-blue, verdigris-green. Streak similar to the colour, paler. Semi-transparent...translucent. Not perfectly sectile. Lustre vitreous, inclining to resinous. Hardness 2.0.—2.5. Sp. gr. 2.92.

It yields to mechanical division, though with difficulty, parallel to all the planes of a rectangular octahedron. P on P′ 60° 40′. M on M′ 72° 22′. M on P 133° 30′.

1. Before the blow-pipe it loses its colour and transparency, and emits arsenical vapours, and is changed into a friable scoria containing white metallic globules. With borax, it yields a green globule and is partly reduced. In nitric acid it dissolves with effervescence. (Rare.)

It consists of

Oxide of copper,	49.00.
Arsenic acid,	14.00.
Water,	35.00.

2. HEXAHEDRAL LIROCONE-MALACHITE.

Hexahedral Olivenite or Cube Ore. Jam.
Arseniate of Iron. Phil. C.

Colour olive-green, passing into yellowish-brown and blackish-brown, hyacinth-red, grass green and emerald green. Streak olive-green...brown, pale. Translucent on the edges. Lustre indistinctly adamantine. Sectile.

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[*] From *leiros*, pale, and *konia* powder.

Fracture conchoidal, uneven. Hardness 2.5. Sp. gr. 3.00.

It yields to cleavage parallel to the planes of the cube, but difficult and imperfect.

1. Exposed to a gentle heat, it becomes red. On charcoal, before the blow-pipe, it emits copious arsenical vapors, and melts in the inner flame into a metallic scoria, which acts upon the magnetic needle.

It consists of

Oxide of iron,	45.50
Arsenic acid,	31.00
Oxide of copper,	9.00
Silex,	4.00
Water,	10.50

It occurs in Cornwall, Eng.

GENUS III. OLIVE-MALACHITE.

H=3.0—4.0.
G=3.6—4.6.

1. PRISMATIC OLIVE-MALACHITE.

Acicular Olivenite. Jam.
Right-Prismatic Arseniate of Copper. Phil. C.

Colour various shades of olive-green, passing into leek-green, brown and wood-brown. Streak olive-green... brown. Lustre indistinctly adamantine. Translucent... opake. Brittle. Hardness 3.0. Sp. gr. 4.28.

Compound varieties occur in globular and reniform shapes. Surface rough and drusy. Composition columnar; individuals straight and divergent: granular and lamellar: the latter often curved.

1. Before the blow-pipe it remains unchanged—with charcoal it melts and is reduced. A white metallic globule is formed which on cooling becomes coated with the oxide of copper. Soluble in nitric acid.

It consists of the

Oxide of copper,	50.62
Arsenic acid,	45.00
Water,	3.50

Occurs in the mines of Cornwall, Eng.

2. DI-PRISMATIC OLIVE-MALACHITE.

Phosphate of Copper. Phil. C.

Colour dark olive-green. Streak olive-green. Translucent on the edges. Lustre resinous. Fracture conchoidal. Brittle. Hardness 4.0. Sp. gr. 3.6.—3.8. Primary form a right rhombic prism of 110° and 70° Cleavage distinct, parallel to the plane P—less distinct parallel to M or M′.

1. Before the blow-pipe on the first impression of heat it fuses into a brownish globule, which by further action of the blow-pipe it extends on the surface of the charcoal and acquires a reddish-gray metallic lustre; in the centre is a small globule of copper.

It consists of Oxide of copper, 68.13
Phosphoric acid, 30.95 *Klaproth.*

GENUS. IV. AZURE-MALACHITE.

H=3.5—4.0.
G=3.7—3.9.

1. PRISMATIC AZURE-MALACHITE.

Blue Copper or Prismatic Malachite. Jam.
Blue Carbonate of Copper. Phil. C.

Colour various shades of azure-blue, passing into berlin-blue. Streak blue, pale. Translucent on the edges. Lustre vitreous. Brittle. Hardness 3.5—4.0. Sp. gr. 3.83. Fracture conchoidal. Structure lamellar. Primary form an oblique rhombic prism. Cleavage perfect parallel to the planes M & M′ and both diagonals; difficult parallel to the plane P, which is usually striated.

Compound varieties occur in botryoidal, reniform and stalactitic shapes, with a composition more or less columnar. Rarely granular or earthy.

1. Before the blow-pipe on charcoal it melts and colours the glass of borax green in the oxidating flame.

It consists of Protoxide of copper, 72 one p.
Carbonic acid, 22 one p.
Water, 9 one p.

It is met with in veins accompanying other ores of copper, lead and silver.

It is found at Southampton, Mass.; Perkiomen lead mines, Pa.; Schuyler's mines, N. J.

GENUS V. EMERALD-MALACHITE.

H=5.0
G=3.2—3.4.

1. RHOMBOHEDRAL EMERALD-MALACHITE.

Dioptase. Emerald Copper. Phil. C.

Colour emerald-green, passing into blackish-green and verdigris-green. Streak green. Transparent...translucent. Lustre vitreous, inclining to resinous. Fracture conchoidal, uneven. Brittle. Hardness 5.0. Sp. gr. 3.27. Primary form an obtuse rhomboid of 126° 17′ and 53° 43′. It frequently occurs in what appear to be elongated rhombic dodecahedrons.

1. Before the blow-pipe on charcoal it becomes black in the exterior of flame, and red in the interior, without melting. It is soluble in borax, and imparts to it a green colour. In muriatic acid it dissolves without effervescence.

2. It consists of

25.57	—Oxide of copper,	55.00
28.57	—Silex,	33.00
0.00	—Water,	12.00
42.85	—Carbonate of lime,	00.00
Lowitz.		*Vauquelin.*

GENUS VI. HABRONEME*-MALACHITE.

H=3.5—5.0.
G=3.6—4.3.

1. PRISMATIC HABRONEME-MALACHITE.

Prismatic Olivenite or Phosphate of Copper. Jam.
Hydrous Phosphate of Copper. Phil.

Colour emerald-green striate with blackish. Streak green, pale. Translucent on the edges. Lustre vitreous, inclining to adamantine. Brittle. Hardness 4.5. Sp. gr. 4. 20. Primary form is considered to be an oblique rhombic prism. Cleavage undetermined.

1. Before the blow-pipe it boils and melts easily into a small vesicular metalloidal globule.

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[*] From *ἅβρος*, delicate, and *νῆμα*, thread.

It consists of	Oxide of copper,	68.13—62.84
	Phosphoric acid,	30.95—21.68
	Water,	00.00—15.45

Klaproth. Lunn.

It is found at Bonn and Virneberg, on the Rhine.

2. HEMI-PRISMATIC HABRONEME-MALACHITE.

Malachite. Jam.
Green Carbonate of Copper. Phil. C.

Colour grass-green, emerald-green, verdigris-green. Streak green, pale. Translucent on the edges. Lustre vitreous, often pearly and adamantine. Brittle. Hardness 3.5—4.0. Sp. gr. 4.0. Primary form right rhombic prism. Yields readily to cleavage parallel to the planes P and M, with difficulty to T.

Compound varieties are usually divided into *compact* and *fibrous* malachite; in the former the individuals have disappeared from their minuteness. The masses are often tuberose, globular and botryoidal. Structure thin columnar. Surfaces often drusy.

1. Before the blow-pipe it decrepitates, becomes black and is partly infusible, and partly converted into a black scoria. It dissolves easily in borax to which it imparts a green colour, and yields a globule of copper.

It consists of	Copper,	58.00
	Oxygen,	12.50
	Carbonic acid,	18.00
	Water,	11.50

2. It occurs in the same repositories as the other ores of copper, especially the Prismatic Azure Malachite.

It is found at Southampton, Mass.; Perkiomen lead mine, Pa.; Cheshire, Ct.

Properties of the following minerals are not sufficiently known to be placed in the system.

1. ATACAMITE.

Prismatic Atacamite. Jam.
Muriate of Copper. Phil. C.

Colour olive, leek, grass, emerald and blackish-green.

Streak apple-green. Translucent. Rather brittle. Hardness 3.0—3.5. Sp. gr. 4.43 *Leonhard*. Cleavage perfect and brilliant parallel to P, less perfect and more difficult to obtain parallel to M and M′. Primary form a right rhombic prism of 100° and 80°.

1. Exposed to the flame of a candle it tinges it blue and green. With the blow-pipe it is decomposed with the developement of muriatic acid vapours.

It consists of	Oxide of copper,	73
	Muriatic acid,	10
	Water,	16

It occurs investing some of the lavas of Vesuvius.

2. BROCHANTITE.

Brochantite. Levy. Ann. of Phil. Oct. 1824. p. 241.

Colour emerald-green. Transparent. Hardness 3.5—4.0.

1. It is considered as a compound of sulphuric acid and oxide of copper, containing either an excess of base or silex or alumina. Occurs in Siberia.

3. EUCHROITE.

Emerald Euchroite. Haidinger. Eding. Jour. Science.

Colour bright emerald-green. Streak pale apple-green. Transparent...translucent. Possesses double refraction. Brittle. Hardness 3.5.—4.0. Sp. gr. 3.38. Fracture small conchoidal.

1. Heated in a matrass it loses water and becomes yellowish-green, and friable. When heated to a certain point it is suddenly reduced with a kind of deflagration, leaving globules of malleable copper. It occurs at Libethen, in Hungary, in quartzose mica slate. Its proper designation is *Prismatic Emerald-malachite*.

GREEN IRON-EARTH. *Werner*.

Malachite?

Colour siskin-green, passing into black and yellow. Streak yellowish-gray. Lustre resinous. Massive. Fracture even—uneven. Surface smooth and shining. Composition thin columnar. Occurs in botryoidal, reniform and globular forms, and sometimes in a powder. Brittle. Semi-hard and not heavy.

1. Before the blow-pipe it becomes black, or brown, but does not melt. Occurs at Schneeberg, in Saxony.

5. RADIATED ACICULAR OLIVENITE. *Jam.*

Oblique Prismatic Arseniate of Copper. Phil.

Colour external blueish-black, passing into deep black, verdigris-green inclining to sky-blue. Streak verdigris-green. Transparent on the edges. Lustre pearly on the cleavage planes. Not very brittle. Hardness 2.5—3.0. Sp. gr. 4.19. Primary oblique rhombic prism of 124° and 56°.

1. Before the blow-pipe it deflagrates and emits arsenical vapors. It consists of

Oxide of copper,	54.00
Arsenic acid,	30.00
Water,	16.00

Found only in Cornwall, England.

6. SCORODITE.

Malachite?
Martial Arseniate of Copper. Phil.

Colour principally leek-green, passing into white, or also into olive-green and liver-brown. Streak white. Semi-transparent...translucent on the edges. Lustre vitreous. Brittle. Hardness 3.5—4.0. Sp. gr. 3.16.

1. Before the blow-pipe it emits arsenical vapours and melts into a reddish-brown scoria, which acts on the magnet. It consists of

Arsenious acid,	31.40
Sulphuric acid,	1.54
Water,	18.00
Protoxides iron, manganese, lime and magnesia,	47.80

Occurs in the Brazil and the Cornish mines.

7. VAUQUELINITE.

Malachite ?
Chromate of Lead and Copper.

Colour blackish-green, olive-green. Streak brownish-green. Lustre adamantine. Faintly translucent, with a fine green olive tint, opake. Fracture uneven. Rather brittle. Hardness 2.5—3.0. Sp. gr. 5.5—5.7 *Leonhard.* Occurs in minute crystals, irregularly aggregated, and constituting a thin crust.

Alone before the blow-pipe it intumesces a little and then melts into a grayish globule, giving a few globules of lead. It imparts a green colour to borax.

It consists of	Oxide of lead,	60.87
	Oxide of copper,	10.80
	Chromic acid,	28.33

It occurs at Beresof, in Siberia, and also in Brazil.

8. VELVET-BLUE COPPER. *Jam.*

Malachite ?

Colour bright smalt-blue. Translucent. Lustre pearly. Occurs in short capillary crystals, or velvety druses and coatings. Rare.

Chemical composition unknown. Occurs at Moldawa, in the Bannat of Temeswar, with other ores of copper.

ORDER V. MICA.

GENUS I. EUCHLORE*-MICA.

H.=1.0—2.5.
G.=2.5—3.2.

1. RHOMBOHEDRAL EUCHLORE-MICA.

Prismatic Copper-Mica. Jam.
Rhomboidal Arseniate of Copper. Phil.

Colour emerald-green, grass-green. Streak emerald-green...apple-green. Transparent...translucent. Lustre pearly. Sectile. Hardness 2.0. Sp. gr. 2.54. Primary form an acute rhomboid of 110° 30′ and 69° 30′. Cleavage perfect, perpendicular to the axis of the prism.

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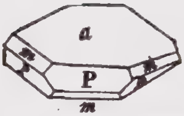
* From *euchlores*, bright, lively green,



P on P′ or P′′	110°	30′
P′ on P′′	69	12
P on a	108	40
P′ or P′′ on a	128	18
a on m or m′	124	42

Phillips, p. 317.

1. Before the blow-pipe it decrepitates, and passes first to the state of a spongy scoria ; after which it melts into a black globule of a slightly vitreous appearance. With borax it affords a bead of copper.

It consists of Oxide of copper,	39.00	
Arsenic acid,	43.00	
Water,	17.00	*Vauquelin.*

2. It is associated with other ores of copper, particularly those of the order *malachite*. It occurs in the vicinity of the copper mines of Redruth, in Cornwall.

2. PRISMATIC EUCHLORE-MICA.

Colour pale apple-green and verdigris-green, inclining to sky-blue. Streak apple-green, paler. Translucent on the edges. Lustre pearly. Very sectile. Thin laminæ flexible. Hardness 1.0—1.5. Sp. gr. 3.09. Occurs reniform and botryoidal. Primary form an oblique rhombic prism.

It consists of oxide of zinc and copper. *Brooke.* Occurs in the Bannat of Temeswar, and in Derbyshire, Eng.

3. PYRAMIDAL EUCHLORE-MICA.

Pyramidal Uranite. Jam.
Phosphate of Uranium. Phil. C.

Colour emerald-green, grass-green, and sometimes leek-green, apple-green or siskin-green, lemon-yellow, gold-yellow. Streak corresponds to the colour, but paler. Lustre pearly. Transparent...translucent on the edges. Sectile. Hardness 2.0—2.5. Sp. gr. 3.11. Fracture not observable. Primary form a square prism. It yields to mechanical division with remarkable ease, parallel to the plane P. It is found crystalized in four, six and eight-sided tables. Structure perfectly lamellar.

1. It consists of

Oxide of uranium,	60.00
Phosphoric acid,	16.00
Oxide of copper,	9.00
Water,	14.50

Alone before the blow-pipe it becomes yellow, and loses its transparency; upon charcoal it intumesces and melts into a black globule, with traces of crystalization upon the surface; with borax it yields a yellowish-green bead; in nitric acid it forms a yellow solution.

2. It is accompanied with the ores of copper, tin and uranium. Occurs in Cornwall, and other mining districts in Europe.

GENUS II. COBALT-MICA.

H.=2.5
G.=2.9—3.1.

1. PRISMATIC COBALT-MICA.

Prismatic red Cobalt. Jam.
Arseniate of Cobalt. Phil.

Colour grayish-white, crimson-red; peach blossom-red it sometimes appears by transmitted light. Streak corresponding to the colour, though a little paler. Powder of the dry mineral possesses a deep lavender-blue tinge. Transparent...translucent on the edges. Sectile; thin laminæ flexible. Hardness 1.5—2.0. Sp. gr. 2.94. Primary form a right oblique angled prism. M on T 124°.

1. It consists of

Oxide of cobalt	34,	one p.
Arsenic acid	58,	one p.
Water	18,	one p.

Before the blow-pipe it emits abundant fumes of arsenic, and ting[illegible]orax blue.

2. It occurs principally at Schneeberg and Annaberg, Saxony, in primitive rocks. It occurs however, in rocks of all ages.

GENUS III. IRON-MICA.

H.=2.0
G.=2.6—2.7.

1. PRISMATIC IRON-MICA.

Prismatic Blue-Iron. Jam.
Vivianite. Phosphate of Iron. Phil. C.

Colour various shades of blue and green. Streak blueish-white, which soon changes to indigo-blue. Powder when dry, liver-brown. Transparent...translucent. Sectile. Thin laminæ perfectly flexible. Lustre pearly on the face of cleavage. Hardness 1.5—2.0. Sp. gr. 2.66. Primary form a right oblique angled prism. Cleavage perfect, only parallel to the plane P. Crystals prismatic, aggregated and of considerable length; it sometimes occurs in reniform and globular masses. Composition often impalpable or earthy.

1. It decrepitates before the blow-pipe, but melts, if first reduced to powder, into a dark-brown scoria, which moves the magnetic needle. It is soluble in diluto sulphuric and nitric acids. Those varieties which are found white in their original repositories, soon assume a blue tinge on exposure to light and air. It consists of

Protoxide of iron,	47.50
Phosphoric acid,	32.00
Water,	20.00

2. This mineral occurs in New-Jersey, in the tertiary formation, particularly at Mullica Hills, Gloucester co. It is found there in cylindrical masses, which are composed internally of groups of crystals, radiating from different centres. These cylinders are about two inches long and half an inch in diameter, externally incrusted with a brown silicious sand. It is likewise found in an earthy form in the same deposites.

GENUS IV. GRAPHITE-MICA.

H.=1.0—2.0.
G.=1.8—2.1.

1. RHOMBOHEDRAL GRAPHITE-MICA.

Rhomboidal Graphite. Jam.
Plumbago Graphite. Black Lead. Phil. C.

Colour iron-black, light and dark steel-gray. Streak black, shining. Opake. Lustre metallic—highest degree on the faces of cleavage. Sectile. Thin laminæ highly flexible. Hardness 1.0—2.0. Sp. gr. 2.08 *Haüy.*

Compound varieties occur in granular, scaly and compact forms. Fracture of the granular form uneven. Lustre glimmering.

1. Before the blow-pipe it is combustible, and leaves a small residue of iron. Infusible.

Occurs in beds in slaty or primitive rocks, and disseminated in the form of scales. It consists of

Carbon,	96.00	
Iron,	4.00	*Saussure.*

One of the most remarkable mines of this mineral is that of Borrowdale, in Cumberland, Eng. It occurs in almost every primitive rock. The finest localities in the United States are in the vicinity of Lake-George, N. Y. and Sterling, Mass. At the latter locality it is nearly as fine as that of Borrowdale.

GENUS V. TALC-MICA.

H.=1.0—2.5.
G.=2.7—3.0.

1. PRISMATIC TALC-MICA.

Rhomboidal Mica (in part.) Jam.
Talc. Green Earth. Chlorite. Phil. C.

Colour various shades of green, varying from pale to very dark-green, greenish and grayish-white. Streak corresponding to the colour. Translucent in very thin scales. Lustre pearly. Cleavage monotonous. Sectile and flexible. Hardness 1.0—1.5. Sp. gr. 2.71.

Compound varieties occur in stellular groups, and in laminæ irregularly aggregated. Sometimes slaty and earthy. The more common forms are made up of small scaly shining individuals, strongly coherent. The earthy or impalpable variety is termed *green earth.*

1. Before the blow-pipe some varieties lose their colour and are fused with difficulty; others are changed into a black scoria, and others are infusible. It is composed of

Silex,	62.00
Magnesia,	27.00
Oxide of iron,	3.50
Alumine,	1.50
Water,	6.00

2. Included in the description of Prismatic Talc-mica, are those varieties known under the name of Chlorite and Talc: the former is subdivided into *foliated, slaty* and *earthy* chlorite, which are of a dark-green colour: the latter includes those varieties which are of a light or pale green colour, and the perfectly white, and is subdivided into *common, earthy* and *indurated* talc.

Scaly talc, or *Nacrite,* consists of particles which cohere but slightly. It is but little known, and is considered by some mineralogists as a distinct species.

3. The more compact kinds of Prismatic Talc-mica possess considerable toughness as well as softness; properties which make them suitable for turning and forming them into vessels of various kinds. One variety, from its having been used for coarse pots, has received the name of Pot-stone. Steatite or soapstone cannot be considered as more than a mere variety of Prismatic Talc-mica. It often passes into serpentine, as may be seen by inspecting the Middlefield quarry of soapstone; indeed the quarry itself might be denominated *Steatitic Serpentine.* Soapstone very rarely crystalizes; the only locality in the United States is that of Middlefield, in a ledge of serpentine, in the south part of the town. The crystals are not *pseudomorphous,* as some mineralogists have suggested.

4. Prismatic Talc-mica is abundant. It forms insulated beds in Talcose Slate on one side and Hornblende on the other. Beds of this mineral may be traced through Vermont, some of which may be seen to advantage in Newfane; and across Massachusetts and Connecticut, nearly in the same range. The vicinity of these beds furnish nearly the same

minerals: the most common are the varieties of hornblende, drusy quartz, chrysoprase, chalcedony, epidote, zoisite, scapolite, &c.

Scaly talc or Nacrite has been found in veins of lead. It occurs in Middlefield, about one mile west of the church. The green mica of Brunswick, Me. is considered as Nacrite.

2. RHOMBOHEDRAL TALC-MICA.

Rhomboidal-Mica (in part.) Jam.
Mica. Phil. C.

Colour various shades of gray, green, brown and black. Streak white...gray. Transparent in the direction of the axis. Lustre pearly, often splendent or metallic. Sectile. Thin laminæ flexible and elastic. Hardness 2.0—2.5. Edges of the laminæ sometimes scratch glass. Sp. gr. 2.94. Primary form an oblique rhombic prism. Cleavage eminent, parallel to P: M on M′ 60° 00′. P on M′ 98° 40′. P on M 81° 20.

It occurs in the form of six-sided tables.

Compound varieties rarely globular or reniform: granular form common. Sometimes imperfectly columnar.

1. Mica before the blow-pipe first loses its transparency and then melts into a scoria, coloured in proportion to the darkness of the specimen employed. Some micas are infusible.

It consists of	Alumina,	36.80	
	Silica,	46.36	
	Oxide of iron,	4.53	
	Potash,	9.22	
	Fluoric acid and water,	1.81	*Rose.*

2. From the diversity which exists in the optical properties of several varieties of mica from different localities, and likewise from the different results obtained by chemical analysis, it is plain, that two or more species still exist in the varieties comprehended under the general name of mica. The determination of these species can be made only by a correct application of the principles of natural history.

3. This mineral enters largely into the composition of most of the primitive rock formations, and is an essential constituent of granite, gneiss and mica slate. In the coarser granite it forms large plates of folia. Beautiful specimens occur in

the Highlands, in the state of *N. Y.* particularly in the town of *Monroe.*

LEPIDOLITE.

Colour usually peach-blossom red, sometimes pale, or even passing into pale-green. Sp. gr. 2.83. Composition generally granular, though sometimes the individuals are large and cleavable.

1. Before the blow-pipe upon charcoal it fuses very easily into a transparent globule.

It consists of

Alumine,	33.61
Silex,	49.06
Oxide of manganese,	1.40
Magnesia,	0.41
Lithia,	3.60
Potash,	4.18
Fluóric acid,	3.45
Water,	4.18

2. The large cleavable variety occurs in Goshen, Mass. A fine, but less cleavable kind, is found in Brunswick, Me.

GENUS VI. PEARL-MICA.

H.=3.5—4.5.
G.=3.0—3.1.

1. RHOMBOIDAL PEARL-MICA.

Rhomboidal Pearl-Mica. Jam.
Margarite. Phil. Fuchs.

Colour grayish-white, passing into reddish. Streak white. Translucent. Lustre pearly. Brittle. Hardness 3.5—4.5. Sp. gr. 3.03. Cleavage perfect in one direction.

1. It is composed of small laminæ which intersect each other in every direction. It strongly resembles silvery mica.

It consists, according to M. Du Menil, of

Silex,	37.00
Alumine,	40.50
Oxide of iron,	4.50
Lime,	8.96
Soda,	1.24

Water,	1.00
Loss,	6.80

2. Rhombohedral Pearl-Mica has been found in a bed of primitive rock, mixed with Prismatic Talc-mica, at Sterzing, in the Tyrol. It is associated with rhombohedral Fluor-haloide and axotomous Iron-ore.

The following minerals belong to the order Mica, but are little known, and are not designated by scientific names.

1. CRONSTEDITE.

Cronstedite. *Steinmann.* Schweigger's Journal.
Cronstedite. Phil.

Colour brownish-black. Streak dark leek-green. Opake. Thin laminæ elastic. Hardness 2.5. Sp. gr. 3.34. *Steinmann.*

1. Before the blow-pipe it froths a little without melting. With borax it yields a black opake globule. Reduced to powder it gelatinizes with muriatic acid.

It consists of	Silex,	22.45
	Oxide of iron,	58.53
	Oxide of manganese,	2.88
	Magnesia,	5.07
	Water,	10.70

It occurs at Przibram, in Bohemia, associated with silver ores.

2. HYDRATE OF MAGNESIA.

Mica ?

Native Hydrate of Magnesia. Brewster. Trans. Roy. Soc. Ed. v. ix.
Hydrate of Magnesia. Phil. C.

Colour white, inclining to green. Streak white. Translucent on the edges. Sectile. Lustre pearly. Thin laminæ flexible. Hardness 1.0—1.5. Sp. gr. 2.35. Massive, rarely crystalized.

1. Before the blow-pipe it loses its water and becomes friable. In acids it dissolves without effervescence.

It consists of	Magnesia,	70
	Water,	30

It occurs in thin veins in serpentine, at Hoboken, N. J.

3. PYROSMALITE.

Pyromalite. Jam. Phil. C.

Colour pale liver-brown, passing into gray and green. Streak paler than the colour. Translucent...opake. Lustre pearly. Brittle. Hardness 4.0—4.5. Sp. gr. 3.07. *Hausmann.*

1. Before the blow-pipe it becomes reddish-brown, and gives off the vapours of muriatic acid. In a strong fire it melts into a globule, which is attractable by the magnet.

It consists of

Silex,	35.85
Protoxide of iron,	21.81
Protoxide of manganese,	21.14
Muriate of iron with excess of base,	14.09
Lime,	1.21
Water,	5.89

2. It occurs in the iron mines of Nordmark, in Wermerland in Sweden.

ORDER VI. SPAR.

GENUS I. SCHILLER-SPAR.

H.=3.5—6.0.
G.=2.6—3.4.

1. DIATOMOUS* SCHILLER-SPAR.

Common Schiller-Spar. Jam.
Schiller-Spar (in part.) Phil. C.
Diallage (in part.)

Colour olive-green and blackish-green, inclining to pinchbeck brown upon the perfect faces of cleavage. Streak grayish-white, inclining a little to yellow. Translucent on the edges. Lustre pearly-metallic upon the cleavage planes. Rather sectile. Hardness 3.5—4.0. Sp. gr. 2.69. Cleavage perfect in one direction, and traces of cleavage in another, producing faces of crystaliza-

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* From *dia*, through, and *temno*, I cut :—easily cleavable in one direction through the crystals.

tion which incline to each other at angles of 135°. Composition usually lamellar, but sometimes passing into granular.

1. Before the blow-pipe it becomes hard, forming a porcelain-like mass. It consists of

Silex,	62
Magnesia,	10
Alumina,	13
Oxide of iron,	13

2. The present species is found imbedded in serpentine. It is difficult to cite localities of this mineral with accuracy, as it is easy to confound or mistake for it the following species: In Europe, the Baste, in the forest of Harzeburg, in the Hartz, is the only locality which is distinctly indicated. A mineral agreeing very nearly with the description, occurs in Blandford, Mass. on the Westfield road, in a block of serpentine.

2. HEMI-PRISMATIC SCHILLER-SPAR.

Bronzite. Schiller-Spar (in part.) Phil. C.

Colour dirty shades of leek-green and blackish-green; brown liver-brown, hair-brown and clove-brown; greenish and ash-gray. Streak corresponds to the colour, but a little paler. Lustre metallic-pearly on the faces of cleavage, and vitreous on a recent fracture. When the colour is pinchbeck-brown the lustre is heightened, or becomes metallic. Sectile. Hardness 4.0—5.0. Sp. gr. 3.25.

1. Before the blow-pipe it loses its water, becomes lighter coloured, but is infusible. It consists of

Silex,	60.00
Magnesia,	27.50
Oxide of iron,	10.50
Water,	0.50

2. It occurs in beds in serpentine, often mixed with hemi-prismatic Augite-spar.

It is found in Warwick, near Amity church, associated with green spinelle and brown hornblende, in carbonate of lime. It has become scarce.

2. PRISMATOIDAL SCHILLER-SPAR.

Hypersthene, or Labrador Schiller-Spar. Jam.
Hypersthene. Phil. C.

Colour dark-brown or greenish-black : Several varieties almost copper-red on the faces of cleavage. Streak greenish-gray. Thin laminæ translucent. Lustre highly metallic-pearly upon the face of cleavage. Brittle. Hardness 6.0. Sp. gr. 3.38. Fracture uneven. Cleavage parallel to the sides of a four-sided prism of 87° and 93°. More perfect, parallel to the short diagonal, and traces parallel to the long diagonal of the prism.

1. Before the blow-pipe it is but little changed, but melts on charcoal into a greenish-gray opake globule, easily soluble in borax.

2. According to the late analysis of this mineral by Prof. Thompson, the elements of the Isle of Skye-Hypersthene and the Paulite of Labrador are as follows :

	Paulite.	Isle of Skye Hypersthene.
Silex,	46.11	51.34
Magnesia,	25.87	11.09
Peroxide of iron,	14.11	33.92
Lime,	5.29	1.83
Alumine,	4.06	0.00
Water,	0.48	0.50

Ann. Lyceum N. Y. April, 1828.

Notwithstanding there is a difference in the chemical constitution of the Baulite and the Isle of Skye-Hypersthene, yet they appear to constitute but one species ; both seem to be essentially composed of Silex, Magnesia and Iron : the Paulite consisting of 3 atoms of bisilicate of magnesia and 1 of iron, while the Hypersthene contains 2 atoms of bisilicate of magnesia and 3 atoms bisilicate of iron. The composition of Hypersthene in general is denoted by the formula—x M n S^{2} + y FS. x & y—denoting the unknown number of atoms of the two bisilicates.*

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* Fr. Köbler infers from his late examination of Metalloidal Diallage, Bronzite and Hypersthene, that they are mineralogically and chemically identical with Augite or Pyroxene. *Poggendorff, Ann.* xii. p. 101—*quoted in vol.* 20 *of the Amer. Jour. Science, p.* 168.

4. PRISMATIC SCHILLER-SPAR.

Anthophyllite. Jam. Phil. C.

Colour between yellowish-gray, clove-brown and greenish-black. Streak white, translucent, sometimes only on the edges. Lustre pearly, inclining to metallic, particularly on the face of cleavage. Brittle. Hardness 5.0—5.5. Sp. gr. 3.12. Cleavage parallel to the sides of a four-sided prism and both diagonals, but more distinct in the direction of the long diagonal. Inclination of the faces about 124°.30′.

Compound varieties.—Composition columnar, straight, divergent and rather broad.

1. Before the blow-pipe alone it is not altered. Borax dissolves it with difficulty, and yields a glass coloured with iron.

It consists of	Silex,	56.00	
	Alumine,	13.30	
	Magnesia,	14.00	
	Oxide of iron,	6.00	
	Oxide of manganese,	3.00	
	Lime,	3.00	
	Water,	1.43	*John.*

2. Anthophyllite occurs in Chesterfield, Chester and Blandford, Mass. It is generally associated with pyroxene, garnet, and staurolide, imbedded in mica-slate.

The mineral found near the city of New-York, well known to mineralogists as radiated asbestus or actynolite, and supposed by some to be *anthophyllite*, has been determined by Prof. Thompson to be a new mineral: It consists of

Silex,	54.98
Magnesia,	13.37
Protoxide of iron,	8.84
Do. manganese,	1.20
Potash,	6.80
Alumine,	1.56
Water,	11.44

The formula given for this analysis is—$5\,M\,S^3+2\,f\,S^3+k\,S^3+9\frac{1}{2}\,Aq$. It may be denominated *hydrous Anthophyllite. Thompson.*

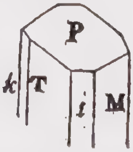
GENUS II. DISTHENE-SPAR.

H. =5.0—7.0
G. =6.0—3.7

1. PRISMATIC DISTHENE-SPAR.

Prismatic Kyanite. Jam.
Kyanite. Cyanite. Phil. C.

Colour some shade of blue, as sky-blue, passing into white, or inclining into green or gray : intensity of colour not uniform, but frequently appearing deep blue in spots, passing off into pale blue or white. Streak white. Transparent...translucent. Lustre pearly on the cleavage planes. Rather brittle. Hardness 5.0—7.0 : the highest degree appears on the solid angles and edges. Sp. gr. 3.67. Cleavage parallel to all the planes of a doubly oblique prism : difficult, parallel to the terminal planes : perfect in the direction M and T.



M on T	106°	15′
P on M	100	50
.. on T	98	15
. i	97	48
. . . . . k	83	38
M on i	145	16
T on i	140	55
. . . . . k	122	20

Phil. Mineralogy, p. 82.

1. Before the blow-pipe it is infusible, but dissolves with difficulty in borax. It consists of

Alumina, 55.5 Silica, 43.0 Oxide of iron, 0.5 *Klaproth.*

Prismatic Disthene-spar always occurs in primitive rocks, more particularly in mica slate ; it is most commonly in long crystaline masses, the individuals of which are applied to each other by thin broad planes.

2. It occurs at Chesterfield, Worthington, Middlefield and Chester, Mass. At the latter place, small dark coloured hemitrope crystals occur in a black fine grained mica slate. The variety, *Rhætizite*, is composed of aggregated fibres, generally interlaced, and of a reddish or grayish-white colour. It has the same geological relation as the species. It occurs in Blandford and Russel, Mass.

GENUS III. TRIPHANE-SPAR.

H.=6.0—7.0.
G.=2.8—3.1.

1. PRISMATIC TRIPHANE-SPAR.

Prismatic Spodumene. Jam.
Spodumene. Phil. C.

Colour various shades of grayish-green, passing into greenish-white, likewise reddish-white and brown. Fracture uneven. Lustre pearly. Streak white. Translucent on the edges. Moderately brittle. Hardness 6.5—7.0. Sp.gr. 3.17. It yields to mechanical division parallel to the sides of a rhombic prism of about 100° and 80°, likewise to the shorter diagonal. Structure perfectly lamellar.

1. Alone before the blow-pipe on charcoal, it intumesces and fuses into colourless and almost transparent beads. It intumesces but does not fuse so readily with borax. With salt of phosphorus it intumesces, and leaves a skeleton of silica.

It consists of		
	Silex,	66.04
	Alumine,	25.03
	Lithia,	8.85
	Oxide of iron,	1.45

Hence it is composed of 1 atom of trisilicate of lithia+3 atoms of bisilicate alumina.

2. It occurs in Goshen, Mass. and Saratoga, N. Y. in coarse grained granite.

2. AXOTOMOUS TRIPHANE-SPAR.

Prismatic Prenite. Jam.
Prehnite. Phil. C.

Colour various shades of green, as leek-green, apple-green, likewise passing into white and gray. Streak white. Lustre vitreous. Semi-transparent...translucent. Brittle. Hardness 6.0—7.0. Sp. gr. 2.92.

Compound varieties occur mostly in two forms—*fibrous* and *foliated*. It assumes reniform, botryoidal, stalactitic and globular shapes. Surface always drusy or rough.

1. Before the blow-pipe it becomes a white frothy scoria, and then melts into a compact globule, which becomes transparent with borax. It dissolves slowly in dilute Muriatic acid.

It consists of	Silex,	43.83	
	Alumina,	30.33	
	Lime,	18.53	
	Oxide of iron,	5.66	
	Water,	1.83	*Klaproth.*

It agrees with the composition of 1 atom bisilicate of lime+ 2 atoms silicate of alumina.

2. This mineral was first brought from the Cape of Good Hope, by Colonel Prehn. Since that time it has been discovered in many countries : it is commonly found in trap rocks, and particularly greenstone, but rarely in primitive. It is found in New-Jersey, Connecticut, Vermont and Massachusetts, wherever trap rocks occur. At Bellows Falls, in Vt. it occurs in a coarse mica slate.

GENUS IV. DISTOME-SPAR.

H.=5.0—5.5.
G.=2.9—3.0.

1. PRISMATIC DISTOME-SPAR.

Prismatic Datolite. Jam.
Borate of Lime. Phil. C.

Colour white, inclining to green, yellow or gray. Sometimes dirty olive-green or of a honey-yellow tinge. Streak white. Translucent in various degrees. Lustre vitreous, inclining to resinous. Brittle. Hardness 5.0—5.5. Sp. gr. 2.98. Fracture imperfectly conchoidal. Primary form a right rhombic prism of 103° 40′ and 76° 20′. P on M or M′ 90° 00′. M on M′ 103° 40′.

Compound varieties have a granular structure. That variety which consists of mammillary concretions, formed of concentric layers on a splintery fibrous structure, has received the name of *Botryolite.*

1. Before the blow-pipe it loses its transparency, intumesces and melts into a glossy globule. In the flame of a candle it becomes friable. It is easily soluble in nitric acid, forming

a siliceous gelatine. If the powder be moistened with a drop of muriatic acid and dried on a slip of paper, and then wet with alcohol and burnt, the flame towards the end of combustion will be tinged green.

This mineral consists of			
	Silex,	36.50	
	Lime,	35.00	
	Boracic acid,	24.00	
	Water,	4.00	*Klaproth.*

The chemical composition is 1 atom of bi-borate of lime+1 atom of tri-silicate of lime+1 atom of water. *Berzelius.*

2. It occurs in primitive as well as trap rocks, accompanied with octahedral Fluor-haloide, rhombohedral Quartz and axotomous Triphane-spar.

It occurs at Patterson, N. J.

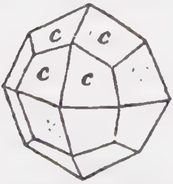
GENUS V. KOUPHONE*-SPAR.

H. =3.5—6.0
G. =2.0—2.5

1. TRAPEZOIDAL KOUPHONE-SPAR.

Dodecahedral Zeolite or *Leucite.* Jam. *Leucite.* Phil. C.

Colour reddish, yellowish or grayish-white; ash or smoke-gray. Streak white. Semi-transparent...translucent. Lustre vitreous. Brittle. Hardness 5.5. Sp. gr. 2.48. It yields to cleavage, though imperfectly, parallel to the planes of the cube, which is considered as the primary form. Generally occurs in the form of a trapezoedron as represented in the figure.



c on c =131° 48′ 16″

c on c″ or c′ on c‴ =146 26 33 *Haüy.*

See Phil. Mineralogy, p. 108.

This mineral exhibits double refraction, which phenomenon is an exception to the law which has been stated, viz.

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[*] From *Kouphos*, light.

that the platonic solids do not possess the doubly refractive power.

1. Before the blow-pipe it is infusible, but with borax or lime it fuses with difficulty into a clear globule. Reduced to powder it changes the colour of tincture of violets into green. It consists of

Silex,	54.00
Alumine,	24.00
Potash,	22.00

Specimen from Albano by Klaproth.

According to the analysis, Leucite is a bi-silicate of alumine and potash.

2. This species occurs chiefly in imbedded crystals and grains in lava. It occurs at Vesuvius and Albano.

2. DODECAHEDRAL KOUPHONE-SPAR.

Sodalite. Jam. Phil. C.

Colour green, greenish-white, passing into grayish and snow-white. Streak white. Lustre vitreous. Transparent. Brittle. Hardness 5.5—6.0. Sp. gr. 2.29. It yields to mechanical division parallel to the planes of a rhombic dodecahedron as well as the cube. P on P′ or P on P″ or P′ on P″ 120° 00′.

1. Alone before the blow-pipe on charcoal it suffers no change, except that its edges become rounded : with borax it affords with difficulty a transparent glass. It consists of

Silex,	38.52	
Alumine,	27.48	
Soda and a little potash,	23.50	
Muriatic acid,	3.00	
Lime,	2.10	
Oxide of iron,	1.00	
Volatile substances,	2.10	*Thompson.*

The composition, according to this analysis, is 1 atom of silicate of soda + 2 atoms of silicate of alumina.

2. The dodecahedral Kouphone-spar is found in West-Greenland, in a bed of mica slate, accompanied with feldspar, zircon and pyroxene.

3. HEXAHEDRAL KOUPHONE-SPAR.

Hexahedral Zeolite or *Analcime.* Jam. Phil. C.

Colour white prevalent, passing into gray, reddish-white and flesh-red. Transparent...translucent. Lustre vitreous. Brittle. Hardness 5.5. Sp. gr. 2.06. Cleavage apparently parallel to the faces of the cube.

