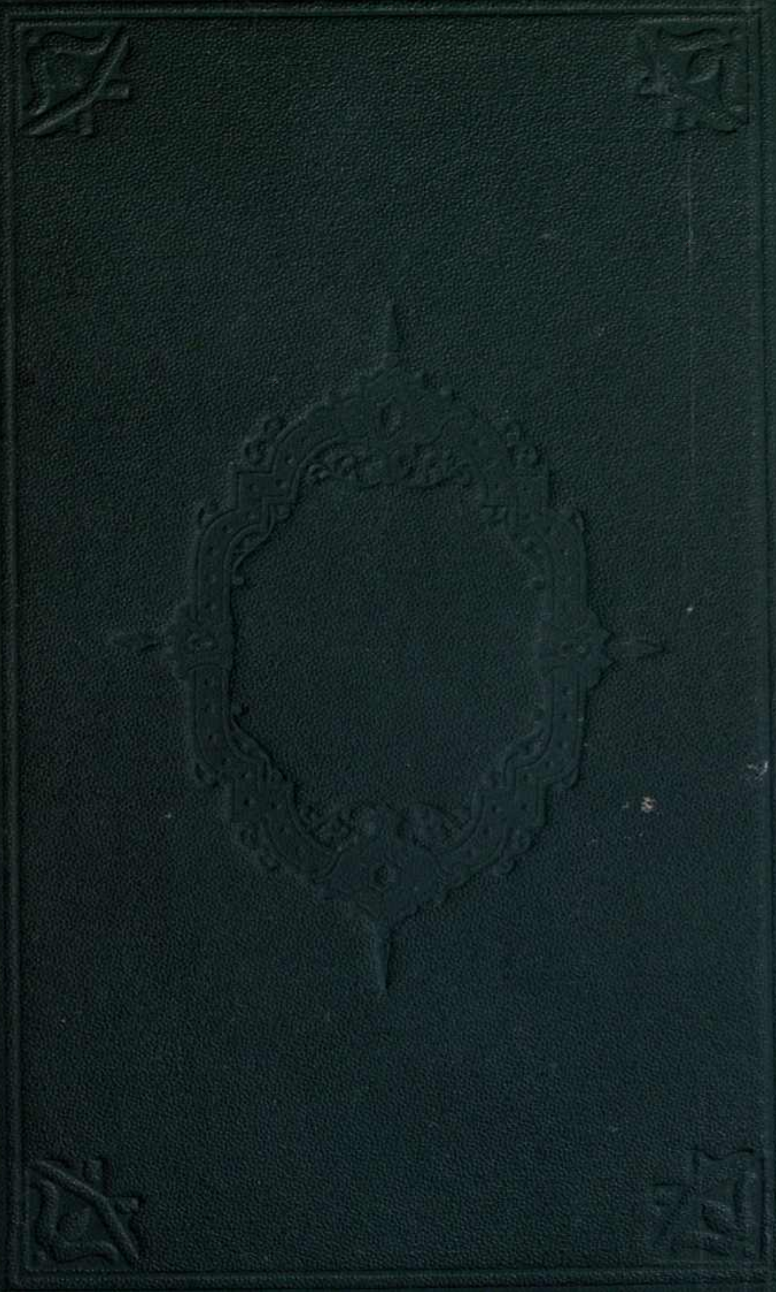

A POPULAR

TREATISE ON GEMS.

Yours Truly
Dr Louis

Heliographic Engraving Co. N.Y.

A POPULAR

TREATISE ON GEMS,

IN REFERENCE TO THEIR

SCIENTIFIC VALUE:

A GUIDE FOR THE TEACHER OF NATURAL SCIENCES

THE

LAPIDARY, JEWELLER, AND AMATEUR:

TOGETHER WITH A

DESCRIPTION OF THE ELEMENTS OF MINERALOGY, AND ALL
ORNAMENTAL AND ARCHITECTURAL MATERIALS.

With Elegant Illustrations.

BY

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PREFACE.

In none of the numerous works on Mineralogy that have lately been published, have Gems been treated in a manner commensurate with the important rank which they hold in the mineral kingdom. The author of this treatise published in 1838 a small work on Gems, which was well received by the scientific world. As that edition was soon disposed of, the author intended to issue a larger and improved edition, but close application to his legitimate pursuits prevented him from accomplishing that object. In 1851 he visited the London Exhibition, where the treasures of the mineral kingdom, and the profusion of brilliant and costly gems from all quarters of the globe, formed a collection such as had never before been witnessed; and he then resolved to embody the facts which he had there collected in a new work on Gems, which he has been encouraged to publish by the solicitations of numerous teachers and jewellers, who had used his former treatise as a work of reference, and who wish to have a work that will impart useful and correct information in regard to the locality and value of Gems in the present state of scientific knowledge. As a work on Gems would be incomplete without a treatise on Mineralogy, and as the author did not wish to enter into details foreign to his subject, he was at a loss how to commence; but on consulting the recent works on the Elements of Mineralogy of Prof. Nichols and Zimmerman, he was convinced that a summary of the leading principles of Mineralogy was indispensable, as an introduction to his main design; and that Crystallography, the mother of Gems, should be explained, before treating them when prepared for the dealer or wearer: he concluded, therefore, to commence his treatise by following the Terminology of Nichols' Elements of Mineralogy, of which he copied the greater part, along with some remarks of Dufresnoy, from the study of whose great work on Mineralogy he derived much valuable information. He feels it incumbent on him publicly to acknowledge his obligations to the author of the Elements of Mineralogy, for the concise and lucid descriptions contained in the first part of that work, which should be read by every student of Mineralogy. In the second part of this work, which treats of *Gems*, the author has followed his own system in their classification; that is, he has arranged them according to their intrinsic value, and not alphabetically, as has been done by some authors, nor as oxydized stones—a system adopted by others. The diamond is placed at the head of the whole class of Gems, and the others follow in the order of their commercial value. Some minerals which are not properly Gems have been included in the list, either on account of certain specific characters which they possess, or their applicability to some useful purpose. Many mineral substances which belong properly to the geological or economical department of the science of mineralogy, have been treated in this part of the work; but they occupy so important a position in the economy of life, that their introduction cannot be regarded as an intrusion. Reference is here made to the detailed account of coal, marble, granite, and sienite—are they not as valuable as the Gems described in this treatise? are they not the foundation on which is to be reared the opulence of future generations? have they not already contributed to the aggrandizement of the United States, the most enterprising nation on the globe?

The revenue arising from the annual production of eight million tons of coal is not inconsiderable. The marble of the country, which is just beginning to be developed, bids fair to compete with that of any other country, and to revolutionize the civilized world. The marble from California, that from the quarry lately discovered in Pennsylvania, the Leocadia Breccia, the Verde-Antique of Vermont, and the white marble from Canaan, Conn., which is used in the construction of the Fifth Avenue Hotel, Madison Square, N. Y., are referred to as illustrations. Are not the sienites and the granites which have been quarried for the last fifty years, and which have been used in the erection of all our public edifices, really as valuable as Gems?

Few persons were aware, until recently, of the existence of fancy (variegated) marbles in this country; and Italy, Greece, and Ireland furnish the materials for ornamenting fine houses and cemeteries, because our own resources have been overlooked, or not developed. What will be the condition of things fifty years hence, when the fine arts will occupy as prominent a position in this country as in any other, and when wealth and taste will compete with the arts and sciences for the ascendency? The Almighty has converted the vegetables of the forest into a mineral substance, the animals of the sea into building-stone, and endowed man with the faculty of exploring and developing the hidden treasures of nature, and this faculty will soon render this country independent of all other nations. The principal aim of the author has been to explain not only the useful, but also the ornamental mineral substances, and such compositions called mosaics as are prepared from them, and he is indebted for much valuable information pertaining to this branch of the subject to the Jury Report of the London Exhibition.

PREFACE TO THE THIRD EDITION.

THE publication of 1859 having been exhausted for several years, the numerous applications from booksellers for a supply have induced the author to issue another edition, and to improve it in adding an Appendix to the work on such subjects which, in his judgment, was considered indispensable; it was to give to his readers the chronology of mineralogical knowledge, from its first dawn to the present day, and with much perseverance and labor he accomplished this task. It was thought advisable and useful to add tables of the distinguishing characteristics of gems, so as to have at one glance a condensed survey of the physical and chemical characters of all the gems, and they were, therefore, copied from Mr. Harry Emanuel's late work on Diamonds and Precious Stones, as also many remarks on the value and market prices of gems, etc.

The author was requested to have his likeness placed in front of the work, and reluctantly complied with it; but while doing so, he is satisfied that his numerous friends on the Pacific will consider it acceptable. On account of the latter change, the former frontispiece had necessarily to be altered, and the best place was Part III., where the individual gems were treated on page 183, but the Kohinoor and Zircon crystals were deemed best to be replaced by other gems, which his friend, Mr. G. C. Newcomb, kindly furnished him for copying; they are a large Ruby spinelle of 100 carats weight, and a large Hyacinthe, and a beautiful precious Opal, which were photographed along with various gems and executed very faithfully.

In the present great Paris Exposition, according to the official catalogue, a great many valuable gems are mentioned, such as the Crown Jewels of France; those from the Queen of Sweden; also those of Russia; and from the various English, German, Turkish and French jewellers; also, a Brazilian Topaz, of 3½ lbs. weight, 7¼ inches long and 4⅝ inches wide, has recently been deposited. The extensive display of Corals, one set of which was valued at $2,300, and many others, but, for want of a detailed description, could not be enumerated in this Treatise.

The author had latterly occasion to examine at the jewelry store of Messrs. Bishop & Rein, under the Fifth Avenue Hotel, New-York, a beautiful white Brilliant, of 14 carats weight, and a great variety of splendid pink Corals. Also, at Doucet's store, Montreal, from Thunder Bay, Lake Superior, large masses of Amethysts, weighing several hundred pounds.

The author takes pleasure in recommending the Heliographic Engraving Company, under the superintendence of Baron Egloffstein; the author's likeness having been executed by them with much skill.

Praise is also due to Mr. Schnapauff, who much improved the coloring of the gems, many of them true to nature.

With these few remarks, the author commits herewith the present edition to the reader, and trusts it may prove useful and instructive, which will ever gratify the public servant,

LEWIS FEUCHTWANGER, M. D.

NEW-YORK, *June* 1, 1867.

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INTRODUCTION.

THE natural productions of our globe may be considered either in their original or in their changed condition. They are divided into two general classes which are determined,—either by certain characters that do not require explanation or investigation,—or, by the external appearances which are presented by them in their altered condition, and by investigating the causes which produced the changes of form or state.

In the former case, the science is called Natural History; in the latter, Natural Philosophy.