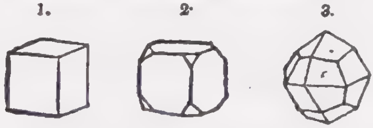


Fig. 1. The primary cube. Fig. 2. The same of which each solid angle is truncated or replaced by three planes. Fig. 3. The secondary plane of fig. 2, complete. The trapezoidal planes incline on the primary 144° 44′ and on each other at angles of 146° 26′.

The *compound varieties* are massive, with a granular composition.

1. Upon charcoal it melts without ebulition into a clear glass. It gelatinizes in Muriatic acid. It consists of

Silex,	58.
Alumina,	18.
Soda,	10.
Lime,	2.
Water,	8.50

It corresponds to 1 atom bisilicate of soda+3 atoms of bisilicate of alumina+3 atoms water. This mineral usually occurs in trap rocks, rarely in primitive.

2. It is found in Chester, in the form of implated globules, or imperfect crystals on mica slate, which exhibit half the number of faces of the trapezoidron.

4. PARATOMOUS KOUPHONE-SPAR.

Pyramidal Zeolite or *Cross Stone.* Jam.
Harmotome. Phil. C.

Prevailing colour white, passing into gray, yellow, red and brown. Streak white. Semi-transparent...translucent. Lustre vitreous, passing into pearly. Brittle. Hardness 4.5. Sp. gr. 2.39. It yields to mechanical division parallel to the planes and both diagonals of a right rectangular prism.

1. Before the blow-pipe it fuses easily without intumescence into a diaphonous glass, with borax into a colourless glass.

It consists of		
	Silex,	49.
	Alumine,	16.
	Baryta,	18.
	Water,	15.

It is represented as consisting of 1 atom of quadricilicate of baryta+4 atoms bisilicate of alumina+7 atoms of water.

2. It occurs in cruciform crystals in metaliferous veins, associated with baryta and calc spar, as at Andreasberg, in the Hartz. Rare.

5. RHOMBOHEDRAL KOUPHONE-SPAR.

Rhombohedral Zeolite or *Chabasite*. Jam.
Chabasie. Phil. C.

Colour white, grayish and yellowish-white, the latter confined to the surfaces. Streak white. Semi-transparent ...translucent. Lustre vitreous. Brittle. Hardness 4.0—4.5. Sp. gr. 2.10. Cleavage pretty distinct, parallel to the planes of an obtuse rhomboid of 94° 46′ and 86° 14′.

1. Before the blow-pipe it melts into a white frothy mass. It is not acted upon by acids. It consists of 1 atom of trisilicate of lime+3 atoms of bisilicate of alumine+6 atoms of water.

2. Chabasie is confined mostly to trap rocks, in which it occurs in cavities or geodes. It usually appears under the primary form.

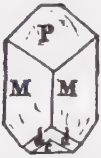
It occurs at Chester, in Mica Slate, accompanied with Stilbite and Heulandite, and hexahedral prisms of carbonate of lime. It is scarce and nearly exhausted.

The variety, termed *Mesoline*, occurs in whitish crystaline coats, lining the cavities of an amygdaloidal rock in Faroe.

6. DIATOMOUS KOUPHONE-SPAR.

Di-prismatic Zeolite or *Laumonite*. Jam.
Laumonite. Phil. C.

Colour white, passing into reddish, yellowish or grayish tints. Streak white. Lustre when recently fractured vitreous, inclining to pearly. Translucent. Not very brittle. Hardness   Sp. gr. 2.3. It yields to mechanical divisions parallel to the planes and both the diagonals of an oblique rhombic prism.



M on M′	113°	30′
P on M or M′	86	15
M or M on c	104	20

Phil. Mineralogy, p. 46.

1. Before the blow-pipe it behaves like the preceding species. It gelatinizes in acids and becomes electric by friction. When exposed to the air it disintegrates and falls to a white mealy powder. Diatomous Kouphone-spar yields by analysis,

Silex,	48.30	
Alumine,	22.70	
Lime,	12.10	
Water,	16.00	*Vogel.*

This mineral is composed of 1 atom of bisilicate of lime+4 atoms of bisilicate of alumina+6 atoms of water.

2. It is usually found in trap rocks, accompanied by others of the same genus. It thus occurs in the *trap* of Connecticut, Maine and Nova-Scotia. See Min. and Geol. of Nova-Scotia, by Messrs *C. T. Jackson* and *Francis Alger.*

7. PRISMATIC KOUPHONE-SPAR.

Prismatic Zeolite or *Mesotype.* Jam.
Mesotype. Phil. C.

Colour generally grayish-white. Streak white. Transparent...translucent. Lustre vitreous. Brittle. Hardness 5.0—5.5. Sp. gr. 2.24. It cleaves parallel only to the side of a prism of 91° 20′ and 88° 40′.

The *compound varieties* are often fibrous, either parallel or radiated; it appears too in an earthy form, which are soft and friable masses and of a rough meagre feel: it is known as the *Mealy Zeolite.*

1. Before the blow-pipe on charcoal it loses its transparency and melts into a glassy globule.

Three varieties seem to be comprehended under this species—the *Scolezite*, *Mesolite* or *Needlestone*, and *Natrolite*. The compositions of each is as follows:

	Scolezite.	Mesolite.	Natrolite.
Silica,	46.75	47.46	47.21
Alumina,	24.82	25.35	25.60
Soda,	0.39	4.87	16.12
Lime,	14.20	10.04	0.00
Water,	13.64	12.41	8.88
Oxide of iron,	0.00	0.00	1.35

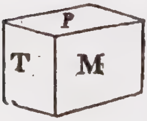
The atomic combination seems to be 1 atom of tri-silicate of soda+3 atoms of silicate of alumina+2 atoms of water.

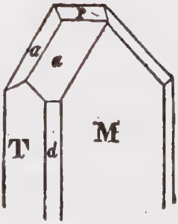
The general repository of the prismatic as well as other Kouphone spars, is in the cavities of trap rocks, accompanied generally with calcareous spar.

8. PRISMATOIDAL KOUPHONE-SPAR.

Prismatoidal Zeolite or *Stilbite*. Jam.
Stilbite. Phil. C.

Prevailing colour white, reddish-white and flesh-red. Streak white. Translucent. Lustre vitreous, inclining to pearly on the faces of cleavage. Brittle. Hardness 3.5—4.0. Sp. gr. 2.16. Primary form a right prism with rectangular bases. It yields to cleavage parallel to the planes T and M.





M on T	90°	00′
P on M or T	90	00
M on à	120	30
a on à	118	60
M on d	133	38?

Phil. Min. p. 37.

In the *compound varieties* the crystals are often aggregated in the form of sheafs, or collected into stellular groups, or inflated globular masses. Fracture often presents broad folia, of a beautiful pearly lustre.

1. Before the blow-pipe it exfoliates and melts into vesicular globules. It does not gelatinize with acids.

It consists of

Alumine,	16.10
Silex,	58.00
Lime,	9.20
Water,	16.40 *Hisinger*.

Atomic constitution is 1 atom tri-silicate of lime+3 atoms of tri-silicate of alumina+6 atoms water.

2. It occurs at Chester, Mass. in Mica Slate. In Nova-Scotia in trap. At the latter place it is abundant.

9. HEMI-PRISMATIC KOUPHONE-SPAR.

Prismatoidal Zeolite or *Stilbite*. Jam.
Heulandite. Phil. C.

Colour various shades of white passing into flesh-red, gray and brown. Streak white. Transparent...translucent on the edges. Lustre strongly pearly on the plane P. Brittle. Hardness 3.5—4.0. Sp. gr. 2.20. It yields to mechanical division parallel only to the plane P of a right oblique angled prism, which is the primary form. P on M or T 90° 00′. M on T 130° 00′. *Brooke*.

Compound varieties are usually in globular and stellular forms, strongly resembling those of stilbite.

1. Before the blow-pipe it gives the same results as the former species. It consists of

Alumina,	10.00	7.19
Silica,	45.00	59.90
Carb. lime,	16.00	0.00
Lime,	11.00	16.87
Water,	12.00	13.43
Oxide of iron,	4.00	10.00
" manganese,	0.50	0.00
	Laugier.	*Walmstedt*.

2. It occurs in the same natural repositories as the other species of Kouphone Spars. It occurs in Chester, in mica slate.

10. PYRAMIDAL KOUPHONE-SPAR.

Axifrangible Zeolite or *Apophyllite* (in part.) Jam. *Apophyllite*. Phil. C. *Mésotype épointée*. Haüy. *Albin*. Werner.

Colour several shades of white, grayish, bluish or reddish. Streak white. Transparent...translucent. Lustre vitreous, passing into pearly. Brittle. Hardness 4.5—5.0. Sp. gr. 2.33. It yields to mechanical division parallel to the planes of a square prism; most readily at right angles to the axis, or in the direction of the plane P.

11. AXOTOMOUS KOUPHONE-SPAR.

Axifrangible Zeolite, or *Apophyllite* (in part.) Jam.
Apophyllite. Phil.
Ichthyophthalmites. Werner.

Colour several shades of white. Streak white. Transparent...translucent. Lustre vitreous, inclining to pearly. Brittle. Hardness 4.5—5.0. Sp. gr. 2.46. *Haüy.* It yields readily to cleavage *perpendicular* to the axis. Slight traces of cleavage appear parallel to the axis.

This and the preceding species may constitute but one. They are provisionally separated until further examination shall dispel the present uncertainty in regard to their constitution.

1. Before the blow-pipe both species exfoliate and melt into a white vesicular globule. They dissolve easily in borax and then gelatinize in acids. They consist of

	Pyramidal Kouphone-Spar.	*Axotom. K. Spar.*
Silex,	52.13	52.38
Lime,	24.71	24.98
Potash,	5.27	5.27
Fluoric acid,	0.82	0.64
Water,	16.20	16.20

Berzelius.

The atomic constitution may be given as consisting of 1 atom of sex-silicate of potash+8 atoms of tri-silicate of lime+16 atoms of water.

2. Apophyllite occurs in Faroe, Utön and Nova-Scotia.

12. BREWSTERITE. *H. J. Brooke.*

Colour white, inclining to gray or yellow. Streak white. Lustre vitreous. Transparent...translucent. Hardness 5.0—5.5. Sp. gr. 2.12—2.20. Cleavage perfect, parallel to the plane P, and apparently at right angles to it. Primary form, as deduced from the secondary planes, is a right oblique angled prism.

1. Before the blow-pipe it becomes opake, then swells up but fuses with difficulty. It gives a skeleton of talc, with salt of phosphorus. Brewsterite consists of

Silex,	53.66	
Alumine,	17.44	
Strontian,	8.32	15.06
Baryta,	6.74	
Lime,	1.34	
Ox. iron,	0.29	
Water,	12.58	*Connell.*

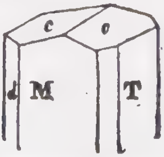
Its atomic constitution may be expressed by 2 atoms of bisilicate of strontia+1 atom bisilicate of baryta+12 atoms trisilicate of alumina+6 atoms of water.

2. It was formerly confounded with the prismatoidal and hemi-prismatic Kouphone-spar. It occurs at Strontian, in Argyleshire, associated with calcareous spar.

13. COMPTONITE.

Comptonite. Dr. Brewster, Ed. Phil. Jour.

Colour white. Streak white. Transparent...translucent. Lustre vitreous. Hardness 5.0—5.5. It yields to cleavage, parallel to the lateral planes of a right rectangular prism.



M on T 90° 00′
T on o′ 93 00
c on o′ 177 5
M on d 135 35 *Phil. Min. p.* 201.

1. Before the blow-pipe it appears much like other species of the Kouphone-spar. In nitric acid it gelatinizes.

2. It occurs lining cavities of an amygdaloid rock, on Vesuvius.

14. GMELINITE. *Brewster.*

Sarcolite. Vauquelin. *Var. of Analcime.* Haüy. *Hydrolite of* De Drée.

Colour white, passing into flesh-red. Streak white.

Translucent. Lustre vitreous. Hardness 4.5. Sp. gr. 2.05. Cleavage direct, parallel to the planes of a rhombohedron. Fracture uneven.

1. When held in the flame of a candle it flies off in numerous scales. It yields by analysis

Silex,	50.00	
Alumine,	20.00	
Lime,	4.50	
Soda,	4.50	
Water,	21.00	*Vauquelin.*

2. It occurs in Glenarm, county of Antrim, Ireland.

16. LEVYNE.

Levyne. Dr. Brewster, Ed. Jour. Science.

Colour white. Streak white. Semi-transparent. Lustre vitreous. Brittle. Hardness 4.0. Fracture uneven, conchoidal. Cleavage indistinct, parallel to the planes of a rhombohedron.

1. When heated in a glass tube it gives off considerable water, and becomes opake. With salt of phosphorus it yields a transparent globule, which contains a skeleton of silica, but becomes opake on cooling.

2. It occurs in Faroe with Heulandite in amygdaloid.

MESOLE.

Mesole. Berzelius. Ed. Phil. Jour. vol. vii. p. 7.

Colour white, sometimes inclining to yellow. Faintly translucent. Hardness 3.5. Sp. gr. 2.37.

It is composed of crystals, radiating from a centre, which together form globular and reniform masses.

1. It consists of

Silex,	42.60
Alumine,	28.00
Lime,	11.43
Soda,	5.63
Water,	12.70

2. It is found in Faroe, lining the cavities in an amygdaloidal rock.

SARCOLITE.

Sarcolite of Thompson.

Colour flesh-red. Fracture presents a vitreous appearance. Hardness sufficient to scratch glass.

1. It is supposed by Haüy to be a variety of hexahedral Kouphone-spar. An accurate determination of this species has never been made.

THOMPSONITE.

Thompsonite. Brooke. Ann. of Phil.

Colour white. Streak white. Small fragments transparent. Lustre pearly. Brittle. Hardness 5.0. Sp. gr. 2.37. Fracture uneven. Cleavage parallel to the lateral planes only of a square prism.

1. It intumesces before the blow-pipe, and becomes white and opake, but does not melt.

It consists of			
	Silex,	36.80	
	Alumine,	31.36	
	Lime,	15.40	
	Magnesia,	0.20	
	Perox. iron,	0.60	
	Water,	13.00	*Thompson.*

2. It occurs in the Trap rock of Kilpatrick, near Dunbarton, in Scotland.

GENUS VI. PETALINE-SPAR.

H.=6.0—6.5
G. =2.4—2.5

1. PRISMATIC PETALINE-SPAR.

Prismatic Petalite. Jam. *Petalite.* Phil. C.

Colour white, in reddish and grayish shades, sometimes inclining to green. Streak white. Translucent. Lustre vitreous, inclining to resinous. Brittle. Hardness 6.0—6.5. Sp. gr. 2.43. It yields to cleavage parallel to the planes, and more distinctly to the long diagonal of a prism of 95°. Traces of cleavage parallel to the shorter diagonal; also perpendicular to the axis.

1. It melts with great difficulty before the blow-pipe, only on the edges. If gently heated it emits a blue phosphorescent light. It consists of

Silex,	79.21	
Alumina,	17.22	
Lithia,	5.76	*Arfwedson.*

It is atomically constituted of 1 atom of sex-silicate of lithia and 3 atoms of tri-silicate of alumina.

It is found at Bolton, Mass.

GENUS VII. FELD-SPAR.

H.=5.0—6.0
G.=2.5—2.8

1. RHOMBOHEDRAL FELD-SPAR.

Rhomboidal Feldspar or Nepheline. Jam.
Somnite. Phil. *Nepheline.* C.

Colour white ; sometimes grayish or greenish. Streak white. Transparent...translucent. Brittle. Hardness 6.0. Sp. gr. 2.56. It cleaves parallel to all the planes of a regular hexahedral prism. Cross fracture conchoidal.

Compound varieties often granular.

1. Before the blow-pipe it fuses into a porous opake bead, and gelatinizes in nitric acid.

It consists of

Alumine,	49.	
Silex,	46.	
Lime,	2.	
Oxide of iron,	1.	*Vauquelin.*

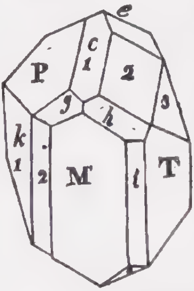
2. It occurs principally at Monte-Somma, in the cavities of limestone rocks, ejected from Vesuvius.

2. PRISMATIC FELD-SPAR.

Prismatic Feldspar. Jam.
Feldspar. Phil. C.

Colour white and reddish-white, inclining to gray, green and blue. Streak white, or grayish-white. Transparent...opake. When polished it presents a greenish-white chatoyant reflection of light. Lustre vitreous. Hardness 6. Sp. gr. 2.55. Limits of the species 2.53—

2.60. Structure always lamellar. It yields to mechanical division parallel to the plane of a doubly oblique prism of the following dimensions:



M on T	120°	35
P on M	90	
— T	67	16.
— c 1	145	20
— c 2	129	30
M on c 1	90	
— on l	160	
— on k 1	120	30
— on h	116	35
T on c 2	111	00
— on l	160	00
— on k 1	60	60
c 1 on c 2	164	42
c 2 on c 3	160	45
c 1 on h	149	10
c 2 on h	162	30
k 1 on k 2	160	

See Phil. Min. p. 114. *Haüy.*

1. The varieties of this species require to be noticed more particularly than those of the preceding species. The more common forms of the compound varieties are granular and compact in different degrees, or in lamellar masses with traces of cleavage more or less distinct. The following are some of the most important varieties.

Var. 1. *Adularia.* Colour white, bluish-white. Structure perfectly lamellar. It is the most perfect form of the mineral.

Var. 2. *Aventurine Feldspar.* Colours various. It is characterized by reflecting light more or less strongly from points.

Var. 3. *Labrador Feldspar.* It presents a beautiful play of colours when viewed in particular directions.

Var. 4. *Fetid Feldspar, Necronite.* It possesses the common characters of the species, but when broken or scraped, it exhales a fetid odor.

Var. 5. *Amazon Stone.* Colour apple-green.

2. Feldspar when placed on charcoal before the blow-pipe generally melts with difficulty into a blebby, semi-transparent glass. The following varieties consist of

	Adularia.	*Labrador Feldspar.*
Silex,	64.00	55.75
Alumine,	20.60	26.50
Lime,	12.00	11.00
Potash,	14.00	0.00
Soda,	0.00	4.00
Oxide of iron,	0.00	1.25
Water,	0.00	0.50

Prismatic Feldspar is an essential element in granite and gneiss; here it is abundant in nature. It passes by disintegration into an earthy form, resembling clay, which is called *porcelain earth*. Both the earth and common feldspar are used in the manufacture of porcelain.

i. ICE SPAR.

Colour grayish-white, occasionally it is said to occur yellowish or greenish-white. Lustre vitreous. Very brittle. Hardness 6. Primary form a right rhombic prism. It yields to mechanical division parallel to all the primary planes, but with difficulty parallel to P, and with ease to T and M. P on M 90° 00′. M on T 129° 00′.

Before the blow-pipe it fuses with difficulty on the edges into a blebby transparent glass.

ii. ALBITE.

Colour white or bluish-white. Translucent. Lustre vitreous, inclining to pearly. Streak white. Structure foliated. Hardness 6.0. Sp. gr. 2.61. Primary form a double oblique prism, yielding angles of 93° 30′ and 86° 30′.

It usually occurs in thin rhombic tables, one or more of the lateral edges are sometimes truncated. A *compound variety* consists of thin slender prisms applied to each other by the broad planes, which frequently radiate or form stellular groups. It also occurs in granular masses, more or less fine, resembling granular dolomite.

1. Before the blow-pipe it fuses with more difficulty than feldspar, but gives the same result.

I consists of	Silex,	70.7
	Alumine,	19.8
	Soda,	9.0
	Lime, oxide of manganese,	0.3

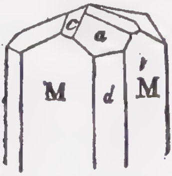
It is constituted of 1 atom of tri-silicate of soda+3 atoms of bisilicate of alumine. It is usually associated with blue, green and red tourmaline, in the coarser granites. It is better known under the name of *Cleavelandite.*

It is found at Chesterfield, at the celebrated tourmaline locality, at Chester, Mass. and at Brunswick, Me.

3. PYRAMIDAL FELD-SPAR.

Pyramidal Feldspar, or *Scapolite. Prismato-Pyramidal Feldspar*, or *Miconite.* Jam. *Dipyne. Scapolite. Miconite.* Phil.

Colour various shades of gray, white and green, and red and purple. Streak grayish-white. Transparent.. translucent on the edges. Lustre vitreous, inclining to pearly. Brittle. Hardness 5.0—5.5. Sp. gr. 2.61. It yields to cleavage parallel to the sides, terminal planes and both diagonals of a square prism.



M on M'	90°	00'
M or M' on d	136	00
M on a	112	30
a on d	122	10

1. Before the blow-pipe it fuses with a lively intumescence into a light spongy mass. It consists of

Silex,	40.53	
Alumine,	32.72	
Lime,	24.00	
Potash and soda,	1.81	
Protoxide of iron,	0.18	*Stromeyer.*

It is constituted atomically of 1 atom of silicate of lime+3 atoms of silicate of alumina.

2. Pyramidal Feldspar occurs in Bolton and Chester, Mass. At the latter place it occurs in veins in mica slate, associated with hornblende, pyroxene and garnet; but the crystalization

is generally confused and indistinct. Fine specimens are found at Chelmsford, Mass. and at Warwick, Orange co. N. Y.

4. ANORTHITE.

Anorthit. G. Rose. Gilbert's Ann. der Physik, 1823.

Colour white. Streak white. Lustre pearly upon cleavage planes. Transparent....translucent. Brittle. Hardness 6.0. Sp. gr. 2.76.

1. Before the blow-pipe it appears like Feldspar. It is entirely decomposed by concentrated muriatic acid.

It consists of	Silex,	44.49
	Alumina,	34.46
	Lime,	15.68
	Magnesia,	5.26
	Oxide of iron,	0.74

2. It occurs only at Mount Vesuvius, associated with paratomous Augite-spar.

6. LATROBITE.

Latrobite. Brooke. Ann. of Phil. xxix. p. 383.

Colour pale pink-red. Hardness 5.0—6.0. Sp. gr. 2.8. It cleaves in three directions, parallel to the planes of a doubly oblique prism, at angles of 98° 3′, 91° and 93° 30′.

1. Alone before the blow-pipe it fuses into a white enamel. With borax it yields a globule, pale-red in the oxidating flame, and colourless in the reducing one. With salt of phosphorus it gives a silica skeleton.

It consists of	Silex,	44.65
	Alumine,	36.81
	Lime,	8.29
	Oxide of manganese and magnesia,	3.78
	Potash,	6.57
	Water,	2.04

2. It occurs at Amitok island, near the coast of Labrador.

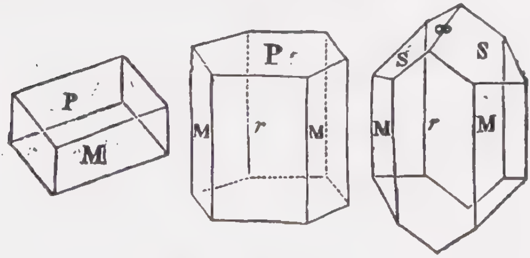
GENUS VIII. AUGITE-SPAR.

H=4.5—7.0
G=2.7—3.5

1. PARATOMOUS AUGITE-SPAR.

Oblique-edged Augite. Jam.
Augite. Pyroxene. Phil. C.

Colour green, often inclining to brown, and passing into gray and white, and also black. Streak white—gray, or corresponding to the colour. Faintly transparent... opake. Lustre vitreous, inclining to resinous. Brittle. Hardness 5.0—6.0. Sp. gr. of a light coloured specimen 3.32. It yields to cleavage parallel to the planes of an oblique rhombic prism, of 87° 5′ and 92° 55′.



M	on	M	87°	42′
M	on	P	101	6
M	on	r	133	51
M	on	s	121	48

Troost. Jour. Nat. Sci. vol. iii, *p.* 120.

1. Under paratomous Augite-spar a great number of varieties are placed. The following are the important ones.

Var. 1. *Augite*, comprehends those opake varieties, the colours of which are green or blackish-green; it occurs foliated and in grains. The former is distinguished by the name of *sahlite*, the latter by the name of *coccolite*. The colours are however very numerous, passing through a series of colours from very dark-green or black, red, gray and grayish-white.

2. *Diopside.* Colour greenish-white or greenish-gray. It occurs in semi-transparent crystals.

3. *Baikalite.* Closely resembles *sahlite,* and can hardly be distinguished from it.

4. *Fassaite* possesses a greenish-yellow colour and presents the same crystaline forms as *diopside.*

5. *Omphazite* is a compact leek-green variety with a splintery fracture. It often passes into a fibrous structure, forming one variety of asbestus.

6. *Jeffersonite,* which is of a dark-brown colour arising from the mechanical mixture of oxides of iron and manganese.

2. Paratomous Augite-spar consists of

Silex,	54.08
Lime,	23.19
Magnesia,	11.49
Protoxide of iron,	10.02
Oxide of manganese,	0.61

Leek-green variety analized by Rose.

The darker specimens contain a greater per cent of iron, the lighter a less per centage.

The atomic constitution of paratomous Augite-spar may be expressed by 1 atom of bisilicate of lime+1 atom of bisilicate of magnesia. The bisilicate of magnesia is sometimes replaced by bisilicate of protoxide of iron, as in the Euchysiderite and Jeffersonite. Its composition is greatly influenced by the adjacent rock in which it occurs.

This mineral, particularly Sahlite, is found in Munroe and Warwick. Sahlite and Coccolite of different colours are found near Roger's Rock, N. Y. also at Middlefield, Chester, Hinsdale, and in most of the mountain towns in New-England, in specimens more or less perfect.

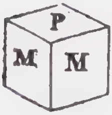
2. HEMI-PRISMATIC AUGITE-SPAR.

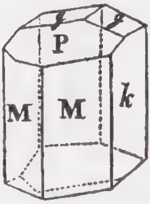
Strait edged Augite. Green Diallage. Jam.
Hornblende. Smaragdite. Asbestus. Phil. C.

Colour various shades of green, often inclining to brown. The series of colours form an uninterrupted passage from perfectly white and green into black. Streak gray-brown. Lustre vitreous, often inclining to pearly ; dull in the darker varieties. Slightly translucent...opake. Brittle.

Hardness 5.0—6.0. Sp. gr. of a dark variety 3.16. It yields to cleavage parallel to the plane of a rhombic prism of 124° 30′ and 55° 30′. Primary form an *oblique rhombic prism* of the following dimensions:

Primary form.





M on M′	124°	30′
M or M′ on P	103	1
M′ on k	117	32
P on g or g′	146	43
M on g or g′	68	42
g on g′	148	22

Compound varieties. Composition granular, often forming an extremely cohesive mass, with a slaty and columnar composition. It often occurs forming mountain masses. Crystaline masses are usually composed of long and delicate fibres, of a silky lustre—they are straight, parallel and divergent, and often form fascicular and scopiform groups.

1. Before the blow-pipe this mineral fuses with intumescence without addition, into a glass more or less coloured, corresponding much to the colour of the specimen. The elements entering into the composition of some of the varieties are as follows:

	A white var.	A green var.	A black var.		Smaragdite.
Silex,	60.31	46.26	45.69		50.00
Magnesia,	24.23	19.03	18.70		6.00
Lime,	13.16	13.96	13.65		13.00
Alumina,	0.26	11.48	12.18		11.00
Protoxide of iron,	0.15	3.43	7.32	ox. iron,	5.05
" manganese,	0.00	9.36	0.22	do copper,	1.50
Fluoric acid,	0.94	1.60	1.50	do chrome,	7 50
Water and foreign substances,	0.10	1.04	0.00		

The different varieties of hornblende are considered as bisilicates of lime and magnesia. The variation in the chemical constitution depends much on the rock with which they are connected.

Under this species are placed a number of minerals which were formerly considered as distinct. Under the name *hornblende* are comprehended the dark-green varieties, having but little lustre, and a substance which is extremely tough in the mass, but separate crystals are brittle. *Actynolite* is a bright green var. always crystalized, and usually in long slender prisms. It is found imbedded in talcose rocks. *Tremolite* is a white variety, and is usually crystalized in what are termed *bladed crystals.* It is found imbedded in dolomite. These varieties all pass into asbestus, forming each of them a variety. Hornblende forms mountain masses, and is abundant. Actynolite is found at Middlefield, Worthington and Cummington, Mass. Newfane, Vt. Tremolite is found abundantly in Sheffield and several other towns in the county of Berkshire, Mass. and in Litchfield county, Ct.

The finest specimens of all the varieties are found in Warwick, Orange county, N. Y. sometimes in detached boulders, and in other cases in carb. of lime. A beautiful reddish-brown hornblende occurs near the church at Amity, both in crystalized and in granular masses.

3. PRISMATOIDAL AUGITE-SPAR.

Prismatoidal Augite. Jam. *Epidote.* Phil.

Prevailing colours green and gray; the green tints incline more to yellow than in pyroxine or hornblende, rarely white or flesh-red. Streak white. Semi-transparent...opake. Lustre vitreous. Brittle. Hardness 6.0—7.0. Sp. gr. 3.26. Primary form a right oblique angled prism. M on T 115° 40′. (For fig. see garnet in the order Gem, marked fig. 4, and referred back to this place.)

Compound varieties—Massive, structure granular, often friable and arenaceous.

1. Before the blow-pipe it fuses with intumescence into a transparent glass. It consists of

Silex,	37.00	
Alumine,	27.00	
Lime,	14.00	
Oxide of iron,	3.00	
" manganese,	1.50	*Descot.*

2. Prismatoidal Augite-Spar occurs in primitive rocks, more especially in Hornblende.

It is found at Franconia, N. H. in fine specimens; Chester, Middlefield, Cummington, Worthington and Plainfield, Mass.

5. ZOISITE.

Colour gray, or grayish-yellow. Translucent...opake. Streak grayish white. Lustre vitreous. Hardness 6.0—7.0. Sp. gr. 3.26. Primary form a right rhombic prism. M on M′ 116° 30′, and apparently a cleavage transverse to the axis, but not sufficiently distinct for measurement, which indicates that the prism is oblique from an obtuse edge. *Brooke.* Crystals deeply striated longitudinally.

Before the blow-pipe Zoisite behaves very much like prismatoidal Epidote. Some varieties intumesce and form a yellowish scoria.

It is found at Brattleborough, Vt. and Hawley, Chesterfield, Mass.

6. PRISMATIC AUGITE-SPAR.

Prismatic Augite, or *Tabular-Spar*. Jam.
Tabular-Spar. Phil. C. *Schalstein*. Werner.

Colour white, inclining to gray, yellow, red and brown. Streak white. Semi-transparent...opake. Lustre vitreous, inclining to pearly, particularly on the faces of cleavage. Brittle. Hardness 4.0—5.0. Sp. gr. 2.80. It is divisible into prisms of 95° 20′ and 84° 40′, and also parallel to both diagonals. Primary form a double oblique prism. M on T 95° 20′.

1. Before the blow-pipe it fuses with a strong heat into a colourless glass.

It consists of	Silex,	50
	Lime,	45
	Water,	5

2. It occurs in the county of Essex, N. Y. and in Easton, Penn. Some localities furnish specimens much resembling *tremolite*.

GENUS IX. AZURE-SPAR.

H.=5.0—6.0
G.=2.9—3.1

1. DODECAHEDRAL AZURE-SPAR.

Azure Stone, or Lapis Lazuli. Jam. Phil. C.

Colour various shades of azure-blue, not uniform but appearing in spots. Streak blue, paler than the colour. Translucent on the edges. Lustre vitreous. Brittle. Hardness 5.5—6.0. Sp. gr. 2.95.

1. Before the blow-pipe it melts with difficulty into a glass globule, which is first of a bluish tinge, but soon becomes white. If previously burnt and reduced to powder, it loses its colour and forms a jelly with acids. It consists of

Silex,	49	Silex,	46
Magnesia,	2	Alumine,	14
Alumina,	11	Carb. lime,	28
Lime,	16	Sulphate of lime,	6.5
Potash and soda,	8	Oxide of iron,	3
Oxide of iron,	4	Water,	2
Sulphuric acid,	2		*Klaproth.*
	Gmelin.		

It occurs in primitive rocks, but its particular geological relations are unknown. It is valuable chiefly as affording a pigment, called *ultra-marine*, which is not liable to change by time and exposure. The finest specimens come from China and Persia.

2. PRISMATIC AZURE-SPAR.

Azurite. Lazulite. Phil.
Prismatic Azure-Spar, (first sub-species.) Jam.

Colour fine deep blue when viewed in the direction of the axis of the crystals, but various shades in other directions. Streak white. Lustre vitreous Brittle. Hardness 5.0—5.5. Cleavage indistinct. Primary form a right rhombic prism. M on M 121° 30′.

1. Before the blow-pipe it intumesces, but does not melt. With borax it yields a clear colourless globule. Treated with boracic acid and iron wire, it gives a globule of phosphuret of iron. *Berzelius.* It consists of

Phosphoric acid,	41.81	
Alumina,	35.73	
Magnesia,	9.34	
Silex,	2.10	
Protoxide of iron,	2.64	
Water,	6.00	*Fuchs.*

It has been found in Salzburg, in narrow veins, traversing clay slate, both massive and crystalized.

3. PRISMATOIDAL AZURE-SPAR.

Blue Feldspar. Phil.
Prismatoidal Azure-Spar, or *Blue-Spar.* Jam.

Colour smalt-blue, inclining to white or green on the faces of cleavage. Lustre vitreous. Streak white. Translucent on the edges ; often nearly opake. Brittle. Hardness 5.5—6.0. Sp. gr. 3.02. Fracture splintery.

Compound varieties present a granular composition, often in large individuals.

1. Before the blow-pipe it loses colour, but does not melt. It is slowly and difficultly dissolved in borax. It consists of nearly the same elements as the preceding species.

Phosphoric acid,	43.32
Silex,	6.50
Alumina,	34.50
Magnesia,.	13.56
Lime,	00.48
Protoxide of iron,	00.80
Water,	00.50

It occurs in the valley of Freschnitz, on the Mürz, in Upper Stiria, associated with quartz and mica.

The following species belong to the order Spar, but their properties have not been sufficiently investigated to give them a place in the system under appropriate names.

1. ACMITE.

Colour brownish-black. Streak pale yellowish-gray ; opake ; very thin edges are translucent, and show a fine yellowish-brown tint. Brittle. Hardness 6.0—6.5. Sp. gr. 3.24.

1. It resembles paratomous Augite-spar in regard to form and composition. It melts readily before the blow-pipe into a blackish globule.

It consists of			
	Silex,	55.25	
	Oxide of iron,	31.25	
	" manganese,	1.08	
	Lime,	0.72	
	Soda,	10.40	*Berzelius.*

It is found at Eger, in Norway, imbedded in granite.

2. ARFVEDSONITE.

Arfvedsonite. Brooke. Ann. Phil. numb. xxix. p. 381.

Colour black. Sp. gr. 3.44. *Brooke.* Cleavage parallel to the planes of a rhombic prism of 123° 55′, with brilliant surfaces.

1. It melts easily before the blow-pipe into a black globule. With borax it gives a glass coloured with iron. With salt of phosphorus it dissolves, leaving a dark-gray skeleton of silex.
2. It occurs in Greenland, and accompanies the dodecahedral Kouphone-spar.

3. BABINGTONITE.

Babingtonite. Lèvy. Ann. of Phil. xl. p. 275.

Colour black, or greenish in thin splinters, which are faintly translucent. Opake in large masses. Lustre vitreous. Hardness 5.5—6.0.

1. It resembles the darker coloured varieties of paratomous Augite-spar. It consists of silica, oxide of iron, lime, manganese and a trace of titanium.
2. It occurs in small crystals at Arendal, in Norway, associated with albite.

4. INDIANITE.

Colour greenish-white. Translucent. Scratches glass. Sp. gr. 2.74. Occurs in grains which have a cleavage in two directions, forming an angle of 95° 15′. *Brooke.*

1. It is infusible before the blow-pipe. If digested in acids it becomes friable and gelatinous. It consists of

Silex,	42.50
Alumina,	37.50
Lime,	15.00
Oxide of iron,	3.00

2. It occurs in the Carnatic, imbedded in prismatic Feldspar, and accompanied by rhombohedral corundum.

5. WITHAMITE.

Withamite. Brewster. Ed. Jour. of Science, vol. ii. p. 218.

Colour carmine-red and pale straw-yellow. Streak white. Translucent. Brittle. Hardness 6.0—6.5. Sp. gr. 3.13.

1. Before the blow-pipe it intumesces, but fuses with difficulty into a dark gray scoria. Salt of phosphorus dissolves it with effervescence into a globule, which contains silica, and becomes opake on cooling. It shows nearly the same reaction as the Epidote from Arendal, with which it agrees in most of its other properties.

2. It occurs at Glencoe, in Scotland, in a reddish traprock. *Haidinger.*

6. AMBLYGONITE.

Amblygonite. Jam. Phil. C.

Colour greenish-white, passing into light mountain-green, or sea-green. Streak white. Semi-transparent... translucent. Hardness 6.0. Sp. gr. 3.00. It occurs in rhombic prisms, which are rough externally. Inclination of M on M′ 106° 10′. It affords brilliant planes by cleavage.

1. Before the blow-pipe it intumesces and is fused with ease, and is converted into a white enamel.

It consists of alumine, phosphoric and fluoric acids and lithia, in greater quantities than any other mineral. *Berzelius.*

It has hitherto been found only at Chursdorf, near Penig, in Saxony, in granite.

7. BERGMANITE.

Bergmanite. Jam. Phil. (Var. of Pyramidal Feldspar or Scapolite.)

Colour gray, passing into white and brick-red. Opake. Massive. Not very brittle. Soft, passing into semihard. *Breithaupt*. Lustre pearly. Composition thin, columnar. Scratches glass, and even quartz. *Haüy.* Sp. gr. 2.3.

1. Before the blow-pipe it becomes white, and then melts without effervescence into a colourless glass. It occurs near Stavern, in Norway.

8. BUCKLANDITE.

Bucklandite. Lèvy. Ann. of Phil. Feb. 1824, p. 134.

Colour dark-brown, nearly black. Opake. Scratches paratomous Augite-spar. Cleavage unknown.

It occurs near Arendal, in Norway, and resembles paratomous Augite-spar.

9. CALAITE.

Calaite, or *Mineral Turquoise.* Jam.
Turquoise. C.

Colour blue, passing into green, rather bright. Streak uncoloured. Translucent on the edges. Opake. Lustre of polished specimens pearly. Fracture conchoidal. Hardness 6.0. Sp. gr. 2.83—3.00. Massive. *Fisher.*

1. Before the blow-pipe it becomes brown in the reducing flame, and imparts to it a green colour. Infusible per se, but fuses easily with borax and salt of phosphorus.

It consists, according to *John*, of

Alumine,	44.50
Phosphoric acid,	30·90
Oxide of copper,	3.75
Water,	19.

It occurs in alluvial soil, in globular and reniform masses, from the size of a nut to that of a goose-egg. It is found in Persia. It is cut and polished for ring-stones, and other ornamental pieces.

10. CHIASTOLITE.

Colour white, yellowish-white, gray and yellowish-gray. Lustre indistinctly vitreous, passing into resinous. Streak white. Fracture conchoidal and splintery; cross-fracture exhibits a black cross. Hardness 5.0—5.5. Sp. gr. 2.94.

Before the blow-pipe the whitish part is infusible, but assumes a whiter colour. With borax and salt of phosphorous it melts with difficulty.

It is a compound of alumine and silex, but it is almost impossible to determine the proportions of its elements. It occurs imbedded in clay slate.

2. It is found in Sterling, Mass., Charlestown, N. H., Brunswick, Me.

11. DIASPORE.

Diaspore. Phil. C.

Colour greenish-gray. Translucent on the edges. Lustre vitreous, inclining to pearly. Scratches glass. Sp. gr. 3.43. Primary form a doubly oblique prism of the following dimensions: M on T 64° 54′. P on T 101° 20′. P on M 108° 30′.

1. Before the blow-pipe it decrepitates most violently and splits into many small scaly particles, which possess the property of changing the vegetable blues to green. According to Vauquelin's analysis, it consists of

Alumina,	80.
Protoxide of iron,	3.00
Water,	17.

Berzelius supposes that it contains an alkali. Locality unknown. Rare.

12. EUDIALYTE.

Colour red, or brownish-red. Translucent. Lustre vitreous. Fracture uneven. Streak white. Hardness 5.0—5.5. Sp. gr. 2.89. The cleavage gives a regular hexahedral prism, affording by measurement angles of 120° of one lateral plane on the next, and 90° of the summit, on each lateral plane.

1. Before the blow-pipe it melts into a leek-green scoria. If reduced to powder it gelatinizes with acids. It consists of,

Silex,	52.00
Zirconia,	10.89
Lime,	10.14
Soda,	13.92
Oxide of iron,	6.85

Oxide of manganese,	2.57	
Muriatic acid,	1.03	*Stromeyer.*

2. It is found in Greenland, mixed with dodecahedral Kouphone-spar, and hemi-prismatic Augite-spar.

13. GEHLENITE.

Gehlenite. Phil. Jam. C.

Colour dark-gray, varying in kind, but never bright. Lustre resinous. Opake. Sometimes faintly translucent in thin fragments. Brittle. Hardness 5.5—6. Sp. gr. 3.02. Crystalizes in rectangular prisms, differing but little from the cube. Sometimes they are tabular.

1. It fuses with difficulty before the blow-pipe. It gelatinizes in warm muriatic acid. It consists of

Alumine,	24.80	
Silex,	29.64	
Lime,	35.30	
Oxide of iron,	6.56	
Water,	3.30	*Fuchs.*

It is found in the valley of Fassa, in the Tyrol, imbedded in calcareous spar.

14. HAUYNE.

Haüyne. Phil. Jam. C.

Colour, when opake, indigo-blue; when translucent, bluish-green; usually bright. Streak white. Translucent. Opake. Fracture uneven. Scratches glass. Sp. gr. 2.68, *Gmelin*—3.33, *Gismondi.* Crystalizes in the form of a rhombic dodecahedron.

1. Before the blow-pipe it loses its colour and melts into a vesicular glass. It effervesces with borax and melts, and forms on cooling a yellow glass.

It consists of

Silex,	35.48
Alumine,	18.87
Lime,	12.00
Sulphuric acid,	12.39
Potash,	15.45
Oxide iron and water,	2.36

2. It occurs at Albano and Frescati, near Rome, among the products of Vesuvius.

15. KARPHOLITE.

Colour high straw-yellow, passing into wax-yellow. Opake. Lustre silky. Hardness low. Sp. gr. 2.93. Massive. Composition thin columnar, and forming scopiform and stellular groups, which are rather incoherent.

1. It intumesces before the blow-pipe, becomes white, and melts into a coherent mass. It consists of

Silex,	37.53	
Alumine,	26.48	
Protoxide of manganese,	17.09	
Do. iron,	5.64	
Water,	11.36	*Steinmann.*

2. It occurs in granite in Bohemia.

The Cummingtonite is considered by some mineralogists as a variety of Karpholite. The conjecture needs stronger proofs than any which have been given.

16. NEPHRITE. *Jade.*

Colour green, particularly leek-green, passing into gray and white. Translucent; often only on the edges. Tough. Fracture splintery. Hardness 7.0. Sp. gr. 2.93—3.02. Massive. Composition impalpable in the mass.

1. Alone before the blow-pipe it is infusible. It consists of

Silex,	50.50	
Magnesia,	31.00	
Alumina,	10.00	
Oxide of iron,	5.50	
Do chrome,	0.05	
Water,	2.75	*Kostner.*

2. It is found at Smithfield, R. I., and at Easton, Pa., imbedded in limestone. Its extreme toughness renders it suitable for the handles of various instruments, and also for delineating delicate figures, without danger of fracture.

17. SAUSSURITE.

Colour leek-green, passing into blue, white and ash-gray. Lustre pearly, inclining to vitreous on the faces of cleavage, resinous on a polished surface. Streak white.

Broken with difficulty. Hardness 5.5. Sp. gr. 3.25. Fracture uneven. Cleavage in two directions, affording an angle of 124°.

1. Before the blow-pipe it melts with difficulty into a white glass.

It consists of	Silex,	49.	
	Alumine,	24.	
	Lime,	10.	
	Magnesia,	3.75	
	Oxide of iron,	6.50	
	Soda,	5.50	*Saussure.*

2. This mineral occurs in primitive mountains, and constitutes, with several species of Augite-spar, the rock called gabbro, and euphotide. It occurs at Monte Rosa, and its neighborhood.

18. SOMERVILLITE.

Somervillite. Brooke. Brand's Quar. Jour.

Colour pale dull yellow. Hardness equals that of feldspar.

It decrepitates before the blow-pipe, and melts alone into a gray coloured globule, and with borax into a colourless glass.

It occurs at Vesuvius.

19. THULITE.

Thulite. Brooke's Crystalography.

Colour rose-red. Streak grayish-white. Less hard than quartz, but yields to the knife with difficulty. It yields to cleavage parallel to the sides of a rhombic prism of 92° 30′ and 87° 30′.

Occurs in Norway; resembles and may be a variety of manganese-spar.

20. MANGANESE-SPAR.

Siliciferous Oxide of Manganese. Phil.

Colour rose-red. Translucent on the edges. Lustre intermediate between pearly and resinous. Hardness 5.0—5.5. Sp. gr. 3.53. *Berzelius.* Massive. Composition fine granular, and strongly coherent. Cleavage apparent, in two directions, and forming an angle of 87° 5′.

1. Before the blow-pipe it becomes dark-brown, and melts into a reddish-brown globule. It imparts to glass of borax in the oxidating flame a hyacinth-red, but in the reducing flame it remains white.

It consists of	Silex,	48.04
	Oxide of manganese,	54.00
	Oxide of iron,	a trace.
	Lime and magnesia,	3.34

2. It occurs at Longlanshyttan, in Sweden, in beds of iron ore.

The minerals called *Allagite, Corneous Manganese, Photizite* and *Rhodonite,* are said to be compact varieties of the preceding species.

21. BISILICATE OF MANGANESE.

Bisilicate of Manganese. Thompson. Ann. of the Lyceum of N. York, for April, 1828.

Colour rose-red, which on expose to air becomes dark and almost black on the surface. Surface often covered with a black crust, which is easily removed in scales. Sp. gr. 3.53.

1. It consists of	Silex,	40.58
	Protoxide of manganese,	38.92
	Protoxide of iron,	13.50
	Water,	3.00
	Carbonic acid,	3.23

The peculiarity furnished by this variety is, that a portion of the Protoxide of manganese is replaced by an equal quantity of Protoxide of iron. This mineral effervesces slightly in acids, from the presence of a small quantity of carbonate of iron.

The Bisilicate of manganese does not differ essentially from *Manganese-spar*, the preceding mineral. It is introduced for the purpose of giving the results of the investigations of Prof. Thompson.

2. It occurs in loose boulders, in Cummington, Mass. It is geologically connected with the hornblende rock.

22. SILICATE OF MANGANESE.

Silicate of Manganese. Thompson. Ann. Lyceum for April, 1828.

Colour light brownish-red, pale straw-yellow. Translucent on the edges. Streak light-red or yellow. Lustre shining and vitreous. Hardness 6.0. Sp. gr. 4.07. *Thompson.* Fracture foliated. Cleavage in two directions, which gives a prism slightly oblique, affording by measurement angles of 86° and 94°, with the common goniometer. Another cleavage less distinct indicates a *right oblique prism*, deviating 3° or 4° from right angles.

1. When ignited it becomes brown and loses 2.7 per cent of its weight. When digested in muriatic acid it gradually dissolves without effervescence. It consists of

Silex,	29.64
Protoxide of manganese,	66.60
Peroxide of iron,	0.92
Moisture,	2.70

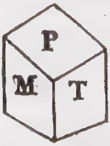
It hence consists of 1 atom of silica, 16+1 atom of protoxide manganese 36. It has been known as the rhomboidal silicate of zinc.

It is found at Franklin, N. Y.

23. FERRO-SILICATE OF MANGANESE.

Fowlerite.

Colour brown, with a shade of red. Lustre dull, externally, but shining and splendent internally, and presenting tints of red and gray. Hardness 6.0. Sp. gr. 3.44. *Thompson.* Cleavage three-fold, indicating a doubly oblique prism for its primary form.



P on M	180°	00
P on T	86	30
M on T	86	30

1. When treated with muriatic acid much chlorine is evolved, becomes white, and its sp. gr. is increased to 3.48.

This mineral was constituted originally of 4 atoms of silicate of manganese, and 1 atom of per-silicate of iron.

It has been known for sometime as crystalized siliceous oxide of manganese.

24. FERRUGINOUS SILICATE OF MANGANESE.

Colour externally brown, with a slight shade of red. Streak flea-brown. Lustre externally glimmering, internally shining and vitreous. Fracture foliated. Cleavage indistinct. Aspect of the crystals dodecahedrons, but their forms are too imperfect to admit of a correct designation and measurement; but by conjecture the inclination of the contiguous planes are 124°. Hardness 2.0—2.5. Sp. gr. 3.01.

1. It dissolves with effervescence in muriatic acid, giving out much chlorine, and leaving the silica undissolved. By analysis the following constituents were obtained:

Silex,	30.65
Protoxide of manganese,	46.21
Peroxide of iron,	15.45
Loss by heat,	7.30

The atomic constitution, as stated by Thompson, is 3 atoms of silicate of manganese+1 atom sesqui-per-silicate of iron.

This mineral was considered as a *Silicate of Zinc*, until the investigation of Prof. Thompson determined its true composition.

It occurs at Franklin and at Stirling, N. J.

25. SESQUISILICATE OF MANGANESE.

Colour iron-black. Streak brown. Lustre vitreous. Powder brown. Brittle, and easily reduced to powder. It is not scratched by the knife, but easily by quartz, and with some difficulty by feldspar. Not magnetic. Sp. gr. 3.67.

1. Its constituents are,

Silex,	38.38
Protoxide of manganese,	51.66
Peroxide of iron,	9.44

Its atomic constituent is stated to be 1½ atom silica+1 atom protoxide of manganese.

It had received the designation of granular dysluite. It is associated with massive yellow *garnet* and *franklinite.* It seems to belong to the order Ore, in the natural system, but is placed now in connexion with the other manganesian minerals.

ORDER VII. GEM.

GENUS I. ANDALUSITE.

H. =7.5
G. =3.0—3.2

1. PRISMATIC ANDALUSITE.

Prismatic Andalusite, (first sub-species.) Jam.
Andalusite. Phil. C.

Colour white, reddish-white, flesh-red, and sometimes purplish-red. Streak white. Translucent. Lustre vitreous. Brittle. Structure lamellar, with natural joints parallel to the side of a rhombic prism, affording by measurement angles of 91° 20′ and 88° 40′. Hardness 7.5. Sp. gr. 3.10. Occurs massive with a composition indistinctly granular.

1. Before the blow-pipe it is infusible; it dissolves with difficulty in borax, and scarcely at all in salt of phosphorus.

It consists of	Alumine,	60.5
	Silex,	36.5
	Oxide of iron,	4.0

2. Andalusite is found imbedded in mica slate and in granite. This species was first discovered in Andalusia in Spain. In the United States it is found at Litchfield, Ct. and at Lancaster and Westford, Mass. in crystals of various shades of red, yellow and brown, associated with rhætizite and a fibrous substance resembling *Bucholzite.* The andalusite of the last mentioned localities resembles that from the *Sualpi in Carinthia.*

GENUS II. CORUNDUM.

H. =8.0—9.0
G. =3.5—4.3

1. DODECAHEDRAL CORUNDUM.

Octahedral Corundum. (2d and 3d sub-species.) Jam.
Pleonaste-Spinelle. *Ruby.* Phil.

Colour red, passing into blue and green, also yellow, brown and black, sometimes nearly white. Streak white. Transparent...translucent only on the edges, if the colour is dark. Lustre vitreous. Fracture conchoidal. Cleavage difficult, parallel to the planes of an octahedron. Hardness 8.0. Sp. gr. 3.52.

Fig. 1. The regular octahedron, which is the primary form. Fig. 2. Edges of the octahedron replaced. Fig. 3. Rhombic dodecahedron.

1. Before the blow-pipe with borax this mineral fuses with difficulty, yielding a deep green enamel.

Included in this species are three varieties, viz: *Blue Spinelle*, *Red Spinelle* and *Pleonaste*. They consist of the following elements:

	Blue Spinelle.	*Red Spinelle.*	*Pleonaste.*
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
	Berzelius.	*Klaproth.*	*Descotils.*

Vauquelin discovered 6.11 per cent of chromic acid in the red spinelle.

2. Fine specimens of Pleonaste and Spinelle have been found at Warwick, N. Y. of extraordinary dimensions, varying from one to sixteen inches round the base. Colours black, grayish-black, bluish-black and reddish-brown and green. It is also found at Haddam, Ct. and Chelmsford, Mass.; at the latter

place of a beautiful sky-blue. The Spinelle of Orange and Sussex counties, though at present not abundant, is found in irregular veins in a coarse crystaline limestone, associated with hornblende, mica, bronzite and Brucite.

2. OCTAHEDRAL CORUNDUM.

Octahedral Corundum, (first sub-species.) Jam.
Automalite. Phil. C.

Colour dirty green, inclining to black and blue. Streak white. Translucent on the edges...opake. Lustre vitreous, inclining to resinous. Hardness 8.0. Sp. gr. 4.23. Cleavage parallel to the planes of a regular octahedron.

1. Alone it is infusible, and nearly so with borax or salt of phosphorus. With soda it fuses into a dark scoria, which on being melted again with soda, deposits an areola of oxide of zinc. It consists of

Alumina,	60.00
Oxide of zinc,	24.25
Oxide of iron,	9.25
Silica,	4.75

2. Automalite is found at Franklin, N. J. and at several places in the neighborhood. It is now a rare mineral.

3. RHOMBOHEDRAL CORUNDUM.

Rhomboidal Corundum. Jam.
Corundum. Phil. C.

Colour blue, red, green, yellow, brown, gray and white. Streak white. Transparent...translucent. Lustre vitreous. It possesses double refraction. Several varieties, when cut round, exhibit a six-sided opalescent star in the direction of the axis. Hardness 9.0. Sp. gr. 3.92—3.97. It yields to mechanical division easily in one direction with a perfect brilliant surface. Primary form a slightly acute rhomboid, affording angles of 86° 4′ and 93° 56′.

The *massive compound varieties* are granular, generally fine and passing into impalpable.

1. Corundum is the name given to the common form of this mineral by the inhabitants of India. When crystalized and pure, it is called *Sapphire ;* when the colour is red, it is called *Oriental Ruby.* The compound variety is known as the *Emery.*

2. Before the blow-pipe it suffers no change even in the form of powder. It dissolves slowly but perfectly in borax. Acids have no effect upon it. The following varieties furnish the following results by analysis :

	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	0.00	0.00
	Klaproth.	*Klaproth.*	*Tennant.*

3. Rhombohedral corundum is found in crystals imbedded in the massive varieties. The most perfect of the species, as the sapphire and oriental ruby, are met with principally in secondary deposites, as the sand of rivers, &c.

The finest varieties are from Pegu. In St. Gothard, red and blue varieties occur in dolomite. Emery is found in Saxony and in the Island of Nazos, in the Grecian Archipelago.

4. There are a few localities of Sapphire in the United States, viz : Newton, in the county of Sussex, N. J. It is there found imbedded along with a white feldspar in limestone, near the junction of the granitic sienite and the white granular limestone. It is blue and white, the central part of a bright berlin-blue, becoming pale towards the surface. It is associated with *pleonaste, red oxide* of *titanium,* yellowish-green *idocrase, condrodite* and pyramidal feldspar. Other localities will probably be discovered by tracing the direction of the veins north and south, as the deposites of all those rare and interesting minerals in the counties of Orange and Sussex, have at least some degree of regularity, or are not to be found very far east or west of a given line.

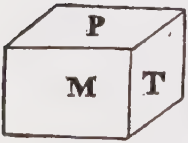
5. The pure and transparent varieties of Octahedral corundum are highly esteemed as ornamental stones. The red are most highly valued, and go by the name of *oriental Ruby ;* the violet blue are called *oriental Amethyst ;* the green, *oriental Emerald ;* the yellow, *oriental Topaz,* and the blue, *oriental Sapphire.*

Corundum is much used for cutting and polishing steel and gems, and it is also said even the diamond.

4. PRISMATIC CORUNDUM.

Prismatic Corundum, or Crysoberyl. Jam.
Crysoberyl. Phil. C.

Colour asparagus-green, passing into greenish-white, olive-green and yellowish-gray. Streak white. Transparent....translucent. Lustre vitreous. Occasionally there appears in the interior an opalescing bluish-white light, if viewed in the direction perpendicular to the shorter diagonal of the primary form. Fracture conchoidal. Hardness 8.5. Sp. gr. 3.75. Primary form a right rectangular prism. It yields to cleavage parallel to the plane M. M on T 90° 00′.



M	on	T	90°	
M	on	i	90	
M	on	s	125	16′
T	on	i	120	
T	on	s	144	44

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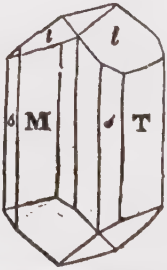


1. Before the blow-pipe it remains unchanged. With borax it fuses with difficulty. It consists of

	Brasil.	*Haddam.*
Alumine,	68.66	73.60
Glucina,	16.00	15.80
Silex,	5.99	4.00
Protoxide of iron,	4.73	3.38
Oxide of titanium,	2.66	1.00
Moisture,	0.66	0.40 *Seybert.*

2. Prismatic Corundum occurs at Haddam, Ct., and at Saratoga, N. Y., in granite.

GENUS III. DIAMOND.

H.=10.0
G.=3.4.—3.6

1. OCTAHEDRAL DIAMOND.

Octahedral, or *Common Diamond.* Jam.
Diamond. Phil. C.

Colour white, prevalent. Also various shades of blue, red, yellow, green, brown, gray, and even black: colours generally pale. Streak white. Transparent...translucent. If cut and polished it exhibits a lively play of light. Hardness 10.0. Sp. gr. 3.52. Cleavage perfect, parallel to the planes of the regular octahedron.

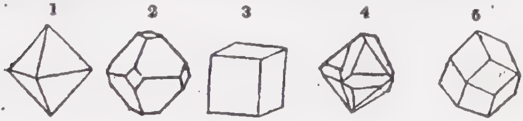


Fig. 1. The primary, the regular octahedral. Fig. 2. Octahedron, with the solid angles replaced. In Fig. 3, those planes are complete. Fig. 4. The edges of the octahedron replaced by six-sided planes. In Fig. 5, those planes are complete.

1. Octahedral Diamond is perfectly combustible at the temperature of about 14° of Wedgewood's pyrometer, and yields with oxygen, carbonic acid gas. Acids and alkalies have no effect upon it. It consists of carbon in its purest form.

2. The Diamond has been found in secondary deposits, in a district which abounds with debris of sandstone rock, which are often aggregated or cemented together into a sort of coarse breccia. It occurs likewise in the loose sand of plains and rivers.

3. The diamond was first discovered in the East Indies. It is likewise found in Brazil, in the district of Serro do Frio, and in the Ural chain of mountains, in the neighborhood of Koushra, and at Nigny-Toura, Russia.

4. This mineral is the most valued of all *gems;* it is used as an ornamental stone, and obtains a preference above all others. For cutting glass, and for engraving, cutting and polishing other hard stones, it is indispensable.

GENUS IV. TOPAZ.

H.=8.0
G.=3.4—3.6

1. PRISMATIC TOPAZ.

Prismatic Topas. Jam.
Topas. Phil. C.

Colour various shades of yellow, green and blue; likewise white; colours generally pale. Streak white. Transparent...translucent. Lustre vitreous. Hardness 8.0. Sp. gr. 3.49. Cleavage distinct and perfect at right angles to the axis, and difficult parallel to the lateral planes of a right rhombic prism, which is the primary form. M on M′ 124° 22′. P on M or M′ 90° 00′. *Haüy.*

1. Before the blow-pipe Topaz is infusible; with borax it fuses slowly into a transparent glass. Berzelius considers the Topaz as a compound of 1 atom of sub-fluate of alumina+3 atoms of silicate of alumina. This corresponds nearly to silex 24, alumina 57.45, fluoric acid 7.75. The Physalite and Pycnite vary but little in composition from the above.

2. The Topaz belongs almost exclusively to primitive countries, and even enters into the composition of some granitic rocks. The *Pycnite* is a compound variety, consisting of individuals closely joined in composition, and deeply streaked longitudinally. It never possesses bright colours, or a high degree of transparency. Physalite is a still more imperfect variety of Topaz. It occurs usually in large massive individuals, whose colours are usually pale greenish-gray.

3. The most perfect crystals of topaz come from Siberia. They are usually green, blue or white. They are associated with rhombohedral Emerald. Those from Brazil are met with in loose pebbles of high yellow colours. The Mexican Topaz is white or limpid.

Prismatic Topaz, when its colours are bright, is used as an ornamental stone, but is less valued than the sapphire. It is found in Munroe, Ct., of a very great size, though not perfect in form; also on the Amonoosuck, near the falls, in the White Mountains, N. H. The former locality is probably exhausted; the latter has furnished but few specimens, but deserves farther examination.

GENUS V. EMERALD.

H.=7.5—8.0
G.=2.6—3.2

1. PRISMATIC EMERALD.

Prismatic Emerald, or *Euclase.* Jam.
Euclase. Phil. C.

Colour green, passing into blue and white, and always pale. Streak white. Transparent...translucent. Lustre vitreous. Very brittle and fragile, from which property the name Euclase has been derived. *Mohs.* Hardness 7.5. Sp. gr. 3.09. Cleavage perfect, parallel to P, less so in the direction M and Z, of a right oblique angled prism, which is considered as the primary form.

1. Before the blow-pipe it intumesces in a strong heat, and becomes white, and finally melts into a white enamel.

It consists of	Silica,	43.22	
	Alumina,	30.56	
	Glucina,	21.78	
	Oxide of iron,	2.22	
	Oxide of tin,	0.70	*Berzelius.*

2. It is yet a scarce mineral. It was first brought to Europe from Peru. It occurs in a chloritic slate, resting, it is said, on sandstone.

2. RHOMBOHEDRAL EMERALD.

Rhomboidal Emerald. Jam.
Beryl. Aquamarine Emerald. Phil. C.

Colour green, passing into blue, yellow and white; the brightest green is termed emerald-green; the colours are generally pale, and unequally diffused through the specimens. Streak white. Lustre vitreous. Hardness 7.5—8.0. Sp. gr. 2.67—2.73.

1. In a strong heat before the blow-pipe the edges of the fragments are rounded; in borax it dissolves slowly.

The two varieties included in this species, Emerald and Beryl, differ only in colour: in the *Emerald* it is a bright and peculiar green; the Beryl is yellow or dull yellowish-green, with surfaces more or less rough, and striated transversely.

They consist of	Silex,	68.35
	Alumina,	17.60
	Glucina,	13.13
	Oxide of iron,	0.72

2. The finest specimens of Emerald are brought from Peru. They are in druses in a limestone rock, and likewise in *hornblende*, *clay-slate* and *granite.* The beryls in this country occur in granite or mica slate, and most of our primitive sections of country furnish them. In Ackworth, N. H., they are very large, but not of fine colours.

GENUS VI. QUARTZ.

H = 5.5—7.5
G. = 1.9—2.7

1. PRISMATIC QUARTZ.

Iolite. Jam. *Iolite. Dichroite.* Phil.

Colour various shades of blue, generally inclining to black. Streak white. Transparent...translucent. Lustre vitreous. When viewed in the direction of the axis the crystal appears blue, and yellowish-gray perpendicular to it. Hardness 7.0—7.5. Sp. gr. 2.58. It is said to possess natural joints, parallel to the planes of a six-sided prism. Occurs crystalized in six and twelve-sided prisms.

Compound varieties are massive, and hard to be distinguished. Composition granular, and strongly adherent.

1. Before the blow-pipe it melts with a high heat on the edges only, into a glass near the colour of the mineral.

Iolite and Peliom scarcely differ sufficiently to form varieties. The former was discovered at Cabo de Gata, in Spain, the latter at Bodenmais, in Bavaria, both massive and crystalized, associated with rhombohedral quartz, garnet, &c. It furnishes by analysis,

Silica,	48.53
Alumina,	31.73
Magnesia,	11.30
Oxide of iron,	5.68

Oxide of manganese,	0.70
Water and loss,	1.64

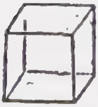
It is said to occur at Goshen, Mass., in granite.

2. RHOMBOHEDRAL QUARTZ.

Rhomboidal Quartz, (excepting Porcelain Jasper.) Jam. *Quartz*, (exc. Hyalite.) *Cats-eye Flint. Chalcedony*, (exc. Cacholong.) *Jasper*, (exc. Porcelain Jasper.) *Hornstone.* Phil.

Prevailing colour of the species white; other distinguishing colours are violet-blue, rose-red, clove-brown, and apple-green, each of which form a variety. Dark-brown and green colours are owing generally to foreign admixtures. Streak white. Transparent...translucent. Opake when impure. Cleavage very difficult and indistinct. Primary form a rhomboid of 94° 15′ and 85° 45′. Hardness 7.0. Sp. gr. 2.69.

1



P on r	141°	40′
Z on r	141	40
P & Z on o	128	20
r on r	120	

2

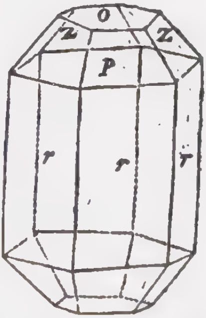


Fig. 1. Primary form. Fig. 2. *Quartz annulaire*, formed by the decrement of one row of molecules parallel to the summit of the rhomboid.

Compound varieties numerous. Thus it occurs in globular, reniform and stalactitic shapes. Also in columnar, of a usually coarse structure, and in laminated and granular masses—the latter passing into impalpable. Sometimes it occurs in pseudo-morphous crystals, which are hexahedrons and octahedrons. It sometimes, though rarely, occurs in ovoidal or globular masses, somewhat resembling fused globules of glass. The forms mentioned in this paragraph usually constitute varieties which receive particular descriptions in books on Mineralogy.

The most important sub-species are the following: 1. *Amethyst*, which is of a violet-blue colour, and of a coarse fibrous structure. 2. *Rock Crystal*, which is limpid and transparent, or semi-transparent, together with the white massive varieties. 3. *Rose Quartz*, which is massive, and of a rose-red colour. 4. *Prase*, which is a dark leek-green; and, 5. *Common Quartz*, which includes the massive, laminated and granular varieties.

1. The *Common Quartz* passes insensibly into the other varieties, such as *Hornstone*, which is translucent, and exhibits a dull, splintery fracture. Hornstone seems very nearly allied to *Flinty Slate*, *Lydian Stone*, *Jasper* and *Heliotrope*. Flinty Slate is divided into many angular masses by seams, but as a whole it is slaty. Lydian stone forms masses in flinty slate, free from seams, and presents a large conchoidal fracture, and a perfectly compact structure. Jasper has a composition which is impalpable, with a large conchoidal fracture, but generally coloured red by the peroxide of iron; it occurs, however, of all colours, and the darker ones resemble Lydian stone. *Heliotrope* is a variety of common quartz, coloured by green earth, but containing blood-red spots of Jasper. The coarser kinds are found in masses in Flinty Slate. Those stalactitic and botryoidal forms of common quartz which are deposited in layers, with surfaces rough or drusy, constitute *Chalcedony*. Colours usually milk-white, when they are red or reddish, are distinguished as Carnelian. Chrysoprase is also a variety of chalcedony, coloured green by the oxide of nickel. *Plasma*, another variety of chalcedony, is coloured leek-green, and sometimes grass-green, by some substance not yet well determined. *Catseye* is a variety of fibrous quartz, of a greenish-gray, and which exhibits a peculiar opalescence when cut into a convex sur-

face and polished. *Hyacinth from Compostella*, is produced by a large admixture of oxide of iron. The individuals are opake, but present the regular hexahedral prism, terminated by pyramids at each extremity, and very rarely modified by replacement. The intermixture of oxide of iron produces a passage of quartz into iron flint, or *flinty iron ore.*

2. Quartz is infusible before the blow-pipe. The most perfect varieties are nearly pure silex. Bucholz obtained 99.37 parts of silex from rock crystal.

3. Silex is one of the most common substances in nature. It enters into the composition of rocks, and is very widely distributed. It is spread all over the globe.

3. UNCLEAVABLE QUARTZ.

Indivisible Quartz. Jam.
Hyalite. Opal. Hydrophane. Menilite. Cacholong. Siliceous Sinter. Phil. C.

Colour white, yellow, red, brown, green, gray. The lively colours are the *red* and *green* ones; the others are pale. The dark colours are owing to foreign admixture. Streak white. Lustre vitreous, inclining to resinous. Fracture conchoidal. Transparent...translucent; sometimes only on the edges. Occasionally some specimens exhibit a lively play of light in the interior; others show different colours by reflected and refracted light. Hardness 5.5—6.5. Sp. gr. 2.9.

Compound varieties.—Small reniform, botryoidal and stalactitic shapes, and large tuberose concretions. In the former the surface is smooth, in the latter rough. Composition impalpable. Fracture conchoidal, even.

1. The following varieties under uncleavable quartz comprehend the most important: 1. *Opal.* It is subdivided into *precious*, *common*, *semi-opal* and *wood opal.* *Precious opal*, when cut and polished into a convex surface, exhibits in the interior a play of light which often preserves constant directions within single parts of the mass. This play of light is supposed to be connected with a regular structure. Common and semi-opal differ from the *precious* by having an inferior degree of lustre and transparency. Wood opal appears in the

form of *trunks, roots* and *branches of trees.* 2. *Hydrophane* is a variety of opal which is naturally opake, but becomes translucent by immersion in water. 3. *Hyalite* occurs in small reniform, botryoidal and sometimes stalactitic shapes, with generally a considerable degree of transparency. It resembles in colour and lustre *gum arabic.* 4. *Menilite* occurs in tuberose forms, but is opake. It is subdivided into *brown* and *gray* Menilite. 5. Siliceous sinter is a deposit of silex from hot springs.

2. Uncleavable quartz consists of

	Precious Opal.	*Hyalite.*	*Menilite.*
Silex,	92.00	90.00	85.50
Water,	6.33	10.00	11.00

3. It usually forms short irregular veins, strongly connected with the matrix, in porphyry and amygdaloid. It occurs more abundantly in Hungary than any other country.

Precious opal is considered as a gem, and is generally cut with a convex surface. If the specimens are large and pure, and possess vivid colours, they are of considerable value.

4. EMPYRODOX* QUARTZ.

Pearlstone. Pitchstone. Pumice. Obsidian. Phil. C.

Colours black, brown, red, yellow, green, gray, white, dull. Streak white. Faintly transparent...translucent on the edges. Lustre vitreous, and resinous. Cleavage none. Fracture conchoidal, perfect, uneven. Hardness 6.0—7.0. Sp. gr. 2.39—2.21.

1. The following varieties are included in *empyrodox* quartz: 1. *Obsidian*, usually opake, and sometimes transparent. Fracture large conchoidal. Lustre purely vitreous, in perfect forms. When the conchoidal fracture is lost, and the lustre becomes resinous, it passes into *Pitchstone.* 2. *Pearlstone* is formed of concretions, more or less rounded, and which may be separated from the mass, and likewise in thin films, which are partially concentric: they sometimes contain a grain of Obsidian. 3. *Pumice* occurs in *fibrous, vesicular* masses, often extremely light and porous, and of a gray colour. These varieties are often connected in the same specimen.

2. They consist as follows:

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* From *empuros*, belonging to fire, and *doxa*, the opinion.

	Obsidian.	*Pitchstone.*	*Pearlstone.*	*Pumice.*
Silex,	72.00	73.00	75.25	27.50
Alumina,	12.50	14.56	12.00	17.50
Potash, and	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,	0.09	8.50	4.50	0.00

3. The above varieties belong exclusively to volcanic mountains.

Obsidian is sometimes used for *mirrors*, *vases*, *snuff-boxes*, &c. Pumice is a well known material, and is useful for grinding and polishing.

GENUS VII. AXINITE.

H.=6.5—7.0
G.=3.0—3.3

1. PRISMATIC AXINITE.

Prismatic Axinite. Jam. *Axinite.* Phil. C.

Colour usually clove-brown, sometimes passes into plum-blue or pearl gray, and when mixed with chlorite, green. Streak white. Transparent...translucent. Hardness 6.5—7.0. Sp. gr. 3.27. Primary form undetermined. Cleavage irregular. General form of the crystals a doubly oblique prism. P on M 134° 40′. P on T 115° 17′. M on T 135° 10′.

Compound varieties. Composition lamellar, passing into granular, and even impalpable.

1. Before the blow-pipe it fuses easily into a dark-green glass. It consists of

Silex,	50.50	
Lime,	17.00	
Alumine,	16.00	
Oxide of iron,	9.50	
" manganese,	5.25	
Potash,	0.25	*Klaproth.*

2. Prismatic axinite occurs in veins in primitive rocks. It is found at Thum in Saxony, hence the name *Thumerstone* or *Thumite.*

GENUS VIII. CHRYSOLITE.

H.=6.5—7.0
G.=2.8—3.0

1. PRISMATIC CHRYSOLITE.

Prismatic Chrysolite. Jam.
Chrysolite. Olivine. Phil. C.

Colour various shades of green, as pistachio-olive, asparagus-green and grass-green, and sometimes passing into brown. Streak white. Transparent...translucent. Lustre vitreous. Fracture conchoidal. Hardness 6.5—7.0. Sp. gr. 3.44. Primary form a right rectangular prism, which may be obtained by cleavage, parallel to all its planes.

Compound varieties. They are principally irregular spheroidal masses, imbedded in rocks. Composition granular individuals easily separated.

1. Before the blow-pipe chrysolite becomes darker, but does not melt. Olivine loses its colour in heated nitric acid. Prismatic chrysolite and olivine, though they differ somewhat in chemical composition, yet they by no means differ in their essential characters. Chrysolite is crystalized and possesses bright colours, while Olivine is a compound variety and possesses inferior colours and less transparency. Their constituent elements are as follows :

	Chrysolite.	*Olivine.*
Silex,	39.00	50.00
Magnesia,	43.50	38.50
Oxide of iron,	19.00	12.00
Lime,	0.00	0.25

2. The original repository of chrysolite is unknown. Imperfect varieties are found imbedded in lava, and come from the neighborhood of volcanoes.

GENUS IX. BORACITE.

H.=7.0
G.=2.8—3.0

1. TETRAHEDRAL BORACITE.

Hexahedral Boracite. Jam.
Boracite. Borate of Magnesia. Phil. C.

Colour white or grayish-white, sometimes inclining to green or yellow. Streak white. Semi-transparent... translucent. Lustre vitreous, inclining to adamantine. Hardness 7.0. Sp. gr. 2.97. Fracture conchoidal, uneven. Primary form a cube. The general form of the crystals cubical.

1. Before the blow-pipe upon charcoal it intumesces and melts into a glassy globule, which becomes opake and white on cooling. It consists of

Boracic acid,	54.55
Magnesia,	30.68
Oxide of iron,	9.57
Silex,	2.27

It is a bi-borate of magnesia.

2. Tetrahedral Boracite is found only at Lüneburg in Brunswick and Segeberg in Holstein, imbedded in prismatic Gypsum-haloide.

GENUS X. TOURMALINE.

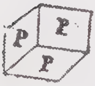
H.=7.0—7.5
G.=3.0—3.2

1. RHOMBOHEDRAL TOURMALINE.

Rhomboidal Tourmaline. Jam.
Tourmaline. Phil. C.

Colour brown, green, blue, red, white and black, generally dark, but rarely bright. Lighter colours transparent...translucent ; dark, opake. Transparency less, if viewed in the direction of the axis than perpendicular to it, and generally the colour also varies. Lustre vitreous. Streak white. Fracture imperfectly conchoidal, uneven. Brittle. Hardness 7.0—7.5. Sp. gr. 3.07. Cleavage very difficult. Primary form a rhomboid of 133° 50′ and 46° 10′. Electric by heat.

Compound varieties.—Rarely granular, generally columnar, parallel or divergent. Crystals often deeply furrowed longitudinally and traversed by seams transversely, which are often filled with quartz.



P on P′	133° 50′
P or P′ on m	156 60
P or P′ on g	141 10
P on i or P′ on i	138 7
P or P′ on e	117 25
e on e′ or e″	120 00
e on f 1	149 30
f 1 on f 2	155 25
e on i or i	147 32
e on g	136 15
a on e	90 00
m on e	103 30
	Phillips.

1. Tourmaline is the name appropriated to all those varieties of this species which are not black. The term Schorl denotes the common black variety. Other varieties are designated by particular names. Thus *rubellite* is a red variety and *indicolite* is an indigo-blue variety, possessing however tints of various hues. Besides these there are *green*, *white* and *brown tourmalines.*

2. Before the blow-pipe Schorl melts easily with intumescence, the green and blue varieties do not melt so easily as black. The red is infusible. They consist of

	Red,	*Green,*	*Blue &*	*Black Tourmaline.*
Silex,	42.00	40.00	40.30	36.75
Alumine,	46.00	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	4.55	21.00
do manganese,	7.00	2.00	1.50	0.00
Boracic acid,	0.00	0.00	1.10	0.00
Water,	0.00	0.00	3.60	0.00
	Vauquelin.	*Vauquelin.*	*Arfvedson.*	*Klaproth.*

3. Tourmaline belongs to primitive rocks or granite and mica slate. The brown or yellowish brown tourmaline is found in dolomite.

4. The green, red and blue varieties are found in Chesterfield, Mass, and the blue in very large crystals in Chester, in a coarse grained granite.

5. Tourmaline when free from flaws and of a good colour, is used as a gem.

GENUS XI. GARNET.

H=6.0—7.5
G=3.1—4.3

1. PYRAMIDAL GARNET.

Pyramidal Garnet, (excepting Gehlenite.) Jam.
Idocrase. Phil. C.

Colour various shades of brown, passing into leek-green, pistachio-green, olive and oil-green. Streak white. Semi-transparent...faintly translucent on the edges. When viewed in the direction of the axis the colours incline to yellow; perpendicular to it, to green. Lustre vitreous. Fracture imperfectly conchoidal, uneven. Hardness 6.5. Sp. gr. 3.39. Primary form a right rectangular prism. Cleavage parallel to all its planes. The general form of the crystals quadrangular; one or more of the solid lateral edges often replaced. Faces often furrowed or streaked longitudinally.

Compound varieties.—Composition granular, and sometimes columnar.

1. Before the blow-pipe on charcoal, pyramidal Garnet melts easily into a globule of a dark colour. Some varieties, as Egerane, furnish a green globule.

It consists of	Silex,	35.50
	Alumina,	33.00
	Lime,	22.25
	Oxide of iron,	7.50
	do manganese,	0.25

2. Idocrase was first discovered among the ejected minerals of Vesuvius, hence it received the name of *Vesuvian*. A variety has been found near Egra in Bohemia, which was then named Egerane; the only difference which exists between

them is, that Egerane occurs in longer crystals, which are deeply streaked and less perfectly formed; the other appears in short prisms and is bounded by a greater number of brilliant faces. All the colours form a continuous series to which no constant limits can be fixed. A variety resembling Egerane has been called *Loboite* and *Frugardite*; another from Tellemarken in Norway, of a blue colour, and containing copper, has been termed *Cyprine*.

3. Pyramidal Garnet has been found at Newton, Sussex county, N. J. associated with rhombohedral and dodecahedral corundum; colour yellowish-green. Also at Salisbury, Ct. crystalized in rhomboidal dodecahedrons; colour reddish-brown with brilliant planes. The same variety has been found at Chester, Mass.

2. TETRAHEDRAL GARNET.

Tetrahedral Garnet, or *Helvine*. Jam.
Helvine. Phil. C.

Colour wax-yellow, inclining to honey-yellow and yellowish-brown, or also to siskin-green. Streak white. Translucent on the edges. Lustre vitreous, inclining to resinous. Fracture uneven. Hardness 6.0—6.5. Sp. gr. 3.10. It occurs in crystals whose general form is that of a tetrahedron, but it yields to mechanical division parallel to all the planes of the regular octahedron.

1. Before the blow-pipe it melts on charcoal in the reducing flame, into a globule of the same colour as the mineral; it becomes dark in the oxidating flame, and the fusion is more difficult. It consists of

Silex,	39.50
Alumina,	15.65
Oxide of iron,	37.75
do. magnesia,	3.75
Lime,	0.50

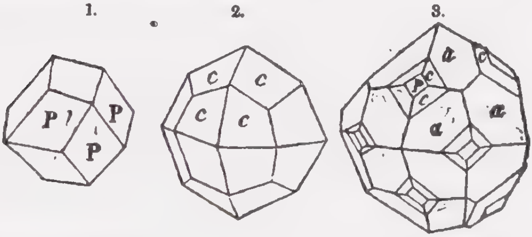
2. It has been found only at Schwarzenberg in Saxony, in beds in gneiss.

3. DODECAHEDRAL GARNET.

Garnet. Phil. C.