Natural History, considered in reference to the original properties of natural productions, must, therefore, be divided into organic and inorganic: to the former belong Zoology and Botany; to the latter, Mineralogy.

Botany and Zoology comprise bodies possessed of vitality, or beings which, increasing by the absorption of nutritive substances, mature after a certain period; their parts are dependent upon each other, and they cannot be separated without destroying the integrity of the individual, which, after a certain period, loses its vitality and ceases to exist;

or death ensues, decomposition takes place, and the original being is entirely destroyed.

Mineralogy, on the contrary, comprises those natural objects which are not possessed of life, and do not increase by absorption, but merely by accretion—that is, by an external growth or addition without any assimilation; they do not mature by age; their parts may be separated without destroying their individuality; and their formation being the result of chemical attraction, they are not liable to decomposition.

Mineralogy comprises two distinct sciences: *Mineralogy* proper, which treats of the simple minerals, either as independent bodies, or in relation to the characters which serve to determine and distinguish them; and *Geology*, which considers both simple and mixed minerals as they exist in nature, and in their dependent relations with soils and rocks. Mineralogy describes the individual qualities of the several mineral species,—Geology treats of them only as associated in the structure of the earth.

The characters of minerals are ascertained by their morphological, physical, and chemical properties. That part of Mineralogy which treats of the application of minerals to the different arts, is called Economical Mineralogy; minerals used by lapidaries in making ornaments, are called Gems.

Geometry, Physics (Natural Philosophy), and Chemistry, form the base for the study of Mineralogy, as without a knowledge of those sciences, the true characters of a mineral cannot be ascertained.

Geology is, according to Lyell's explanation, the science which investigates the successive changes that have taken place in the organic and inorganic kingdoms of nature. It inquires into the causes of these changes, and the influence which they have exerted in modifying the surface and external structure of our planet. By these researches into the state of the earth and its inhabitants at former periods, we acquire a more perfect knowledge of its present condition, and more comprehensive views concerning the laws now governing its animate and inanimate productions. When we study history, we obtain a more profound insight into human nature, by instituting a comparison between the present and former states of society. We trace the long series of events which have gradually led to the actual posture of affairs, and by connecting effects with their causes, we are enabled to classify and retain in the memory a multitude of complicated relations, the various peculiarities of national character, the different degrees of moral and intellectual refinement, and numerous other circumstances, which, without historical associations, would be uninteresting or imperfectly understood. When we carry back similar relations into the history of nature, we likewise investigate nature's operations in former epochs.

The form of a coast, the configuration of the interior of a country, the existence and extent of lakes, valleys, and mountains, can often be traced to the former prevalence of earthquakes and volcanoes in regions which have long been undisturbed. To these remote convulsions the present fertility of some districts, the sterile character of others, the elevation of land above the sea, the climate, and various peculiarities, may be distinctly referred. Many distinguishing features of the surface of the earth may often be ascribed to the operation, at a remote era, of slow and tranquil causes, to the gradual deposition or sediment in a lake or in the ocean, or to the prolific increase of testacea and corals. We also find in certain localities subterranean deposits of coal, consisting of vegetable matter formerly drifted into seas and lakes. These seas and lakes have since been filled up, the lands whereon the forests grew have disappeared or changed their form, the rivers and currents which floated the vegetable masses can no longer be traced, and the plants belonged to species which for ages have passed away from the surface of our planet, yet the commercial prosperity and numerical strength of a nation may now be mainly dependent on the local distribution of fuel determined by that ancient state of things. Geology is intimately connected to almost all physical sciences, as history is to the moral. An historian should, if possible, be profoundly acquainted with ethics, politics, jurisprudence, the military art, theology, and with all branches of knowledge, by which an insight into human affairs, or into the moral and intellectual nature of man, can be obtained. No less desirable is it for a geologist to be well versed in chemistry, natural philosophy, mineralogy, zoology, comparative anatomy, botany, and every science relating to organic and inorganic nature. Having such accomplishments, the historian and geologist would rarely fail to draw correct and philosophical conclusions from the various monuments transmitted to them from former occurrences. They would know to what combination of causes analogous effects were referable, and would often be enabled to supply by inference information concerning many events unrecorded in the defective archives of former ages.

Mineralogy is sometimes understood as comprising the natural history of every portion of inorganic nature. Here we consider it as limited to the natural history of simple minerals, or mineral species. In the strictest sense, a mineral species is a natural inorganic body, possessing a definite chemical composition, and assuming a regular determinate form, or series of forms. Many substances heretofore regarded as minerals will naturally be excluded—such as all the artificial salts, the inorganic secretions of plants and animals, the remains of former living beings now imbedded in rocks. Many substances originally organic products have by common consent found a place in mineral systems—such as coal, amber, and mineral resins—which ought not to be the case; also some amorphous substances, with no forms or chemical composition, as some kinds of clay, have also been introduced into works on Mineralogy, but often improperly, and with no beneficial result. Aggregates of simple minerals or rocks are likewise excluded from the science of Mineralogy, though the various associations of minerals, their modes of occurrence, and their geological position, are important points in the history of the different species. One most important object in Mineralogy is a full description of minerals, their essential properties and distinctive characters, as will enable the student to distinguish the various species, and to recognize them when they occur in nature.

The gems, or precious stones, are obtained from minerals. It is indispensable, therefore, to be fully acquainted with all the characters which distinguish them from one another, which is accomplished by the terminology or nomenclature of the science of Mineralogy—that is, with the meaning of the terms used in describing the properties of minerals, and the various modifications they may undergo, and also an account of the properties themselves. The system of classification is another closely related portion of Mineralogy. It gives an account of the order in which the mineral species are arranged. A third and most important part of Mineralogy is the physiography of the various species—giving an account of their characteristic marks, and a description of their appearance or external aspect and forms, their principal physical and chemical properties, their mode of occurrence, with their geological and geographical distribution, and their various uses, whether in nature or whether in the arts, or as gems for ornamental purposes.

PART I.

TERMINOLOGY.

CHAPTER I.

FORM OF MINERALS.

The physical properties of a mineral comprise all those properties belonging to it as a body existing in space, and consisting of matter aggregated in a peculiar way. The more important of these are,—its form as shown in crystallization; its structure as determining its mode of cleavage and fracture; its hardness and tenacity; its weight or specific gravity; and its relations to light, heat, electricity, and magnetism.

Crystalline and Amorphous.—Mineral substances occur in two distinct modes of aggregation. Some consist of minute particles simply collected together, with no regularity of structure or constancy of external form, and are named amorphous. All fluid minerals are in this condition, together with some solid bodies, which appear to have condensed either from a gelatinous condition like opal, when they are named *porodine*, or from a state of igneous fluidity like obsidian and glass, when they are named *hyaline*. The other class have their ultimate atoms evidently arranged according to definite law, and are named *crystalline*, when the regularity of structure appears only in the internal disposition of the parts; and *crystallized*, when it also produces a determinate external form, or a *crystal*.

CRYSTALS.

Faces, Edges, Angles, Axes of Crystals.—The word *crystal* in mineralogy designates a solid body exhibiting an original (not artificial) more or less regular polyhedric form. It is thus bounded by plane surfaces, named *faces*, which intersect in straight lines or *edges*, and these again meet in points and form *solid angles*, bounded by three or more faces. The space occupied by a crystal is often named a *form of crystallization*, which is thus the mathematical figure regarded as independent of the matter that fills it. Crystals bounded by equal and similar faces are named *simple forms;* while those in which the faces are not equal and similar are named *compound forms*, or *combinations*, being regarded as produced by the union or combination of two or more simple forms. The cube or hexahedron (fig. 1), bounded by six equal and similar squares; the octahedron (fig. 2), by eight equilateral triangles; and the rhombohedron, by six rhombs,—are thus simple forms. An *axis* of a crystal is a line passing through its centre and terminating either in the middle of two faces, or of two edges, or in two angles; and axes terminating in similar parts of a crystal are named similar axes. In describing a crystal, one of its axes is supposed to be vertical or upright, and is then named the *principal axis*, and that axis is chosen which is the only one of its kind in the figure. A few other technical terms used in describing crystals will be explained as they occur.

Systems of Crystallization.—The forms of crystals that occur in nature seem almost innumerable. On examining them, however, more attentively, certain relations are discovered even between highly complex crystals. When the axes are properly chosen, and placed in a right position, the various faces are observed to group themselves in a regular and beautiful manner around these axes, and to be all so related as to compose connected series produced according to definite laws. In every mineral species there is a certain form of crystal from which, as a primary, every other form of crystal observed in that mineral species may be deduced. In each species the axes, bearing to each other definite numerical proportions, intersect at angles which are constant. So also the faces of the various forms are related to each other, and to their primary, according to certain definite laws. When viewed in this manner, and referred to their simplest forms, the innumerable variety of crystals occurring in nature may all be reduced to six distinct groups, or, as they are named, systems of crystallization. The following are the names given to these systems of crystallization in some of the best authors:

Naumann.	Mohs.	Weiss and G. Rose.
1. Tesseral System.	Tessular.	Regular.
2. Tetragonal System.	Pyramidal.	2 and 1 axial.
3. Hexagonal System.	Rhombohedral.	3 and 1 axial.
4. Rhombic System.	Orthotype.	1 and 1 axial.
5. Monoclinohedric System.	Hemiorthotype.	2 and 1 membered.
6. Triclinohedric System.	Anorthotype.	1 and 1 membered.

In the following treatise the terminology of Naumann is adopted, his method of classifying and describing crystals appearing the simplest and best adapted to promote the progress of the student.

Holohedric and Hemihedric.—Before describing these systems, it must be observed that certain crystals appear as the half of others, and are therefore named *hemihedric;* while the crystals with the full number of faces are named *holohedric.* Hemihedric crystals are formed when the alternate faces or groups of faces of a holohedric crystal increase symmetrically, so as to obliterate the other faces. Thus, if four alternate faces of the octohedron increase so as to obliterate the other four, a tetrahedron with half the number of faces is formed.

I. The first, or *Tesseral System*, named from *tessera*, a cube, which is one of the most frequent varieties, is characterized by three equal axes intersecting each other at right angles. Properly speaking, this system has no chief axis, as any one of them may be so named, and placed upright in drawing and describing the crystals. Of these there are thirteen varieties, which are thus classed and named from the number of their faces:

1. One Tetrahedron, or form with four faces.
2. One Hexahedron, with six faces.
3. One Octahedron, with eight faces.
4. Four Dodecahedrons, with twelve faces.
5. Five Icositetrahedrons, with twenty-four faces.
6. One Tetracontaoctahedron, with forty-eight faces.

The dodecahedrons are further distinguished, according to the form of their faces, into rhombic, trigonal, deltoid, and pentagonal dodecahedrons; and some of the icositetrahedrons have also received peculiar names.