Colour red, brown, yellow, green, black and white, the only bright ones are the red colours. Streak white.

Translucent...opake. Lustre vitreous, inclining to resinous, in some specimens more of the latter than the former. Hardness 6.5—7.5. Sp. gr. 3.61 Grossular. 3.70 Melanite. 3.76 Common brown garnet. 3.78 Pyrope. 4.09 precious Garnet. 4.20 precious Garnet of Haddam. Cleavage imperfect and difficult. Primary form dodecahedron with rhombic faces.



P or P′ on P′′ 120°.

P on c 160° 54′
P on a 149 50
a on c 169 6

Fig. 1. Primary form. Fig. 2. Trapezoedron. Fig. 3. Triémarginé of Haüy.

1. Before the blow-pipe garnet melts pretty uniformly without effervescence into a black globule, dull externally but presenting a vitreous fracture.

2. The numerous colours and forms which dodecahedral garnet presents, has led to the designation of several varieties; the most important of which are as follows. 1. *Grossular*, it occurs only in imbedded crystals of the forms of icositetrahedrons, and combines with the dodecahedron. Its colours are confined to asparagus-green and mountain-green. 2. *Pyreneite* occurs in imbedded crystals in limestone, colour grayish-black and grayish-white, semi-transparent. 3. *Melanite*, colour velvet-black, opake. 4. *Pyrope* occurs in grains, translucent, of a remarkable blood-red colour. 5. *Precious garnet* is always red and usually crystalized in the primary form. 6. *Common garnet* is brown and dull. 7. *Colophonite* presents a combination of colours which gives a peculiar irridescence very pleasing to the eye, it occurs mostly in grains which cohere but feebly.

3. The different varieties of dodecahedral Garnet consist as follows:

	Grossular.	*Melanite.*	*Precious garnet.*	*Colophonite.*	*Pyreneite.*	*Pyrope.*
Silex,	44.	35.50	35.75	37.	43.	40.
Alumine,	8.50	6.	27.25	13.50	16.	28.50
Lime,	33.50	32.50	0.	29.	20.	3,50
Oxide of iron,	12.	24.25	36.	7.50	16.	16.50
do manganese,	a trace.	0.40	0.25	4.75	0.	0.25
Magnesia,	0.	0.	0.	6.50	0.	10.

The Pyrope contains besides the above elements, 2.11 per cent of chromic acid.

The atomic constitution may be expressed generally thus—1 atom of bisilicate of protoxide of iron+2 atoms of silicate of protoxide of manganese+2 atoms of silicate of alumina. Those garnets which are called aluminiferous, are double silicates of alumina and one or two of the four bases, *protoxides of iron, manganese, magnesia* and *lime*. If the protoxide of iron predominates, the globule after fusion is coated with a pelicle of reduced iron, but the pelicle becomes thinner as the other elements increase, and the globule is more vitreous.

4. A few less distinct varieties have been noticed by different mineralogists thus: *Topazolite*, which possesses a topaz yellow colour, and *Succinite* an amber-yellow, and *Allochroite* which is a mixed variety, has a yellowish, greenish or brownish-gray colour. *Manganesian Garnet* contains a large proportion of oxide of manganese, and gives before the blow-pipe with borax and nitre, a violet coloured globule.

5. Dodecahedral Garnet is extremely abundant in the primitive rocks, especially gneiss and mica slate.

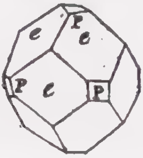
Precious Garnet is found abundantly at Hanover, in gneiss. At Franconia, fine crystals of the variety termed by Haüy, *triémarginé*, represented by fig. 3. See Shepard's Min. journey, in the Journal of Science, No. 37, p. 132. Colophonite, at Willsborough, N. Y. Allochroite near Baltimore, Md. Melanite at Chester, Mass. and at Franklin, N. J. Manganesian Garnet near Philadelphia, Pa. Pyrope, Chester co. Pa.

Remarkably large brown garnets occur at Franklin, N. J.

The two following species, the Aplome and Cinnamon stone, have not as yet been determined to be distinct species, hence they are placed in connexion with dodecahedral Garnet.

i. APLOME.

Colour brown, sometimes yellowish. Streak white. Translucent on the edges...opake. Lustre vitreous, inclining to resinous. Brittle. Hardness 7.0—7.5. Sp. gr. 3.44. The primary form is supposed to be a cube. Cleavage imperfect. Fracture uneven.



P on P 90°
e on e 120
P on e 136

1. It appears like garnet before the blow-pipe. It is found to consist of

Silex,	40.
Alumine,	20.
Lime,	15.5
Ox. manganese,	2.
Ferriferous silex,	2.

2. It occurs on the banks of the Lina in Siberia, and in Saxony and Bohemia. Rare.

ii. CINNAMON STONE, OR ESSONITE.

Colour intermediate between hyacinth-red and orange-yellow. Streak white. Lustre vitreous, inclining to resinous. Transparent...translucent. Hardness 7.0—7.5. Sp. gr. 3.63. Usually massive, with traces of cleavage parallel to a prism of 102° 40′. Fracture uneven.

1. Before the blow-pipe it melts easily into a brownish-black globule.

It consists of

Silex,	36.80	
Alumina,	21.20	
Lime,	31.25	
Oxide of iron,	6.50	*Klaproth.*

2. The cinnamon stone cannot be considered distinct from the garnet, unless its crystaline form belongs to the prismatic system, and the optical researches of Brewster and Biot render it probable at least, that it is identical with the dodecahedral Garnet.

5. PRISMATOIDAL GARNET.

Prismatic Garnet. Jam. *Staurotide.* C.
Staurolite. *Grenatite.* Phil.

Colour dark reddish-brown. Streak white. Lustre resinous externally, and inclining to vitreous on a recent fracture. Translucent only on the edges...opake. Fracture uneven. Hardness 7.0—7.5. Sp. gr. 3.72. Primary form a right rhombic prism of 129° 20′ and 50° 40′. The crystals are usually modified by a replacement of its acute lateral edges.

1. Before the blow-pipe it is infusible. It consists of

Silex,	33.	
Alumine,	44.	
Lime,	3.84	
Oxide of iron,	13.00	
Oxide of manganese,	1.00	*Vauquelin.*

2. It belongs exclusively to primitive rocks, and is usually found in single or double crystals, in the form of a cross, in mica slate. It is associated with garnet and cyanite. It is abundant in most places where mica slate is the prevailing rock.

GENUS XII. ZIRCON.

H=7.5
G=4.5—4.7

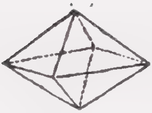
1. PYRAMIDAL ZIRCON.

Pyramidal Zircon. Jam.
Zirçon. Phil. C.

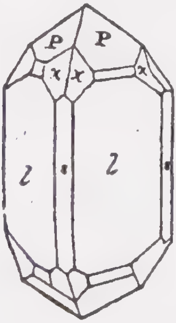
Colour red, brown, yellow, gray, green and white; usually dull, unless when red. Streak white. Transparent...opake. Lustre more or less adamantine. Hardness

7.5. Sp. gr. 4.50. Primary form an octahedron with a square base, affording angles on the natural planes of 84° 20′ and 95° 40.′.

1



2



P on u	162°	8′
P on x	160	5
l on u	159	17
l on x	142	56
l on s	135	0

Troost. Jour. Nat. Sci. vol. ii, p. 59.

1. Infusible before the blow-pipe. It consists of

Zirconia,	69.00	70.00	
Silex,	26.50	25.00	
Oxide of iron,	0.50	5.00	*Klaproth.*

2. There are three varieties, which are usually distinguished by particular names. The Hyacinth, Jargoon and Zirconite. The Hyacinth is of various shades of red, passing into orange-red. Transparent...translucent. Colours bright. Structure perfectly lamellar, and yields to cleavage parallel to the faces of the primary octahedron. It is esteemed as a gem. The Jargoon occurs in prismatic crystals of a grayish, brownish or reddish colour. Structure irregular. Opake. Zirconite is reddish-brown and nearly opake.

3. Zircon occurs near Philadelphia, on the York road, exhibiting the modifications of fig. 2, termed by Haüy Zircon bisunitaine. The variety Zirconite is found in Buncombe, N. C. Also at Warwick, at the base of the mountain Eve, in a sienitic granite.

GENUS XIII. GADOLINITE.

H.=6.5—7.0
G.=4.0—4.3

1. PRISMATIC GADOLINITE.

Prismatic Gadolinite. Jam.
Gadolinite. Phil. C.

Colour greenish-black, dark. Streak greenish-gray. Lustre vitreous, inclining to resinous. Translucent on the edges...opake. Hardness 6.5—7.0. Sp. gr. 4.23. Primary form an oblique rhombic prism.

Compound varieties. Massive. Composition impalpable. Fracture conchoidal.

1. Before the blow-pipe it decrepitates, but does not melt. If heated upon charcoal, it incandesces at once, and becomes pale. In nitric acid it forms a jelly. It consists of

Yttria,	45.00
Protoxide of iron,	11.43
Protoxide of cerium,	17.92
Silica,	25.80

2. Gadolinite occurs in gneiss and granite, along with feldspar, albite and quartz. It is found at Ytterby, Finbo, and Brodelbo in Sweden.

The following minerals are placed in connection with the order Gem, but the precise relation of some of them is not accurately determined.

1. CHONDRODITE.

Chondrodite. Haüy.
Chondrodite. Brucite. Maclureite. Phil.

Colour yellow, reddish-yellow, pale straw-yellow, brown, reddish-brown, and brick-red. Colours dull, excepting the bright-red. Translucent...opake. Lustre vitreous, inclining to resinous. Brittle. Hardness 6.5. Sp. gr. 3.19. Fracture foliated, with a cleavage which indicates the doubly oblique prism* as the primary form. M on T 75°, P on S 65°, by approximation. *Thompson.*

1. It fuses with difficulty, but soon loses its colour, and becomes opake.

It consists of	Silex,	32.66	
	Magnesia,	54.00	
	Peroxide of iron,	2.33	
	Fluoric acid,	4.08	
	Potash,	2.10	
	Water,	1.00	*Seybert.*

2. The atomic constitution is expressed by 1 atom fluate of magnesia+6 atoms of silicate of magnesia. *Thompson.*

3. It occurs in Sussex county, New-Jersey, and in Orange county, New-York, in various places, also sparingly in the county of Worcester, Mass. Chondrodite is found imbedded in granular limestone of a highly crystaline structure.

2. FOSTERITE.

Fosterite. Ann. of Phil. xxxvii. p. 61.

Colourless. Surfaces brilliant. Translucent. Scratches quartz. It occurs in prismatic crystals having nearly the same dimensions as corundum. Cleavage distinct perpendicular to the axis.

1. It consists of silica and magnesia. It is found near Vesuvius associated with spinelle and green pyroxene.

3. HYALOSIDERITE.

Hyalosiderite. Walchner. Edin. Jour. of Science, vol i. p. 184.

Colour reddish or yellowish-brown. Streak a cinnamon colour. Translucent on the edges, transmitting a hyacinth-red and wine-yellow colour. Lustre vitreous, on a recent fracture, but metallic on an exposed surface, from a tarnish which it acquires, which is a brass-yellow or a gold-yellow. Fracture small conchoidal. Hardness 5.5. Sp. gr. 2.85. Cleavage at right angles to the axis of an octahedron.

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* The general form of some of the most distinct crystals which have been observed, is that of a very low octahedron, with a rectangular base.

1. Before the blow-pipe it melts into a black globule, which is magnetic. With borax it becomes black, but with salt of phosphorus, greenish. It consists of

Silex,	31.63
Protoxide of iron,	29.71
Magnesia,	32.40
Potash,	2.78
Oxide of manganese,	0.48
Chrome,	a trace.

2. It occurs in amygdaloid, near the village of Sasbach in Brisgaw. It resembles the chrysolite.

4. KNEBELITE.

Colour gray, spotted with dirty-white, brownish-red, brown and green. Opake. Lustre glistening. Hard. Brittle, and difficultly frangible. Fracture imperfect conchoidal. Sp. gr. 3.71. Massive. Surface uneven and cellular.

It consists of

Silex,	32.5
Protoxide of iron,	32.
Protoxide of manganese,	35.

Dobereiner.

5. LIGURITE.

Ligurit. Leonhard. *Ligurite.* Phil.

Colour apple-green. Streak grayish-white. Transparent...translucent. Lustre of a recent fracture intermediate between vitreous and resinous. Fracture uneven. Hardness above 5.0. Sp. gr. 3.49. It is said to occur in oblique rhombic prisms of 140° and 40°.

1. It consists of

Silex,	57.45
Alumine,	7.36
Lime,	25.30
Magnesia,	2.56
Oxide of iron,	3.00
Oxide of manganese,	0.50

Viviani.

2. It has been found only on the banks of the Stura, in the Appenines, in a talcose rock. It is considered a gem, and is superior in hardness to the chrysolite.

6. MELLILITE.

Mellite. Jam. Phil. C.

Colour yellow, inclining to red or green. Opake. Gives sparks with steel. Crystalizes in square prisms. P on M or M′ 90°. M on M′ 90°.

1. It has been found only at Capo di Bove and Tivoli, near Rome, in lava.

7. SPHÆRULITE.

Colour various shades of brown and gray. Translucent on the edges...opake. Brittle. Hard. Scratches quartz. Sp. gr. 2.52. Cleavage none.

1. Before the blow-pipe it is almost infusible; the edges only becoming coated with enamel. It occurs in small roundish masses, sometimes aggregated in the botryoidal form, with a fibrous structure.

2. It occurs in Pitchstone and Pearlstone, in Iceland, Saxony and Scotland. It is nearly related to Obsidian in respect to composition.

8. SPINELLANE.

Spinellane. H. Nosin. Leonbard.

Colour grayish-black, passing into ash-gray and brown. Lustre vitreous, inclining to resinous. Sometimes a whitish play of light parallel to the faces of the hexahedron. Hardness 5.5—6.0. Sp. gr. 2.28. Primary form a rhombic dodecahedron, the lateral planes of which are unduly lengthened so as to give the general form of six-sided prisms, with triedral terminations. P or P′ on P″ 120°.

1. Before the blow-pipe it is infusible, whether alone or with additions. It consists of

Silex,	43.
Alumine,	29.50
Lime,	1.50
Soda,	19.

Oxide of iron,	2.	
Sulphur,	1.	
Water,	2.50	*Klaproth.*

2. It is found on the shores of Lake Laach. It resembles Pitchstone, according to Dr. Brewster, when examined in thin splinters under a powerful microscope.

9. ZEAGONITE.

Abrasite. Zeagonite. Gismondine. Phil.

Colour pale smalt-blue, milk-white, rose-red. Translucent in small crystals. Lustre adamantine. Fracture conchoidal. Hardness 7.0—7.5. It crystalizes in octahedrons with a square base, which are sometimes modified by replacements of the edges of the base. P on P′ 122° 54′. P′ on P″ 85° 2′. *Brooke.*

1. It phosphoresces before the blow-pipe, but does not fuse. It gelatinizes in acids, without effervescence.

It consists of	Silex,	41.4	
	Lime,	48.6	
	Alum,	2.5	
	Magnesia,	1.5	
	Oxide of iron,	2.5	*Carpi.*

2. It is found in the cavities of volcanic rocks, at Capo di Bove, near Rome.

Zeagonite differs but little from pyramidal Zircon, and has often been considered a variety of it.

ORDER VIII. ORE.

GENUS I. TITANIUM-ORE.

H=5.0—6.5
G=3.4—4.4

1. PRISMATIC TITANIUM-ORE.

Prismatic Titanium-ore, or *Sphene.* Jam.
Sphene. Phil.

Colour brown, yellow, gray, green; generally dull, excepting the pistachio-green ones. Streak white. Lustre resinous, inclining to admantine. Transparent...translucent on the edges. Hardness 5.0—5.5. Sp. gr. 3.46, of a massive yellow variety from Norway. Primary form an oblique rhombic prism. M on M′ 133° 30′. P on M or M′ 121° 50′.

1. Before the blow-pipe 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 dissolve in hot nitric acid, and leave a silicious residue.

It consists of	Lime,	33.	
	Oxide of titanium,	33.	
	Silex,	35.	*Klaproth.*

2. It occurs in primitive rocks, chiefly associated with pyroxene; more particularly with the variety *Sahlite.*

3. It is found at various places in the counties of Orange, N. Y., and Sussex, N. J. Also at Munroe in the Highlands. It is found of a straw-yellow in Chester and Middlefield, Mass., in hornblende rocks.

2. PERITOMOUS TITANIUM-ORE.

Prismato-Pyramidal Titanium-Ore. Jam.
Titanite. Nigrine. Phil.

Colour reddish-brown, passing into red, sometimes yellowish. Streak very pale brown. Translucent...opake. Lustre metallic, adamantine. Hardness 6.0—6.5. Sp. gr. 4.24. It is mechanically divisible, parallel to the lateral planes of a right prism with square bases. Natural crystals generally striated longitudinally, and frequently geniculated. P on M or M′ 90°. M on M′ 90°.

1. Before the blow-pipe it is infusible by itself, but with borax it gives a yellow glass in the reducing flame. When farther acted upon it assumes an amethyst colour.

It consists of	Titanium	32, one p.
	Oxygen	8, one p.

2. It occurs in primitive rocks generally, in quartz in long striated prisms, which are exceedingly brittle. It is never abundant at one place, but in most places where primitive rocks, especially hornblende, occur, we may expect to find titanium.

3. PYRAMIDAL TITANIUM-ORE.

Pyramidal Titanium-Ore, or Octahedrite. Jam.
Anatase. Octahedrite. Phil.

Colour various shades of brown, more or less dark; also indigo-blue. Streak white. Lustre metallic adamantine. Semi-transparent...translucent. Hardness 5.5—6.0. Sp. gr. 3.82. Structure lamellar. Primary form an acute octahedron with a square base. It yields to mechanical division parallel to the faces of the octahedron and the common base of the two pyramids.

1. Before the blow-pipe it appears like the preceding, but the Comte de Bournon observes that some crystals acquire by heat the property of acting on the magnetic needle. It is considered as a pure oxide of titanium.

2. It is found in Dauphiny, Switzerland, Cornwall, Eng. Norway, Spain and Brazil.

GENUS II. ZINC-ORE.

H.=4.0—4.5
G.=5.4—5.5

1. PRISMATIC ZINC-ORE.

Red Oxide of Zinc. Phil. C.

Colour red, inclining to yellow. Streak orange-yellow. Translucent on the edges. Lustre adamantine. Brittle. Hardness 4.0—4.5. Sp. gr. 5.43.

Compound varieties.—Massive. Composition granular.

1. On exposure to air it becomes dull. Alone it is infusible, but with borax it yields a yellow transparent glass. It is soluble with effervescence in nitric acid. It consists of

Oxide of zinc,	92.
Oxide of manganese and iron,	8.

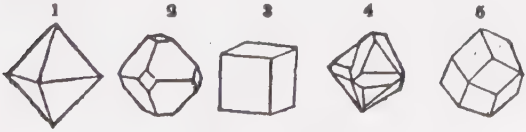
2. It is found massive in large quantities in Sussex county, N. J., associated with Franklinite.

GENUS III. COPPER-ORE.

H.=2.5—4.0
G.=5.6—6.0

1. OCTAHEDRAL COPPER-ORE.

Colour between cochineal-red and lead-gray; also pure cochineal-red, and when in capillary crystals almost carmine-red and crimson-red. Surfaces occasionally irridescent, sometimes black. Lustre adamantine, and sometimes metallic adamantine, or imperfect metallic. Streak several shades of brownish-red, shining. Semi-transparent...translucent on the edges. Brittle. Hardness 3.5—4.0. Sp. gr. 5.99. Structure lamellar. Primary form a regular octahedron, under which form it often appears.



[Figures 6 and 7 omitted.]

Fig. 1. Primary crystal. Fig. 2. Octahedron, with the solid angles replaced by quadrangular planes. Fig. 3. The planes complete, forming the cube. Fig. 4. Octahedron, with the edges replaced by six-sided planes. Fig. 5. Those planes complete, forming the rhombic dodecahedron. Fig. 6. The octahedron, whose edges are bevelled. Fig. 7. Octahedron whose solid angles are replaced by four triangular planes.

Compound varieties.—Massive. Composition granular. Individuals of various sizes, sometimes impalpable.

1. Before the blow-pipe on charcoal in the reducing flame, metallic copper is obtained. It dissolves with effervescence in nitric acid.

It consists of Copper 64, one p.
Oxygen 8, one p.

2. The oxide of copper sometimes contains oxide of iron. The colour is then brown or dark-brown, with resinous lustre.

It is denominated Tile-ore, of which there are two varieties—*earthy* and *indurated* Tile-ore. Of the red copper-ore there are three sub-species, the *foliated*, *capillary* and *compact*.

Octahedral copper-ore occurs in beds and veins in several rocks. It is highly valued as an ore of copper.

GENUS IV. TIN-ORE.

H.=6.0—7.0
G.=6.3—7.1

1. PYRAMIDAL TIN-ORE.

Pyramidal Tin-Ore. Jam.
Oxide of Tin. Phil. C.

Colour various shades of white, gray, yellow, red, brown and black. Streak pale gray; in varieties pale brown. Semi-transparent....opake. Lustre adamantine. Brittle. Hardness 6.0—7.0. Sp. gr. 6.96 of crystalized variety—6.51 thin columnar composition. Primary form an obtuse octahedron. P on P, 133° 30′. P on P or P′ on P′ 112° 10′, over the summits.

Compound varieties.—Massive. Composition thin columnar; rarely reniform or botryoidal. Granular, almost impalpable, and strongly connected. Fracture uneven. Tin-stone or Wood-tin is found among the compound varieties.

1. Before the blow-pipe the oxide of tin in the oxidating flame takes fire and burns like tinder, and is converted into the peroxide. This does not fuse, but in the inner flame, if well regulated, may be reduced to the metallic state. With soda on charcoal it is readily reduced; but those specimens which contain columbium are not so easily reduced without the addition of a small quantity of borax.

It consists of	Tin	58, one p.
	Oxygen	16, two p.

2. Oxide of tin belongs to the oldest primitive rocks, or the oldest granite. It occurs in Cornwall, Eng., also in Spain, and Saxony. A single specimen in crystals has been found in Goshen, Mass.

3. Tin is one of the most valuable metals. It resists for a great length of time the action of the atmosphere and moisture. It forms alloys with lead and iron, producing compounds which combine properties more extensively useful than can be obtained in their separate states. The oxide of tin also forms an essential part of the celebrated scarlet dye. The tin of commerce is principally obtained from the pyramidal Tin-ore.

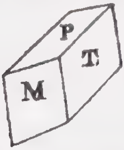
GENUS V. SCHEELIUM-ORE.

H.=5.0—5.5
G.=7.1—7.4

1. PRISMATIC SCHEELIUM-ORE.

Prismatic Wolfram. Jam.
Wolfram. *Tungstate of Iron.* Phil. C.

Colour dark grayish-black, or brownish-black, or brown. Streak dark reddish-brown. Lustre metallic adamantine. Opake. Not very brittle. Hardness 5.0—5.5. Sp. gr. 7.15. Structure lamellar. It yields to mechanical division parallel to the planes of a right oblique angled prism, which is the primary form.



M on T 117° 22′.
P on M or P on T 90°.

1. Before the blow-pipe on charcoal it may be fused into a globule whose surface presents a collection of tolerably large lamellar, iron-gray crystals, having a metallic lustre. With borax it fuses readily. With salt of phosphorus it also fuses easily, and in the reducing flame the glass becomes dark-red. Sometimes it decrepitates strongly. Prismatic Scheelium-ore consists of

Tungstic acid,	78.77
Protox. manganese,	6.22
Protox. iron,	18.32
Silex,	1.25

2. It is most frequently met with in primitive rocks along with pyramidal Tin-ore, both in veins and beds.

It is found in Huntington, Ct. where it occurs, both massive and crystalized, in octahedrons.

GENUS VI. TANTALUM-ORE.

H.=6.0
G.=6.0—6.3

1. PRISMATIC TANTALUM-ORE.

Prismatic Tantalum-Ore. Jam. *Columbite.* Phil.

Colour grayish and brownish-black. Streak dark brownish-black. Opake. Lustre imperfect metallic. Brittle. Hardness 6.0. Sp. gr. 6.0. Primary form a right rectangular prism. General form of the crystals quadrangular prisms, which are generally striated longitudinally and variously modified.

Compound varieties.—Massive. Composition granular.

1. Before the blow-pipe alone it suffers no change. With borax it dissolves slowly but perfectly. The glass presents the tint of iron only at a certain point of saturation, but it takes by flaming a grayish-white colour, and when still further saturated, it spontaneously becomes opake on cooling. As long as it remains transparent its colour is pale bottle-green.

Prismatic Tantalum-ore consists of

Oxide of tantalum,	75.	
Oxide of tin,	1.	
Oxide of iron,	17.	
Oxide of manganese,	5.	*Vogel.*

2. This scarce and interesting mineral was first found in Haddam, Ct. It has since been found in Chesterfield.

GENUS VII. URANIUM-ORE.

H.=5.5
G.=6.4—6.6

1. UNCLEAVABLE URANIUM-ORE.

Indivisible Uranium, or *Pitch-Ore.* Jam.
Uran-Ochre. Pitch-blende. Phil.

Colour grayish-black, inclining sometimes to iron-black, also to greenish and brownish-black. Lustre imperfectly metallic and sometimes dull, but usually resinous. Streak black and a little shining. Opake. Fracture uneven or small conchoidal. Cleavage none.

Compound varieties.—Massive. Reniform, globular. Composition columnar, impalpable. Sometimes there is a combination of carved laminæ with smooth and shining surfaces.

1. Alone before the blow-pipe it does not fuse; with borax it fuses into a dark yellow glass which becomes dirty green in the oxidating flame. If reduced to powder it is slowly soluble in nitric acid. It consists of

Protoxide of Uranium,	86.50
Protoxide of iron,	2.50
Silex,	5.
Sulphuret of lead,	6.

Klaproth.

2. Uncleavable Uranium-ore is found in Cornwall, Eng. accompanied with various ores of silver and led. 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.

H.=5.5
G.=4.9—5.0

1. UNCLEAVABLE CERIUM-ORE.

Colour intermediate between clove-brown and cherry-red, passing into gray. Lustre adamantine. Streak white. Translucent on the edges. Brittle. Hardness 5.5. Sp. gr. 4.91. Regular forms and cleavage unknown.

Compound varieties.—Massive. Composition granular, nearly compact. Fracture uneven, splintery.

1. Alone it is infusible, but with borax, it forms an orange-yellow globule which becomes paler on cooling.

1. It consists of

Oxide of cerium,	68.59
Silex,	18.
Oxide of iron,	2.
Lime,	1.25
Water and carb. acid,	9.60

2. This rare mineral occurs in a bed of gneiss, at the copper mine of Nya Bastnaes, Sweden. Accompanying this ore is another named *Cerine*, by Berzelius, but too little known to allow its being received into the system. Colour brownish-black. Streak yellowish-gray, inclining to brown. Hardness 5.5—6.0. Sp. gr. 4.17.

Before the blow-pipe 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 bead. It consists of

Silex,	30.17
Alumine,	11.31
Lime,	9.12
Oxide of barium,	28.19
do. iron,	20.72

It agrees very nearly in several of its properties with Allanite.

GENUS IX. CHROME-ORE.

H.=5.5
G.=4.4—4.5

1. OCTAHEDRAL CHROME-ORE.

Colour iron-black and brownish-black. Streak brown. Opake. Lustre imperfect metallic. Brittle. Hardness 5.5. Sp. gr. 4.49. Fracture uneven, imperfect conchoidal.

Compound varieties.—Massive. Composition granular; individuals of various sizes and generally firmly connected.

1. Alone it is infusible, but acts upon the magnetic needle after having been acted upon in the reducing flame. It is difficultly soluble in borax, furnishing a beautiful grass-green globule. It consists of

Oxide of chrome,	43.
Protoxide of iron,	34.70
Alumine,	20.30
Silex,	2.

The varieties of the present species most frequently occur in a compound state. But crystals in the form of octahedrons are said to occur at Hoboken, N. J. and at the Bare Hills, near Baltimore, Md. It is found in Serpentine and Talcose slate.

2. The octahedral chrome-ore is a valuable mineral, from which is extracted the oxide of chrome, which furnishes with lead a fine durable yellow pigment. With other metals, as cobalt and mercury, it yields green and red pigments which are used for painting on porcelain and for painting in oil.

GENUS X. IRON-ORE.

=5.0—6.5
=3.8—5.3

1. AXOTOMOUS IRON-ORE.

Titanitic Iron.

Colour dark iron-black. Streak black. Lustre imperfect metallic. Opake. Fracture conchoidal. Brittle. Hardness 5.0—5.5. Sp. gr. 4.66. Primary form an acute rhombohedron, whose plane angle at the apex is 18°. *Bournon.*

It consists of the oxide of iron and the oxide of titanium. Its only locality is the department of the Isère in France.

2. OCTAHEDRAL IRON-ORE.

Octahedral Iron-Ore. Jam.
Oxidulated Iron. Phil.

Colour iron-black. Lustre metallic, in some varieties imperfect metallic. Streak black. Opake. Brittle. Hardness 5.5—6.5. Sp. gr. 5.09. Cleavage parallel to the planes of the regular octahedron. Generally obedient to the magnet.

Fig. 1. The primary, the regular octahedron. Fig. 2. The same with the edges replaced, and by an enlargement of these planes the rhombic dodecahedron is formed, as in Fig. 3.

Compound varieties.—Massive. Composition granular, coherence of the individuals variable. Sometimes it is in the form of loose sand.

1. Before the blow-pipe it is infusible, but when exposed to a great heat it assumes a brown colour and loses its magnetic properties. It dissolves in heated muriatic acid, but not in nitric. It consists of

Protoxide of iron,	31.	
Peroxide of iron,	69.	*Berzelius.*

2. Octahedral iron-ore occurs principally in talcose slate; occasionally in other rocks, as mica slate, hornblende, chlorite slate; also in serpentine it is considerably abundant.

It is found in Hawley and Middlefield, Mass. Somerset, Vt. and in the counties of Essex and Orange, N. Y. Also at Baltimore, Md.

3. DODECAHEDRAL IRON-ORE.

Franklinite. Phil. C.

Colour iron-black. Lustre metallic. Streak dark-brown. Opake. Brittle. Magnetic, but does not possess polarity. Hardness 6.0—6.5. Sp. gr. 5.09. Cleavage imperfect, parallel to the planes of the octahedron. Fracture conchoidal. Surfaces always smooth.

Compound varieties.—Massive. Composition fine granular; individuals strongly connected.

1. It consists of

Peroxide of iron,	66.
Oxide of zinc,	17.
Oxide of manganese,	16.

It dissolves without effervescence in heated muriatic acid.

2. It is found at Franklin, N. J. associated with the red oxide of zinc. The crystalized variety is rare.

4. RHOMBOHEDRAL IRON-ORE.

Rhomboidal Iron-Ore. Jam.
Specular[*] *Iron. Red Iron-Ore.* Phil.

Colour dark steel-gray, iron-black. Lustre metallic. Streak cherry-red, reddish-brown. Surface often tarnished or irridescent. Opake; very thin laminæ faintly translucent, and show a deep blood-red colour. Brittle. Fracture uneven, conchoidal. Sometimes shows a feeble action upon the magnetic needle. Hardness 5.5—6.5. Sp. gr. 5.25. It is crystalized in many forms, which are derived from a slightly acute rhomboid of 86° 10′ and 93° 50′.

Compound varieties.—Globular, reniform, botryoidal and stalactitic shapes. Composition more or less columnar, sometimes impalpable. Massive. Composition granular, passing into impalpable. When the cohesion among the particles is diminished, the varieties become scaly and glimmering, the granular ones earthy and dull.

It occurs in primitive and transition rocks, both in beds and veins, and is associated with oxidulated iron.

The mines of this substance in the Island of Elba are of great extent, and have been worked it is said upwards of 3000 years.

5. PRISMATIC IRON-ORE.

Prismatic Iron-Ore. Jam.
Hydrous Oxide of Iron. Phil.

Colour various shades of brown; of which hair-brown, clove-brown and blackish-brown, are the most common. Streak yellowish-brown. Lustre adamantine. Crystals

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[*] *Specular*, from its brilliancy.

often semi-transparent, and showing a blood-red tint. Other varieties opake. Brittle. Exhibits no action on the magnet. Hardness 5.0—5.5. Sp. gr. 3.92. Surfaces of the crystals are deeply streaked in a longitudinal direction. The primary form is a right rectangular prism, the only cleavage being parallel to the plane M. P on M or T 90°. T on M 90°.

Compound varieties.—Globular, reniform, stalactitic and fruticose shapes. Surface often drusy, smooth, granulated. Composition columnar. Individuals delicate, and often impalpable. Composition often repeated. Massive. Composition columnar or impalpable. Particles often slightly coherent, earthy, dull.

1. Before the blow-pipe it becomes black and magnetic. It melts with borax into a green or yellow glass, and is soluble in heated nitro-muriatic acid. It consists of

Peroxide of iron,	82.
Water,	14.
Oxide of manganese,	2.
Silex,	1.

2. Prismatic Iron-ore occurs in veins and beds, associated with brachytypous Parachrose-baryte, prismatic Hal-baryte, &c., but more generally connected in this country with granular quartz and granular limestone. Several varieties are included in this species. The fibrous brown Iron-ore, or brown Hematite, are crystalized, but are compound varieties under imitative shapes. Compact brown Iron-ore is a massive variety in which the composition is not discernable. The ochery brown Iron-ore is an earthy variety, with texture loose and friable. The mixed and impure varieties of this species are the clay Iron-ores; as the granular, common, pisiform and the reniform clay Iron-ore. It is an important ore, and is used extensively in the manufacture of wrought and cast-iron. The pig-iron obtained from the purer varieties with charcoal in particular, may be easily converted into steel.

3. It is found at Salisbury, Ct., Richmond and Lenox, Mass. and Bennington, Vt., and at numerous other places in the United States.

1. DI-PRISMATIC IRON-ORE.

Lievrite. Jam.
Lievrite. Yenite. Phil. C.

Colour intermediate between iron-black and dark-grayish-black, passing into greenish-black. Lustre imperfect metallic. Streak black, sometimes inclining to green or brown. Opake. Brittle. Hardness 5.5—6.0. Sp. gr. 3.99. Primary form a right rhombic prism. M on M′ 110° 30′. P on M or M′ 90°. It admits of cleavage parallel to the long diagonal of the prism.

Compound varieties.—Massive. Composition columnar, thin and straight. Sometimes fine granular.

1. Before the blow-pipe it melts easily without effervescence into an opake glass, which is magnetic. Glass of borax is coloured yellowish-green. It is soluble in muriatic acid. It consists of

Oxide of iron,	55.	
Silex,	28.	
Lime,	12.	
Oxide of manganese,	3.	*Descotils.*

2. Di-prismatic Iron-ore is found at Cumberland, R. I., along with Ferro-silicate of Manganese.

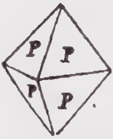
GENUS XI. MANGANESE-ORE.

H.=2.5—6.0
G.=4.0—4.8

1. PYRAMIDAL MANGANESE-ORE.

Foliated Black Manganese-Ore. Jam.
Manganese. Phil.

Colour black, or brownish-black. Lustre imperfect metallic. Streak dark reddish or chesnut-brown. Opake. Hardness 5.0—5.5. Sp. gr. 4.72. Primary form an octahedron with a square base. Cleavage parallel to all its planes.



P on P″ or P′ on P‴ 117° 30′.
P on P′ or P″ on P‴ 105 45.
Brooke.

Compound varieties.—Massive. Composition granular. Particles firmly connected.

1. It consists of

Per and protoxides of manganese,	75.80
Silex,	15.17
Alumine,	2.80
Oxide of iron,	4.14

2. On charcoal, in a strong heat, it fuses on the edges and preserves its gray-black. With borax it fuses readily.

2. UNCLEAVABLE MANGANESE-ORE.

Compact and Fibrous Manganese-Ore, or Black Hematite. Jam.
Black Iron-Ore, (in part.) *Compact Gray Oxide of Manganese.* Phil.

Colour bluish-black and grayish-black, passing into dark steel-gray. Streak brownish-black, shining. Lustre imperfectly metallic. Opake. Brittle. Hardness 5.0—6.0. Sp. gr. 4.14. Regular form and cleavage unknown. Fracture not observable.

Compound varieties.—Reniform, botryoidal and fruticose shapes. Composition columnar, impalpable. Fracture flat conchoidal, even. Massive. Composition fine granular. Particles strongly connected.

1. Before the blow-pipe it colours the glass of borax violet-blue. It is supposed to be a mixture of oxide of manganese and iron.

2. It is associated with the ores of manganese, and even the ores of iron. It is found in Saxony, many places in the Hartz, and in Cornwall, Eng.

3. PRISMATOIDAL MANGANESE-ORE.

Gray Oxide of Manganese. Phil.

Colour dark steel-gray, iron-black. Lustre metallic. Streak brownish-black. Opake. Brittle. Hardness 2.5—3.0. Sp. gr. 4.62. Fracture uneven. Its primary form is a rhombic prism. P on M or M′ 90°. M on M′ 100°. It yields to mechanical division with perfect and brilliant faces parallel to the lateral planes and both diagonals of the primary form.

Compound varieties.—Reniform and imitative shapes. Surfaces generally rough and drusy. Massive. Composition granular. Particles of various sizes. Fracture uneven, and sometimes earthy.

1. Before the blow-pipe it is infusible. With borax it forms a violet-blue glass. It is insoluble in nitric acid. In heated sulphuric acid it disengages oxygen gas. Also alone with a strong heat. It consists of

Black oxide of manganese,	90.50
Oxygen,	2.25
Water,	7.00

2. Prismatoidal Manganese-ore frequently accompanies the prismatic and rhombohedral Iron-ores; sometimes the earthy variety forms a bed by itself.

3. It occurs in Cornwall, Eng., and in the Hartz, Bennington, Vt., Richmond, Mass., both earthy and compact. It is a useful mineral, and is employed in the manufacture of glass and painting in enamel. Also valuable in chemical operations, as bleaching, for which it is indispensable in furnishing chlorine at a moderate expense.

4. The earthy incoherent variety is called *Black Wad.* It occurs as a coating on the other ores of manganese and the ores of iron. Colour brown. Structure compact. Lustre rarely imperfect metallic, generally earthy and dull. Sp. gr. 3.76, and hardness about 0.5. Sectile, soils and writes. It absorbs water rapidly. It consists of

Oxide of manganese,	68.
Oxide of iron,	6 50
Water,	17.50

Carbon,	1.
Baryta and silica,	9.

Black Wad and Brown Iron-froth are very similar in their mode of formation, and occur under the same imitative shapes.

5. It is found at Cornwall, Eng., and in the Hartz.

The following species belong to the order Ore, but are not sufficiently known to be arranged in the system.

1. ALLANITE.

Colour brownish or greenish-black. Streak greenish-gray. Lustre imperfect metallic. Opake, or only faintly translucent in thin splinters, transmitting a brownish light. Brittle. Hardness 6.0. Sp. gr. 4.00.

1. Alanite froths before the blow-pipe and melts imperfectly into a black scoria. It gelatinizes in nitric acid.

It consists of

Oxide of cerium,	33.90
Oxide of iron,	25.40
Silex,	35.40
Lime,	9.20
Alumine,	4.10

2. It was discovered at Alleck, in East Greenland, by Sir Charles Giesecke.

2. BROOKITE.

Brookite. Lèvy. Ann. of Phil. Feb. 1826.

Colour hair-brown, passing into a deep orange-yellow, and some reddish tints. Lustre metallic adamantine. Streak yellowish-white. Translucent...opake. The colours are brighter by transmitted light. Brittle. Hardness 5.5—6.

1. It contains titanium, but has not been analyzed.
2. It is found in Dauphiny, and at Snowden in Wales, associated with pyramidal Titanium-ore.

3. FERGUSONITE.

Fergusonite. Haidinger. Trans. Roy. Soc. Edin.
Allanite, (in part.) Phil.

Colour dark brownish-black, in thin splinters, pale. Streak very pale brown, like peritomous Titanium-ore.

Lustre imperfect metallic, inclining to resinous. Opake; in thin splinters translucent. Brittle. Hardness 5.5—6.0. Sp. gr. 5.83 *Allan.* 5.80 *Turner.* Not magnetic.

1. It loses its colour before the blow-pipe and becomes pale greenish-yellow, but alone is infusible. It is entirely dissolved with salt of phosphorus, but some particles remain a long time unaltered. The pale greenish globule becomes opake by flaming, when very much saturated, or on cooling. Before the whole portion is dissolved it assumes a pale rose colour in the reducing flame. It is described by Phillips, and Mohs in the German original of his work, under the name of Yttro-tantalite.