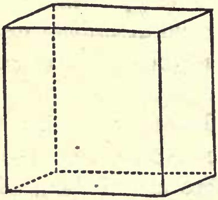


Fig. 1.

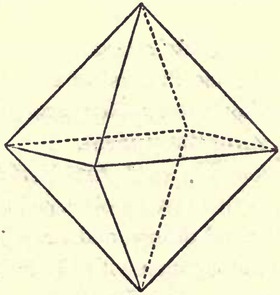


Fig. 2.

The following is a description, with figures, of the different forms above mentioned, beginning with

The *Holohedric forms.*

1. The hexahedron or cube (fig. 1) is bounded by six equal squares, has twelve edges, formed by faces meeting at 90°, and eight trigonal angles. The principal axes join the centre points of any two opposite faces.—Examples are fluor spar, galena, boracite.

2. The octahedron (fig. 2), bounded by eight equilateral triangles, has twelve equal edges, with planes meeting at 109° 28′, and six tetragonal angles. The principal axes join the opposite angles, two and two.—Example, alum, spinel, magnetic iron ore.

3. The rhombic-dodecahedron (fig. 3) is bounded by twelve equal and similar rhombs (diagonals as 1 and $\sqrt{2}$), has twenty-four equal edges of 120°, and six tetragonal and eight trigonal angles. The principal axes join two opposite tetragonal angles.—Ex., garnet, boracite.

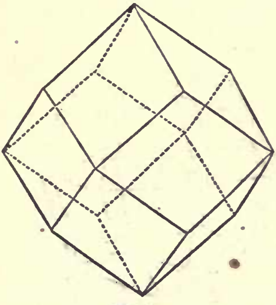


Fig. 3.

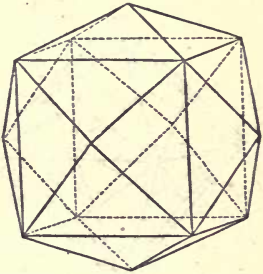


Fig. 4.

4. The tetrakishexahedrons (variety of icositetrahedron, fig. 4) are bounded by twenty-four isosceles triangles, arranged in six groups of four each. They have twelve longer edges which correspond to those of the primitive or in-

scribed tube, and twenty-four shorter edges placed over each of its faces. The angles are eight hexagonal and six tetragonal; the latter joined two and two by the three principal axes. This form varies in general aspect, approaching, on the one hand, to the cube; on the other, to the rhombic-dodecahedron.—Ex., fluor spar, gold.

5. The triakisoctahedrons (variety of icositetrahedron, fig. 5) are bounded by twenty-four isosceles triangles, in eight groups of three, and, like the previous form, vary in general aspect from the octahedron on one side, to the rhombic-dodecahedron on the other. The edges are twelve longer, corresponding with those of the inscribed octahedron, and twenty-four shorter, three and three over each of the faces. The angles are eight trigonal and six ditetragonal (formed by eight faces); the latter angles joined two and two by the principal axes.—Ex., galena, diamond.

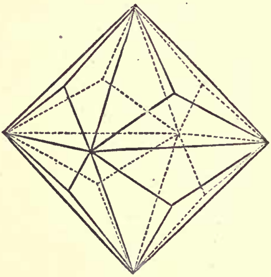


Fig. 5.

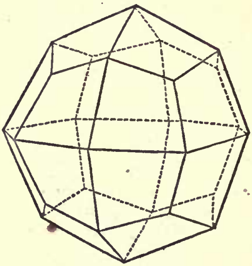


Fig. 6.

6. The icositetrahedrons (most common variety, fig. 6) are bounded by twenty-four deltoids or figures with four sides, of which two and two adjacent ones are equal. This form varies from the octahedron to the cube, sometimes approaching the former and sometimes the latter in general aspect. The edges are twenty-four longer and twenty-four shorter. The angles are six tetragonal joined by the

principal axes, eight trigonal, and twelve rhombic, or tetragonal with unequal angles.

7. The hexakisoctahedrons (fig. 7), bounded by forty-eight scalene triangles, vary much in general aspect, approaching more or less to all the preceding forms; but most frequently they have the faces arranged either in six groups of eight, or eight of six, or twelve of four faces. There are twenty-four long edges, often corresponding to those of the rhombic-dodecahedron; twenty-four intermediate edges lying in pairs over each edge of the inscribed octahedron; and twenty-four short edges in pairs over the edges of the inscribed cube. There are six ditetragonal angles joined by the principal axes, eight hexagonal and twelve rhombic angles.—Ex., fluor spar, garnet, diamond.

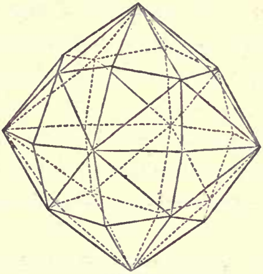


Fig. 7.

The seven forms of crystals now described are related to each other in the most intimate manner. This will appear more distinctly from the following account of the derivation of the forms, with which is conjoined an explanation of the crystallographic signs or symbols by which they are designated. We have adopted these symbols throughout this work, in the belief that they not only mark the forms in a greatly abbreviated manner, but also exhibit the relations of the forms and combinations in a way which words could hardly accomplish.

The *derivation of forms* is that process by which, from one form chosen for the purpose, and considered as the *type*—the *fundamental* or *primary form*—all the other forms of a system may be produced, according to fixed principles or general laws. In order to understand this process or method of derivation, the student should keep in mind that the position of any plane is fixed when the positions of any three points in it, not all in one straight line, are known. To determine the position, therefore, of the face of a crystal, it is only necessary to know the distance of three points in it from the centre of the crystal, or the points in which the face or its supposed extension would intersect the three axes of the crystal. The portion of the axes between this point and the centre are named parameters, and the position of the face is sufficiently known when the relative length or proportion of these parameters is ascertained. When the position of one face of a simple form is thus fixed or described, all the other faces are in like manner fixed, since they are all equal and similar, and all intersect the axes in a uniform manner; and the expression which marks or describes one face, marks and describes the whole figure.

The octahedron is generally adopted as the primary or fundamental form of the tesseral system, and distinguished by the first letter of the name, O. Its faces cut the half axes at equal distances from the centre; so that these semi-axes, or the parameters of the faces, have to each other the proportion 1 : 1 : 1. In order to derive the other forms from the octahedron, the following construction is employed. The numbers refer to the descriptions above.

Suppose a plane so placed in each angle of the octahedron as to be vertical to the axis passing through that angle and consequently parallel to the two other axes (or to cut them at an infinite distance $= \infty$); then the hexahedron or cube (1) is produced, designated by the crystallographic sign $\infty\, O\, \infty$; expressing the proportion of the parameters of its faces, or $\infty : \infty : 1$. If a plane is supposed placed in each edge parallel to one axis, and cutting the two other axes at equal distances, the resulting figure is the rhombic dodecahedron (3), designated by the sign ∞O, the proportion of the parameters of its faces being $\infty : 1 : 1$. The triakisoctahedron (5) arises when on each edge of the octahedron planes are placed cutting the axis not belonging to that edge at a distance from the centre m which is a rational number greater than 1. The proportion of its parameters is therefore $m : 1 : 1$, and its sign mO; the most common varieties being $\frac{3}{2}O$, $2O$, and $3O$. When, on the other hand, from a similar distance m in each two semiaxes prolonged, a plane is drawn to the other semiaxis, or to each angle, an ikositetrahedron (6) is formed; the parameters of its faces have consequently the proportion $m : 1 : m$, and its sign is mOm; the most common varieties being $2O2$ and $3O3$, the former very frequent in leucite, analcime, and garnet. When, again, planes are drawn from each angle, or the end of one semiaxis of the octahedron, parallel to a second axis, and cutting the third at a distance n, greater than 1, then the tetrakishexahedron (4) is formed, the parameter of its faces $\infty : 1 : n$; its sign ∞On; and the most common varieties in nature $\infty O\frac{3}{2}$, $\infty O2$, and $\infty O3$. Finally, if in each semiaxis of the octahedron two distances, m and n, be taken, each greater than 1, and m also greater than n, and planes be drawn from each angle to these points, so that the two planes lying over each edge cut the second semiaxis belonging to that edge, at the smaller distance n, and the third axis at the greater distance m, then the hexakisoctahedron (7) is produced, the parameters of which are $m : n : 1$, its sign mOn, and the most common varieties $3O\frac{3}{2}$, $4O2$, and $5O\frac{5}{3}$.

The next class of crystals are the *semi-tesseral forms;* and first, those with oblique faces, often named tetrahedral, from their relation to the tetrahedron. (1.) This form (fig. 8) is bounded by four equilateral triangles, has six equal edges with faces meeting at 70° 32′, and four trigonal angles. The principal axes join the middle points of each two opposite edges.—Ex., gray-copper ore, boracite, and helvine. (2.) The trigonal dodecahedrons (fig. 9) are bounded by twelve isosceles triangles, and vary in general form from the tetrahedron to the hexahedron. There are six longer edges corresponding to those of the inscribed tetrahedron, and twelve shorter placed three and three over each of its faces; and four hexagonal and four trigonal angles.—Ex., gray-copper ore, and bismuth-blende. (3.) The deltoid-dodecahedrons (fig. 10) are bounded by twelve deltoids, and vary in general form from the tetrahedron on the one hand, to the rhombic-dodecahedron on the other. They have twelve longer edges lying in pairs over the edges of the inscribed tetrahedron; and twelve shorter edges, three and three over each of its faces. The angles are six tetragonal (rhombic), four acute trigonal, and four obtuse trigonal angles. The principal axes join two and two opposite rhombic angles.—Ex., gray-copper ore. (4.) The hexakistetrahedrons (fig. 11) are bounded by twenty-four

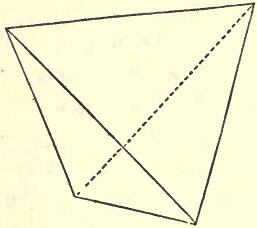


Fig. 8.

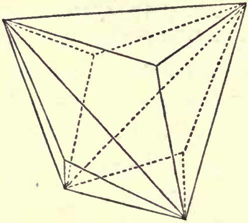


Fig. 9.

scalene triangles, and most commonly have their faces grouped in four systems of six each. The edges are twelve shorter and twelve longer, lying in groups of three over

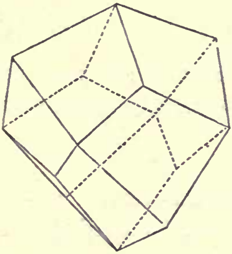


Fig. 10.

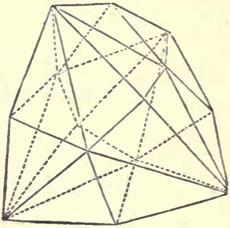


Fig. 11.

each face of the inscribed tetrahedron, and twelve intermediate in pairs over its edges. The angles are six rhombic, joined in pairs by the principal axes, and four acuter and four obtuser hexagonal angles.—Ex., diamond.