2. It is imbedded in Quartz, near Cape Farewell, Greenland.

4. ORTHITE.

Orthit. Berzelius. *Orthite.* Phil.

Colour ash-gray, passing into brown by decomposition. Streak brownish-gray. Opake. Lustre vitreous. Form long and straight acicular masses. Massive. Composition impalpable. Fracture conchoidal. Scratches glass, though with difficulty. Sp. gr. 3.28.

1. Before the blow-pipe it froths, becomes yellowish-brown and melts with effervescence into a black vesicular globule, and with borax into a transparent one. It gelatinizes in heated acids. It consists of

Silex,	32.
Lime,	7.84
Alumine,	14.80
Oxide of cerium,	19.44
Protoxide of iron,	12.44
Oxide of manganese,	3.40
Yttria,	3.44
Water,	5.36

2. It occurs at Finbo, near Fahlun, in Sweden, along with albite, quartz and feldspar, in veins traversing gneiss.

5. PHOSPHATE OF MANGANESE.

Phosphat of Manganese. Jam. Phil. C.

Colour blackish-brown. Streak yellowish-gray. Lustre resinous, inclining to adamantine. Translucent on the edges...opake. Brittle. Hardness 5.0—5.5. Sp. gr. 3.43.

1. Before the blow-pipe it melts easily into a black scoria, and is readily dissolved in nitric acid without effervescence.

It consists of	Oxide of iron,	31.
	Oxide of manganese,	42.
	Phosphoric acid,	27.

2. It has been found near Limoges, in France, in granite.

6. STILPNOSIDERITE.

Stilpnosiderite. Jam. Phil. C.

Colour brownish-black, blackish-brown. Streak yellowish-brown. Lustre resinous. Feebly translucent on the edges...Opake. Brittle. Hardness 4.5. Sp. gr. 3.61.

1. Before the blow-pipe it becomes black, but is infusible. With borax it yields a dark olive-green glass, but is not melted itself.

It consists of	Oxide of iron,	80.25
	Silex,	3.75
	Water,	15.

2. It is supposed to contain phosphoric acid. It occurs in Saxony and Thuringia, and in the Hartz. It is smelted as an ore of iron, and has been considered as a variety of prismatic Iron-ore.

7. YTTRO-TANTALITE.

Yttro-Tantalite. Jam. *Yttro-Columbite.* Phil.

i. BLACK YTTRO-TANTALITE.

Colour black. Streak gray. Imperfect metallic lustre. Opake. Brittle. Scratches glass. Sp. gr. 5.39. Fracture lamellar in one direction, coarse granular in another. Indistinct traces of crystalization.

ii. YELLOW YTTRO-TANTALITE.

Colour yellowish-brown, accidentally spotted or striped with green. Lustre resinous on the surface, vitreous in the fracture. Opake. Streak white. Scratches glass with difficulty, but is very distinctly scratched by it. Sp. gr. 5.88.

iii. DARK YTTRO-TANTALITE.

Colour black, inclining to brown. Streak white. Lustre intermediate between vitreous and resinous. Very thin fragments translucent. Almost colourless; sometimes a little yellowish. Hardness equals the yellow variety.

1. These varieties consist of

	Black.	*Yellow.*	*Dark.*
Oxide of tantalum,	57.00	59.50	51.81
Yttria,	20.25	24.90	38.51
Lime,	6.25	3.29	3.26
Oxide of uranium,	0.50	8.23	1.11
Tungstic acid with tin,	8.25	1.25	2.59
Oxide of iron,	3.50	2.72	0.55

ORDER IX. METAL.

GENUS I. ARSENIC.

H.=3.5
G.=5.7—5.8

1. NATIVE ARSENIC.

Native Arsenic. Jam. Phil. C.

Colour tin-white, a little inclining to lead-gray, very soon tarnishes and becomes dark-gray on being exposed to air. Lustre metallic. Streak unchanged, rather shining. Brittle. Hardness 3.5. Sp. gr. 5.76, but according to Bergmann that of melted arsenic is 8.30. Regular forms and cleavage unknown.

Compound varieties.—Generally in reticulated, reniform and stalactitic shapes. Composition fine granular and often compact.

1. Before the blow-pipe it exhales the odor of garlic and copious white fumes are formed, and at last it disappears.

It consists of

Arsenic,	96.
Antimony,	3.
Oxide of iron and water,	1.

It is generally found in veins, accompanied by several species of the orders *Metal, Pyrites* and *Glance.*

2. It occurs rather abundantly in the mines of Minsberg, Schneeberg and Marsenberg, in Saxony.

GENUS II. TELLURIUM.

H.=2.0—2.5
G.=6.1—6.2

1. NATIVE TELLURIUM.

Hexahedral Tellurium. Jam.
Native Tellurium. Phil.

Colour tin-white. Lustre metallic. Streak unchanged. Rather brittle. Hardness 2.0. Sp. gr. 6.11. *Klaproth.*

Compound varieties.—Massive. Composition granular and sometimes foliated. Individuals small.

1. Before the blow-pipe on charcoal it melts easily and burns with a reddish-green flame, and is volatilized.

Native Tellurium consists of

Tellurium,	92.55
Iron,	7.20
Gold,	0.25

2. It has been found in Transylvania, but is at present rare.

GENUS III. ANTIMONY.

H.=3.0—3.5
G.=6.5—10.0

1. RHOMBOHEDRAL ANTIMONY.

Dodecahedral Antimony. Jam.
Native Antimony. Phil.

Colour tin-white. Lustre metallic. Streak unchanged. Rather brittle. Hardness 3.0—3.5. Sp. gr. 6.64.

Compound varieties.—Reniform. Composition flattened grains, collected into curved lamellæ.

1. Before the blow-pipe it melts quickly into a globule and burns when heated to redness, even if the blast is discontinued. It emits copious white vapours which are deposited round the globule, and when collected form prismatic crystals of oxide of Antimony.

2. The present species was found at Sahlberg, near Sahla, in Sweden.

2. PRISMATIC ANTIMONY.

Octahedral Antimony. Jam.
Antimonial Silver. Phil.

Colour silver-white, inclining to tin-white. Lustre metallic. Streak unchanged. Hardness 3.5. Sp. gr. 9.44 *Haüy.* 9.82 *Klaproth.*

Compound varieties.—Massive. Composition granular, individuals of various sizes and easily separated.

1. Before the blow-pipe the fine varieties yield a globule of silver, while the antimony is driven off. Antimonial silver consists of from

16—24	Antimony.
76—84	Silver.

2. It is found in the Hartz, but is a rare mineral, and is highly valued for the silver it contains.

GENUS IV. BISMUTH.

H.=2.0—2.5
G.=9.6—9.8

1. OCTAHEDRAL BISMUTH.

Octahedral Bismuth. Jam.
Native Bismuth. Phil.

Colour silver-white, inclining to reddish-yellow. Subject to tarnish. Lustre metallic. Streak unchanged. Sectile and almost malleable. Hardness 2.0—2.5. Sp. gr. 9.73—9.61 the melted metal.

Compound varieties.—Imbedded, plumose and arborescent shapes. Massive. Composition in the mass foliated.

1. Before the blow-pipe it melts easily, even fusible in the flame of a candle. On charcoal it deposites a yellow coating. It is soluble in nitric acid from which it is precipitated white by water.

Octahedral Bismuth occurs in veins in granite and clay-slate.

2. It is found at Huntington, Ct. and a single specimen in the county of Essex, N. Y. It enters into the composition of several alloys used in the arts.

GENUS V. MERCURY.

H.=00.0—3.0
G.=10.5—15.0

1. DODECAHEDRAL MERCURY.

Dodecahedral Mercury, or *Native Amalgam.* Jam.
Native Amalgam. Phil.

Colour silver-white. Lustre metallic. Streak unchanged. Brittle. It emits a grating noise when cut with a knife. Hardness 3.0—3.5. Sp. gr. 13.75. Cleavage indistinct, parallel to the planes of a dodecahedron. Fracture conchoidal, uneven. Surface smooth and shining.

1. There are two kinds of Native amalgam, distinguished in reference to the *solid* or *fluid* state in which it is found. The fluid varieties are solutions of the solid or pure Mercury.

Dodecahedral Mercury consists of

Silver,	36.00	27.00
Mercury,	64.00	72.50
	Klaproth.	*Cordier.*

2. It is always found in repositories of peritomous Ruby-blende. Before the blow-pipe the mercury is driven off, and a globule of pure silver is obtained.

2. FLUID MERCURY.

Fluid Native Mercury. Jam.
Native Quicksilver. Phil.

Amorphous. Liquid. Lustre metallic. Colour tin-white. Hardness 0.0. Sp. gr. 13.58. *Haüy.*

1. Fluid Mercury is the pure metal as produced by nature. It is entirely volatile before the blow-pipe, and easily soluble in nitric acid.

2. It occurs at Idria in Carniola, and Almaden in Spain.

The quantity of Fluid Native Mercury is small; the metal is employed for making thermometers and barometers, also in various chemical preparations, in the amalgamation of gold and silver ores; in the production of artificial amalgam for silvering mirrors, and for gilding, &c.

GENUS VI. SILVER.

H.=02.5—3.0
G.=10.0—10.5

1. HEXAHEDRAL SILVER.

Hexahedral Silver. Jam.
Native Silver. Phil.

Colour silver-white, more or less subject to tarnish. Streak shining. Lustre metallic. Ductile and malleable. Hardness 2.5—3.0. Sp. gr. 10.47. Primary form a cube. Cleavage none. Fracture hackly.

Compound varieties.—Dentiform, filiform and capillary shapes. Massive. Plates formed in fissures and superficial coatings.

1. Native silver has been divided into *common* and *auriferous* native silver. The specific gravity and yellow colour are the distinct marks between them, but it is not determined whether the latter is a *species* or *variety*, as the gold may be only in juxta position. The auriferous native silver was found to consist of

Silver,	36.	72.
Gold,	54.	28.

2. Native silver occurs principally in veins traversing gneiss, clay-slate, and other primitive and transition rocks. The mining districts of Saxony and Bohemia, but more particularly those of Peru and Mexico, furnish it in the greatest abundance. Native silver is said to occur in Michigan, near Point aux Barques, on Lake Huron, in gneiss.

3. Silver, as it is employed in coinage and plate, is well known. It is also useful in the construction of chemical and philosophical apparatus, for which it must be perfectly pure. It is also used in pharmacy.

GENUS VII. GOLD.

H.= 2.5—3.0
G.=12.0—20.0

1. HEXAHEDRAL GOLD.

Hexahedral Gold. Jam.
Native Gold. Phil.

Colour various shades of gold-yellow. Streak shining. Lustre metallic. Ductile and malleable. Hardness 2.5—3.0. Sp. gr. 14.85 a rolled mass, 19.25 melted. *Haüy.* Primary form a cube. Cleavage none. Fracture hackly.

Compound varieties.—Filiform, capillary and aborescent shapes. Also plates, superficial coatings and rolled masses.

1. Hexahedral Gold has been distinguished into *gold-yellow*, *brass-yellow* and *grayish-yellow* native gold. The first is the purest gold, the second contains silver, and the last platina. A variety of the brass-yellow native gold yielded Lampadius,

Gold,	96 60
Silver,	2.
Iron,	1.10

Hexahedral gold melts pretty easily, and is soluble only in chlorine or nitro-muriatic acid.

2. The greatest quantity of gold has been found in the alluvial soil in Brazil, Mexico and Peru. It is also found in North-Carolina, and various other places in the southern states, and recently in Somerset, Vt. These deposits of gold are connected with the Talcose slate-rock, and may be found usually wherever the protoxide of iron forms an extensive deposit in that formation.

GENUS VIII. PLATINA.

H.= 4.0—4.5
G.=16.0—20.0

1. NATIVE PLATINA.

Native Platina. Jam. Phil. C.

Colour perfect steel-gray. Streak unchanged, shining. Lustre metallic. Ductile. Hardness 4.0—4.5. Sp. gr.

17.33, rolled masses. Irregular forms, grains. Surface uneven, or worn and polished by attrition. Cleavage none. Fracture hackly.

1. Native Platina is soluble only in nitro-muriatic acid. It generally contains a little iron. It is also accompanied by iridium, osmium, rhodium, palladium, copper, chrome and titanium.

2. Native Platina is found principally in South America, in the provinces of Choco and Barbacoas. Also at Matto Grosso, in Brazil. Also in St. Domingo. Recently it has been found in Russia, in the Ural mountains.

3. The refractory property of this metal and its resistance to almost every chemical re-agent, render it extremely valuable in the construction of philosophical and chemical apparatus. It is also used for covering other metals; for painting on porcelain, and like gold and silver for various other purposes. In Russia it is used in coinage.

GENUS IX. IRON.

H.=4.5
G.=7.4—7.8

1. OCTAHEDRAL IRON.

Octahedral Iron. Jam.
Native Iron. Phil.

Colour pale steel-gray. Streak unchanged, shining. Lustre metallic. It exhibits strong action on the magnet. Ductile. Hardness 4.5. Sp. gr. 7.76 of a meteoric variety from Elbogen. Primary form an octahedron. Cleavage none. Fracture hackly.

1. Octahedral Iron consists of

	Agram.	*Siberia.*	*Mexico.*	
Iron,	96.50	98.50	96.75	
Nickel,	3.50	1.50	3.25	*Klaproth.*

It resembles pure iron in most of its chemical and physical properties, but is not so liable to rust.

2. Masses of native meteoric iron are scattered over the continent of North America. The most remarkable was that discovered in Louisiana, and which may be seen in the cabinet

of the Lyceum of Natural History in New-Yoak. Native Terrestrial Iron is found in Guilford county, North Carolina, both massive and under the primary form of the species. Also in Pennsylvania.

GENUS X. COPPER.

H.=2.5—3 0
G.=8.4—8.9

1. OCTAHEDRAL COPPER.

Octahedral Copper. Jam.
Native Copper. Phil. C.

Colour copper-red. Streak unchanged, shining. Lustre metallic. Ductile and malleable. Hardness 2.5—3.0. Sp. gr. 8.58. Primary form a cube. Cleavage none. Fracture hackly. Surface rough. It is liable to tarnish.

Compound varieties.—Plates, dendritic and arborescent forms, generally superficial.

1. Before the blow-pipe it melts pretty easily, but is covered on cooling with an oxidised coat. Dissolves easily in nitric acid, and yields a blue solution with ammonia.

2. It is found in beds and veins, and is associated with the ores of copper and sometimes with those of iron. It is not uncommon in the native state. It is considerably abundant near Lake Superior and sometimes in extraordinary large masses. It is often connected with serpentine rock. Single specimens have been found in various places in the soil.

3. Copper is extensively applied in the arts and manufactures, as in roofing houses, coppering ship bottoms, coining, and in the fabrication of various utensils.

IRIDIUM.

Iridium. Jam.
Alloy of Iridium and Osmium. Phil.

Colour pale steel-gray. Lustre metallic. Opake. Brittle. Harder than native Platina. Sp. gr. 19.5. Structure lamellar. When crystalized there is a cleavage parallel to the terminal planes. Occurs in flattened grains.

1. If melted with nitre it becomes black, but again acquires its lustre and colour. It is not soluble in nitro-muriatic acid. It is an alloy of iridium and osmium, and is found in South America with native Platina.

NATIVE LEAD.

Colour pure lead-gray. Streak shining. Lustre metallic. Malleable. Fracture hackly. Hardness 1.5. Sp. gr. 11.35. Disagreeable odour by friction.

1. It melts easily before the blow-pipe, and covers the charcoal with a yellow oxide.

2. Metallic lead, when it occurs in nature, is mostly found in circumstances which indicate its having been in a state of fusion.

PALLADIUM.

Palladium. Jam.
Native Palladium. Phil.

Colour steel-gray, inclining to silver-white. Lustre metallic. Hardness superior to wrought iron. Sp. gr. 11.8 *Wollaston.* 12.14 *Lowry.* Occurs in grains and octahedrons with a square base.

1. With nitric acid it yields a red solution. By itself it is infusible, but melts with sulphur. The pure metal is ductile and malleable, and flexible in thin slips but not very elastic.

2. It occurs with native Platina in Brazil.

ORDER X. PYRITES.

GENUS I. NICKEL-PYRITES.

H.=5.0—5.5
G.=7.5—7.7

1. PRISMATIC NICKEL-PYRITES.

Prismatic Nickel-Pyrites. Jam.
Copper Nickel. Arsenical Nickel. Phil.

Colour copper-red. Streak pale brownish-black. Lustre metallic. Brittle. Hardness 5.0—5.5. Sp. gr.

7.65. It is said to occur in six-sided prisms. Fracture imperfect, conchoidal.

Compound varieties.—Massive. Composition fine granular, and strongly connected. Fracture uneven.

1. Before the blow-pipe it melts on charcoal and emits an arsenical smell. The metallic lead is white and brittle. In nitric acid it soon becomes covered with a green coating. It is soluble in nitro-muriatic acid.

It consists of	Arsenic,	54.72
	Nickel,	44.20
	Iron,	0.33
	Lead,	0.32
	Sulphur,	0.40

The Arseniate of Nickel which is found investing the prismatic Nickel pyrites, is produced by the decomposition of the present species, and consists of 37.35 oxide of nickel and a little cobalt, 36.97 arsenic acid and 24.32 of water.

2. The present species is found in veins at Schneeberg, Annaberg, and other mining districts of Saxony.

GENUS II. ARSENICAL-PYRITES.

H.=5.0—6.0
G.=5.7—7.0

1. AXOTOMOUS ARSENICAL-PYRITES.

Prismatic Arsenical-Pyrites. Jam.

Colour between silver-white and steel-gray. Streak grayish-black. Lustre metallic. Brittle. Hardness 5.0—5.5. Sp. gr. 7.22. Fracture uneven. Surface streaked.

Compound varieties.——Massive. Composition fine granular, often impalpable, and the individuals are strongly connected.

Axotomous Arsenical-pyrites has been found only in beds along with carbonate of iron and primitive Iron ore in Serpentine, near Hüttenberg in Carinthia, also at Schladming, in Stiria.

2. PRISMATIC ARSENICAL-PYRITES.

Di-prismatic Arsenical-Pyrites. Jam.
Arsenical Iron. Mispickel. Phil.

Colour silver-white, inclining and passing into steel-gray. Streak dark grayish-black. Lustre metallic. Brittle. Hardness 5.5—6.0. Sp. gr. 6.12. Primary form a right rhombic prism, parallel to its planes; it admits of mechanical division. Dimensions 111° 12′ and 68° 48′.

1. Before the blow-pipe on charcoal it gives out copious arsenical vapours, without destroying the form of the crystal. If the heat is continued it melts into a globule which is nearly pure sulphuret of iron. It is soluble in nitric acid, with the exception of a whitish residue.

It consists of		
	Iron,	36.04
	Arsenic,	42.88
	Sulphur,	21.08

Prismatic Arsenical-pyrites occurs in beds and veins. It is often accompanied by the ores of silver and lead.

2. This mineral is plentiful in the mining districts of Saxony. It occurs abundantly in the town of Warwick, Orange county, N. Y. and in Franconia, Ct.

The accidental admixture of silver renders some varieties useful as an ore of that metal. It sometimes also contains a proportion of gold.

GENUS III. COBALT-PYRITES.

H.=5.5
G.=6.1—6.6

1. OCTAHEDRAL COBALT-PYRITES.

Octahedral Cobalt-Pyrites. Jam.
Bright White Cobalt. Phil.

Colour tin-white, inclining to steel-gray. Streak grayish-black. Lustre metallic. Brittle. Hardness 5.5. Sp. gr. 6.46. Fracture uneven. Primary form a cube.

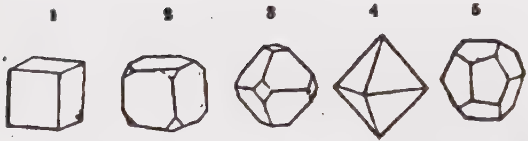


Fig. 1. The primary; a cube. Fig. 2. Cube of which the solid angles are replaced by triangular planes. Fig. 3. These planes are so increased as to reduce the primary planes to small cubes or squares. In Fig. 4. the primary planes entirely disappear, producing the regular octahedron. Fig. 5. Is a pentagonal dodecahedron formed by a replacement of the edges of the cube, by irregular six-sided planes, alternately in different directions.

Compound varieties.—Imitative shapes of various kinds. Massive. Composition granular, individuals generally small and strongly connected. Fracture uneven.

1. Before the blow-pipe it emits copious arsenical fumes and melts into a white 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.

It consists of

Cobalt,	20.31
Arsenic,	94.21
Iron,	3.42
Copper,	0.15
Sulphur,	0.88

2. Octahedral Cobalt-Pyrites is principally within veins, in rocks of various ages. It is accompanied by the ores of silver and copper. It is a valuable mineral for the preparation of the blue enamel colours, but particularly smalt.

The Gray Cobalt-ore and the Radiated White Cobalt-ore, are considered by Haüy as varieties of the present species, but the examination of some individuals indicate that they belong to the prismatic system, but they are too imperfectly known to be placed in the order Pyrites. Both varieties are brittle. Hardness 5.5. Sp. gr. 7.28. The radiated white variety consists of

Cobalt,	28.00
Arsenic,	65 75
Iron and manganese,	6.25

The radiated variety occurs at Schneeberg, in Saxony.

2. HEXAHEDRAL COBALT-PYRITES.

Hexahedral Cobalt-Pyrites. Jam.
Bright White Cobalt. Phil.

Colour silver-white, inclining to red. Streak grayish-white. Lustre metallic. Brittle. Hardness 5.5. Sp. gr. 6.29. Fracture imperfect conchoidal, uneven. Cleavage parallel to the planes of a hexahedron.

Compound varieties.—Massive. Composition granular : individuals generally small, but easily discernible.

1. Before the blow-pipe 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 in a manner similar to the preceding species.

2. It occurs at Tunaberg in Südermanland, in Sweden, and in Cornwall, Eng.

It is highly valued as an ore of Cobalt for painting on porcelain, and manufacturing smalt.

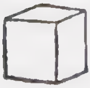
GENUS IV. IRON-PYRITES.

H.=3.5—6.5
G.=4.4—5.5

Hexahedral Iron-Pyrites, or Common Iron-Pyrites. Jam.
Iron-Pyrites, (in part.) Phil.

Colour bronze-yellow in different shades, sometimes steel-gray. Streak brownish-black. Lustre metallic. Brittle. Hardness 5.03. Sp. gr. 4.6—4.8. Primary form a cube. It yields to cleavage parallel to the planes both of the cube and octahedron, but the cubical planes are more brilliant than those of the octahedron. Fracture uneven.

1.



2.

3.*

4.

5.

[*For Fig. 3, see No. 3, under Cobalt-Pyrites in the preceding page.]

Fig. 1. Cube. Fig. 2. Cube with the solid angles replaced by triangular planes. In Fig. 3. these planes are so increased that the primary planes have nearly disappeared. Fig. 4. Is the octahedron completed. Fig. 5. Is a pentagonal dodecahedron, produced by the replacement of the edges of the primary by irregular six-sided planes, alternately in different directions.

Compound varieties.—Globular, capillary, stalactitical and pseudomorphous shapes. Massive. Composition fine granular. Strongly coherent. Fracture uneven.

1. Before the blow-pipe on charcoal in the oxidating flame it becomes red, the sulphur is driven off and the iron remains. At a high temperature it melts into a globule which is magnetic. Some varieties are subject to decomposition on exposure to the atmosphere. It consists of

Iron,	47.30
Sulphur,	52.15

Hexahedral Iron-pyrites constitutes beds by itself in primitive slate. It is frequently mixed with coal seams and the beds of clay which occur along with them. It sometimes contains gold mechanically mixed with it, it is then termed *auriferous Pyrites.*

The present species is a very common mineral, occuring in almost every rock formation.

It is often roasted for extracting sulphur; after having been exposed to the oxidating influence of the atmosphere it yields sulphate of iron and sulphuric acid.

2. PRISMATIC IRON-PYRITES.

Prismatic Iron-Pyrites. Jam.

Iron-Pyrites, (in part.) *White Iron-Pyrites.* Phil.

Colour pale bronze-yellow, sometimes inclining to green or gray. Streak grayish or brownish-black. Lustre metallic. Brittle. Hardness 6.0—6.5. Sp. gr. 4.67—4.84. Primary form a right rhombic prism. M on M′ 106° 2′. P on M or M′ 90°. Cleavage rather perfect, parallel to the planes of the preceding prism. It occurs in very flat crystals, having at first sight the appearance of dodecahedrons with triangular planes, but which however are macles consisting of similar portions of five crystals.

Compound varieties.—Globular, reniform, botryoidal and other imitative shapes. Massive. Composition fine granular. Fracture even, flat conchoidal.

1. Before the blow-pipe it appears like hexahedral Iron-pyrites. Some of its varieties are particularly subject to decomposition. It consists of

Iron,	45.07	
Sulphur,	53.35	
Manganese,	0.70	
Silex,	0.80	*Berzelius.*

2. The varieties included in the present species are the *Radiated-Pyrites*, *Spear-Pyrites*, *Cockscomb-Pyrites*, *Hepatic-Pyrites*, and some varieties of the *Cellular-Pyrites.* The distinction among the varieties depends on composition and shape, and several accidental circumstances. The crystals of Radiated-Pyrites are generally simple. Spear-Pyrites is found in compound crystals, consisting of two, three or more individuals, regularly grouped. Cockscomb-Pyrites occur both in simple and compound crystals of a particular form, with indentations along their edges, and a colour much inclining to green or gray. Hepatic-Pyrites occurs sometimes in pseudomorphoses of six-sided prisms. It decomposes easily.

The varieties of this species are very useful in manufacturing sulphur, sulphate of iron and sulphuric acid.

3. RHOMBOHEDRAL IRON-PYRITES.

Rhomboidal Iron-Pyrites, or *Magnetic-Pyrites.* Jam.
Magnetic Iron-Pyrites. Phil. C.

Colour intermediate between bronze-yellow and copper-red. Streak dark grayish-black. Lustre metallic. Slight action on the magnet. Brittle. Hardness 3.5—4.5. According to the Count de Bournon, it occurs in irregular six-sided prisms, variously modified. Cleavage parallel to the terminal planes of the prism. M on M 120°. P on M or M′ 90°.

Compound varieties.—Massive. Composition granular; individuals of various sizes, or even impalpable. Fracture uneven.

1. It consists of	Iron,	59.85	56.37	
	Sulphur,	40.15	43.63	*Stromeyer.*

It occurs in beds along with other minerals containing iron.

2. It is found in the Hartz, Siberia, and other European countries.

GENUS V. COPPER-PYRITES.

H.=3.0—4.0
G.=4.1—5.1

1. OCTAHEDRAL COPPER-PYRITES.

Variegated Copper. Jam.
Purple Copper. Phil.

Colour intermediate between copper-red and pinchbeck-brown. Streak pale grayish-black, a little shining. Rather sectile. Hardness 3.0. Sp. gr. 5.0. Primary form a regular octahedron. General form of some crystals a cube, of which the solid angles are replaced. It yields to mechanical division parallel to all the planes of the regular octahedron.

Compound varieties.—Massive. Composition granular. Individuals strongly connected. Fracture conchoidal and uneven.

1. Before the blow-pipe it is fusible into a globule which is strongly magnetic.

It consists of	Copper,	61.07	
	Sulphur,	23.75	
	Iron,	14.	
	Silex,	0.50	*R. Phillips.*

2. It occurs in beds and veins; the crystalized only in veins. The crystalized variety is found only at Cornwall, Eng. in the vicinity of Redruth.

3. It is a valuable mineral for extracting copper.

2. PYRAMIDAL COPPER-PYRITES.

Octahedral Copper-Pyrites. Jam.
Copper-Pyrites. Yellow Copper-Ore. Phil.

Colour brass-yellow, often irridescent externally.

Streak greenish-black, a little shining. Lustre metallic. Rather sectile. Hardness 3.5—4.0. Sp. gr. 4.16. Primary form an octahedron with a square base. The general form of the crystals is that of a tetrahedron having the solid angles always replaced. Structure perfectly lamellar.

Compound varieties.—Globular, reniform, botryoidal, stalactitic and other imitative shapes. Surface generally rough. Composition impalpable. Massive. Composition granular. Individuals of various sizes, often impalpable and strongly coherent. Fracture uneven or flat conchoidal.

1. Upon charcoal it becomes black before the blow-pipe; red on cooling. It melts into a globule which becomes magnetic if kept in the blast for sometime. 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. Pyramidal Copper-Pyrites consists of

Copper,	34.40	33.12	
Iron,	30.47	30.	
Sulphur,	38.87	36.52	
Silex,	0.27	0.39	*H. Rose.*

2. It is frequently found in beds and veins. In beds it is accompanied with the ores of iron and copper. The black friable substance called *Copper-black*, is the product from the decomposition of pyramidal Copper-pyrites, and also from that of several other species. If pure it is the peroxide of Copper.

3. It is found in most of the mining districts of Europe. In the United States at the Perkiomen lead mines, Pa., at Sing-sing, and various places on the Hudson, Cheshire, Simsbury, Ct., Southampton, Mass.

It is a valuable ore for the extraction of copper.

3. COBALT-KIES.

Pyrites?

Cobalt-Kies. Jam.
Sulphuret of Cobalt. Phil.

Colour pale steel-gray, often tarnished copper-red.

Lustre metallic. Semi-hard. Massive. Composition granular, impalpable. Individuals indistinctly cleavable. Fracture conchoidal, uneven.

Compound varieties.—Botryoidal. Brilliant externally.

1. It emits a sulphureous odour before the blow-pipe, and after having been roasted it communicates a blue colour to glass of borax.

It consists of		
	Cobalt,	43.20
	Copper,	14.40
	Iron,	3.53
	Sulphur,	38.50

2. It is found at Riddarhyttan in Sweden, associated with pyramidal Copper-pyrites, and hemi-prismatic Augite-spar.

4. NICKELIFEROUS GRAY ANTIMONY.

Nickeliferous Gray Antimony. Jam.

Colour steel-gray, inclining to silver-white. Lustre metallic. Brittle. Hardness 5.0—5.5. Sp. gr. 6.45. Primary form a cube, to the planes of which it yields a perfect cleavage. Massive. Composition granular.

1. Before the blow-pipe it is partly volatilized, and the charcoal is covered with a white coating. It at last melts into a metallic globule, which communicates to glass of borax a blue colour. It consists of

Nickel,	36.60	25.25
Antimony,	43.80	47.75
Arsenic,	0.00	11.75
Sulphur,	17.71	15.25
Iron and manganese,	1.89	0.00
	Stromeyer.	*Klaproth.*

2. It is met with in several mines in the principality of Nassau, along with hexahedral Lead-glance, and pyramidal Copper-pyrites.

ORDER XI. GLANCE.

GENUS I. COPPER-GLANCE.

H.=2.5—4.0
G.=4.4—6.8

1. TETRAHEDRAL COPPER-GLANCE.

Tetrahedral Copper-Pyrites. Jam.
Fahlers. *Gray Copper.* Phil. C.

Colour steel-gray, passing into iron-black. Streak unchanged, sometimes inclining to brown. Lustre metallic. Rather brittle. Hardness 3.0—4.0. Sp. gr. 5.10. Fracture conchoidal, of different degrees of perfection. Cleavage indistinct, parallel to the planes of the octahedron. Some mineralogists consider the tetrahedron to be the primary form. P on P′ 70° 31′.

1. There are several varieties comprised within the species tetrahedral Copper-glance, which differ much from each other both in their external characters and chemical constitution. But hitherto it has not been possible to fix on those distinctive characters which are required to limit particular species. Hereafter, it is probable that some of the included varieties will constitute separate species in the Natural Historical System.

2. At present there are three principal varieties, viz: the *Arsenical Gray Copper*, *Antimonial Gray Copper*, and *Platiniferous Gray Copper*. These varieties differ much in their reaction before the blow-pipe. Some yield arsenic and others antimony when roasted, and the residue melts in different ways. After roasting they yield a globule of copper. There are varieties, however, which contain zinc, mercury, lead, silver and gold.

3. The present species occurs in most of the mining districts of Europe.

2. PRISMATOIDAL COPPER-GLANCE.

Prismatic Antimony-Glance. Jam.

Colour blackish lead-gray. Streak unchanged. Lustre metallic. Brittle. Hardness 3.0. Sp. gr. 5.73. Fracture conchoidal, imperfect. Surface rough.

1. Prismatoidal Copper-glance is nearly allied to the following species. It contains sulphur, antimony, lead and copper, and it yields a little silver. It gives about the same results before the blow-pipe.
2. It is found at St. Gertraud, near Wolfsberg, in Carinthia.

3. DI-PRISMATIC COPPER GLANCE.

Axifrangible Antimony-Glance, or *Bournonite*. Jam.
Bournonite. *Triple Sulphuret*. Phil.

Colour steel-gray, inclining to blackish lead-gray or iron-black. Streak unchanged. Lustre metallic. Brittle. Hardness 2.5—3.0. Sp. gr. 5.76. Primary form a right rectangular prism of 93° 30′ and 86° 30′. It yields readily to mechanical division, and furnishes brilliant planes on a recent face of cleavage. Structure perfectly lamellar.

1. Before the blow-pipe on charcoal it melts, smokes, and afterwards yields a black globule. In a strong heat the charcoal becomes covered with oxide of lead. It is easily soluble in heated nitric acid.
2. Di-prismatic Copper-glance has been found in Cornwall, associated with hexahedral Lead-glance, and prismatoidal Antimony-glance.

4. PRISMATIC COPPER-GLANCE.

Rhomboidal Copper-Glance, or *Vitreous Copper*. Jam.
Vitreous Copper. *Sulphuret of Copper*. Phil.

Colour blackish lead-gray, occasionally irridescent. Streak unchanged, sometimes shining. Lustre metallic. Very sectile. Hardness 2.5—3.0. Sp. gr. 5.69, of a compact variety. It is found crystalized in six-sided prisms variously modified.

1. In the oxidating flame of the blow-pipe it melts and emits with a noise glowing drops. In the reducing flame it becomes covered with a coat, but does not melt. If the sul-

phur is driven off a globule of copper remains. In heated nitric acid the copper is dissolved, and the solution assumes a green colour, and the sulphur remains. By decomposition it is converted into black copper.

It consists of	Copper,	76.50
	Sulphur,	22.
	Iron,	0.50

2. It is one of the most common of the ores of copper, and is rich and valuable.

GENUS II. SILVER-GLANCE.

H.=2.0—2.5
G.=6.9—7.2

1. HEXAHEDRAL SILVER-GLANCE.

Hexahedral Silver-Glance. Jam.
Sulphuret of Silver. Phil. C.

Colour blackish lead-gray. Streak shining. Lustre metallic. Subject to tarnish. Fracture small conchoidal, uneven. Surface generally rough, uneven and possessing but little lustre. Malleable. Hardness 2.0—2.5. Sp. gr. 7.19. Traces of cleavage parallel to the planes of a dodecahedron.

Compound varieties.—Reticulated, arborescent, dentiform, filiform and capillary shapes. Individuals not always distinguishable. Some of the imitative forms longitudinally streaked.

1. It intumesces and fuses easily before the blow-pipe, and gives a globule of silver. It is soluble in dilute nitric acid.

It consists of	Silver,	85.	
	Sulphur,	15.	*Klaproth.*

2. It is found in veins accompanied with a great variety of the ores of silver, lead, antimony and zinc. It is found in Mexico and Peru.

3. It is a valuable ore of silver, and is the one principally employed for the extraction of that metal.

GENUS III. LEAD-GLANCE.

H.=2.5
G.=7.4—7.6

1. HEXAHEDRAL LEAD-GLANCE.

Hexahedral Galena, or *Lead-Glance*. Jam.
Galena. *Sulphuret of Lead*. Phil. C.

Colour pure lead-gray; by decomposition black or blackish-gray. Streak unchanged. Lustre metallic. Rather sectile. Hardness 2.5. Sp. gr. 7.56. Primary form a cube, which is easily obtained by mechanical division.

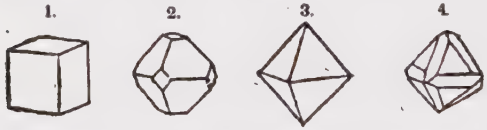


Fig. 1. Primary. Fig. 2. Cube passing into the octahedron. Fig. 3. The octahedron complete. Fig. 4. Octahedron with its edges replaced.

Compound varieties.—Reticulated, tabular and other imitative shapes. Massive. Composition fine granular, passing into impalpable; the colour is then pale lead-gray; the fracture even or flat conchoidal, and the streak shining.

1. Before the blow-pipe, if heated cautiously, it melts and yields globules of metallic lead, after the sulphur is driven off. It is partly soluble in nitric acid, and leaves a whitish residue.

It consists of Lead 104, one p.
Sulphur 16, one p.

2. Hexahedral Lead-glance is commonly divided into the following varieties, viz: *Granular*, *Compact*, *Specular* or *Slickensides*, *Antimoniated* and *Argentiferous Galena*. The *Blue Lead* is only the common galena, in the form of rhombohedral Lead-baryte. The Super-Sulphuret of Lead is an earthy variety of a bluish-gray colour, and so highly inflammable that it takes fire and burns on being held in the flame of a candle.

3. The present species is a very abundant mineral, and furnishes all the lead of commerce. Remarkable beds of it are found in Missouri. It also occurs in Southampton, Mass. and several other places in the neighborhood of Southampton.

This mineral sometimes contains a sufficient quantity of silver to make it profitable to work for that metal. It sometimes also contains gold.

GENUS IV. TELLURIUM-GLANCE.

H.=1.0—1.5
G.=7.0—7.1

1. PRISMATIC TELLURIUM-GLANCE.

Prismatic Black Tellurium. Jam.
Black Tellurium. Phil.

Colour blackish lead-gray. Streak unchanged. Lustre metallic. Thin laminæ highly flexible. Very sectile. Hardness 1.0—1.5. Sp. gr. 7.08. Crystalizes in small and nearly tabular crystals. Primary form a right square prism.

1. Before the blow-pipe it melts easily upon charcoal, emits white fumes, which are deposited upon the charcoal and gives a malleable metallic globule. With borax it gives a bead of gold containing a little silver. It is easily soluble in nitric acid. It consists of

Tellurium,	32.20	
Lead,	54.00	
Gold,	9.00	
Silver,	0.50	
Copper,	1.30	
Sulphur,	3.00	*Klaproth.*

2. Its chief locality is Nagyag, in Transylvania.

GENUS V. MOLYBDENA-GLANCE.

H.=1.0—1.5
G.=4.4—4.6

1. RHOMBOHEDRAL MOLYBDENA-GLANCE.

Rhomboidal Molybdena. Jam.
Sulphuret of Molybdena. Phil. C.

Colour pure lead-gray. Streak unchanged. Lustre metallic. Thin laminæ highly flexible. Very sectile. Opake. Hardness 1.0—1.5. Sp. gr. 4.59. It crystalizes in low six-sided prisms, which yield to cleavage parallel to the terminal planes.

1. Before the blow-pipe it does not melt nor is it reduced, but emits sulphureous fumes which are deposited on the charcoal. It deflagrates with nitre, and is soluble with effervescence in nitric acid, leaving a gray residue.

It consists of Molybdena 48, one p.
Sulphur 32, two p.

It is found imbedded or disseminated in primitive rocks, as granite and gneiss.

2. It is found near Baltimore, Brunswick, Me. Shaftsbury, Vt. Brimfield, Mass.

GENUS VI. BISMUTH-GLANCE.

H.=2.0—2.5
G.=6.1—6.4

1. PRISMATIC BISMUTH-GLANCE.

Prismatic Bismuth Glance. Jam.
Sulphuret of Bismuth. Phil.

Colour lead-gray, inclining a little to steel-gray. Streak unchanged. Lustre metallic. Opake. Rather sectile. Hardness 2.0—2.5. Sp. gr. 6.54. Brittle. It crystalizes in small crystals deeply striated longitudinally. They yield to cleavage parallel to the plane P, the inclination of which on the lateral planes is about 90°, also indications of cleavage parallel to the planes of a right rhombic prism of about 130° and 50°.

1. It melts in the flame of a candle. Before the blow-pipe it is volatilized and covers the charcoal with a yellow areola. It is easily soluble in nitric acid, and the solution yields a white precipitate on being diluted.

It consists of Bismuth, 60.
Sulphur, 40.

2. It is a rare mineral, and is found only in a few of the mining districts of Europe.

GENUS VII. ANTIMONY-GLANCE.

H.=1.5—2.5
G.=4.2—5.8

1. PRISMATIC ANTIMONY-GLANCE.

Graphic Gold-Glance, or *Graphic Tellurium*. Jam.
Graphic Tellurium. *Graphic Gold*. Phil.

Colour pure steel-gray, sometimes tin-white. Streak unchanged. Lustre metallic. Opake. Very sectile. Hardness 1.5—2.0. Sp. gr. 5.72. Fracture even. Brittle. Crystals minute, cleaving easily, but the primary form is unknown.

Compound varieties.—Massive. Composition imperfectly columnar or granular, small but not impalpable.

1. The prismatic Antimony-glance melts easily into a gray globule, which fumes and covers the charcoal with a white oxide. After continuing the blast for sometime, a ductile metallic globule is obtained. It is soluble in nitric acid.

It consists of	Tellurium,	60.
	Gold,	30.
	Silver,	10.

2. It is found at Offenbanya, in Transylvania. It is a valuable ore on account of its contents of gold and silver.

2. PRISMATOIDAL ANTIMONY-GLANCE.

Prismatic Antimony-Glance, or *Gray Antimony*. Jam.
Gray Antimony. *Sulphuret of Antimony*. Phil.

Colour lead-gray, often iridescent, inclining to steel-gray. Streak unchanged. Lustre metallic. Sectile. Opake. Thin laminæ slightly flexible. Hardness 2.0. Sp. gr. 4.62.. Primary form a right rhombic prism of about 88° 30′ and 91° 30′.

1. It is very fusible before the blow-pipe and is absorbed by the charcoal. By continuing the heat it may be volatilized without leaving any considerable residue.

It consists of	Antimony,	75.
	Sulphur,	25.

2. It occurs in the Hartz, Cornwall, Eng. and in Scotland, associated with species of the orders Glance, Blende and Haloide. It is used for extracting the crude antimony, or the metal itself, which is employed in the manufacture of several metallic alloys, and in medicine.

3. AXOTOMOUS ANTIMONY-GLANCE.

Prismatoidal Antimony-Glance, or *Gray Antimony* (in part.) Jam.

Colour steel-gray. Streak unchanged. Lustre metallic. Opake. Sectile. Hardness 2.0—2.5. Sp. gr. 5.56.

Compound varieties.—Massive. Composition columnar; individuals generally very delicate, straight and parallel, or divergent.

1. Nothing is as yet known of the proportions among the elements of the present species. It contains sulphur, antimony and lead.

2. The axotomous antimony-glance is a rare mineral. It occurs however in Cornwall, in masses of considerable dimensions.

GENUS VIII. MELANE*-GLANCE.

H.=2.0—2.5
G.=5.9—6.4

1. PRISMATIC MELANE-GLANCE.

Rhomboidal Silver-Glance, or *Brittle Silver-Glance*. Jam.
Brittle Sulphuret of Silver. Phil.

Colour iron-black, dark-lead or bluish-gray. Streak unchanged. Lustre metallic. Opake. Sectile. Hardness 2.0—2.5. Sp. gr. 6.26. Fracture conchoidal. Occurs crystalized in low six-sided prisms, of which the terminal edges are sometimes replaced.

1. Before the blow-pipe on charcoal it yields a dark coloured metallic globule, which may be reduced by the addition of nitre, or soda and silex. It is soluble in nitric acid.

It consists of	Silver,	66.50
	Antimony,	10.

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[*] From *melas*, black.

Iron,	5.	
Sulphur,	12.	
Copper and Arsenic,	0.50	*Klaproth.*

2. It is found chiefly in Saxony, along with other silver ores.

The two following minerals require to be noticed here, as they seem to be nearly allied to the preceding species.

i. FLEXIBLE SULPHURET OF SILVER. *Phil.*

Colour dark externally, nearly black. Streak shining, but less so than hexahedral Silver-glance. Lustre metallic. Thin laminæ flexible, yields readily to the knife. Cleavage perfect parallel to P. Primary form a right oblique angled prism, of which the lateral planes incline to each other alternately at angles of 125° and 55°. Crystals minute, shining and flexible.

It consists of silver, sulphur and a little iron. The locality of the mineral is supposed to be Hungary.

ii. SULPHURET OF SILVER AND ANTIMONY. *Phil.*

Colour approaching silver-white. Lustre metallic. Yields easily to the knife. Sp. gr. 5.5. Primary form a right rhombic prism of 100° and 80°. Cleavage perfect.

Before the blow-pipe it gives off copious white fumes and a slight sulphureous odor, leaving behind a white metallic globule. It consists chiefly of antimony, sulphur and silver.

2. ARGENTIFEROUS COPPER-GLANCE.

Argentiferous Copper-Glance. Jam.
Sulphuret of Silver and Copper. Phil.

Colour blackish lead-gray. Streak shining. Lustre metallic. Perfectly sectile. Soft. Sp. gr. 6.25. Fracture flat conchoidal, even. Massive. Composition impalpable.

It consists of

Silver,	52.27	
Copper,	30.47	
Iron,	0.33	
Sulphur,	15.78	*Stromeyer.*

3. BISMUTHIC SILVER.

Glance. ?

Bismuthic Silver. Jam. Phil.

Colour light lead-gray, liable to tarnish. Lustre metallic. Opake. Sectile. Soft. Occurs in acicular and capillary crystals. Fracture uneven.

1. It melts readily before the blow-pipe, covers the charcoal with an areola of the oxides of lead and bismuth, and finally yields a silver button. It is dissolved in dilute nitric acid, and yields by analysis

Lead,	33.	
Bismuth,	27.	
Silver,	15.	
Iron,	4.30	
Copper,	0.90	
Sulphur,	16.30	*Klaproth.*

2. It has been found at Schapback, in Baden. It is used as an ore of silver.

4. COBALTIC GALENA, or COBALTIC LEAD-GLANCE.

Colour lead-gray, inclining to blue. Lustre metallic, splendent. Opake. Soft. Sectile. Soils a little. Very small, moss-like grouped crystals. Massive. Composition granular. Individuals cleavable. Sp. gr. 8.44.

To borax before the blow-pipe it communicates a smalt-blue colour. It consists of

Lead,	62.89
Arsenic,	22.47
Sulphur,	0.47
Iron,	2.11
Cobalt,	0.94
Arsenical pyrites,	1.44

5. CUPREOUS BISMUTH.

Glance ?

Cupriferous Sulphuret of Bismuth. Phil. Jam.

Colour pale lead-gray, passing into steel-gray and tin-white, subject to tarnish. Lustre metallic. Streak black. Opake. Soft. Sectile. Massive. Composition columnar, impalpable. Fracture uneven.

1. It is partly soluble in nitric acid, leaving the sulphur undissolved. It consists of

Bismuth,	47.24
Copper,	34.66
Sulphur,	12.58

2. It occurs in the principality of Fürstenberg, in cobalt veins.

6. EUCAIRITE.

Seleniuret of Silver and Copper. Phil.

Colour lead-gray. Streak shining. Lustre metallic. Opake. Massive. Composition granular. Cleavable. Soft.

1. Before the blow-pipe it melts easily and emits the odor of selenium. It is soluble in boiling nitric acid.

It consists of

Silver,	38.93
Copper,	23.05
Selenium,	26.00
Foreign substances,	8.90

2. It is found in Smaland in Sweden, in a talcose or serpentine-like rock.

7. MOLYBDENA-SILVER.

Molybdena-Silver. Jam. *Molybdic-Silver.* Phil.

Colour pale steel-gray. Lustre metallic. Not particularly sectile. Soft. Elastic. Sp. gr. 8.0. Cleavage perfect parallel to the planes of a rhombohedron.

1. Before the blow-pipe it melts easily into a globule, that can be entirely volatilized, during which the supporting charcoal is covered with a yellow oxide. If dissolved in a state of powder in nitric acid, a precipitate of sulphur is formed,

It consists of		
	Bismuth,	95.
	Sulphur,	5.

2. It has been found in Hungary, associated with species of the genus Lime-haloide, Iron-pyrites, &c.

8. NATIVE NICKEL.

Native Nickel. Jam. Phil.

Colour brass-yellow, inclining to bronze-yellow and steel-gray. Lustre metallic. Occurs in delicate capillary crystals.

1. It consists of		
	Nickel,	64.35
	Sulphur,	34.26

Before the blow-pipe it melts into a brittle metallic globule. It colours the glass of borax blue. In nitric acid it is dissolved without leaving a residue, and forms a pale green solution.

2. It occurs in Saxony and Bohemia along with several species of Iron-pyrites and Lime-haloide.

9. NEEDLE-ORE.

Needle-Ore. Jam.
Plumbo-cupriferous Sulphuret of Bismuth. Phil.

Colour blackish lead-gray. Lustre metallic. Fracture uneven. Hardness 2.0—2.5. Sp. gr. 6.12. Cleavage unknown, imperfect. Prismatic.

1. Before the blow-pipe its sulphur is driven off, and it melts and emits numerous sparkling and metallic globules. A button of lead containing copper remains, which communicates a greenish-blue colour to borax. It is soluble in nitric acid, and consists of

Bismuth,	43.20	
Lead,	24.32	
Copper,	12.10	
Nickel,	1.58	
Tellurium,	1.32	
Sulphur,	11.55	
Gold,	0.79	*John.*

2. It occurs at Catharineburg, in Siberia, imbedded in Quartz, and associated with Gold and several species of the orders Malachite, Glance and Pyrites.

10. SELENIURET OF COPPER.

Seleniuret of Copper. Phil.

Colour silver-white. Streak shining. Lustre metallic. Soft. Malleable. Massive. Also superficial upon fissures in rhombohedral Lime-haloide.

1. It acquires negative electricity by friction. It melts easily upon charcoal into a gray malleable globule, giving out a strong smell of selenium, and consists of selenium and copper.

2. It has hitherto been found exclusively in a copper mine at Smaland, in Sweden.

11. TENNANTITE.

Tennantite. Jam. Phil.

Colour blackish lead-gray. Streak reddish-gray. Lustre metallic. Opake. Brittle. Scratches prismatic and tetrahedral copper-glance. Sp. gr. 4.37. Cleavage parallel to the planes of a dodecahedron, but imperfect. Sometimes massive, with a granular composition, which passes into impalpable. Fracture even.

1. Before the blow-pipe tennantite decrepitates a little, and burns with a blue flame, emitting copious arsenical vapors, and melting at last into a black scoria, which is magnetic.

It consists of	Copper,	45.32
	Arsenic,	11.84
	Iron,	9.26
	Sulphur,	28.74
	Silex,	5.

2. It occurs in several of the Cornish copper mines, in veins traversing granite and clay-slate.

12. TIN-PYRITES.

Colour steel-gray, inclining to yellow. Lustre metallic. Streak black. Opake. Brittle. Hardness 4.0. Sp. gr. 4.35. Massive. Fracture uneven, imperfect conchoidal. Composition granular. Strongly coherent.

1. Before the blow-pipe the sulphur is driven off, and the mineral melts into a blackish scoria, without yielding a metallic button. It is soluble in nitro-muriatic acid, during which the sulphur is precipitated.

It consists of	Tin,	34.	
	Copper,	36.	
	Iron,	2.	
	Sulphur,	25.	*Klaproth.*

2. It is found at St. Agnes, in Cornwall, with pyramidal Copper-pyrites.

13. YELLOW TELLURIUM.

Yellow Gold-Glance, or Yellow Tellurium. Jam.
Yellow Tellurium. Phil.

Colour silver-white, much inclining to brass-yellow. Opake. Lustre metallic. Imbedded crystaline laminæ. Fracture uneven. Only traces of cleavage. Rather brittle. Soft. Sp. gr. 10.67.

1. Before the blow-pipe it melts into a metallic globule and emits a pungent odor. It is soluble in nitric acid.

It consists of	Tellurium,	44.76
	Gold,	26.75
	Lead,	19.50
	Silver,	8.50
	Sulphur,	0.50

2. The only locality is Nagyag in Transylvania, where it occurs with prismatic Tellurium-glance and hexahedral Glance-blende, &c.

ORDER XII. BLENDE.

GENUS I. GLANCE-BLENDE.

H.=3.5—4.0
G.=3.9—4.05

1. HEXAHEDRAL GLANCE-BLENDE.

Prismatic Manganese-Blende. Jam.
Sulphuret of Manganese. Phil.

Colour iron-black; on a recent fracture dark steel-gray. Streak dark-green. Lustre imperfect metallic. Opake.

Rather sectile. Hardness 3.5—4.0. Sp. gr. 4.01. Fracture uneven, imperfect conchoidal. Surface rough. Primary form a cube. Cleavage perfect; traces of cleavage parallel to the planes of a dodecahedron.

1. Before the blow-pipe it is melted only on the thinnest edges. It emits sulphuretted hydrogen if pulverised and thrown into nitric acid, and is dissolved. It consists of

Protoxide of manganese,	82.
Sulphur,	11.
Carbonic acid,	5.

2. It is a rare mineral. It occurs chiefly in veins, with prismatic Tellurium-glance, at Nagyag, in Transylvania.

GENUS II. GARNET-BLENDE.

H.=3.5—4.0
G.=4.0—4.2

1. DODECAHEDRAL GARNET-BLENDE.

Dodecahedral Zinc-Blende. Jam.
Blende. Sulphuret of Zinc. Phil.

Colour green, yellow, red, brown, black; none of them bright. Streak white, or corresponding to the colour. Lustre adamantine. Transparent...translucent. Brittle. Hardness 3.5—4.5. Sp. gr. 4.07. of a cleavable variety; 4.02 of a compound variety. Primary form a dodecahedron. Cleavage perfect. Fracture conchoidal.

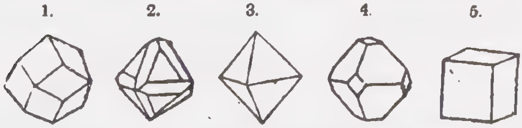

Fig. 1. Primary, a rhombic dodecahedron. Fig. 2. The same, of which eight of the solid angles are replaced by as many triangular planes, forming a passage into the regular octahedron. Fig. 3. The octahedron complete. Fig. 4. The octahedron, with the solid angles replaced by quadrangular planes. Fig. 5. Those planes complete, forming the cube.

Compound varieties.—Reniform, and other imitative shapes. Surface rough. Composition columnar, often almost impalpable. Massive. Composition granular, columnar, and sometimes impalpable. Fracture uneven, or even.

1. When strongly heated in the oxidating flame of the blow-pipe it gives off vapours of zinc, which form a coating on the charcoal, but it does not melt. It is soluble in nitric acid, during which process sulphuretted hydrogen is disengaged.

It consists of Zinc 34, one p.
Sulphur 16, one p.

It contains, however, from one to twelve per cent of iron.

2. Dodecahedral Garnet-blende is met with in veins and beds, accompanied chiefly with hexahedral Lead-glance, Iron-pyrites, species of the orders Haloide and Baryte.

3. It is found at Southampton and Leverett, Mass., Perkiomen lead mines, Pa., Hamburgh, N. J., in the Shawangunk Mountains, the Highlands, N. Y., and in Berlin, Ct.

GENUS III. PURPLE-BLENDE.

H.=1 0—1.5
G.=4.5—4.6

1. PRISMATIC PURPLE-BLENDE.

Prismatic Antimony-Blende, or Red Antimony. Jam.
Red Antimony. Phil.

Colour cherry-red. Streak cherry-red or brownish-red. Lustre common or metallic adamantine. Feebly translucent. Sectile. Thin laminæ are slightly flexible. Hardness 1.0—1.5. Sp. gr. 4.5—4.6. Primary form is supposed to be a right square prism.

Compound varieties.—Tufts of capillary crystals. Massive. Composition thin columnar, straight and divergent from common centers.

1. Before the blow-pipe it melts easily upon charcoal by which it is absorbed, and at last entirely volatilised. Immersed in nitric acid, it is covered with a white coating.

It consists of		
	Antimony,	67.50
	Oxygen,	10.80
	Sulphur,	19.70

2. It is always accompanied with prismatoidal Antimony-glance. It occurs in veins. It is found in Saxony, Hungary, and Dauphiny in France.

GENUS IV. RUBY-BLENDE.

H.=2.0—2.5
G.=5.2—8.2

1. RHOMBOHEDRAL RUBY-BLENDE.

Rhomboidal Ruby-Blende, or *Red Silver*. Jam.
Red Silver. *Ruby Silver*. Phil.

Colour iron-black, sometimes passing into cochineal-red. Streak several shades of cochineal-red, or corresponding to the colour ; in some varieties it is aurora-red. Lustre adamantine : metallic adamantine in the dark coloured varieties. Semi-transparent...opake. Sectile. Hardness 2.0—2.3. Sp. gr. 5.84. Brittle. Primary form an obtuse rhomboid of 108° 30′ and 71° 30′. Structure perfectly lamellar.

Compound varieties.—Dendritic and scaly forms. Massive. Composition granular, of various sizes of individuals, strongly connected.

1. It decrepitates before the blow-pipe upon charcoal, melts and emits fumes of sulphur and antimony, after which it yields a globule of silver. It is soluble in dilute nitric acid.

It consists of		
	Silver,	58.94
	Antimony,	22.84
	Sulphur,	16.60

2. Rhombohedral Ruby-blende has been found at only a few localities, but in some of these it is said to occur in considerable quantities. It is found in the mining districts of Saxony, also in Mexico and Peru.

It is a valuable mineral for the extraction of silver. The dark-red varieties yield a greater quantity than the light.

2. HEMI-PRISMATIC RUBY-BLENDE.

Dark-Red Silver.

Colour iron-black. Streak dark cherry-red. Lustre intermediate between metallic and metallic-adamantine. Opake, except in thin splinters, when it transmits a deep blood-red colour. Very sectile. Hardness 2.0—2.5. Sp. gr. 5.22. Fracture imperfect conchoidal.

It agrees nearly in its results before the blow-pipe with the preceding species. It contains only about 30...40 per cent of silver, besides sulphur and antimony. Very rare.

3. PERITOMOUS RUBY-BLENDE.

Prismato-rhomboidal Ruby-Blende, or Cinnabar. Jam.
Cinnabar. Sulphuret of Mercury. Phil.

Colour several shades of cochineal red, the darker varieties inclining to lead-gray. Lustre adamantine, inclining to metallic in dark coloured varieties. Streak scarlet-red. Semi-transparent...translucent on the edges. Sectile. Hardness 2.0—2.5. Sp. gr. 8.09. Primary form an acute rhomboid of 71° 48′ and 108° 12′. Structure lamellar.

Compound varieties.—Rarely in imitative shapes. Massive. Composition fine granular, passing into impalpable in some varieties. Fracture uneven or even.

1. Before the blow-pipe the pure varieties are entirely volatilized. It is soluble in nitric acid.

These two varieties, which are usually known under distinct names, are the *Hepatic Cinnabar* and the *Bituminous Cinnabar*. It consists of

Mercury,	84.50
Sulphur,	14.75

2. It occurs at Idria in Carniola, in beds of bituminous slate. Also at Almaden in Spain.

It is used for the extraction of mercury; when very pure it may be employed as a pigment in its natural state.

ORDER XIII. SULPHUR.

GENUS I. SULPHUR.

H.=1.5—2.5
G.=1.9—3.6

1. PRISMATOIDAL SULPHUR.

Yellow Orpiment, or *Prismatoidal Sulphur*. Jam.
Orpiment. Phil.

Colour several shades of lemon-yellow. Streak lemon-yellow, generally a little paler than the colour. Lustre metallic. Pearly upon the perfect faces of cleavage, for the rest, resinous. Sectile. Transparent...translucent on the edges. Thin laminæ flexible. Hardness 1.5—2.0. Sp. gr. 3.48. Primary form a right rhombic prism of 100° and 80°. It yields to mechanical division parallel only to the longer diagonal of the prism.

Compound varieties.—Reniform, botryoidal and other imitative shapes. Massive. Composition granular, of various sizes of individuals.

1. Before the blow-pipe upon charcoal it burns with a blue flame, and emits fumes of sulphur and arsenic. It is soluble in nitric, muriatic and sulphuric acids.

It occurs in nodules or in imbedded crystals in blue clay.

2. It is found in Hungary, near Vienna, and at Kaprick in Transylvania.

2. HEMI-PRISMATIC SULPHUR.

Red Orpiment, or *Ruby Sulphur*, or *Hemi-Prismatic Sulphur*. Jam.
Orpiment. Phil.

Colour aurora-red in several shades, but which differ but little from each other. Streak orange-yellow, sometimes passing into aurora-red. Lustre resinous. Sectile. Hardness 1.5—2.0. Sp. gr. 3.55. It cleaves parallel to the planes of a rhombic prism of 105° 45′ and 74° 15′. The terminal plane on the lateral being about 104° 6′.

Compound varieties.—Massive. Composition granular. Cross fracture conchoidal, with a splendent lustre.

It appears before the blow-pipe like the preceding species.

It consists of	Sulphur,	31.00
	Arsenic,	69.00

3. PRISMATIC SULPHUR.

Prismatic Sulphur. Jam. *Sulphur.* Phil.

Colour several shades of sulphur-yellow, inclining sometimes to red or green. Streak sulphur-yellow, passing into white. Lustre resinous. Transparent...translucent on the edges. Sectile. Hardness 1.5—2.5. Sp. gr. 2.07. Primary form an octahedron with a rhombic base.

Compound varieties.—Imbedded globules. Massive. Composition granular, often impalpable, strongly coherent ; sometimes pulverulent.

1. Sulphur burns with a bluish flame. By friction it acquires resinous electricity. It is insoluble in water, but unites readily with soda or potash.

2. It is found principally in volcanic districts, and often occurs in splendid crystals. Sometimes it is produced by the decomposition of pyrites.

3. Prismatic Sulphur requires to be purified, either by melting or sublimation, before it is fit to be an object of commerce. It is used in the manufacture of gun-powder, sulphuric acid, and various other articles.

CLASS III. RESIN COAL.

ORDER I. RESIN.

GENUS I. MELICHRONE*-RESIN.

H.=2.0—2.5
G.=1.4—1.6

1. PYRAMIDAL MELICHRONE-RESIN.

Pyramidal Honeystone. Jam. *Mellite.* Phil.

Colour honey-yellow, inclining often to red or brown.

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* From the Greek, signifying the colour of honey.

Streak white. Lustre resinous. Transparent...translucent. Sectile. Hardness 2.0—2.5. Sp. gr. 1.59. Crystalizes in the form of obtuse octahedrons, of which the common base is a square. It yields to mechanical division parallel to all its planes, but not with brilliant faces.

It loses its colour and transparency in the flame of a candle, and is soluble in nitric acid. Only one authenticated locality, viz. Arten in Thuringia.

GENUS II. MINERAL-RESIN.

H.=0.0—2.6
G.=0.8—1.2

1. YELLOW MINERAL-RESIN.

Yellow Mineral-Resin, or *Amber*. Jam.
Amber. Phil. C.

Prevailing colour yellow, passing into red, brown and white. Streak white. Lustre resinous. Transparent... translucent. Not very brittle. Hardness 2.4—2.5. Sp. gr. 1.08. Resinous electricity produces friction. Cleavage none. Fracture conchoidal. Surface uneven and rough.

1. It burns with a yellow flame, giving out an agreeable odour, and leaves a carbonaceous residue. It is soluble in alcohol.
2. It is found in the greatest quantity on the Prussian coast on the Baltic. Also on the coasts below Amboy, N. J.
3. It is cut into various ornaments and works of art. Considerable value is attached to large transparent specimens.

2. BLACK MINERAL-RESIN.

Black Mineral Resin. Jam.
Mineral Oil. *Bitumen*. *Mineral Pitch*. Phil.

Prevailing colour black, but passes into various brown and red tints. Aggregation solid or fluid, and all the intermediate stages. Fluid varieties are sometimes perfectly colourless. Streak commonly unchanged. Fracture conchoidal, more or less perfect, uneven. Translucent on the edges...opake. Some fluid varieties transparent. Sectile. Malleable. Elastic. Bituminous odour. Hardness 0.0—2.0. Sp. gr. 0.82, brown malleable variety; 1.07 black and slaggy variety; 1.16 hyacinth-red, slaggy variety. No regular form or cleavage. Massive.

1. The present species has been divided into two distinct species, viz: Mineral Oil and Mineral Pitch. They differ, however, only in their state of aggregation, and there is a perfect transition from the most perfect fluid to the solid varieties. Mineral Pitch has been divided into *elastic earthy* and *slaggy*. Those varieties are also joined by transitions. The fluid variety, called Naptha, consists of

Carbon,	82.20	87.60
Hydrogen,	14.80	12.78

2. All the varieties are highly inflammable, and burn with a white flame and much smoke.

3. The fluid varieties ooze out of several rocks, as sandstone, clay-slate and the bituminous carbonate of lime rock. The slaggy varieties are met with in the form of nodules in limestone, in agate balls, in veins with hexahedral Lead-glance. Also on the shores of the Dead Sea.

Elastic Bitumen, or Elastic Mineral Pitch, has been found only in Castleton, Derbyshire, though I have observed indications of it in a fibrous limestone from the vicinity of Munroe, Ct.

4. The different varieties allow of considerable application for illumination, for fuel, in fire-works, in the manufacture of varnish, of black sealing wax, and other purposes.

3. RETINITE.

Retinite. Jam.
Retinasphalt. Phil.

Colour green, yellow, red, brown, sometimes in striped delineation. Lustre resinous. Semi-transparent...opake. Hardness 1.5—2.0. Sp. gr. 1.13.

1. It takes fire in the flame of a candle, melts and burns with a particular odor. It is partly soluble in alcohol, leaving behind an unctuous residue.

It consists of	Vegetable resin,	55.
	Bitumen or Asphalt,	42.
	Earthy matter,	3.

2. It has been found in the beds of earthy-brown coal, near Halle, on the Saale.

ORDER II. COAL.

GENUS I. MINERAL-COAL.

H.=1.0—2.5
G.=1.2—1.5

1. BITUMINOUS MINERAL-COAL.

Brown Coal, (excepting Alum-Earth.) *Black Coal.* Jam.
Black Coal. Common Coal. Cannel Coal. Jet-Brown Coal. Phil.

Colour black or brown, passing on earthy varieties into grayish tints. Streak unchanged, except that it sometimes becomes shining. Opake. Lustre resinous, more or less distinct. Sectile in different degrees. Hardness 1.0—2.5. Sp. gr. 1.22, moor coal; 1.27, common brown coal; 1.27, black coal from Newcastle; 1.32, common brown coal from Stiria; 1.43, cannel coal from Wigan, Lancashire.

Compound varieties.—Massive. Composition lamellar; faces of composition smooth and even. Texture granular, often impalpable, and then the fracture is uneven or flat conchoidal. There are some varieties which have a loose friable texture.

1. Several varieties are included in the present species, as *slate coal, foliated coal, coarse coal, cannel coal, pitch coal,* and *earthy coal.* All these varieties are joined by almost imperceptible gradations. They all are more or less easily inflammable, and burn with flame and a bituminous odour. Some of the varieties become soft and coke when kindled. They leave a more or less earthy residue.

2. Bituminous Mineral-coal is very generally distributed,

and the important uses to which it is applied are well known. Deposits of it are found in Virginia, Ohio and Pennsylvania.

3. Coal is probably always produced from vegetables. The opinion is rendered at least plausible, from the fact that in the vicinity of most coal-beds vegetables are preserved in the rocks, sometimes in immense quantities.

2. NON-BITUMINOUS MINERAL-COAL.

Glance Coal. Jam.
Mineral Carbon. Mineral Charcoal. Anthracite. Blind Coal. Phil.

Colour black or iron-black, sometimes inclining to grayish-black. Streak unchanged. Opake. Lustre imperfect metallic. Fracture conchoidal. No regular form or structure. Not very brittle. Hardness 2.0—2.5. Sp. gr. 1.40—1.48.

Compound varieties.—Massive. Composition lamellar, impalpable. Some varieties are vesicular, others are divided into columnar masses, meeting in rough faces.

1. The present species contains the following varieties, viz: Conchoidal and Slaty Glance-coal, both of which are designated by the name of Anthracite.

2. The varieties do not contain any bitumen, but consist almost wholly of carbon, occasionally mixed with variable proportions of oxide of iron, silex and alumine. It is frequently disseminated in quartz crystals.

3. The most interesting deposits of Anthracite are those of Wilkesbarre and Carbondale, Pa. The coal region of Pennsylvania is quite extensive, and numerous beds of coal have been discovered on the Lehigh, Susquehannah and Schuylkill rivers. The deposits of Anthracite at Worcester, Mass., and Portsmouth, R. I., differ much in their characters from the Lehigh and Wilkesbarre anthracite. The coal of the two former localities is much less combustible, and of course less valuable.

APPENDIX I.

The following minerals comprise those which are rare. The greater part are proposed species, which are not fully established.

AESCHINITE. *Brooke.*

Colour brownish-yellow. Hardness between apatite and feldspar. Sp. gr. 5.14. Resembles gadolinite. It is found in Siberia.

ALLOPHANE. *Jam. Phil.*

Colour blue, green, brown. Transparent...translucent on the edges. Lustre vitreous, inclining to resinous. Hardness 3.0. Sp. gr. 1.85—1,88.

1. Infusible before the blow-pipe. With borax it melts into a transparent, colourless glass. It consists of

Alumine,	32.20
Silex,	21.92
Lime,	0.72
Sulphate of lime,	0.51
Carbonate of copper,	3.05
Hydrate of iron,	2.27
Water,	41.30

2. It is found at Saalfeld, in Thuringia.

ARFVEDSONITE.

Peritomous Augite-Spar. Partsch.

Hardness 5.0—6.0. Sp. gr. 3.3—3.4. Inclination of M on M 123° 55′.

ARSENIET OF ANTIMONY. *Thomp.*

Colour bluish-gray. Lustre metallic. Sectile. Texture fine granular. Soft. Sp. gr. 6.13. Massive.

It is not altered by exposure to air. Before the blow-pipe it fuses, sublimes in white smoke, having a strong arsenical smell; leaving scarcely any residue.

It consists of	Antimony,	46.61
	Arsenic,	38.50
	Loss,	14.88

ARSENICAL ANTIMONY-GLANCE.

Colour tin-white. Lustre metallic. Hardness 2.0—3.0. Sp. gr. 6.2.

ARSENICAL BISMUTH.

Colour dark hair-brown. Lustre resinous. Soft. Heavy.

ARSENIC-GLANCE.

Colour lead-gray. Structure compact. Hardness 2.0. Sp. gr. 5.2—5.5.

BABINGTONITE.

Axotomous Augite-Spar.

Inclination of M on M′ 155° 25′.

BERTHIERITE.

Sulphuret of Antimony and Iron.

Colour dark steel-gray, inclining to pinchbeck-brown. Lustre metallic.

1. It consists of 4 atoms of sulphuret of Antimony, and 3 proto-sulphuret of Iron.
2. It occurs at Chazelles, in Auvergne.

BEUDANTITE. *Levy.*

Colour black. Lustre somewhat resinous; thin fragments translucent. Primitive form an obtuse rhomboid of 92° 30′.

Composed of oxide of Lead and Iron. Occurs on the banks of the Rhine.

BI-SELENIURET OF ZINC.

Colour gray.

It consists of	Selenium,	49.
	Zinc,	24.
	Mercury,	19.
	Sulphur,	1.5

It is therefore a bi-seleniuret of Zinc and proto-sulphuret of Mercury, and is represented by the following formula: $\tilde{Zn}. \ddot{Se}. + Hgs.$

BISMUTH-BLENDE. *Breithaupht.*

Colour reddish-brown. Semi-transparent....opake. Hardness 5. Sp. gr. 5.9. Primary form a rhombic dodecahedron.

It is found in the vicinity of Schneeburgh, along with Quartz, the oxide of and native Bismuth.

BISMUTH COBALT-ORE.

Colour intermediate between lead and steel-gray. Lustre metallic, and glistening or glimmering. Texture in some parts radiated, in others partly stellular and partly parallel. Scratches fluor-spar, but this degree of hardness may be owing to an intermixture of fine particles of quartz. Streak dull, unchanged.

1. Before the blow-pipe on charcoal it gives out white vapors of arsenious acid, at the same time it deposits on the coal a yellow crust. When well roasted before the blow-pipe, and then mixed with glass of borax and melted, it communicates a smalt-blue colour.

It is composed of	Arsenic,	77.96
	Cobalt,	9.88
	Iron,	4.76
	Bismuth,	3.88
	Copper, Nickel and Sulphur,	3.41

2. It occurs at Schneeberg.

BLACK COBALT OCHRE.

Colour blueish and brownish-black, blackish-brown. Streak shining, even in friable varieties, with a somewhat resinous lustre. Opake. Sectile. Soft; sometimes passing into very soft. Sp. gr. 2.20. Forms botryoidal, stalactitic. Massive. Composition impalpable. Fracture conchoidal...very fine earthy.

Before the blow-pipe it gives out an arsenical smell and colours borax smalt-blue. It consists of the oxides of Cobalt and Manganese.

BOLTONITE.

Bi-Silicate of Magnesia.

Hardness 5.0—6.0. Sp. gr. 2.8—2.9. Vitreous. Colour grayish-white and yellowish-gray. Streak white. Composition granular.

BOTRYOGENE.

Colour hyacinth-red. Hardness 2.0. Sp. gr. 2.03. Primary form a right rhombic prism. Inclination of M on M′ 120°.

BRACHYTIPOUS MANGANESE-ORE.

Braunite. Haidinger.

Primary form octahedron with a square base. Hardness 6.0—6.5. Sp. gr. 4.8.

BREISLAKITE.

Colour reddish or chestnut-brown.

1. Before the blow-pipe with salt of phosphorus a green globule is obtained in the oxidating flame, but red in the reducing flame.

2. It occurs in delicate capillary crystals, bent and grouped like wool, on the surface of cavities in lava, at Vesuvius and Monticelli.

BUSTAMITE. *Brongniart.*

Colour light gray, greenish or reddish. Hardness 6.0—6.5. Sp. gr. 3.1—3.3. Occurs in reniform masses.

CALCAREOUS HEAVY-SPAR. *Breithaupt.*

Sp. gr. 4.0—4.2. Effloresces.

CARBONATE OF BISMUTH.

Colour gray and brown. Earthy. Sp. gr. 4.3.

CHALKOSIDERITE. *Ullmann.*

CHAMOISITE. *Berthier.*

Colour dark greenish-gray. Earthy. Sp. gr. 3.4. An impure magnetic Iron-ore?

CHLOROPAL, *Phil.*

Colour pistachio-green. Opake, or only translucent on the edges. Massive. Composition impalpable, earthy. Fracture conchoidal, passing into earthy. Hardness 3.0—4.0. Sp. gr. 2.0. Fragile.

1. It consists of

Silex,	46.
Oxide of iron,	35.30
Manganese,	2.
Alumina,	1.
Water,	18.

2. It is remarkable for a very singular magnetic property. When taken from its original repositories, it breaks pretty readily into parallelopipeds, the upper end and two adjoining lateral edges having the opposite magnetic poles from the other two edges and the lower end.

3. It occurs in Hungary, and is often called Green Iron-Earth. *Mohs.*

CHLOROPHEITE. *M'Culloch.*

Colour dark-green or pistachio-green, but changing to black or brown on exposure. Brittle. Hard. Scratched by a quill. Sp. gr. 2.02.

1. Before the blow-pipe it remains unchanged, either in colour or transparency. It contains silex, iron and alumina.

2. It occurs in trap rocks.

CHRESITE.

Massive. Composition granular, passing into impalpable. Lustre slightly resinous.

It melts easily before the blow-pipe into a translucent globule. It dissolves entirely and with effervescence in acids.

CONDURRITE. *Phil.*

Colour brownish-black. Streak dark lead-gray, powder-black. Brittle. Hardness 5.0? Composition impalpable.

COTTUNITE. (*Chloride of Lead.*)

COUZERANITE. *Charpentier.*

Colour black. Lustre vitreous, passing into resinous. Opake. Scratches glass, but not quartz. Structure foliated. Primary form a right rhombic prism.

1. Before the blow-pipe it fuses into a white enamel.

It consists of	Silex,	52.37
	Alumine,	24.02
	Lime,	11.85
	Magnesia,	1.40
	Potash,	5.52
	Soda,	3.96

2. It is found in the Pyrennees, in transition limestone.

CUMMINGTONITE.

Var. of Anthophyllite? Karpholite?

CUPREOUS ANALCIME. *Jackson* and *Alger.*

Colour verdigris-green; paler towards the interior of the crystals.

CUPREOUS MANGANESE.

Colour bluish-black. Streak unchanged. Lustre resinous. Opake. Not very brittle. Intermediate between semi-hard and soft. Sp. gr. 3.19—3.21. Small reniform and botryoidal groups. Massive. Composition impalpable. Fracture imperfect conchoidal.

Before the blow-pipe it becomes brown, but is infusible. To borax and salt of phosphorus it communicates the colour of copper and manganese. It consists of

Black oxide of manganese,	82.
Brown oxide of copper,	13.50
Silex,	2.

DIATOMOUS ANTIMONY-PHYLLITE. *Breithaupt.*

Hardness 1.0. Sp. gr. 4.0. Lustre pearly. Colour grayish-white. Translucent. Feel greasy.

DERMATINE.

Colour green or dark-brown. Lustre greasy. Hardness 2.0. Sp. gr. 2.13. Occurs in kidney-shaped or globular pieces. Fracture conchoidal. Translucent. Saline.

DEWEYLITE.

Colour white, yellowish and greenish-white. Translucent. Streak white. Lustre vitreous, inclining to resinous, faint. Easily frangible, especially if immersed in water. Hardness 3.0. Sp. gr. 2.2—2.3. Composition impalpable. Surface rough, and sometimes drusy, exhibiting small mamillary concretions. Fracture even, and imperfectly conchoidal.

Before the blow-pipe it decrepitates, but when exposed carefully to the flame, small fragments melt with difficulty into a white enamel without ebullition. With borax it forms a colourless transparent glass.

It consists[*] of	Silex,	40.	
	Magnesia,	40.	
	Water,	20.	*Shepard.*

DYSLUITE.

Primary form a regular octahedron. Hardness 7.5. Sp. gr. 4.35—4.36. Colour yellowish-brown. Lustre semi-metallic.

DYSODILE. *Cordier.*

Colour greenish and yellowish, passing into liver-brown. Streak shining. Fracture earthy. Soft. Scratched by a quill. Sp. gr. 1.1—1.2.

EDINGTONITE. *Haidinger.*

Colour greenish-white. In small crystals. Hardness 4.5. Sp. gr. 2.7.

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[*] Nearly the same results were obtained by myself. The specimen which was examined contained nearly 10 per cent more of water, which I attribute to the fact that it had been taken from its bed only a few days previous to its examination.

ERLANITE.

Colour greenish-gray, usually light. Streak white. Lustre resinous. Massive, and in fine granular concretions, from which it passes into compact. Fracture splintery or even. Hardness between apatite and feldspar. Sp. gr. 3.0—3.1.

1. Before the blow-pipe it melts into a transparent bead; with borax into a greenish glass.

It consists of	Silex,	53.16
	Alumine,	14.13
	Lime,	14.39
	Soda,	2.61
	Magnesia,	5.42
	Oxide of iron,	7.13

2. It is used as a flux in the iron works of Erla, in the Saxon Erzgebirge. It belongs to the oldest gneiss formation. Resembles gehlenite.

FAHLUNITE.

Colour olive-green and oil-green, passing into yellow, brown and black. Streak grayish-white. Feebly translucent on the edges...opake. Lustre vitreous. Fracture conchoidal, uneven, splintery. Scratches glass. Sp. gr. 2.61—2.66. Reniform. Massive.

1. Before the blowpipe it becomes pale-gray, and melts on its thinnest edges. It is dissolved in glass of borax, and communicates to it the colour produced by oxide of iron.

It consists of	Silex,	46.79	
	Alumine,	26.73	
	Magnesia,	2.97	
	Protoxide of iron,	5.01	
	Oxide of manganese,	.43	
	Water,	13.50	*Hisinger.*

2. It occurs at Fahlun, in Sweden, in talcose or chloritic slate.

FERRUGINOUS PLATINA.

Magnetic. Less malleable than Native Platina. Sp. gr. 14.6—15.7.

FIBROLITE.

Colour white, gray, inclining to green. Fracture conchoidal. Scratches quartz. Sp. gr. 3.21. Primary form a right rhombic prism, with angles of 100° and 80°.

1. It is composed of

Alumine,	58.
Silex,	38.

2. It is found in the Carnatic, accompanying the corundum.

FIGURESTONE, *or* AGALMATOLITE.

Massive. Composition impalpable. Fracture coarse splintery, imperfectly slaty. Colour white, gray, green, yellow, red, brown; but none of them bright. Translucent, in most cases only on the edges. Soft. Sp. gr. 2.81.

1. Infusible before the blow-pipe. It consists of

Silex,	54.50
Alumine,	34.
Potash,	6.25
Water,	4.