The derivation and signs of these forms are as follows:—The tetrahedron arises when four alternate faces of the octahedron are enlarged, so as to obliterate the other four, and its sign is hence $\frac{O}{2}$. But, as either four faces may be thus enlarged or obliterated, two tetrahedrons can be formed similar in all respects except in position, and together making up the octahedron. These are distinguished by the signs + and −, added to the above symbol, but only the latter in general expressed thus $-\frac{O}{2}$. In all hemihedric systems two forms similarly related occur, which may thus be named complementary forms. The trigonal dodecahedron is derived from the icositetrahedron, by the expansion of the alternate trigonal groups of faces. Its sign is $\frac{mOm}{2}$, the most common variety being $\frac{2O2}{2}$, found in gray-copper ore. The deltoid-dodecahedron is in like manner the result of the increase of the alternate trigonal groups of faces of the triakisoctahedron, and its sign is $\frac{mO}{2}$. Lastly, the hexakistetrahedron arises in the development of alternate hexagonal groups of faces in the hexakisoctahedron, and its sign is $\frac{mOn}{2}$.

The parallel-faced semitesseral forms are two. (1.) The pentagonal dodecahedrons (fig. 12) are bounded by twelve

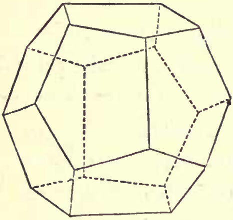


Fig. 12.

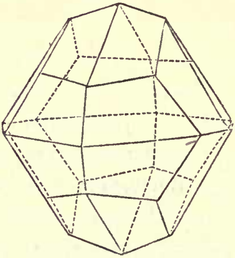


Fig. 13.

symmetrical pentagons, and vary in general aspect between the hexahedron and rhombic-dodecahedron. They have six regular (and in general longer) edges, lying over the faces of the inscribed hexahedron, and twenty-four generally shorter (seldom longer) edges, usually lying in pairs over its edges. The angles are eight of three equal angles, and twelve of three unequal angles. Each principal axis unites two opposite regular edges. This form is derived from the tetrakishexahedron, and its sign is $\frac{\infty On}{2}$, one of the most common varieties being $\frac{\infty O2}{2}$, found frequently in iron pyrites and cobaltine. (2.) The dyakisdodecahedron (fig. 13), bounded by twenty-four trapezoids with two sides equal, has twelve short, twelve long, and twenty-four intermediate edges. The angles are six equiangular rhombic, united in pairs by the principal axes, eight trigonal, and twenty-four irregular tetragonal angles. It is derived from the hexakisoctahedron, and its sign is $\left[\frac{mOn}{2},\right]$ the brackets being used to distinguish it from the hexakistetrahedron, also derived from the same primary form. It occurs in iron pyrites and cobaltine. There are two other tetrahedral forms, the pentagonal dodecahedron (fig. 14), and the pentagonal icositetrahedron (fig. 15), both bounded by irregular pentagons, but not yet observed in nature.

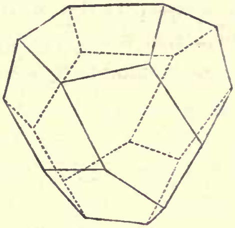


Fig. 14.

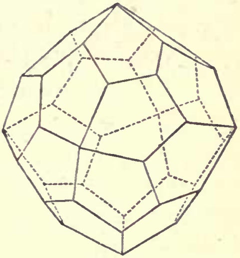


Fig. 15.

Combinations.—These forms of the tesseral system (and this is true also of the five other systems of crystallization) not only occur singly, but often two, three, or more are united in the same crystal, forming what are named combinations. In this case it is evident that no one of the individual forms can be completely developed, because the faces of one form must partially interfere with the faces of the other forms. A combination therefore implies that the faces of one form shall appear symmetrically disposed between the faces of other forms, and consequently in the room of certain of their edges and angles. These edges and angles are thus, as it were, cut off, and new ones produced in their place, which properly belong neither to the one form nor the other, but are edges or angles of combination. Usually, one form predominates more than the others, or has more influence on the general aspect of the crystal, and hence is distinguished as the predominant form, the others being named subordinate. The following terms used on this subject require explanation. A combination is *developed* when all the forms contributing to its formation are pointed out; and its sign consists of the signs of these forms, written in the order of their influence on the combination, with a point between. An angle or edge is said to be *replaced* when it is cut off by one or more secondary planes; it is *truncated* when cut by one plane, forming equal angles with the adjacent faces; and an edge is *bevelled* when replaced by two planes, which are equally inclined to the adjacent faces.

It will be readily seen that such combinations may be exceedingly numerous, or rather infinite; and only a few of the more common can be noticed, simply as specimens of the class. Many others more complicated will occur in the descriptive part of this treatise. Among plenotesseral combinations, the cube, octahedron, and also the rhombic-dodecahedron, are the predominant forms. In fig. 16 the

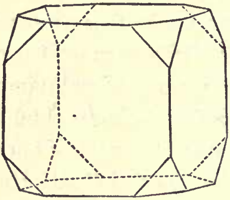


Fig. 16.

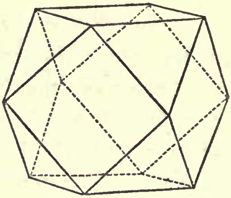


Fig. 17.

cube has its angles replaced by the faces of the octahedron, and the sign of this combination is $\infty O \infty$. O. In fig. 17 this process may be regarded as having proceeded still further, so that the faces of the octahedron now predominate, and the sign, of the same two elements but in reverse order, is $O \,.\, \infty O \infty$. In fig. 18 the cube has its edgesre placed

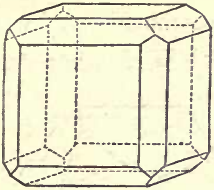


Fig. 18.

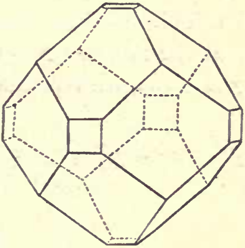


Fig. 19.

by the faces of the rhombic-dodecahedron, the sign being $\infty O \infty \,.\, \infty O$; while in fig. 19 there is the same combination, but with the faces of the cube subordinate, and hence the symbol is $\infty O \,.\, \infty O \infty$. The former figure, it will be seen, has more the general aspect of the cube; the latter of the dodecahedron.

In combinations of semitesseral forms with oblique faces, the tetahedron, the rhombic-dodecahedron, or even the hexahedron, seldomer a trigonal-dodecahedron, are the more

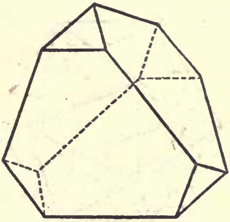


Fig. 20.

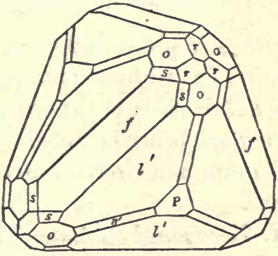


Fig. 21.

common predominant forms. In fig. 20 two tetrahedrons in opposite positions, $\frac{O}{2} \,.\, -\frac{O}{2}$, are combined. In fig. 21 a very complex combination of seven forms is represented in a crystal of gray-copper ore, its full sign being—

$$\frac{2O2}{2}(l') \,.\, \infty O \infty \,(f) \,.\, \infty O(o) \,.\, \frac{O}{2}(P) \,.\, -\frac{2O2}{2}(r) \,.\, \frac{\frac{3}{2}O}{2}(n') \,.\, \infty O3(s);$$

the letters in brackets connecting them with the respective faces of the figure. As examples of combinations of semitesseral forms with parallel faces, we may take fig. 22, in which each of the angles of the cube is unsymmetrically replaced by three faces of the dyakisdodecahedron, and hence $\infty O \infty \,.\, \left[\frac{4O2}{2}\right]$; or fig. 23, in which the pentagonal-dodecahedron has its trigonal angles replaced by the faces of the octahedron, consequently with the sign $\frac{\infty O2}{2} \,.\, O$.

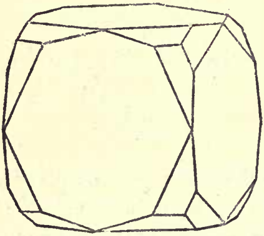


Fig. 22.

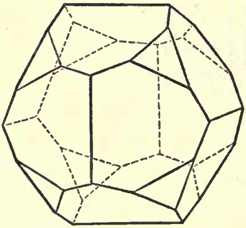


Fig. 23.

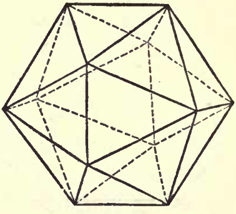


Fig. 24.

Figure 24 represents the same combination but with greater predominance of the faces of the octahedron, the crystal being bounded by eight equilateral and twelve isosceles triangles.

II. *Tetragonal System.*—This system has three axes at right angles, two of them equal and one unequal. The last is the principal axis, and when it is brought into a vertical position the crystal is said to be placed upright. Its ends are named poles, and the edges connected with them polar edges. The two other axes are named subordinate or lateral axes, and a plane passing through them is named the basis of the crystal. The two planes that pass through the principal and one of the lateral axes are named normal chief sections, and a plane through the chief axis intermediate to them, a diagonal chief section. The name tetragonal is derived from the form of the basis, which is usually quadratic.

There are eight tetragonal forms, of which five are *closed*,—that is, bounded on all sides by planes, and of definite extent,—and three *open*, which in certain directions are not bounded, and consequently of indefinite extent.

The description of the varieties is as follows, it being premised that a crystallographic pyramid is equivalent to two geometrical pyramids joined base to base.

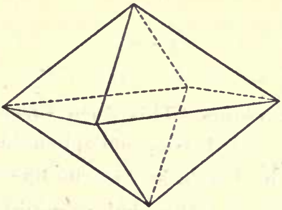


Fig. 25.

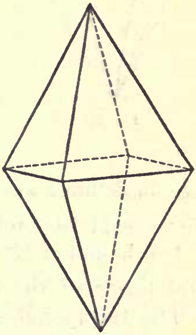


Fig. 26.