2. It is brought from China.

GIBBSITE.

Colour white, prevalent. Streak white. Slightly translucent. Lustre resinous, faint. Hardness 3.5. Sp. gr. 2.40. Fracture uneven. Cleavage none. Reniform, botryoidal and stalactitic shapes. Massive. Composition fine granular, passing into impalpable. Earthy.

1. Before the blow-pipe it is infusible. It consists of

Alumine,	64.8
Water,	34.7

2. It occurs in Richmond, Mass., along with brown hematite. A single specimen has been found in Lenox.

GIESECKITE.

Colour olive-green, gray, brown. Streak uncoloured. Lustre resinous, faint. Hardness 2.5—3.0. Sp. gr. 2.83.

It consists of	Silex,	46.07
	Alumine,	33.82
	Magnesia,	1.20
	Black oxide of iron,	3.35
	Manganese,	1.15
	Potash,	6.20
	Water,	4.88

GLAUCOLITE. *Sokoloff.*

Colour lavender-blue, passing into green. Lustre vitreous. Translucent on the edges. Hardness 5.0—6.0. Sp. gr. 2.71.

1. Before the blow-pipe it melts with difficulty, but *is soluble* in glass of borax.

It consists of	Silex,	54 58
	Alumine,	29,77
	Potash,	4 57
	Lime,	11.18

2. It occurs near Baikal, in Siberia, in compact feldspar.

GOKUMITE.

Colour light yellowish-green. Opake. Scratched by the knife. Sp. gr. 3.74.

1. It consists of	Silex,	35.68	
	Lime,	25.74	
	Protoxide of iron,	34.46	
	Alumine,	1,40	
	Water,	0.60	*Thompson.*

2. It occurs at Gökum quarry, Sweden.

HALLOYITE.

Colour white, or slightly blue. Lustre waxy. Hardness 1.5—2.0. Adheres to the tongue.

HARD COBALT-PYRITES.

Colour dark tin-white. Lustre metallic. Hardness 5.0—6.0. Sp. gr. 6.7—6.8.

HATCHETINE.

Colour yellowish-white, wax-yellow, and greenish-yellow. Lustre slightly glistening and pearly. When in flakes, translucent. Hardness like soft tallow. Very light. Without odor or elasticity. Composition sometimes granular.

1. Fusible below 212° F. Soluble in ether. Smell bituminous when distilled over a spirit lamp.
2. It occurs filling small contemporaneous veins, lined with calcareous spar and small crystals of quartz, in South Wales.

HEDYPHANE.

Hardness 3.0—3.5. Sp. gr. 5.40. Lustre greasy. Colour grayish-white. Composition granular, impalpable.

HERDERITE. *Haidinger.*

Colour yellow or greenish-white. Streak white. Translucent. Lustre vitreous, inclining to resinous. Brittle. Hardness 5. Sp. gr. 2.98.

It is found in the tin mines of Saxony.

HERRENITE. *Del Rio.*

Carbonate of Tellurium and Bi-carbonate of Nickel.

HERSCHELITE.

Primary a regular hexagonal prism. Hardness 3.0—3.5. Sp. gr. 2.1. In six-sided prisms, whose terminal edges are replaced, the new planes inclining to the base under angles of 132°; bases dull and curved.

HISINGERITE. *Berzelius.*

Colour black. Streak greenish-gray. Sectile. Soft. Sp. gr. 3.04. Massive. Fracture earthy. Cleavage in one direction.

1. If heated gently it becomes magnetic; in a stronger heat it melts into a dull, opake, black globule. With borax it yields a yellowish-green glass.

It consists of	Oxide of iron,	51.50
	Silex,	27.50

Alumina,	5.50
Oxide of Manganese,	0.77
Volatile substance,	11.75

2. It has been found in Südermanland, intermixed with rhomboidal Lime-haloide.

HOPEITE.

Prismatoidal Orthoklase-Haloide. Partsch.

HUMBOLDTINE. *Mariano De Rivero.*

Colour bright yellow. Soft, yielding to the nail. Sp. gr. 1.3. Acquires resinous electricity by friction.

1. On ignited charcoal it is decomposed, giving out a vegetable odor, while the remaining oxide of iron is changed into different shades of yellow, then black, and at last red. It is insoluble in water or alcohol.

It consists of	Protoxide of iron,	53.56
	Oxalic acid,	46.14

2. It is found in coal in Bohemia.

HUMITE.

Colour various shades of yellow, sometimes almost white, passing into reddish-brown. Transparent...translucent. Lustre vitreous. Brittle. Hardness 6.5—7.0. Sp. gr. 2.5. Primary form a right rhombic prism. Inclination of M on M′ 120°.

HYDRO-CARBON. *Scherer.*

Colour white or yellowish-white. Sp. gr. 0.65. Lustre pearly. Crystals acicular.

HYDROUS-PHOSPHATE OF COPPER.

Primary, a right rhombic prism. Hardness 4.5—5.0. Sp. gr. 4.2. Inclination of M on M′ 37° 30′.

HYDRO-SILICITE. *Kuh.*

Colour white, without lustre. Feels greasy. Soft, and translucent. Does not adhere to the tongue.

ILMENITE.

Axotomous Iron-Ore.

Colour black. Lustre metallic, brilliant. Fracture varies from uneven to conchoidal. Cleavage none. Scratches glass. Sp. gr. 5.43. Primary form a right rhombic prism of 136° 30′. The terminal edges are to the lateral as 17.11.

It is found at Ilmen, in Siberia, in a matrix of Albite, along with titaniferous iron.

IODIDE OF MERCURY. *Del Rio.*

Resembles dark-coloured Cinnabar.

IODIDE OF SILVER. *Vauquelin.*

IRID-OSMIUM. *Schweizau.*

Colour lead-gray. Hardness 5.0—6.0. Sp. gr. 17.9—18.5. Crystalizes in low six-sided prisms.

IRON SINTER.

Colour yellowish and blackish-brown. Brittle. Lustre resinous. Fracture conchoidal. Sp. gr. 2.40. Transparent...translucent on the edges. Not very brittle. Hardness soft.

1. Before the blow-pipe it intumesces, and some varieties emit a strong arsenical odor, during which it is partially volatilized. It consists of

Oxide of iron,	67.00	33.46
Arsenic acid,	0.00	26.06
Sulphuric acid,	8.00	10.75
Protoxide of manganese,	0.00	0.59
Water,	25.00	28.00

2. It is found at Saxony, in several old mines, as at Freiberg and Schneeberg.

KARPHOSIDERITE.

Colour yellowish-white. Massive, or in reniform masses. Lustre resinous. Hardness 4.5. Sp. gr. 2.5.

It fuses before the blow-pipe on charcoal into a black globule; with borax and salt of phosphorus into a dark scoria. Composed of oxide of manganese and zinc. Greenland.

KEROLITE.

Hardness 2.0—2.5. Sp. gr. 2.0. Lustre vitreous, faint. Colour greenish-white.

KONIGENE. *Levy.*

Primary form a right rhombic prism. Hardness 2.0. Colour dark emerald-green. Crystals barrel-shaped, and closely aggregated.

KORNITE. *Breit.*

KUPFERINDIG. *Breit.*

Colour indigo-blue, inclining sometimes to blackish-blue. Lustre resinous. Streak resinous, higher than the colour. Opake. Not particularly sectile. Intermediate between soft and very soft. Sp. gr. 3.80—3.82. Implanted spheroidal globular shapes, with a crystaline surface. Massive. Composition impalpable. Fracture flat conchoidal, uneven.

1. Before the blow-pipe it burns before it is red hot with a blue flame, and melts into a globule, and emits sparks. It finally yields a globule of copper.
2. It occurs in Thuringia.

LEELITE.

Massive. Lustre and translucency like horn. Fracture splintery. Sp. gr. 2.71. *Clarke.*

It consists of	Silex,	75.
	Alumine,	22.
	Manganese and Water,	3.00

MARMOLITE. *Nuttall.*

Massive. Cleavage in two directions, intersecting each other obliquely. Lustre pearly. Colour pale green or gray. Opake. Brittle. Easily cut with a knife. Sp. gr. 2.47.

It is considered as a variety of serpentine, and occurs in serpentine, at Hoboken, N. J. and at the Bare Hills, near Baltimore, Md.

MINERAL HYDRO-CARBON.

In acicular crystals. Sp. gr. 0.65? Lustre nacreous. Colour yellowish-white.

MOHSITE.

Colour iron-black. Lustre high metallic. Hardness 6.0—6.5. Crystals small, flat, circular tables, with alternate re-entering and salient angles on their edges, inclination of 73° 43′.

MOLYBDATE OF SILVER. *Breithaupt.*

Sp. gr. 5.89. Lustre metallic. Inflexible, bladed masses of a dark-gray colour.

MONAZITE.

Colour brick-red. Lustre vitreous. Streak flesh-red. Sp. gr. 4.92.

MONOPHANE.

Colour white. Lustre vitreous. Hardness below feldspar. Sp. gr. 2.15.

MONTICELLITE.

Colour generally yellowish, but sometimes colourless and transparent. Primary form a right rhombic prism of 132° 54′. Terminal edges to the lateral as 1 to 1.046. In muriatic acid the surfaces become dull and coated with a yellowish powder. Hardness between apatite and feldspar. Cleavage none.

It occurs at Vesuvius.

MURCHISONITE.

Colour white, with a slight tinge of red. Opake. It possesses cleavage in three directions, two of which are at right angles to each other, like the two principal cleavages of feldspar. The third has a nacreous appearance, and is as easily obtained as the other two, and is perpendicular to one of them, and inclines to the other at an angle of 106° 50′; so that the solid is a tetrahedron.

1. It consists of	Silex,	68.60
	Alumine,	16.60
	Potash,	14.80

2. It is found at Dawlish, Eng. It is sometimes pulverulent.

NICKEL-GLANCE.

Colour like Arsenical Pyrites. Hardness 5.5. Sp. gr. 6.09. Cleavage parallel to the faces of the cube.

NONTRONITE.

Colour pale straw-yellow. Soft. Opake. Unctuous and tender. In onion-shaped masses.

OKENITE. *Kobel.*

Hardness 4.5—6.0. In almond-shaped masses, and allied to the zeolites.

OLIGOKLASE. *Breit.*

OSMELITE. *Breit.*

Hardness 5.5. Sp. gr. 2.70—2.83. Resembles the Kouphone-Spars.

OSTRANITE.

Hardness 6.5. Sp. gr. 4.3—4.4. Lustre vitreous. Colour pale-brown. Streak pale-brown. Fracture uneven.

OXAHEVRITE.

Colour light leek-green, olive-green and reddish brown.

Crystalizes in acute octahedrons. Cleavage axotomous. Sp. gr. 2.21.

1. It consists of	Silex,	50.76
	Lime,	22.39
	Peroxide of iron,	3.39
	Alumine,	1.00

2. It is found in petrified wood near Oxhaver, in Iceland.

PEGANITE.

Hardness 4.5. Sp. gr. 2.49. Primary form a right rhombic prism. M on M′ 127°.

PEKTOLITE. *Von Kobell.*

Colour grayish-white. Lustre pearly. Surface generally dull. Hardness between fluor and feldspar. Sp. gr. 2.69. It occurs in spheroidal masses which consist of delicate fibres radiating from a common centre.

1. Before the blow-pipe it fuses into a transparent glass.

It is composed of	Silex,	51.30
	Lime,	33.77
	Soda,	8.26
	Potash,	1.57
	Water,	3.89

Its formula is $4\,C\,S^2 + 3\left.\begin{matrix}N\\K\end{matrix}\right\}Sz + 6\,Ag.$

2. It occurs in a deposit of manganese and clay.

PERIKLIN.

Heterotomous Feldspar. Partsch.

Hardness 6.0. Sp. gr. 2.54. Primary form a doubly oblique prism. P on M 93° 19′. M on T 114° 45′.

PETROSILEX, *(of Sahlberg.)*

Colour deep flesh-red. Transparent. Compact. Fracture fine grained.

PHASTIM. *Breit.*

PICOTITE. *Charpentier.*

PICROLITE.

Colour leek-green, passing into yellow. Streak shining. Translucent on the edges. Hardness 3.0—6.0.

It consists of	Silex,	40.04
	Magnesia,	38.80
	Water,	9.08
	Protox. of iron,	8.28
	Carbonic acid,	4.70

Colours the glass of borax green when hot. It disappears when cold. It occurs in veins and beds in iron ore in the Faberg, in Sweden.

PICROSMINE. *Haidinger.*

Colour greenish-white. Streak white, dull. Translucent on the edges...opake. Very sectile. Hardness 2.5—3.0. Sp. gr. 2.66.

1. Before the blow-pipe it is infusible. Resembles asbestus. It gives a transparent glass with borax, and is soluble in heated acids with the exception of a black powder.

It consists of	Silex,	10.43
	Alumine,	3.59
	Protoxide of cerium,	13.92
	Protoxide of iron,	6.08
	Yttria,	4.87
	Lime,	1.81
	Protoxide of manganese,	1.39
	Water,	26.50
	Carbon,	31.41

2. It is found near Fahlun, in Sweden, in granite.

PINGUITE. *Breit.*

Hardness 1.0. Sp. gr. 2.31. Resembles green iron-earth.

PINITE.

Colour blackish-green...greenish-gray. Streak uncoloured. Feebly translucent on the edges. Sectile. Hardness 2.0—2.5. Sp. gr. 2.78.

1. Before the blow-pipe it melts in thin splinters imperfectly. It consists of

Silex,	55.96
Alumine,	25.48
Potash,	7.89
Oxide of iron,	5.51
Magnesia,	3.76
Water,	1.41

It occurs in mica slate and other primitive rocks.

2. It is found at Haddam, Ct. Chester, Mass. and Charleston, N. H.

POLYHASITE.

Hardness 2.5. Sp. gr. 6.2. Colour iron-black. Lustre splendent. Primary form a hexagonal prism.

POLYMIGNITE. *Berzelius.*

(Which signifies multiplicity of elements.)

Colour black. Lustre metallic. Crystalizes in small rectangular prisms.

It consists of the oxides of *titanium*, *iron*, *manganese*, *tin*, *cerium*, and of the earths *zirconia*, *yttria*, *lime*, *magnesia* and *silex*, and the alkali *potash*.

POLYSPHÆRITE.

Hardness 3.0. Sp. gr. 5.80. Lustre greasy. Colour clove-brown and yellowish-gray. In rounded balls made up of concentric layers.

POONAHALITE

Hardness 5.0—5.5. Primary form a right rhombic prism. Inclination of M on M′ 92° 20′.

PRISMATOIDAL BISMUTH GLANCE. *Wehrle.*

Hardness 2.4. Sp. gr. 7.8. Crystals prismatic.

PYRALLOLITE.

Colour white, greenish-white. Lustre resinous. Translucent on the edges...opake. Massive. Composition granular. Fracture earthy. Hardness 3.5—4.0. Sp.

gr. 2.55—2.60. Powder phosphoresces with a bluish light.

1. Before the blow-pipe it first becomes black then white, and finally intumesces and melts on the edges.

It consists of	Silex,	56.62
	Magnesia,	23.38
	Alumine,	3.38
	Lime,	5.58
	Oxide of iron,	0.99
	Protox. manganese,	0.99
	Water,	3.58

2. It occurs at Pargas, in Finland.

PYRORTHITE.

Colour brownish-black, if decayed yellowish-brown. Streak brownish-black. Lustre resinous. Opake. Is scratched by carbonate of lime. Sp. gr. 2.19. Massive.

If gently heated on one side it takes fire and burns without flame or smoke, after which it becomes white and melts into a black enamel.

PYROLUSITE.

Prismatic Manganese-Ore. Haidinger.

Hardness 2.0—2.5. Sp. gr. 4.94. Primary form a right rhombic prism. Inclination of M on M′ 93° 40′

PYROMORPHITE.

Rhombohedral Lead-Baryte. M.

RADIOLITE. *Brevig.*

Hardness above 4.0. Sp. gr. 2.2. Colour white. Lustre silky. Massive, with a radiating fracture.

RUBELLAN.

Colour brownish-red. Brittle. Hardness 3.0. Lustre vitreous, inclining to resinous.

SAPPARITE. *Schlotheim.*

Colour pale berlin-blue. Streak grayish-white. Hardness 4.0. Lustre vitreous.

SAPHIRIN. *Stromeyer.*

Colour sapphire-blue. Streak white. Translucent. Lustre vitreous. Hardness above 7.0. Sp. gr. 3.4.

SCHEERERITE. *Stromeyer.*

Colour whitish. Lustre pearly. Very friable. Rather heavier than water. In loosely aggregated grains and scales.

SELENIURET OF LEAD AND COBALT.

Resembles Galena. Fracture granular.

SELENIURET OF LEAD AND COPPER.

Fracture granular. Colour lead-gray.

SELENIURET OF LEAD AND MERCURY. *Rose.*

Sp. gr. 7.8.

SERPENTINE.

Colour dark blackish and leek-green. Seldom lighter shades of oil-green and siskin-green, and none of them bright. Also brown and gray, yellowish gray. Lustre resinous. Indistinct, low degrees of intensity. Streak white. Translucent...opake. Sectile. Hardness 3.0. Sp. gr. 2.50.

Compound varieties.—Massive. Composition granular, passing into impalpable. Varieties of this kind present red, brown, black, yellow and gray colours, in veined, spotted and other delineated forms. Regular forms have been observed in the blackish-green and yellowish-green varieties, which belong to the prismatic system. Serpentine is usually divided into two kinds, the *common* and *precious*. The latter presents a splintery conchoidal fracture, a degree of translucency, and a superior hardness.

1. It consists of

Silex,	42.50	
Magnesia,	38.63	
Alumine,	1.00	
Oxide of iron,	1.50	
Oxide of manganese,	0.52	
Oxide of chrome,	0.25	
Lime,	0.25	
Water,	15.20	*John.*

2. Serpentine forms mountain masses and beds in primitive rocks. It is found in Newfane, Vt., Cummington, Middlefield and Chester, Mass., and at the Bare Hills, near Baltimore, Md.

SILLIMANITE.

Hardness 7.5—8.0. Sp. gr. 3.2. Primary form an oblique rhombic prism, oblique from an obtuse edge. M on M′ 90° 30′. Cleavage brilliant, parallel to the longer diagonal.

SORDAWALLITE. *Nordenskiöld.*

Colour greenish or grayish-black. Lustre vitreous. Massive. Hardness 5.0—6.0. Sp. gr. 2.53. Fracture conchoidal.

STERNBERGITE.

Colour dark pinchbeck-brown, rather darker than magnetic pyrites. Lustre metallic. Streak black. Sectile. Tarnishes violet-blue. Thin laminæ perfectly flexible. Hardness 1.0—1.5. Sp. gr. 4.21.

1. Before the blow-pipe it burns, giving off at the same time the oder of sulphureous acid. The globule which remains is coated with silver, and is obedient to the magnet. It is composed of the sulphuret of silver and iron.

2. It is found at Jouchimsthal, in Bohemia.

SULPHURET OF SILVER AND COPPER. *Phil.*

Colour blackish lead-gray. Lustre metallic. Soft. Sp. gr. 6.25. Massive. Composition impalpable.

TAUTOLITE. *Breithaupt.*

Colour velvet-black. Streak gray. Lustre vitreous. Hardness 6.5—7.0. Sp. gr. 3.86.

Before the blow-pipe it melts into a blackish scoria, which is magnetic. With borax it melts into a green glass. It consists of silex, alumine, and the oxides of iron and manganese. It has the same relation to Crysolite that Ceylanite has to Spinelle.

TELLURIC BISMUTH. *Berzelius.*

Colour silver-white. Lustre metallic. Massive. Sometimes broad foliated.

TEPHROITE. *Breithaupt.*

Colour ash-gray. Lustre adamantine. Hardness 5.0—6.0. Sp. gr. 4.1.

TESSERALKIES. *Breithaupt.*

THENARDITE.

Anhydrous Sulphate of Soda.

Primary form a right rhombic prism. Hardness 2.0—2.5. Sp. gr. 2.73. Inclination of M on M′ 125°.

THORITE.

Colour black. Hardness 6.0. Sp. gr. 4.63.

Infusible before the blow-pipe. Occurs at Brevig, in Norway, in Sienite.

TURNERITE.

Pictite.

Colour yellowish. Semi-transparent. Hardness 4.5—5.0. Primary form an oblique rhombic prism. Inclination of M on M′ 96° 10′.

VELVET-BLUE COPPER.

Colour bright smalt-blue. Lustre pearly. In small capillary crystals.

VIGNITE.

Blue Magnetic Iron-Ore.

Colour dark greenish-blue. Sp. gr. 3.71.

WAGNERITE.

Hemi-Primatic Fluor-Haloide. M.

Primary an oblique rhombic prism. Hardness 3.0—3.5. Sp. gr. 3.1. Inclination of M on M′ 95° 25′. P on M 109° 20′. Crystals complicated, but resembling in colour and lustre the Brazilian Topaz.

WILLEMITE. *Levy.*

Colour white, yellowish or reddish. Translucent. In small rhomboidal crystals.

YTTRO-CERITE. *Berzelius.*

Hardness 4.0—4.5. Sp. gr. 3.44. Colour violet-blue. Massive. Opake.

ZINKENITE.

Haidingerite. Berthier.
Berthierite. Haidinger.

Hardness 3.5. Sp. gr. 5.3. Lustre metallic. Colour steel-gray. Streak unchanged.

ZURLITE.

Hardness 6.0. Sp. gr. 3.27. Lustre resinous. Colour green, passing into gray. In rectangular four-sided tables.

APPENDIX II.

Minerals which will probably never form distinct species in the Mineral System.

ADHESIVE SLATE.

Adhesive Slate. Jam. Phil.

Colour yellowish-gray, passing into white and smoke-gray. Streak a little shining. Feebly translucent on the edges. Sectile. Adheres strongly to the tongue. Very soft. Sp. gr. 2.08. Massive. Composition impalpable. Fracture slaty. Cross fracture even, flat conchoidal.

On exposure to a red heat it becomes brown. It absorbs water rapidly, but does not fall to pieces.

It consists of	Silex,	66.50	30.80
	Alumine,	7.00	0.00
	Magnesia,	1.50	28.00
	Lime,	1.25	0.80
	Oxide of iron,	2.50	11.20
	Carbonic acid,	0.00	27.00
	Water,	19.00	0.30

ALUM-SLATE.

Alum-Slate. Jam. Phil.

Colour intermediate between grayish and bluish-black. Streak black, acquires some lustre. Opake. Dull. Not very brittle. Intermediate between semi-hard and soft. Sp. gr. 2.33—2.58. *Kirwan.* Massive. Sometimes in spheroidal masses. Composition impalpable. Principal fracture slaty.

Alum-Slate has been divided into two kinds, *common* and *shining*. Alum-Slate is closely allied to Clay-Slate. Sometimes when exposed to the fire it burns and becomes bluish-gray. It is found in Pownal, Vt.

BITUMINOUS SHALE.

Bituminous Shale. Jam. Phil.

Colour brownish-black and blackish-brown. Streak shining, with a resinous lustre. Opake. Lustre faintly glimmering. Sectile. Sp. gr. 1.99. Massive. Composition impalpable.

According to Werner it is clay-slate with a small quantity of bitumen. It occurs in the variety of coal mines. It is to be distinguished from a variety of clay-slate which is coated with plumbago.

BOLE.

Bole. Jam. Phil.

Colour brown, yellow and red. Streak shining and resinous. Feebly translucent on the edges...opake. Faintly glimmering. Dull. Rather sectile. Adheres to the tongue. Soft. Sp. gr. 1.60. Massive. Composition impalpable.

If thrown into water it emits a crackling noise and falls to powder. It occurs disseminated in wacke, trapp-tuff, &c.

COMMON CLAY.

Common Clay. Jam. Phil.

Colour white, gray, brown, red, yellow, &c. Dull. Sometimes spotted and variegated. Massive and sectile. Streak shining. Adheres to the tongue. Feels more or less greasy. Soft. Massive. Composition impalpable.

Common clay has been divided into *loam*, *potter's clay*, *variegated clay* and *slate clay*. The appropriate varieties of clay are of various important applications in pottery, in manufacturing stone ware, porcelain, &c. &c.

DRAWING SLATE, *or* BLACK CHALK.

Colour intermediate between grayish and bluish-black.

Streak unchanged. Soils more or less, and writes. Opake. Sectile. Adheres to the tongue. Soft. Sp. gr. 2.11. Massive. Composition impalpable.

1. Exposed to the fire it loses its black colour, and becomes reddish-gray.

It consists of	Silex,	64.50
	Alumina,	11.26
	Oxide of iron,	2.75
	Carbon,	11.00
	Water,	7·50

2. It occurs in rocks of clay-slate, and is nearly allied to clay and alum-slate. The finest varieties come from Italy, Spain and France.

FULLER'S EARTH.

Colour green, gray, white. Streak shining, resinous. Dull. Feebly translucent on the edges...opake. Fracture uneven and splintery. Earthy. Sectile. Adheres but feebly to the tongue, or not at all, and is very soft. Sp. gr. 1.81.

If thrown into water it falls to pieces, and forms a paste which is not plastic. It absorbs oil and fat; hence it is used for cleansing woollen cloth.

LITHOMARGE.

Lithomarge. Jam. Phil.

Colour white, pearl-gray, lavender-blue, flesh-red, ochre-yellow. Streak shining. Opake. Fracture uneven; and flat conchoidal in the large, fine earthy in the small. Adheres to the tongue. Sectile. Massive. Composition impalpable. Sp. gr. 2.43.

It has been divided into two kinds, the *friable* and *solid Lithomarge.* It does not fall to powder when thrown into water, and hardens when exposed to a strong heat.

MOUNTAIN SOAP.

Colour light brownish-black. Streak shining, resinous. Opake. Dull. Sectile. Does not soil, but writes. Adheres strongly to the tongue. Feels greasy; is very soft and light. Massive. Composition impalpable. Fracture fine earthy.

It has been found in Poland. A mineral agreeing with the character of mountain soap is found in small masses in granular limestone, in Williamstown, Mass.

POLISHING SLATE.

Colour yellowish-gray, inclining to white or brown. Feels fine, but meagre. Adheres but little to the tongue. Soft. Friable. Sp. gr. 0.59. Massive. Composition impalpable.

1. It imbibes water, but does not fall to pieces. It becomes red when burnt, but is infusible.

It consists of

Silex,	79.
Alumina,	1.
Lime,	1.
Oxide of iron,	4.
Water,	14.

2. It is supposed to have been formed from the ashes of burnt coal.

TRIPOLI.

Colour gray, more particularly yellowish and ash-gray. Opake. Not particularly brittle. Does not adhere to the tongue. Feels meagre. Massive. Composition impalpable. Fracture earthy. Sp. gr. 1.85.

1. It imbibes water, which softens it. It consists of

Silex,	81.	90.
Alumine,	1.	7.
Oxide of iron,	8.	3.
Sulphuric acid,	3.50	0.
Water,	5.	0.

2. It is a fine variety of quartz, mixed with a little clay.

UMBER.

Colour liver, chestnut and dark yellowish-brown.

Streak a little shining. Opake. Dull. Imperfectly sectile. Adheres strongly to the tongue. Does not soil, but writes. Feels rough, and is very soft. Sp. gr. 2.20. Massive. Composition impalpable.

It imbibes water with avidity, and emits air bubbles, but does not become soft. It is used by painters as a brown colour.

WHET-SLATE.

Colour greenish-gray, mountain, asparagus, oil-green. Streak grayish-white. Translucent on the edges. Soft. Fracture fine, splintery in the small. Sp. gr. 2.72. Massive. Composition impalpable.

Whet-slate is slaty rock, containing a great proportion of quartz, in which the component particles are so fine as to withdraw themselves from observation. It occurs in beds, in clay-slate. It is used as a grinding material.

YELLOW EARTH.

Colour ochre-yellow. Streak faintly shining. Opake. Faintly glimmering, dull. Sectile. Soils a little, and writes. Soft and friable. Fracture fine, earthy. Sp. gr. 2.24. Massive. Composition impalpable.

If thrown into water it falls to powder and emits a noise. If burnt it becomes red. It is a mixture of fine sand, oxide of iron, and clay. It is employed as a coarse colouring material.

INTRODUCTION

TO THE

STUDY OF GEOLOGY.

§ 1. *Definition.*

Geology is the science which explains the Structure of the Earth.

This science consists essentially in a systematic arrangement of facts concerning the structure and relative position of the strata which compose the exterior of the earth. It considers also those causes which have had an agency in modifying and changing the surface of the earth, and endeavors to fix the dates when particular changes occurred.

§ 2. *Foundation of Geology.*

The foundation on which Geology rests is *observation.*

It is impossible from the nature of the science that it should be otherwise. Many geologists, even after they have made numerous observations, have fallen into error. The cause is perfectly plain, viz. the great extent of the earth, compared with the limited means which any individual can enjoy for collecting facts; the concealment of strata, by overlaying deposits, and the derangements which have taken place since their deposition: these and many more prevent that accuracy of judgment which could be made in case all the materials were exposed and without derangement.

§ 3. *Uses of Geology.*

The uses to which geology may be applied are numerous and important. It initiates us into the history of the earliest created beings. It confirms the records of creation as given by inspiration, both as it regards the order and the successive periods of events. By it we are taught that useful substances are connected in a certain order in every district of country; and hence are to be sought for only in particular associations. By knowing the character of the different deposites, the agriculturist may be aided in the improvement of soils worn out, or naturally barren.

§ 4. *History of Geology.*

Geology is a modern science. Its foundation was laid by Lehman, the German, about the middle of the last century. He was followed by Mitchell and Whitehurst in England, and Werner in Saxony, all of whom have left monuments of their industry and ability. The latter especially has given character and great interest to this department of science. The name of Werner always brings to mind that of Hutton, from the fact that they respectively advanced and supported theories diametrically opposite to each other. Which deserves the meed of having done the most for geology, it is not for partial critics to say. Hutton, however, aided by the happy illustrations of a Playfair, seems to have ultimately triumphed, though many of Werner's views are as unshaken as the rocks of his own country.

Saussure, Humboldt, Kirwan, De Luc, Dolomieu, Pallas, Jameson and Du Fond, have been active and enlightened inquirers after geological facts, and have added much to complete the history of the earth. Cuvier has done more than all his predecessors in fixing the dates of remarkable events, as the creation and the deluge, and in bringing to light remarkable fossils and remains of animals which are now extinct. Bakewell, Brogniart, Conybeare and Phillips, and Buckland, have discovered much in relation to the age, position and contents of the strata, which will serve to fill up the outline of a general history of the earth. In saying what some have done in this interesting field of labor, we would by no means undervalue the efforts of those who are still in the field, collecting new facts and correcting the errors of former observers. It is a science which is eminently progressive, and it will be a long time before materials can be collected sufficient to form a well proportioned edifice.

§ 5. *Objects which Geology considers.*

The general objects which geology considers are the strata, and the relative position they occupy, and the minerals and fossils which they embrace.

In mineralogy the objects are single individuals. In geology the masses are generally mixed and always compound. They occupy great space, but differ from each other in this respect. They also differ in relative *position*, and this is the most prominent feature in the science. Granite, for instance, is never found resting on graywacke or chalk.

§ 6. *Method of Studying Geology.*

The only method of studying geology is to form an acquaintance with rocks in the field, in their natural deposits, or in the situations which they now occupy, by transposition or displacement. The student may apply the mineralogical characters from books to hand-specimens in the cabinet; but after all, the rocks or strata must be seen, and their relative position observed. We are also to observe what minerals or fossils the stratum contains; the inclination, whether it is horizontal, or dips to the horizon, or is vertical, and how either of these positions affects the strata above. The thickness, extent, &c., are to be accurately noticed.

§ 7. *Limits of Observation.*

The observations which we are able to make, are limited to what is termed the rind of the earth.

We can know but little of the interior structure. But the inequalities of its surface often give us admission to a considerable depth.

§ 8. *Weight of the Earth.*

The earth is supposed to be about five times heavier than a mass of water of the same bulk. As the gravity of the external coat is only about two, it is inferred that the interior is composed of metals or materials more dense than the exterior.

§ 9. *Internal Heat of the Earth.*

From experiments which have been made, principally by Cordier, it seems to be established that the temperature diminishes as we penetrate into the earth, until we are below the limit of solar influence. And that from that point the temperature increases at the rate of about one degree of Fahrenheit for every fifty feet. The ratio of increase varies in different countries. But it is remarked by Prof. Eaton, that it is not probable that this ratio of increase is preserved to the centre of the earth.*

§ 10. *External Heat of the Earth.*

Geology seems to demonstrate that the external temperature of the earth has diminished, and is perhaps still diminishing. The external part would evidently cool most rapidly, while the internal, being protected by the external crust, would cool more slowly. The facts in relation to the external and internal temperature of the earth, may be applied to a certain extent to explain the difference of temperature of the same parallels of latitude.

§ 11. *Sources of Information concerning the Internal Structure of the Earth.*

The structure of the earth is revealed by the obliquity of strata, by deep excavations, by rivers and water courses, by vallies and defiles, by precipices, clefts, slides and avulsions. From these sources of information, geologists have demonstrated a great degree of regularity in the deposition of strata composing the earth's surface. The earth, therefore, is not an exception to the general law of order which is so conspicuous in the mechanism of the universe.

§ 12. *Bearing of Geology on Revelation.*

In speaking of the bearing of geology on revelation, it is to be borne in mind that the great object of revelation is to pre-

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* The Edin. Rev. vol. 52, p. 49, contains some valuable remarks on this subject, and a notice of observations by M. Moyle, which show grounds of error not taken into consideration by Cordier.

sent to fallen man the relation he holds to his Maker, and the rules of action which he ought to observe, together with the method of regaining that high standing as a moral being which he once possessed; hence the subject of revelation is not physical truth, and hence, too, we are not to expect that precision of language which a book on philosophy observes, where physical truths are taught. In the Bible, however, there are two important eras mentioned, viz: the creation and deluge, which have occasioned among philosophers no little contention. But it is no less true than agreeable to the Christian, that geology confirms revelation, in language which cannot be gainsayed by the sophistry of infidels, or set aside by the cavilings of sceptics.

In the first place, the antiquity of the earth is attested by numerous facts, and it can be shown that this antiquity extends back only to a limited time. In the second place, in regard to the deluge, we have indubitable evidence that such a catastrophe once happened. The marks of it are now to be seen in every country. The agreement of geological facts with those revealed in sacred writ, is at least consolatory to the humble inquirer after truth. It is by no means necessary, however, that such a coincidence should exist, to entitle the scriptures to our implicit credence; for they carry such authority and evidence of truth on every page, that the assistance which geology renders is but small indeed.

§ 13. *Design which is manifest in the Arrangement of the Materials of the Earth.*

There is evidence of design in the arrangement of the strata composing the crust of the earth.

The obliquity of the strata and the provision furnished in the machinery of nature for a supply of water by rivers and springs, are not to be considered as accidental effects, or as occurrences by which no end was to be accomplished, or one end as well as another. We have undoubted evidence of design in those arrangements. Again, the disintegration of rocks to form soils for the support of vegetable and animal life, is a circumstance which ought not to be passed over.

Many more facts of a similar character might be mentioned, but these few are sufficient to show that geology furnishes proofs of design in the general construction of the earth.

§ 14. *Geological Theory.*

A geological theory should be a deduction from geological facts.

It has been remarked, that geology is founded on observation; yet it is proper to admit theory as a means of advancing its interests. And so long as conclusions are drawn from facts, or are formed agreeably to the inductive method, its conclusions will have as much certainty as those which belong to general physics, and often approximate to a demonstration.

CONSIDERATIONS WHICH RELATE TO THE STRATA.

§ 15. *Division of Strata.*

The strata have been variously divided by different geologists. The first grand division worthy of notice was proposed by the German Lehman. The lower rocks he observed were crystalline, very hard, and sometimes slaty; they were also destitute of the remains of animals. These rocks he denominated Primary, or Primitive. Resting upon these he observed another class of rocks, which were comparatively soft, earthy in texture, and contained the remains of animals. These he called Secondary, for plain reasons. This division was undoubtedly of great use in the infancy of the science. It served to stimulate men of science to observe attentively the position or order of the rocky strata. The discoveries which were consequently made, rendered it necessary to make a more accurate classification. A more perfect division or classification of strata is as follows:

1. Primitive.
2. Transition.
3. Secondary.
   (*a*) The Lower Secondary Series.
   (*b*) The Upper Secondary Series.

4. Tertiary.
5. Volcanic and Basaltic.
6. Diluvial and Alluvial Ground.

This arrangement is substantially followed by a majority of the geologists of the present day, even by those who are opposed to the terms primitive, transition, &c., proving that the classification is founded in nature.

§ 16. *General Character of the preceding Classes.*

1. *Primitive Rocks*—Were so called because no fossil remains of animals or vegetables, nor any fragments of other rocks being found in them, it was inferred that they were formed prior to the creation of organic beings. The rocks of this class are hard crystaline, and occupy, geologically, the lowest place in the series.

2. *Transition Rocks.*—They are so called because it is supposed that the earth, during their deposition, was passing from an uninhabitable to a habitable state. In them we firs. observe the existence of the remains of animals. These animals form the first link in the scale of animated beings. They are generally less crystaline in structure, softer, and are composed of the fragments of the primitive rocks. As they are interposed between the primitive and secondary, they frequently partake of the character belonging to both.

3. *Secondary Rocks.*—This series is divided into Lower and Upper Series.

(a) Lower Series. The lower series are almost all distinctly stratified. They consist of sandstone, soft argillaceous slate, called shale, and beds of coal and iron-stone. In many of the lower secondary series we find abundance of vegetable fossils, as ferns, palms and reeds; while the rocks in the transition class abound in marine animals. This change in the kind of fossil, indicates an important change in the state of the globe.

(b) Upper Series. The prevailing rocks in this division are stratified limestone, with beds of clay, shale and sandstone. The organic remains are again animals, which show

that another important revolution had taken place. These animals, however, are of different genera and species from those in the lower rocks. The position, too, of the upper secondary is different from the lower; the former resting upon the inclined edge of the latter unconformably. The last of the upper secondary is chalk, a rock which is wanting in America, and some other countries.

4. *Tertiary Strata*—Comprise the regular beds that have been deposited since the chalk strata, and on which they frequently repose. These strata occupy considerable extent. They are the last regularly formed strata, and consist mostly of alternate beds of sand and clay. The lower series contain numerous marine shells, while the middle and upper contain shells allied to those now found in rivers and bays. The most remarkable feature of this formation is, that some of the deposits contain numerous bones of quadrupeds of the class Mammalia, but which belong to species now extinct.

5. *Volcanic and Basaltic Rocks.*—They always cover, in an irregular manner, the rocks of the preceding classes. They have evidently been in a state of fusion, and some have poured from the rents and fissures in the earth's surface in a liquid state. In some instances, in cooling, the masses have partially crystalized, forming many-sided columns or pillars; in other cases, the melted matter fills vast fissures, called by miners, *dykes.*

6. *Diluvial and Alluvial.*—The greater part of the ground in most countries is covered with thick beds of gravel, sand, clay, and fragments of rock or loose stones, more or less rounded by attrition. Frequently these masses of rock have been transported a great distance. They indicate the action of mighty currents, which have swept over the face of the earth with an overwhelming power.

§ 16. *Distinguishing Characters of the preceding Classes of Rocks.*

The different rocks and strata, except the primitive, are distinguished by their appropriate organic remains.

This declaration is perhaps too general and sweeping. It may be that in some instances two deposits belonging to different periods may embrace similar organic remains; but there are boundaries or lines which may be drawn, where we can say that above or below it such and such organic remains are never found, and it would be as useless to look for them as for coal in granite.

§ 17. *The Passing of one Stratum into another.*

Strata do not always preserve a perfect uniformity or distinctness throughout their several courses, but frequently pass into each other.

Strata sometimes pass into each other in a remarkable manner. Thus mica slate passes into talcose slate, talcose slate into soapstone, and soapstone into serpentine. Granite passes into gneiss, and sienite into a coarse mica slate. These transitions more frequently occur among the primitive strata than the others. They may be seen throughout the primitive region of New-England; so that, in fact, the primitive rocks might be considered as one vast stratum, composed of alternating layers of granite, gneiss, mica slate, talcose slate and hornblende.

§ 18. *Inclination of the Strata.*

The strata are rarely equally inclined, especially in different formations.

The position of the primitive strata are usually nearly vertical, and very commonly seem to have been forced through the superincumbent rocks, and hence they crown the summits of the highest mountains.

The transition appear at a lower level, near the bases or on the sides of mountains, and their position is of course inclined. But the degree of inclination varies at different places, and sometimes near their edges they are thrown into a vertical position.