Closed forms.—(1.) Tetragonal pyramids (figs. 25, 26) are inclosed by eight isosceles triangles, with four middle edges all in one plane, and eight polar edges. There are three kinds of this form, distinguished by the position of the lateral axes. In the first these axes unite the opposite angles; in the second they intersect the middle edges equally;

and in the third they lie in an intermediate position, or divide these edges unequally; the latter being hemihedral forms. These pyramids are also distinguished as obtuse (fig. 25) or acute (fig. 26), according as the vertical angle is greater or less than in the octahedron, which, though intermediate, is never a tetragonal form. (2.) Ditetragonal pyramids (fig. 27) are bounded by sixteen scalene triangles, whose base lines are all in one plane. This form rarely occurs except in combinations. (3.) Tetragonal sphenoids (fig. 28), bounded by four isosceles triangles, are the hemihedral forms of the first variety of tetragonal pyramids. (4.) The tetragonal scalenohedron (fig. 29), bounded by eight scalene triangles, whose bases rise and fall in a zig-zag line, is the hemihedral form of the ditetragonal pyramid. The latter two forms are rare.

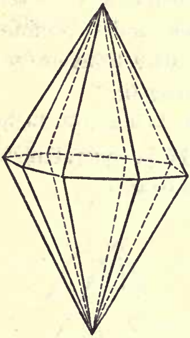


Fig. 27.

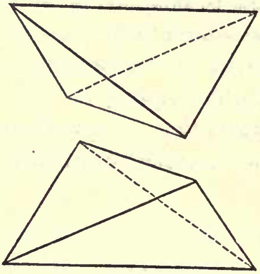


Fig. 28.

Open forms.—Tetragonal prisms (fig. 30) bounded by four planes parallel to the principal axis; ditetragonal prisms by eight similar planes. In these prisms the principal axis is supposed to be prolonged infinitely, or to be unbounded. Where it is very short and the lateral axes infinite, the basal pinacoid is formed, consisting merely of two parallel faces.

The various series of tetragonal crystals are distinguished from each other only by their relative dimensions. To determine these, one of the series must be chosen as the fundamental form, and for this purpose a tetragonal pyramid of the first variety, designated by P as its sign, is selected. The angle of one of its edges, especially the middle edge, found by measurement, determines its angular dimensions; while the proportion of the principal axis (a) to the lateral axes supposed equal to 1, gives its linear dimensions. The parameters, therefore, of each face of the fundamental form are 1 : 1 : a.

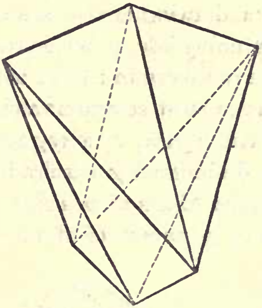


Fig. 29.

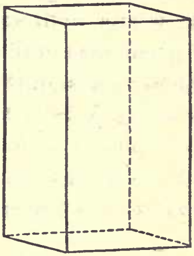


Fig. 30.

Now if m be any (rational) number, either less or greater than 1, and if from any distance ma in the principal axis planes be drawn to the middle edge of P, then new tetragonal pyramids of the first kind, but more or less acute or obtuse than P, are formed. The general sign of these pyramids is mP, and the most common varieties $\frac{1}{2}$P, 2P, 3P; with the chief axis equal to $\frac{1}{2}$, twice or thrice that of P. If m becomes infinite, or $= \infty$, then the pyramid passes into a prism, indefinitely extended along the principal axis, and with the sign ∞P; if $m=0$, which is the case when the lateral axes are supposed infinite, then it becomes a pinacoid, consisting properly of two basal faces, open towards the lateral axes, and designated by the sign $0P$. The ditetragonal pyramids are produced by taking in each lateral axis distances n greater than 1, and drawing two planes to these points from each of the intermediate polar edges. The parameters of these planes are therefore $m : 1 : n$, and the general sign of the form mPn, the most common values of n being $\frac{3}{2}$, 2, 3, and ∞. When $n = \infty$, a tetragonal pyramid of the second kind arises, designated generally by $mP\infty$, the most common in the mineral kingdom being $P\infty$ and $2P\infty$. The relation of these to pyramids of the first

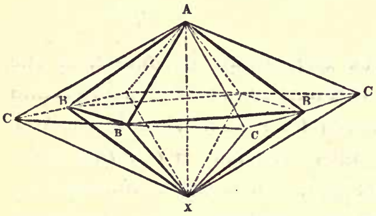


Fig. 31.

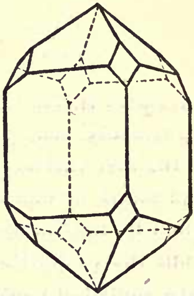


Fig. 32.

kind is shown in fig. 31, where ABBBX is the first, and ACCCX the second kind of pyramid. In like manner from the prism ∞P, the ditetragonal prisms ∞Pn are derived, and finally when $n = \infty$, the tetragonal prism of the second kind, whose sign is $\infty P\infty$.

The combinations of the tetragonal system are either holohedric or hemihedric; but the latter are rare. Prisms and pinacoids must always be terminated on the open sides by other forms. Thus in fig. 32 a square prism of the first kind is terminated by the primary pyramid, and has its lateral angles again replaced by another more acute pyramid of the second kind, so that its sign is ∞P . P . 2P∞. In fig. 33 a prism of the second kind is first bounded by the fundamental pyramid, and then has its edges of combination replaced by a ditetragonal pyramid, and its sign is here ∞P∞ . P . 3P3. In fig. 34 the polar edges of the pyramid are replaced by another pyramid, its sign being P. P∞. In fig. 35 a hemihedric form very characteristic of copper pyrites is represented, P and P′ being the two sphenoids, *a* the basal pinacoid, and *b*, *c*, two ditetragonl pyramids.

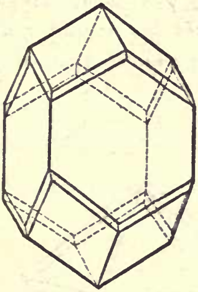


Fig. 33.

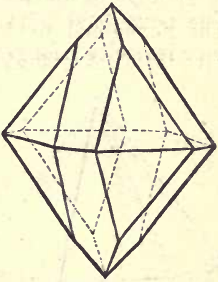


Fig. 34.

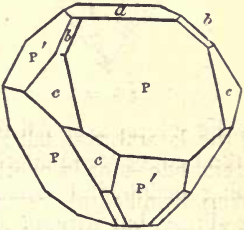


Fig. 35.

III. *The Hexagonal System.*—The essential character of this system is, that it has four axes,—three equal lateral axes intersecting each other in one plane at 60°, and one principal axis at right angles to them. The extremities of the principal axis are named poles, and sections through it and one lateral axis, normal chief sections. The plane through the lateral axes is the basis, and from its hexagonal form gives the name to the system. As in the last system, its forms are either *closed* or *open;* and are divided into holohedral, hemihedral, and tetartohedral,—the last forms with only a fourth part of their faces developed. The tetartohedral and many of the hemihedral forms are of rare occurrence, and only a few of the more common require to be here described.

The hexagonal pyramids (figs. 36, 37) are bounded by twelve isosceles triangles, and are of three kinds, according as the lateral axes fall in the angles, in the middle of the lateral edges, or in another point of these edges, the latter being hemihedral forms. They are also classed as acute or obtuse, but without any very precise limits. The trigonal pyramid is bounded by six triangles, and may be viewed as the hemihedral form of the hexagonal. The dihexagonal pyramid is bounded by twenty-four scalene triangles, but has never been observed alone, and rarely even in combinations. The more common prisms are the hexagonal of six sides, and the dihexagonal of twelve sides.

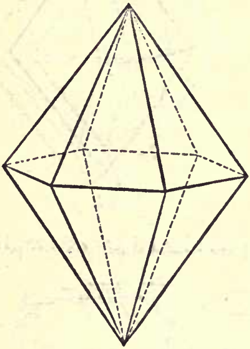


Fig. 36.

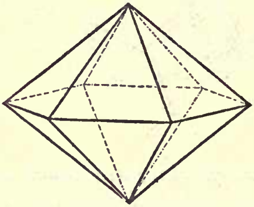


Fig. 37.

As the fundamental form of this system, a particular pyramid P is chosen, and its dimensions determined either from the proportion of the lateral to the principal axis (1 : a), or from the measurement of its angles. From this form (mP) others are derived exactly as in the tetragonal system. Thus dihexagonal pyramids are produced with the general sign *m*P*n*, the chief peculiarity being that, whereas in the tetragonal system *n* might have any rational value from 1 to ∞, in the hexagonal system it can only vary from 1 to 2, in consequence of the geometric character of the figure. When $n=2$ the dihexagonal changes into an hexagonal pyramid of the second kind, whose sign is *m*P2. When *m* is = ∞ various prisms arise from similar changes in the value of *n*; and when $m=0$, the basal pinacoid.

Few hexagonal mineral species form perfect holohedric combinations. Though quartz and apatite appear as such, yet properly the former is a tetartohedral, the latter a hemihedral species. In holohedric species the predominant faces are usually those of the two hexagonal prisms ∞P and ∞P2, or of the pinacoid 0P; while the pyramids P and 2P2 are the most common subordinate forms. Figure 38 represents the prism, bounded on the extremities by two pyramids; one, P, forming the point, the other 2P2, the rhombic faces on the angles, or ∞P . P . 2P2. In some crystals the lateral edges of the prism are replaced by the

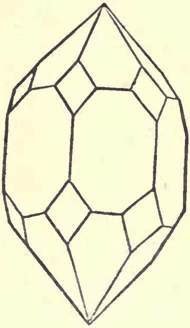


Fig. 38.

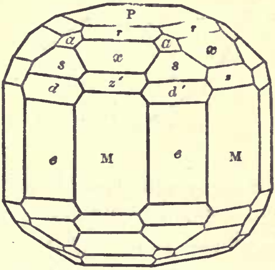


Fig. 39.

second prism $\infty P2$, producing an equiangular twelve-sided prism, which always represents the combination $\infty P \,.\, \infty P2$, and cannot occur as a simple form. An example of a more complicated combination is seen in fig. 39, of a crystal of apatite, whose sign with the corresponding letters is $\infty P(M) \,.\, \infty P2(e) \,.\, 0P(P) \,.\, \frac{1}{2}P(r) \,.\, P(x) \,.\, 2P(z) \,.\, P2(a) \,.\, 2P2(s) \,.\, 4P2(d)$.

Hexagonal minerals more frequently crystallize in those series of hemihedral forms that are named rhombohedral, from the prevalence in them of rhombohedrons. These are bounded by six rhombs (fig. 40), whose lateral edges do *not* lie in one plane, but rise and fall in a zig-zag manner. The principal axis unites the two trigonal angles, formed by three equal plane angles, and in the most common variety the secondary axes join the middle points of two opposite edges. When the polar edges form an angle of more than 90°, the rhombohedrons are named obtuse; when of less, acute. Hexagonal scalenohedrons (fig. 41) are bounded by twelve scalene triangles, whose lateral edges do not lie in one plane. The principal axis joins the two hexagonal angles, and the secondary axes the middle points of two opposite lateral edges.

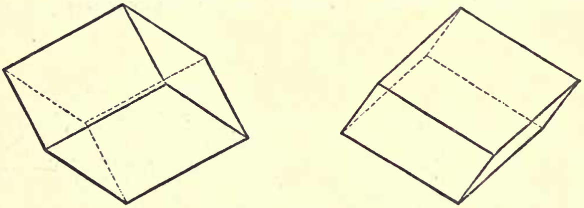


Fig 40.

The rhombohedron is derived from the first kind of hexagonal pyramid by the hemihedric development of its alternate faces. Its general sign should therefore be $\frac{mP}{2}$;

but on several grounds it is found better to designate it by R or mR, and its complimentary figure by $-m$R. When the prism or pinacoid arise as its limiting forms, they are designated by ∞R and 0R, though in no respect changed from the limiting forms ∞P and 0P of the pyramid. The scalenohedron is properly the hemihedric form of the dihexagonal pyramid, but is better derived from the inscribed rhombohedron mR. If the halves of the principal axis of this are multiplied by a definite number n,

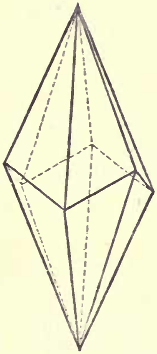


Fig. 41.

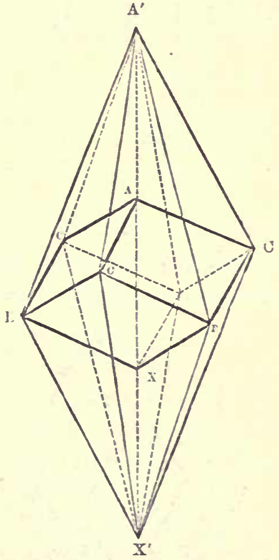


Fig. 42.

and then planes drawn from the extremities of this enlarged axis to the lateral edges of the rhombohedron, as in figure 42, the scalenohedron is constructed. Hence it is designated by $m\mathrm{R}^n$, the n being written on the right hand, like an algebraic exponent: and the dihexagonal prism is in like manner designated by $\infty\mathrm{R}^n$.

The combinations of rhombohedric forms are very numerous, some hundreds being described in calc-spar alone. Among the more common is the prism in combination with a rhombohedron, as in the twin crystal of calc-spar (fig. 43), with the sign $\infty R . -\frac{1}{2}R$, the lower half being the same form with the upper, but turned round 180°. In figure 44, the rhombohedron mR has its polar edges replaced by another rhombohedron $-\frac{1}{2}mR$; and in figure 45 its lateral edges bevelled by the scalenohedron mR^n. A more com-

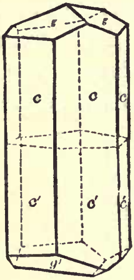


Fig. 43.

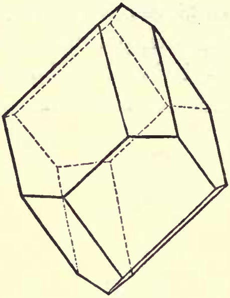


Fig. 44.

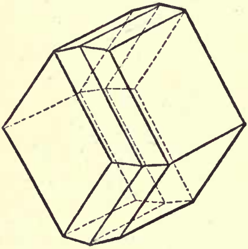


Fig. 45.

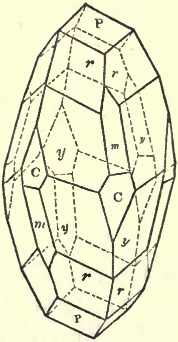


Fig. 46.

plex combination of five forms is represented in the crystal of calc-spar, fig. 46, its sign with the letters on the faces being $R^5(y) . R^3(r) . R(P) . 4R(m) . \infty R(c)$. Tetartohedric combinations are seen most distinctly in pure quartz or rock-crystal, the pyramids of the first kind appearing as rhombohedrons, those of the second kind as trigonal pyramids, the dihexahedral prisms as ditrigonal prisms, and the prism $\infty P2$ as a trigonal prism. Most of these forms, however, occupy but a very subordinate place in the combinations which consist essentially of the prism ∞P, and the rhombohedron $R = \frac{P}{4}$.

IV. *Rhombic System.*—The rhombic system is characterized by three axes, all unequal, but at right angles to each other. One of these is assumed as the chief axis, when the others are named subordinate. The plane passing through the secondary axes, or the basis, forms a rhomb, and from this the name is derived. This system comprises only a few varieties of forms that are essentially distinct, and its relations are consequently very simple.

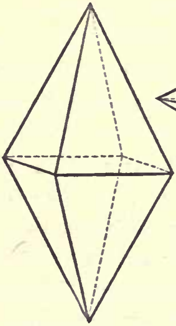


Fig. 47.

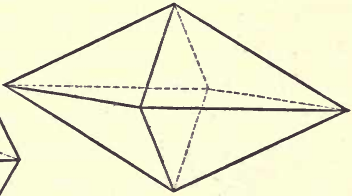


Fig. 48.

The *closed* forms are,—(1*st.*) The rhombic pyramids (figs. 47, 48), bounded by eight scalene triangles, whose lateral edges lie in one plane, and form a rhomb. They have eight polar edges,—four acute and four more obtuse. —and four lateral edges, and six rhombic angles, the most acute at the extremities of the longest axis. (2*d.*) The rhombic sphenoids (fig. 49) are bounded by four scalene triangles with their lateral edges not in one plane; and are a hemihedric form of the rhombic pyramid of unfrequent occurrence. The *open* forms again are,—(3*d.*) Rhombic prisms bounded by four planes parallel to one of the axes which is indefinitely extended. They are divided into upright and horizontal prisms, according as either the principal or one of the lateral axes is supposed to become infinite. For the latter form the name *doma* or *dome* has been used; and two kinds, the macrodome and the brachydome, have been distinguished. Rhombic pinacoids also arise when one axis becomes=0, and the two others are indefinitely extended.

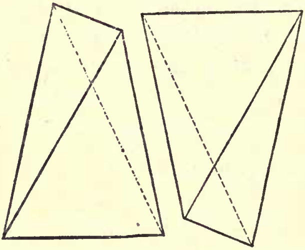


Fig. 49.

In deriving these forms from a primary, a particular rhombic pyramid P is chosen, and its dimensions determined either from the angular measurement of two of its edges, or by the linear proportion of its axes $a : b : c$; the greater lateral axis b being assumed equal to 1. To the greater lateral axis the name macrodiagonal is frequently given; to the shorter, that of brachydiagonal; and the two principal sections are in like manner named macrodiagonal and brachydiagonal, according to the axis they intersect. The same terms are applied throughout all the derived forms, where they consequently mark only the position of the faces in respect to the axes of the fundamental crystal, without reference to the relative magnitude of the derived axes.

By multiplying the principal axis by any rational number *m*, greater or less than 1, a series of pyramids arise, whose general sign is $m\mathrm{P}$, and their limits the prism and pinacoid, the whole series being contained in this formula, $0\mathrm{P} - - - - - m\mathrm{P} - - - - - \mathrm{P} - - - - - m\mathrm{P} - - - - - \infty\mathrm{P}$; which is the fundamental series, the lateral axes always remaining unchanged. From each member a new series may, however, be developed in two directions by increasing one or other of the lateral axes. When the macrodiagonal is thus multiplied by any number *n* greater than 1, and planes drawn from the distance *n* to the polar edges, a new pyramid is produced, named a macropyramid, with the sign $m\bar{\mathrm{P}}n$, the mark over the P pointing out the axis enlarged. When $n = \infty$ a macrodome results, with the sign $m\bar{\mathrm{P}}\infty$. If the shorter axis is multiplied, then brachypyramids and brachydomes are produced with the signs $m\breve{\mathrm{P}}n$ and $m\breve{\mathrm{P}}\infty$. So also from the prism $\infty\mathrm{P}$, on the one side, numerous macroprisms $\infty\bar{\mathrm{P}}n$, with the limiting ma-

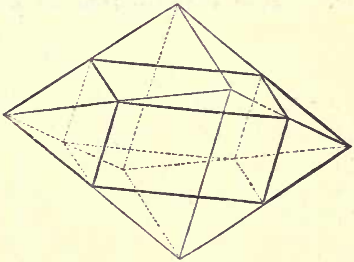


Fig. 50.

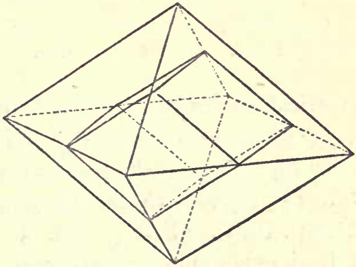


Fig. 51.

cropinacoid $\infty\bar{P}\infty$; on the other, numerous brachyprisms $\infty\breve{P}n$, with the limit form $\infty\breve{P}\infty$, or the brachypinacoid. In figs. 50, 51, the two domes are shown in their relation to the primitive pyramid.

The pyramids seldom occur independent, or even as the predominant forms in a combination,—sulphur, however, being an exception. Prisms or pinacoids usually give the general character to the crystal, which then appears either in a columnar or tabular, or even in a rectangular pyramidal form. The determination of the position of these crystals, as vertical or horizontal, depends on the choice of the chief axis of the fundamental form. In the topaz crystal (fig. 52) the brachyprism and the pyramid are the predominant elements, associated with the prism, its sign and letters being $\infty\breve{P}2(l)$. $P(o)$. $\infty P(m)$. Fig. 53 of stilbite is another example, the macropinacoid $\infty\bar{P}\infty$ or *M*, being combined with the pyramid $P(r)$, the brachypinacoid $\infty\breve{P}\infty$ (*T*), and the basal pinacoid $0P$ (*P*). Another instance is fig. 54 of a lievrite crystal, where the brachyprism and pyramid combine with the macrodome, or $\infty\breve{P}2$. P . $\bar{P}\infty$. The following figures are very common forms of barytes; figs. 55 and

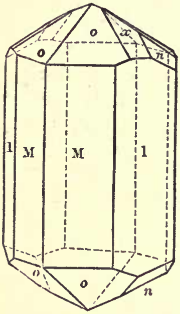


Fig. 52.

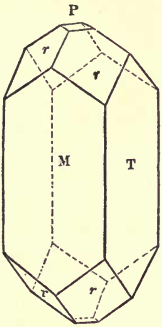


Fig. 53.

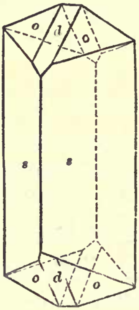


Fig. 54.

56 being both composed of the pinacoid, a brachydome, and macrodome, with sign $0P$ $(c)\ .\ \breve{P}\infty\ (f)\ \frac{1}{2}\bar{P}\infty\ (d)$, the variation in aspect arising from the predominance of different faces; and fig. 57 consisting of the macrodome $\frac{1}{2}\bar{P}\infty$, the prism $\infty P (g)$, and the pinacoid $0P$.