The secondary approach the horizontal position, often resting upon the inclined edges of the inferior rocks. The country they occupy is generally flat and level.

CONSIDERATIONS WHICH RELATE TO VOLCANOES AND EARTHQUAKES.

§ 19. *Seat of Volcanoes.*

Volcanic action is seated below the primitive rocks. Thus the products of ancient as well as modern volcanoes are analogous in their composition to the oldest granite, sienite and porphyry.

§ 20. *Kind and Quantity of Materials which Volcanoes throw out.*

The quantity of lava and other substances which volcanoes throw out is enormous. It is said by Kircher in 1660, that the ejections of Mount Ætna would, if collected, form a mass twenty times as large as the mountain itself. And in a few years after, in 1669, the same mountain was covered with a fresh current of lava, eighty-four square miles. And again in 1775, according to Dolomieu, the same volcano poured out another stream of lava twelve miles in length, and one mile and a half in breadth, and two hundred feet in depth. The largest known current of modern lava was formed by a volcano in Iceland, and was ejected in 1783. It is sixty miles in length and twelve broad.

The kinds of matter thrown out by different volcanoes varies at different times. Thus sometimes appear smoke, steam, flame, stones, sand, ashes, mud and lava.

When a volcano breaks out, especially if in a new situation, it is preceded by violent earthquakes. The heated ground swells up until a fissure is formed, which is sometimes of vast extent. Through this rent, flame and smoke, and melted stones are ejected. Hence earthquakes are always connected with volcanic action.

§ 21. *Cause of Volcanic Action.*

Werner supposed that volcanic action was produced by the combustion of beds of coal. This supposition is abundantly disproved by the fact that volcanic action is far below the coal deposits; and if it were not, no beds of coal of sufficient extent could be found to supply combustible matter for a single capital operation. A more rational theory of volcanic action has been proposed, which is founded on the intense chemical action which ensues when many elementary bodies are brought in contact. Or it may be remarked that galvanic action illustrates very perfectly the condition under which volcanic action may take place. For an exposition of the theory of volcanic action, see Bakewell's Geology, American edition.

§ 22. *Conclusion.*

In the preceding sketch it was intended to present only some of the leading and prominent features of geological science, or just so much as would excite inquiry and stimulate to action those in whose hands the book should happen to fall. The study of geology is one of increasing interest to this country. Its resources are yet to be developed, and much depends on scientific geology. If, therefore, the few geological facts and principles which this slight outline contains shall serve to create a taste for the science, or prove its utility, the object of the author will be accomplished.

NOTES

REFERRED TO IN THE INTRODUCTION TO MINERALOGY.

NOTE A.

According to the views of Prof. Mohs, a primary form is a simple form, from which other simple forms are derived, and is denominated a *fundamental form*, and the class of figures derived from that fundamental form, systems of crystalization. These systems are termed the Tessular, Pyramidal, Prismatic, Rhombohedral, Hemi-prismatic, and Tetarto-prismatic.

The tessular system embraces the regular tetrahedron, regular octahedron, cube and rhombic dodecahedron. The pyramidal system contains the octahedron with a square base, and the right square prism. The prismatic system contains the rectangular and rhombic octahedron. The rhombohedral system includes the rhombohedron and the regular hexagonal prism. The hemi-prismatic includes the right rhomboidral and the oblique rhombic prisms. The tetrato-prismatic contains the doubly oblique prism. This distinction is so far important, that all the forms which a mineral assumes, must belong to the same *system of crystalisation*. For instance, the forms belonging to the tessular system produce among themselves various combinations, but they admit into them no form which is a rhomboid, or a four-sided pyramid with a square base, or an oblique four-sided pyramid. The rhomboid and octahedron with a square base, and the octahedron with an oblique base, are forms which cannot by any means be derived from each other. Hence those systems of crystalization form *groups* which are altogether distinct from the rest.

NOTE B.

The common goniometer consists essentially of a semi-circle graduated to 180°, and two arms moveable on a common centre. To use this instrument, the arms at one extremity must be applied accurately to two adjoining planes; the number of degrees which the arm on the opposite side of its centre cuts off, indicates the angle at which the planes meet.

The reflecting goniometer is an instrument much more complicated. It consists of an entire circle, divided into degrees upon its edge, and so disposed as to move vertically upon an horizontal moveable axis. The axis projects on both sides of the graduated circular plate. On the one side there are two lesser circles or wheels, one of which moves the axis only, and the other the graduated circle and axis. On the opposite side the axis projects for the purpose of attaching the crystal to be measured. To use the instrument, it must first be adjusted, which is effected by placing it on a small stand on a firm table, of such an elevation as to permit the experimenter to steady his elbows on the table, while his eye shall not be above the axis of the instrument. The table must be placed before a common window, with the wheel moving vertically to the window, and from six to twelve feet from it. A black line is to be drawn parallel to the horizontal bars of the window, between it and the floor. The crystal is now to be attached to the axis of the instrument by a piece of wax. In attaching the crystal, the edge formed by the meeting of the planes whose angle we wish to measure, must coincide with the centre of the axis of the instrument, or a line passing through the axis. This being done, we are to observe if the line which indicates 180° upon the circle, corresponds with a line marked O on the vernier, and also that the reflection of a known bar of the window is seen along the black line. The exterior axis is now to be turned until the image of the bar reflected from the other plane is seen to coincide with the same line below. The number of degrees and minutes at which the planes incline, may now be observed.

The instruments which are here partially described, are both of them useful, and the reflecting goniometer indispensable to the student who would be an accomplished mineralogist. The relative advantages of each become evident on reflection, and do not require a particular consideration.

NOTE C.

There are some secondary forms which, as we have seen, are derived from the primary by certain symmetrical modifications in these cases. We shall be able, in general, to say that a crystal of this sort belongs to one of two or three of the primary forms. For instance, if the crystal is a trapezoedron, we know it can come only from the *cube*, the regular octahedron, or rhombic dodecahedron; if a pentagonal dodecahedron, it must come from the cube; if a dodecahedron with scaline triangular faces, it can come only from the rhomboid. In the absence of cleavage, the student will occasionally meet with some embarrassment. In this case it will be best to obtain several forms of the mineral, which will perhaps enable him to fix upon the primary agreeably to symmetrical changes, as noticed in § 50. Thus if the crystal is a cube, that must be the primary form; or a tetraedron, regular octahedron, or rhombic dodecahedron—the only forms with which it can be connected. If an octahedron with a square base, it must be identical with that, or the right square prism; if the regular hexagonal prism, that must be the primary, or it is derived from the rhomboid. There are cases, however, more difficult than any we have yet noticed. When, for instance, all the primary planes are extinguished, and when in addition to this many of them are unduly extended, though they may still be symmetrically disposed. Some experience, aided by a few rules, will enable the student to overcome most difficulties which occur. When the secondary crystal retains some portion of the primary planes, we should in that case observe whether there be on the crystal any series of planes whose edges are parallel to each other. If such is the fact, we should then hold the crystal in such a manner, that the series of parallel edges may be vertical or upright; and while in this position, we should observe whether there be any plane at right angles to the vertical planes. If on examining the secondary forms of crystals, we meet with two sets of parallel planes, either of which held upright, the crystal would present a series of parallel planes, we should in that case endeavor to ascertain whether the planes belonging to one set are more symmetrical than the other set. If so, they are to be made the vertical series. *If there exist a series of vertical planes and a horizontal plane*, we should observe whether any of the vertical planes are at right angles to each other, and whether there be any oblique planes lying between some of the vertical planes and the horizontal planes.

We should remark the equality or inequality of the angle at which any of the vertical or oblique planes incline on the several adjacent planes, and also if there is a symmetrical arrangement of the vertical planes, or of the oblique planes, which would induce us to refer our crystal to any particular class of primary forms. If the crystal is contained within any series of vertical planes, and is terminated by a single oblique one, the crystal may belong to the class of oblique rhombic prisms, doubly oblique prisms or rhomboids. If there are four oblique planes inclining to each other at *equal angles*, the crystal may belong to the class of square prisms, or of octahedrons with square bases. If there are *four oblique planes*, each of which inclines on two adjacent planes at unequal angles, the crystal probably belongs to the class of right rectangular, right rhombic prisms, or octahedrons with rectangular or rhombic bases. If the series of vertical planes are six, nine, twelve, or some multiple of three, and if there be a single horizontal plane, the crystal may belong to one of the classes of right prisms, rhomboids, or hexagonal prisms. If there be three oblique planes, the primary is a rhomboid. But if the termination consists of six oblique and equal planes, the crystal belongs to the rhomboid or hexagonal prisms.

The most difficult forms to be understood, are those belonging to the doubly oblique prisms. These can only be learnt by cleavage, and from comparing crystals with each other, and with tables of modification. See Brooke, p. 106, 211.

NOTE D.

The importance of observing the appearance of surfaces will become evident from the following remarks. They will be made under the following heads, viz: *Faces of crystalisation—Faces of cleavage—Faces of composition*, and *Faces of fracture.*

The most interesting faces are those which are even, since they are subject to a constant law. These are always faces of crystalization or faces of cleavage. The different qualities of even faces consist in their being smooth, or in being provided with slight elevations which do not obscure the general form of the crystal, or interrupt the continuity of faces. Those faces which are not perfectly smooth may be *striated*, *rough* or *drusy*. The *striæ* which appear on faces are produced by the alternating reappearance of the faces of those simple forms which are contained in the compound ones, and are always parallel to the edges of combination, or between the simple and compound forms. In rhombohedral quartz, the alternate lateral faces are striated longitudinally. Hexahedral iron-pyrites are streaked, the stria being parallel on parallel faces. In beryl the faces are striated longitudinally. Faces which are homologous show similar appearances on their faces, which circumstance furnishes a character by which they may be known.

Faces which are termed rough and drusy, arise from projecting solid angles instead of edges. Those faces differ principally in the size of the elevations. In octahedral fluor-haloide, the octahedral crystals seem to be composed of cubic crystals, the faces of which are perpendicular to each other; and a plane passing through their solid angles is parallel to the faces of the octahedron. Those particles which thus project are not to be considered as compound; they rather indicate the gradual formation of crystals, and the interruption which they suffer during their formation.

The faces of composition are those in which two or more individuals touch one another. They are rarely smooth, but frequently streaked, but without any determined direction. In rough faces of composition, the lustre of those faces is very low; which character may be used to distinguish between the faces of cleavage and those of composition. And they may be distinguished from uneven faces of fracture by comparing them with real faces of fracture in the same individual.

The character of the faces of composition differ from those of cleavage and crystalization in one circumstance, viz: they do not produce regular forms, from the reason that they preserve no determined direction. The only exception which it is necessary to make is where parallel individuals touch one another, or those which depend on regular composition.

NOTE E.

Polarized Light.

Light reflected from polished surfaces, or transmitted through refracting media, with a certain angle of incidence, acquires properties entirely different from those which it before possessed, and is called *polarized light.*

For example, if a pencil of rays fall upon a plate of glass at an angle of incidence of 56° and after reflexion be received with the same angle of incidence upon a second plate so placed as to reflect them in a plane at right angles to that in which they first moved, almost all the rays refuse to be reflected. If the second plate be now turned around, the same angle of incidence being maintained, more and more rays will be reflected, until the plane of their reflexion *coincides* with that in which they first moved, when the reflexion is the greatest possible. The light in this case is said to be polarized; that is, the rays have poles or sides of different properties.

From the various phenomena which light presents when decomposed or polarized in crystals, mineralogists are enabled to judge of the mode of the intimate combination of the particles of those bodies: in other words, they give an insight into the nature of their crystaline structure. The light which passes through them reveals to the experienced eye the peculiarities in the mode of formation and composition, acting, as it were, to borrow the language of another, as a "sounding instrument, with which to probe the substance of matter, and which, insinuating itself between the minutest parts, permits us to study their arrangement, at which previously we could only guess, by inspecting their external forms."

Double Refraction.

Is that property which some transparent crystalized bodies possess which enables them to exhibit a double image of an object seen through them in certain directions. This property is possessed by a great number of minerals and artificial salts. In all doubly refracting substances there are one or more lines, or one or more planes along which double refraction exists. Those substances which have only one line or plane, are called crystals with one axis, or one plane of axes of double refraction. And those which have two, three, four, &c., axes, or planes of axes, of double refraction. Crystalized carbonate of lime, or as it is commonly called Iceland spar, and rhombohedral quartz, are examples in which this property resides. Minerals which belong to the tessular system are not known to possess this property.

NOTE F.

The instrument here described is the one proposed by Benj. H. Coates, M. D., in the Journal of Science, p. 361—370, vol. 1. It consists of a lever like a common steel-yard, and is so contrived as to balance exactly by making the shorter end wider, or with an enlargment at the extremity. The upper edge is rectilinear and free from notches. The shorter end is undivided, but on the longer side there is a scale, of which every division, reckoning from the extremity of the lever, is marked with a number, which is the quotient of the length of the whole scale, divided by the distance of the division from the end. Thus at half of the length is marked the number 2, at one-third 3, at one-fourth 4, &c. Also, at two-thirds the length is marked one and a half; at two-fifths two and a half, and so of the fractions sufficiently minute. These numbers extend as high as *the specific* gravity of platina, the pivot represents unity, and a notch is made at the farther end.

In using this instrument, any convenient weight is suspended by a hook from the notch at the end of the scale. The body under examination is to be suspended from the other by a horse hair, and slid along till an equilibrium is produced. It is then without alteration to be immersed in water and balanced a second time, by *sliding* the weight. The hook of the latter then marks the specific gravity on the scale. By this instrument it will be seen that the labor and inconvenience of calculation is saved, and that the specific gravity of any mineral may be ascertained in a few moments, without pen and ink.

NOTE G.

This character is confined mostly to iron and its ores. The latter manifests only a weak degree of it, but is generally proportioned to the degree of oxidation. A very weak magnetism may be detected by the following method: Place a magnet on a level with a needle, and in a direct line with it, but with reversed poles. The needle will move round and point E and W, which shows that the polar attraction is just balanced, being divided between the earth and the magnet. If now a mineral with only a small quantity of iron is brought near the needle it will act upon it; whereas in the ordinary position of the needle no action would be observed.

NOTE H.

Chemical Characters.

The facility which the blow-pipe affords for discovering the constituent parts of minerals, especially those which are usually termed metallic compounds, renders it necessary to say something on the mode of using that instrument, the kinds and uses of the fluxes employed for reducing the metals and for detecting other component parts of bodies, &c.

For general use the common blow-pipe of goldsmiths will answer all the purposes of a more expensive kind, and as experience is the only way to become master of it, little need be said on the particular mode of using it. It may however be proper to say, that the air should not be forced out by means of the muscles of the chest but by the cheeks, while the breathing is kept up through the nostrils, and that the size of the particle of the mineral operated on ought in general to be no larger than a common pin head.

Of the combustible. Every kind of flame, if it is not too small, may be used in experiments with the blow-pipe, whether it be that of a wax or tallow candle, or of an oil lamp, the latter is the best. The wick ought to be rather large, but proportioned to the tube which encloses it. The best fuel is said to be olive oil.

Kinds of flame. If the flame is examined when under the influence of the blow-pipe, we shall remark a division of it into two unequal parts; the external, which is the largest and most luminous, and the internal which is small, well defined, and of a blue colour. The former is called the *oxidating* and the latter the *reducing* flame. The greatest heat is just at, or a little within, the apex of the blue flame, and is the point where the mineral should be placed. The surrounding luminous flame tends to preserve the heat. To attain the greatest heat we must not blow too strongly nor too gently: in the first case, the heat is carried off by the current of air, and in the second, sufficient air is not supplied in a given time.

Effects to be attained. In general the effects we wish to produce are *oxidation* and *reduction*. The former is to be effected by exposing the fragment under trial before the extreme point of the flame, where the combustible particles are soon supplied, or saturated, with oxygen. Oxidation goes on most actively at an incipient red heat, and the orifice in the beak of the blow-pipe ought to be larger for this kind of operation than in reduction. For reduction the orifice on the beak ought to be rather fine, and the beak should not be inserted too far into the flame of the lamp. The assay must be exposed to the brilliant part of the flame so as to be surrounded by it on all sides, and this is just before the point of the blue flame or a little within it.

OF THE SUPPORT.

1st. *Charcoal.* That charcoal is the best which is made from the pine tree, or from the alder or the light woods in general. It should be well burnt; that which splits, crackles and smokes is unfit for use.

2d. *Platina.* In using platina a fine wire may be bent into the form of a hook at the extremity, or fused into a globule under the compound blow-pipe, and then flattened and shaped into the form of a spoon, or we may use platina foil. Each form has its advantages under some circumstances.

3d. *A fibre of Asbestus* is sometimes a very convenient support.

4th. *Plates of Mica* may also be used.

5th. *Glass tubes* are useful as well as necessary to roast a substance to ascertain what it is combined with. One or two inches in length and the 1·8 of an inch in diameter is the right size, and open at both ends. In the tube, a little distance from one end, the assay must be placed: it may be heated with a spirit lamp or the blow-pipe. The volatile substances sublime and condense in the upper and cooler part of the tube.

OF THE REAGENTS.

The reagents employed are the sub-carbonate of soda, *borate of soda*, and the double salt formed of phosphate of soda and phosphate of ammonia.

1. *Soda*. Either of the carbonates may be used. There are two principal objects to be obtained by their use. 1st. To ascertain the fusibility or infusibility of substances which are combined with them, and 2d, to assist in the reduction of the metallic oxides.

(a) The fusion of bodies by Soda. A large number of bodies combine with soda at high temperatures, but many are infusible. With silex, the acids, and a few metallic oxides, it forms fusible compounds. The quantity of soda to be employed may be taken up on the point of a knife, previously moistened, and then intimately mixed with the powder of the assay. This must be dried before the flame and then heated till it fuses.

(b) Reduction of metallic Oxides. The soda in the reduction of metallic oxides is applied in powder to the assay as long as any matter of the assay remains on the charcoal. The place where the assay and soda rested on the charcoal is to be removed with a knife and reduced to very fine powder in a mortar. This powder is then to be washed with water to free it from charcoal. If the assay contained no metallic substance, nothing will remain after the last washing. But if it contained any portion of reducible metal it will be found at the bottom of the mortar, either in the form of brilliant metallic scales, if malleable, or in a powder, if brittle and unmalleable. In either case we can perceive metallic traces on the bottom of the mortar. The metals reducible by soda are gold, silver, tin, molybdenum, tungsten, antimony, tellurium, bismuth, lead, copper, nickel, cobalt and iron.

2. *Borax* is used to effect the solution of a great number of substances. In using this reagent we are to notice whether a solution is effected; whether effected slowly or readily; with, or without effervescence.

Certain bodies have the property of forming a clear glass with borax, which preserves its transparency after cooling, but when slightly heated by the exterior flame of the lamp, becomes opake and turns milk-white, or is coloured, particularly if the flame has been directed on the glass in an unequal and intermitting manner.

Such are the *alkaline earths,* yttria, glucina, zirconia, the oxides of cerium, columbium, titanium. The same thing does not happen with silica, alumina, the oxides of iron and manganese, or when silica is present in a compound.

3. *Salt of Phosphorus.* This salt may be procured by dissolving 16 parts of sal ammonia in a very small quantity of boiling water and adding 100 parts of crystalized phosphate of soda. Liquify the whole together by heat, and filter the mixture whilst boiling hot; the double salt will crystalize in grains as it cools. This salt is particularly applicable to the examination of metallic oxides whose characteristic colours it developes.

OTHER REAGENTS.

1. *Saltpetre* may be employed to discover portions of manganese, too minute to colour glass without it.

2. *Nitrate of Cobalt* is used to detect the presence of alumina and magnesia. To the former it imparts a fine *blue,* and to the latter a pale *rose* colour. To be employed as a test for alumina the assay must be heated strongly, but not fused. In the latter case the assay must be fused.

Tin. This metal is employed in the state of foil, cut into long strips half an inch wide, and closely rolled up. Its use is to promote the reduction in the highest degree in the fused vitreous compounds, when the assay contains small portions of the metallic oxides, capable of being reduced to protoxides. We are to introduce into the hot assay, previously exposed to the reducing flame, the extremity of the roll of tin, a part of which fuses and remains in the assay, and the whole is immediately remelted in the same flame.

Iron. This is used in the form of fine wire. Bergmann and Gahn employed it to precipitate copper, lead, nickel and antimony, and to separate them from sulphur or fixed acids. For this purpose, a small portion of one end of the wire is immersed in the assay when hot, and the iron becomes covered with the reduced metal. But a more important use of iron is to detect phosphoric acid. Used as above, the phosphates are reduced to the state of phosphorus, which, acting on the iron, produces phosphuret of iron, and which, fusing with the assay, forms a white brittle metallic globule.

Certain substances undergo a change of form and aspect, without, however, entering into fusion. Some swell up like borax, or form ramifications which have a cauliflower appearance. Others afford a blebby glass. In the use of fluxes the blast ought not to be suspended too soon. A substance may at first seem infusible, but after a few moments begin to yield. The flux ought to be applied in small doses at a time, and we should wait till the first has united with the assay before we add a second dose.

When operating with fluxes before the reducing flame, it sometimes happens that the assay globule oxidates as the charcoal cools. To obviate this, let the charcoal be turned upside down while the globule is still fluid, that it may fall on a metallic plate. In conclusion it may be remarked, that in all the phenomena which the assay presents before the blow-pipe, we should observe the action of both flames, with their separate effects, all of which ought to be noted down separately.

ACTION OF ACIDS.

The acids usually employed as chemical tests are the *sulphuric*, nitric and muriatic. The latter is the best to discover the carbonates of the alkalies, earths and metallic oxides. Either of them may be employed for this purpose in a diluted state. A small fragment must be detached from the mass, pulverized, and put in a watch-glass or wine-glass, and the diluted acid poured upon it. The effervesence will then be apparent, from the liberation of the *carbonic acid gas*.

If our object is to form a jelly with the *silicated earths*, a large quantity of the pulverized mineral must be employed, and the acid used undiluted. It is commonly necessary to employ heat for digesting the powder. On cooling the fluid gelatinizes. Occasionally the colour of the solution is to be noticed. The sulphuric acid is used undiluted for detecting the fluoric acid. The powdered mineral in this case is to be put into a small glass tube, and the acid added, and then heat is to be applied; when if any fluoric acid is present, it will come off and corrode the glass, or diminish its transparency.

NOTE I.

It was regarded by the Abbe Haüy as an axiom in crystalography, that two minerals may possess analogous forms, each for instance a *rhombic prism*, yet the dimensions of those prisms are different. Identity of form, therefore, (not including the tessular system) was thought to indicate identity of composition. In the year 1819, a discovery was made by Prof. Mistcherlich, of Berlin, relative to the connexion between crystaline form and chemical composition, which is exceedingly important to mineralogy and chemistry. It appears from his investigations, that certain substances are capable of being substituted for each other in combination, without influencing the form of the compound. This remarkable fact has been ably traced by Prof. Mistcherlich, in the salts of phosphoric and arsenic acid. Thus the neutral phosphate and bi-phosphate of soda have exactly the same form as the arseniate and bi-arseniate of soda. The same has been shown of other salts and minerals. From these and analogous facts, it appears that certain substances, when similarly combined with the same body, are disposed to affect the same crystaline form. This discovery has led to the formation of groups, each comprehending substances which crystalize in the same forms, and which are hence termed *iso-morphous.*

Another fact connected with the preceding remarks is, that some substances may assume two fundamental forms. For instance, carbonate of lime yields a rhomboid, and a right rhombic prism. Other instances of the kind may yet be discovered, which will serve to confirm the fact or disprove it.

NOTE K.

The process by which a mineral is determined is as follows: first its form, whether it be regular or irregular; if it is regular, what is the Primary form—then the hardness and specific gravity must be determined with proper accuracy. The specific character requires these data; they are of use also in the classes, orders and genera. After this examination the characteristic may be applied, and it will at the same time point out what other characters are wanting. The given individual is now to be carried through the subordinate characters of the classes, orders, genera and species, one after the other, comparing its properties with the characteristic marks contained in the characters of the systematic unities. From their agreement with some, and their difference from other characters, we infer that the mineral belongs to one of the classes, to one of the orders, to one of the genera, and to one of the species. Having in this manner advanced to the character of the species, it will generally be necessary to ascertain the dimensions of the form. The common goniometer will in most cases answer our purpose. It is seldom necessary to read over the whole of any character of a class, order or genus; one term that does not agree suffices for its exclusion. To illustrate this process more particularly, let us take an example: first let the mineral yield by mechanical division a cube, let its hardness=2.5 and its sp. gr. 7.4—7.6. In this case the specific gravity excludes it from classes first and third: hence it belongs to class second. Comparing now the properties of the individual with the characters of the orders in the second class, we shall find that its specific gravity is too great for the orders Haloide, Baryte, Malachite, Mica, Spar, Gem and Sulphur, and is excluded from Pyrites by its less degree of hardness. The consideration of other characters now requires attention, as both hardness and specific gravity fall within the limits of orders Kerate, Metal, Glance and Blende. If the mineral has a metallic lustre it is excluded from the order Kerate. Our mineral then belongs to one of three orders, Metal, Glance or Blende. In the order Metal the lustre is metallic, colour not black, which is indecisive, and both hardness and specific gravity bring it within the limits of the order Metal, but if the colour is gray the mineral must be malleable, which excludes the mineral under examination from this order, as ours is not malleable, and this exclusion leads us next to consider the order Glance. First, our mineral is metallic and colour is gray, and both hardness and specific gravity include the mineral under examination. If the cleavage is monotomous the gravity will be under 5.0, but the gravity being above 5.0 the cleavage is of no consequence—the gravity in the order Glance, together with the other characters, agreeing with the one under examination, we infer that it belongs to the order Glance. In comparing our mineral with the genera in the order Glance, we shall find *that* it will be excluded from the genus Copper-glance, both by the character of cleavage and greater specific gravity, and from Silver-glance by its greater specific gravity and a want of malleability, and that it agrees with Lead-glance in colour, hardness, specific gravity and cleavage; hence we infer that our mineral belongs to the genus Lead-glance, and as this genus comprehends but one species, it renders it probable that our mineral is *Hexahedral Lead-Glance.*

CHARACTERS OF THE CLASSES AND ORDERS.

Characters of the Classes.

CLASS I.

Gravity under 3.8
No bituminous odor.
Solid : taste.

CLASS II.

Gravity above 1.8
Tasteless.

CLASS III.

Gravity under 1.8
Fluid: bituminous odor.
Solid: no taste.

Characters of the Orders.

Characters of the Orders of Class I.

I. ORDER—GAS.

G.=0.0001—0.0014
Expansible.
Not acid.

II. ORDER—WATER.

G.=1.0
Liquid.
Without odor or taste.

III. ORDER—ACID.

G.=0.0015—3.7
Acid.

IV. ORDER—SALT.

G.=1.2—2.9
Solid.
Not acid.

Characters of the Orders of Class II.

I. ORDER—HALOÏDE.

Non-metallic.
Streak uncoloured.
H.=1.5—5.0
G.=2.2—3.3

Pyramidal or prismatic: H.=4.0, and less, cleavage imperfect, in oblique directions.
Cleavage regular octahedron: H.=4.0.
Cleavage monotomous, eminent: G.=2.4, and less.
H. under 2.5: G.=2.4, and less.
G.=2.4, and less: H. under 2.5, no resinous lustre.

II. ORDER—BARYTE.

Non-metallic.
Streak uncoloured, or orange yellow.
H.=2.5—5.0
G.=3.3—7.3

Cleavage monotomous: G.=4.0, and less; or=5, and more.
Lustre adamantine or imperfect metallic: G.=5.0, and more.
Streak orange-yellow: G.=6.0, and more.
H.=5.0: G. under 4.5.
G. under 4.0, and H.=5.0: cleavage prismatic.

III. ORDER—KERATE.

Non-metallic.
Streak uncoloured.
Cleavage not monotomous, not perfect peritomous.
H.=1.0.—2.0
G. above 5.5

IV. ORDER—MALACHITE.

Non-metallic.
Colour blue, green, brown.
Cleavage not monotomous.
H.=1.0—5.0
G.=2.0—4.6

Colour or streak brown: H.=3.0, and less; G. above 2.5.
Streak blue: H.=4.0, and less.
Streak unclouded: G.=2.2, and less; H. under 3.0.

V. ORDER—MICA.

Cleavage monotomous, eminent.
H.=1.0—4.5
G.=1.8—3.2

Metallic: G. under 2.2.
Non-metallic: G. above 2.2.

H.=3.0, and more: rhombohedral.
G. under 2.5: metallic.

VI. ORDER—SPAR.

Non-metallic.
Streak uncoloured...brown, blue.
H.=3.5—7.0
G.=2.0—3.7

Forms cube, tetrahedron, regular octahedron, rhombic dodecahedron: G.=3.0, and less.
Rhombohedral: G.=2.2, and less; or H.=6.0.
H.=4.0, and less: cleavage monotomous, eminent.
H. above 6.0: pearly lustre; G. under 2.6, or above 2.8.
G. above 3.3: forms right rhombic and oblique rhombic prisms, or doubly oblique prisms; or H.=6.0; no adamantine lustre.
G.=2.4, and less: not without traces of forms and cleavage.

VII. ORDER—GEM.

Non-metallic.
No metallic adamantine lustre.
Streak uncoloured.
H.=5.5—10.0
G.=1.9—4.7

H.=6.0, and less: tessular, G.=3.1, and more; or G.=2.4, and less, and no traces of form and cleavage.
G. under 3.8: no pearly lustre upon faces of cleavage.

VIII. ORDER—ORE.

No green streak.
H.=2.5—7.0
G.=3.4—7.4

Metallic: colour black.
Non-metallic: lustre adamantine, or imperfect metallic.
Streak yellow or red: H.=3.5, and more, G.=4.8, and more.
Streak brown or black: H.=5.0, and more; or cleavage monotomous.
H.=4.5, and less: streak yellow, red or black.
H.=6.5, and more, and streak uncoloured: G.=6.5, and more.

IX. ORDER—METAL.

Metallic.
Colour not black.
H.=0.0—6.0
G.=5.7—20.0

Colour gray: malleable, G.=7.4, and more.
H. above 4.0: malleable.

X. ORDER—PYRITES.

Metallic.
H.=3.0—6.5
G.=4.1—7.7

H.=4.5, and less: G. under 5.3
G.=5.3, and less; colour yellow or red.

XI. ORDER—GLANCE.

Metallic.
Colour gray-black.
H.=1.0—4.0
G.=4.2—7.6

Cleavage monotomous; G. being under 5.0: colour lead-gray.
G.=above 7.4: colour lead-gray.

XII. ORDER—BLENDE.

Streak green, red, brown, uncoloured.
H.=1.0—4.0
G.=3.9—8.2

Metallic: colour black.
Non-metallic: lustre adamantine.
Streak green: colour black.
Streak brown...uncoloured: G. between 4.0 and 4.2, form tessular.
Streak red: H.=2.5, and less.
G.=4.3, and more: streak red.

XIII. ORDER—SULPHUR.

Non-metallic.
Colour yellow, red, brown.
Prismatic.
H.=1.0—2.5
G.=1.9—3.6

Cleavage monotomous: G.=3.4, and more.
G. above 2.1: streak yellow or red.

Characters of the Orders of Class III.

I. ORDER—RESIN.

H.=0.0—2.5
G.=0.7—1.6

G.=1.2, and more: streak uncoloured.

II. ORDER—COAL.

Streak brown, black.
H.=1.0—2.5
G.=1.2—1.5

NOTE L.

NON-METALLIC COLOURS.

A. WHITE.

1. *Snow-white*. The colour of newly fallen snow. Ex. Rhombohedral lime-haloide, or the purest white marble.
2. *Reddish-white*. White somewhat inclining to red. Ex. Several varieties of rhombohedral lime-haloide.
3. *Yellowish-white*. White inclining to yellow. Ex. Several var. of uncleavable quartz.
4. *Grayish-white*. White inclining to gray. Ex. Common limestone.
5. *Greenish-white*. White inclining to green. Ex. Common talc.
6. *Milk-white*. White inclining to blue. Ex. Chalcedony.

B. GRAY.

1. *Bluish-gray*. Gray inclining to blue, rather dirty. Ex. Splintery hornstone.
2. *Pearl-gray*. Gray mixed with red and blue. Ex. It is pale in the pearls, but of the same kind.
3. *Smoke-gray*. Gray mixed with brown. The colour of thick smoke.
4. *Greenish-gray*. Gray mixed with green. Ex. Several varieties of rhombohedral quartz, or cats-eye, &c.
5. *Yellowish-gray*. Gray mixed with yellow. Ex. Flint.
6. *Ash-gray*. A mixture of black and white. Ex. Zoisite.

C. BLACK.

1. *Grayish-black*. Black mixed with gray. Ex. Basalt.
2. *Velvet-black*. Colour of black velvet.
3. *Greenish-black*. Black mixed with green. Ex. Some varieties of augite-spar.
4. *Brownish-black*. Black mixed with brown. Ex. Bituminous mineral coal.
5. *Bluish-black*. Black mixed with blue. Ex. Black cobalt, the reniform and botryoidal varieties from Thuringia.

D. BLUE.

1. *Blackish-blue*. Blue mixed with black. Ex. Prismatic azure-malachite.
2. *Azure-blue*. A very bright blue mixed with red. Ex. Lapis Lazuli.
3. *Violet-blue*. Blue mixed with red. Ex. Amethyst.
4. *Lavender-blue*. Blue with a little red and much gray. Ex. Lithomarge.
5. *Plum-blue*. A colour somewhat inclining to brown, and like some varieties of plums. Ex. Dodecahedral corundum.
6. *Prussian* or *Berlin-blue*. The purest blue colour. Ex. Prismatic disthene-spar.

7. *Smalt-blue.* Ex. The colour of some varieties prismatoidal gypsum-baloide.
8. *Indigo-blue.* Blue mixed with black and green. Ex. Prismatic iron-mica.
9. *Duck-blue.* Blue with a great deal of green and a little black. Ex. Ceylanite.
10. *Sky-blue.* A pale-blue colour, with a little green.

E. GREEN.

1. *Verdigris-green.* A green, inclining to blue. Colour of verdigris.
2. *Celandine-green.* Green mixed with blue and gray. Ex. Prismatic talc-mica.
3. *Mountain-green.* Green with a great proportion of blue. Ex. Rhombohedral emerald.
4. *Leek-green.* Green with a little brown. Col. of the leaves of garlic.
5. *Emerald-green.* The purest green colour. Ex. Emerald.
6. *Apple-green.* A light-green colour, with a trace of yellow. Ex. Chrysophrase.
7. *Grass-green.* The colour of fresh grass.
8. *Pistachio-green.* Green with yellow and a little brown. Ex. Prismatic chrysolite.
9. *Asparagus green.* Pale-green, with a great proportion of yellow. Ex. Asparagus stone.
10. *Blackish-green.* Green with black. Ex. Paratomous augite-spar.
11. *Olive-green.* Pale-green, with a great deal of brown and yellow. Ex. Some varieties of olivine.
12. *Oil-green.* A green still lighter, or more yellow and less brown. The colour of olive-oil.
13. *Siskin-green.* A light-green colour, very much inclining to yellow. Ex. Pyramidal euchlose-mica.

F. YELLOW.

1. *Sulphur-yellow.* Colour of pure sulphur.
2. *Straw-yellow.* A light-yellow with a little gray. Ex. Prismatic topas.
3. *Wax-yellow.* Yellow with gray and a little brown.
4. *Honey-yellow.* Yellow with a little red and brown. The dark colour of honey.
5. *Lemon-yellow.* The purest yellow colour. Ex. Prismatoidal sulphur.
6. *Ochre-yellow.* Yellow with brown. Ex. Those varieties of quartz which are much mixed with iron.
7. *Wine-yellow.* A pale-yellow colour, with a little red and gray. Ex. Prismatic topas.
8. *Cream-yellow.* A pale-yellow, with a little red and very little brown. Some varieties of lithomarge.

9. *Orange-yellow.* Yellow, very much inclining to red. The colour of ripe oranges.

G. RED.

1. *Aurora-red.* Red with much yellow. Ex. Hemiprismatic sulphur.
2. *Hyacinth-red.* Red with yellow and a little brown. Ex. Pyramidal zircon.
3. *Brick-red.* Red with yellow, brown and gray. Colour of newly baked bricks.
4. *Scarlet-red.* The brightest red colour, with a slight tint of yellow. Ex. Cinnabar.
5. *Blood-red.* Red with a little of yellow and black; the colour of blood. Ex. Dodecahedral garnet.
6. *Flesh-red.* A pale-red with gray and a little yellow. Ex. Prismatic hal-baryte.
7. *Carmine-red.* The purest red colour. Rare. Some varieties of copper-ore.
8. *Cochineal-red.* Red with a little blue and gray.
9. *Rose-red.* A pale-red mixed with white and a little gray. Ex. Rhombohedral quartz.
10. *Crimson-red.* Red with a little blue. Ex. Prismatic cobalt-mica.
11. *Peachblossom-red.* Red with white, and more of gray than rose-red. The colour of peach blossom.
12. *Columbine-red.* Red with a little blue and much black. Distinct in dodecahedral garnet.
13. *Cherry-red.* A dark red colour mixed with much blue and a little brown and black. Ex. Prismatic purple-blende.
14. *Brownish-red.* Red with much brown. Ex. Reddle.

H. BROWN.

1. *Reddish-brown.* Brown mixed with much red. Ex. Pyramidal zircon.
2. *Clove-brown.* Brown with red, a little blue. Ex. Axinite.
3. *Hair-brown.* Brown with a little yellow and gray. Ex. Prismatic iron-ore.
4. *Broccoli-brown.* A brown colour mixed with blue, red and gray. Rare. Ex. Pyramidal zircon.
5. *Chesnut-brown.* The purest brown colour. Ex. Quartz mixed with the brown oxide of iron.
6. *Yellowish-brown.* Brown with much yellow. Ex. Jasper.
7. *Pinchbeck-brown.* Yellowish-brown with a metallic lustre. Ex. Rhombohedral talc-mica.
8. *Wood-brown.* Brown with yellow and gray. The colour of rotten wood.
9. *Liver-brown.* Brown with gray and a little green. Ex. Common jasper.
10. *Blackish-brown.* Brown with much black. Ex. The mineral resins.

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ERRATA.

Page.	*Line.*	*Error.*	*Correction.*
8,	17 from the bottom,	planer,	plane.
8,	9,	light,	eight.
36,	—	Marsh-gas,	Hydrogen-gas.
109,	Fig. 2 misplaced and the proper Fig. omitted.		
115,	4,	talc,	silica.
120,	9,	here,	hence.
128,	9,	passage in the parenthesis should be expunged.	
149,	Fig. 1, should be considered as half turned round.		
274,	16th line from top, longitudinally should be *transversely*.		

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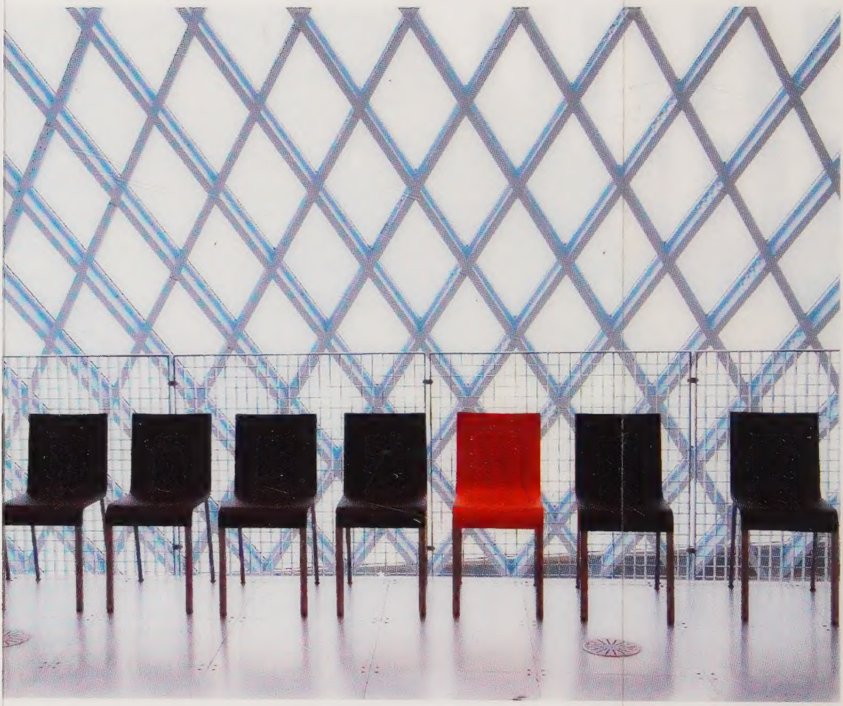

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