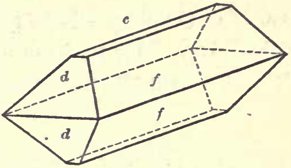


Fig. 55.

Fig. 56.

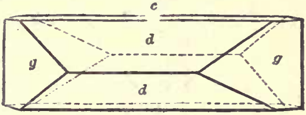


Fig. 57.

V. *The Monoclinohedric System.*—This system is characterized by three unequal axes, two of which intersect each other at an oblique angle, and are cut by the third at right angles. One of the oblique axes is chosen as the chief axis, and the other axes are then distinguished as the orthodiagonal (right-angled) and clinodiagonal (oblique-angled). The same terms are applied to the chief sections, and the name of the system refers to the fact that these two planes and the base, together with two right angles, form also one oblique angle *C.*

The forms of this system approach very near to those of the rhombic series, but the inclination of the axes, even when almost a right angle, gives them a peculiar character, by which they are always readily distinguished. Each pyramid thus separates into two altogether independent forms or hemipyramids. Three varieties of prism also occur,—vertical, inclined, and horizontal,—with faces parallel to the chief axis, the clinodiagonal or the orthodiagonal. The horizontal prisms, like the pyramids, separate into two independent partial forms, named hemiprisms or hemidomes. The inclined prisms are often designated clinodomes, the term prism being restricted to the vertical forms. Orthopinacoids and clinopinacoids are also distinguished from their position in relation to the axes.

The monoclinohedric pyramids (fig. 58) are bounded by eight scalene triangles of two kinds, four and four only being similar. Their lateral edges lie all in one plane, and the similar triangles are placed in pairs on the clinodiagonal polar edges. The two pairs in the acute angle between the orthodiagonal and basal section are designated the positive hemipyramid; while the two pairs in the obtuse angles of the same sections form together the negative hemipyramid. But as these hemipyramids are wholly independent of each other, they are rarely observed combined. More frequently each occurs alone, and then forms a prism-like figure, with faces parallel to the polar edges, and open at the extremities. Hence, like all prisms, they can only appear in combination with other forms. The vertical prisms are bounded by four equal faces parallel to the principal axis, and the cross section is a rhomb; the clinodomes have a similar form and section; while the horizontal prisms or domes have unequal faces, and their section is a rhomboid.

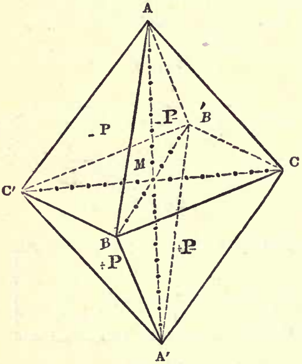


Fig. 58.

The mode of derivation of these forms closely resembles that of the rhombic series. A complete pyramid is assumed as the fundamental form, and designated ± P, in order to express the two portions of which it consists. Its dimensions are given when the proportion of its axes $a:b:c$, and the angular inclination of the oblique axes C, which is also that of the orthodiagonal section to the basis, are known. The fundamental series of forms is $0P$ . . . . . $\pm mP$ . . . . . $\pm P$ . . . . . $\pm mP$ . . . . . ∞P; from each of whose members, by changing the dimensions of the other axes, new forms may be again derived. Thus from $\pm mP$, by multiplying the orthodiagonal by any number n, a series of orthopyramids $\pm mPn$, is produced with the orthodomes $\pm mP\infty$, as limiting forms. The clinodiagonal produces a similar series, distinguished from the former by the sign being put in brackets, thus, $\pm(mPn)$, with the limiting clinodome $(mP\infty)$ always completely formed, and therefore without the signs ± attached. From ∞P arise orthoprisms ∞Pn, and the orthopinacoid $\infty P\infty$; and clinoprisms (∞Pn), and the clinopinacoid $(\infty P\infty)$.

The combinations of this system may be easily understood from their resemblance to those of the rhombic; the chief difficulty being in the occurrence of partial forms, which, however, closely resemble the hemihedric forms of the previous systems. We shall therefore only select a few examples frequently observed in the mineral kingdom. Fig. 59 represents a very common form of gypsum crystals $(\infty P\infty)$ (P) . $\infty P(f)$. $P(b)$. The most common form of augite is represented in fig. 60, with the sign $\infty P(m)$.

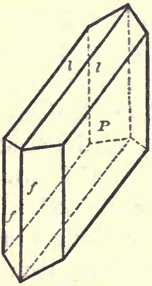


Fig. 59.

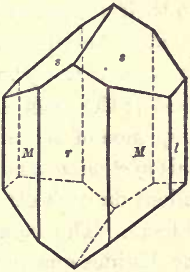


Fig. 60.

$\infty P \infty$ (*r*) . ($\infty P \infty$) (*l*) . P(*s*). Fig. 61 is a crystal of common felspar or orthoclase, composed of the clinopinacoid ($\infty P \infty$) (*M*), the prism ∞P(*T*), the basal pinacoid 0P (*P*), and the hemidomes $2P\infty$ (*y*): to which, in fig. 62 of

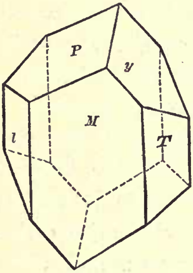


Fig. 61.

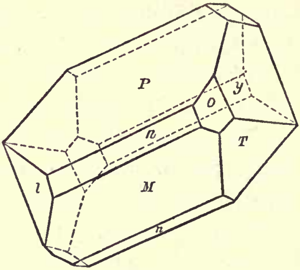


Fig. 62.

the same mineral, the hemipyramid P(*o*), and the clinodome ($2P\infty$) (*n*), are added.

VI. *Triclinohedric System.*—This is the least regular of all the systems, and departs the most widely from symmetry of form. The axes are all unequal, and inclined at angles none of which are right angles, so that to determine any crystal or series of forms the proportion of the axes $a : b : c$, and also their angles, or those of the inclination of the chief sections, must be known. As in the previous system, one axis is chosen as the principal axis, and the two others distinguished as the macrodiagonal and brachydiagonal axes. In consequence of the oblique position of the principal sections, this system consists entirely of partial forms wholly independent on each other, and each composed only of two parallel faces. The complete pyramid is thus broken up into four distinct quarter pyramids, and the prism into two hemiprisms. Each of these partial forms is thus nothing more than a pair of parallel planes, and the various forms consequently mere individual faces. This circumstance renders many triclinohedric crystals very unsymmetrical in appearance.

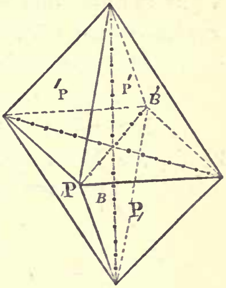


Fig. 63.

Triclinohedric pyramids (fig. 63) are bounded by eight triangles, whose lateral edges lie in one plane. They are equal and parallel two and two to each other; each pair forming, as just stated, a tetartopyramid or open form, only limited by combination with other forms, or, as we may suppose, by the chief sections. The prisms are again either vertical or inclined; the latter named domes, and their section is always rhomboidal. In deriving the forms, the fundamental pyramid is placed upright with its brachydiagonal axis to the spectator, and the partial forms designated, the two upper by 'P and P′, the two lower by ,P and P,, as in the figure. The further derivation now follows as in the rhombic system, with the modifications already mentioned, so that we need not delay on it longer, especially as the minerals crystallizing in these forms are not numerous.

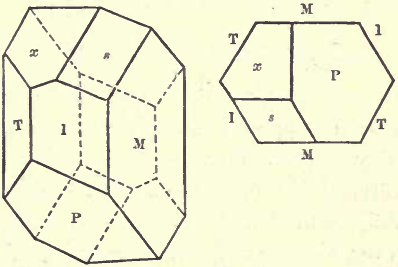


Fig. 64.

Some combinations of this system, as the series exhibited by most of the felspars, approach very near to the monoclinohedric system; while others, as the blue copper, or vitriol, and axinite, show great incompleteness and want of symmetry. In the latter case the determination of the forms is often difficult and requires great attention. As specimens, we may notice the albite crystal (fig. 64), in which *P* is the basal pinacoid $0P$; *M* the brachydiagonal pinacoid $\infty\breve{P}\infty$; *s* the upper right pyramid P'; *l* the right hemiprism $\infty P'$; *T* the left hemiprism $\infty{}'P$; and *x* the hemidome $'\bar{P}'\infty$. Figures 65 and 66 are crystals of axinite, the former from Dauphiné, the latter very common in Cornwall, of whose faces the following is the development:—*r* the macropinacoid $\infty\bar{P}\infty$; *P* the left hemiprism $\infty{}'P$; *u* the left upper quarter pyramid $'P$; *l* the left upper quarter pyramid $2'P$; *s* the left upper partial form of the macropyramid $3'\bar{P}3$; and *x* the hemidome $2'P_{,}\infty$.

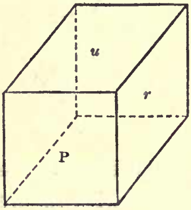


Fig. 65.

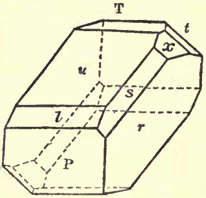


Fig. 66.

Imperfections of Crystals.

In the foregoing description of the forms of crystals the planes have been supposed smooth and even, the faces equal and uniform, or at the same distance from the centre or point of intersection of the axes, and each crystal also perfect or fully formed and complete on every side. In nature, however, these conditions are rarely if ever realized, and the edges of crystals are seldom straight lines, or the faces mathematical plane surfaces. A very interesting variety of these irregularities, which pervades all the systems except the tesseral, is named *hemimorphism*. In this the crystals are bounded on the opposite ends of their chief axis by faces belonging to distinct forms, and hence only the upper or under half of each form is produced, or the crystal, as the name implies, is half-formed. Figure 67 represents a common variety of tourmaline, bounded on the upper end by the planes of the rhombohedrons R and −2R, and on the lower end by the basal pinacoid. In fig. 68 of electric calamine the upper extremity shows the basis *k*, two brachydomes *o* and *p*, and two macrodomes *m* and *l*; while on the lower end it is bounded by the faces P of the primary form. This appearance becomes more interesting from the fact that most hemimorphic crystals acquire polar electricity from heat,—that is, exhibit opposite kinds of electricity at opposite ends of the crystal.

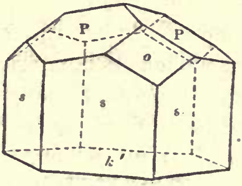


Fig. 67.

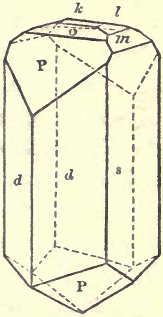


Fig. 68.

The faces of crystals are very frequently rendered imperfect by *striæ*, or minute linear and parallel elevations and depressions. These arise in the oscillatory combination of two crystal forms, alternately prevailing through small spaces. The striæ, therefore, are in reality the edges of combined forms. They are very common on quartz, shorl, and some other minerals; and frequently indicate combinations where only a simple form would otherwise appear to exist. The cubes and pentagonal dodecahedrons of iron pyrites are frequently striated, and in three directions at right angles to each other. In calc-spar the faces of the rhombohedron,—$\frac{1}{2}$R (*g* in fig. 43 above) are almost never without striæ parallel to the oblique diagonal. The striation is said to be simple when only one series of parallel lines appears on each face, or feathered when two systems diverge from a common line. In other crystals the faces, then said to be *drusy*, are covered by numerous projecting angles of smaller crystals; an imperfection often seen in fluor spar. The faces of crystals occasionally appear curved either, as in tourmaline and beryl, from the peculiar oscillatory combination mentioned, or by the union of several crystals at obtuse angles, like stones in a vault, as in stilbite and prehnite. A true curvature of the faces probably occurs in the saddle-shaped rhombohedrons of brown spar and siderite, in the lens-like crystals of gypsum, and in the curved faces so common on diamond crystals. In chabasite similar curved faces occur, but concave. In galena and augite the crystals are often rounded on the corners, as if by an incipient state of fusion. On other crystals the faces are rendered uneven from inequalities following no certain rule. These imperfections furnish valuable assistance in developing very complex combinations, all the faces of each individual form being distinguished by the same peculiarity of surface.

Irregularities in the forms of crystals are produced when the corresponding faces are placed at unequal distances from the centre, and consequently differ in form and size. Thus the cubes and octahedrons of iron pyrites, galena, and fluor spar, are often lengthened along one axis. Quartz is subject to many such irregularities, which are seen in a very remarkable manner on the beautiful transparent and sharply angular crystals from Dauphiné. In such irregular forms, instead of one line, the axes are then represented by an infinite number of lines, parallel to the ideal axis of the figure. The same irregularity carried to a greater extent frequently causes certain faces required for the symmetry of the form, altogether to disappear. Again, some crystals do not fill the space marked out by their outline, holes and vacancies being left in the faces, occasionally to such an extent that they seem little more than mere skeletons. This appearance is very common on crystals produced artificially, as in common salt, alum, bismuth, silver, &c. A perfect crystal can only be produced when, during its formation, it is completely isolated, so as to have full room to expand on every side. Hence the most perfect crystals have been originally imbedded singly in some uniform rock mass. Next to them in perfection are forms that grow singly on the surface of some mass of similar or distinct composition, especially when the point of adherence is small. An incompleteness of form, or at least a difficulty in determining it, arises from the minuteness of some crystals, or from their contracted dimensions in certain directions. Thus some appear mere tabular or lamellar planes, while others run out into acicular, needle-shaped, or capillary crystals. Amid all these modifications of the general form of the crystal, of the condition and aspect of its individual faces, or of its linear dimensions, one important element, the angular measurement, remains constant. In some monoaxial crystals, indeed, increase of temperature produces an unequal expansion in different directions, slightly changing the relative inclination of the faces, but so small as to be scarcely perceptible in common measurements, and hence producing no ambiguity. More important are the angular changes which in many species accompany slight changes in chemical composition, particularly in the relative proportions of certain isomorphous elements. But notwithstanding these limitations, the great truth of the permanence of the angular dimensions of crystals, announced by Romé de l'Isle, remains unaffected; only, as Mohs well states, it must not be interpreted with a rigid immutability, inconsistent with the whole analogy of other parts of nature.

The Goniometer and Measurement of Crystals.

The fact just stated of the permanence of the angular dimensions of crystals, shows the importance of some accurate method of measuring their angles; that is, the inclination of two faces to each other. Two instruments have been specially used for this purpose,—the common or contact goniometer, invented by Carangeau, and the reflecting goniometer of Wollaston. The former is simply two brass rulers turning on a common centre, between which the crystal is so placed that its faces coincide with the edges of the rulers, and the angle is then measured on a graduated arc. This instrument is sufficiently accurate for many purposes and for large crystals; but for precise determination is far inferior to the reflecting goniometer. This requires smooth and even faces, but these may be very small, even the hundredth of an inch, in skilful hands; and as small crystals are generally most perfect, far greater accuracy can

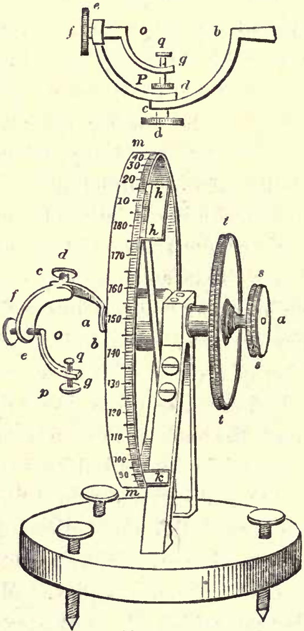


Fig. 69.

be attained, and the measurement depended on to one minute (1′).

The reflecting goniometer is represented in fig. 69. It consists essentially of a graduated circle *mm*, divided on its edge into twice 180°, or more often into half degrees, the minutes being read off by the vernier *hh*. This circle turns on an axis connected with *tt*, so that by turning this the circle is moved round, but is stopped at 180°, when moving in one direction, by a spring at *k*. The other part of the instrument is intended to attach and adjust the crystal to be measured. The first axis of *mm* is hollow, and a second axis, *aa*, passes through it from *ss*, so that this and all the connected parts from *b* to *f* can be turned without moving the circle *mm*. The axis *d* passes through a hole in *bc*, so that it can turn the arm *de* into any required position; *f* is a similar axis turning the arm *og*; and *pq* a fourth axis, in like manner movable in *g*, and with a small knob at *q*, to which the crystal to be measured is attached.

When about to use the instrument, it should be placed on a table, with its base horizontal, which is readily done by the screws in it, and opposite to a window at about 12 or 15 feet distance, so that its axis shall be parallel to the horizontal bars of the window. One of the upper bars of the window, and also the lower bar, or, instead of the latter, a white line on the floor or table parallel to the window, should then be chosen in order to adjust the crystal. The observer places himself behind the instrument with the side *a* at his right hand. The crystal is then attached to *q* by a piece of wax, with the two faces to be measured upward. The axis *fo* is made parallel to *aa*, and the eye being brought near to the first face of the crystal, the axes *aa* and *p* are turned till the image of the window is seen reflected in the face with the horizontal and vertical bars in their position. The axis *d* is then turned through a considerable angle (say 60°), and the image of the window again sought and brought into its proper place by turning the axis *f*, without moving *p*. When this is done, that face is brought into its true position, normal to *d*, so that no motion of *d* can disarrange it. Hence the image of the window may now be sought in the second face and brought into its true position, with the horizontal bars seen horizontal, by moving the axes *d* and *a*. When this is done the crystal is properly adjusted, and the angle is thus measured. First bring the zero of the circle and vernier to coincide, and then turn the inner axis *a* or *ss*, and move the eye till the image of the upper bar of the window reflected from the more distant face of the crystal coincides with the lower bar or horizontal line seen directly. Keeping the eye in its place, turn the outer axis *tt* till the reflected image of the upper bar in the other face in like manner coincides with the lower line, and the angle of the two faces is then read off on the divided circle. As the angle measured is not directly that of the faces, but of the rays of light reflected from them, or the difference of the angle wanted from 180°, the circle has the degrees numbered in the reverse direction, so as to give the angle without the trouble of subtracting the one from the other.

The above apparatus for adjusting the crystal is an improvement suggested by Naumann. In the original instrument the axis *fo* was made to push in or out in a sheath, and had a small brass plate, bent at right angles, inserted in a cleft at *o*, to which the crystal was attached. The crystal was adjusted, as formerly, by moving the plate, or the axis *fo*, and by slight motion of the arm *de*, which should be at right angles nearly to *bc* when used. A considerable improvement is, to have a small mirror fixed on the stand below the crystal, with its face parallel to the axis *aa*, and inclined at 45° to the window, when the lower line can be dispensed with, and the instrument used for various other purposes of angular measurement. Many alterations have been suggested for the purpose of insuring greater accuracy, but the simple instrument is sufficient for all purposes of determinative mineralogy, and the error from the instrument will in most cases be less than the actual variations in the dimensions of the crystals. Greater simplicity is indeed rather desirable, and the student will often find it sufficient to attach the crystal by a piece of wax to the axis *a* directly, and give it the further adjustment by the hand. The only use of the parts from *b* to *q* is to enable the observer to place the crystal properly; that is, with the edge to be measured parallel to the axis of the instrument, and as nearly as possible coinciding with its centre. This is effected when the reflection of the horizontal bar in the two faces appears parallel to that edge.

Macles or Twin Crystals.

When two similar crystals of a mineral species are united with their similar faces and axes parallel, the one forms merely a continuation or enlargement of the other, and every crystal may be regarded as thus built up of a number of smaller crystals. Frequently, however, crystals are united according to precise laws, though all their similar faces and axes are not parallel, and then are named macles or twin crystals. In one class of macles the axes of the two crystals are parallel, and in another they are inclined. The former only occur among hemihedric forms, and the two crystals are then combined in the exact position in which they would be derived from or reproduce the primary holohedric form. The second class, with oblique axes, occur both in holohedric and hemihedric forms, and the two individuals are placed in perfect symmetry to each other, in reference to a particular face of the crystal which forms the plane of union, or the equator of the macle. We may also suppose the two crystals originally parallel, and the one turned round the normal of the united faces by 180° (often 90° or 60°), while the other is stationary. Or we may suppose a crystal cut into halves in a particular direction, and one half turned 180° on the other; and hence the name of hemitrope given to them by Hauy. The position of the two individuals in this case corresponds with that of an object and its image in a mirror, whose surface then represents the plane of union.

The manner in which the crystals unite also differs. Some are merely opposed or in simple contact; others are, as it were, grown together, and mutually interpenetrate, occasionally so completely as to appear like one individual. The twin edges and angles in which the two unite are often re-entering; or they may coincide in one plane, when the line of union is either imperceptible, or is only marked by the meeting of two systems of striæ, or other diversity in the physical characters of the two faces.

The formation of twin crystals may be again repeated, forming groups of three, four, or more. When the faces of union are parallel to each other, the crystals form rows of indeterminate extent; where they are not parallel, they may return into each other in circles, or form bouquet-like or other groups. Where crystals are merely in juxtaposition, they are sometimes much shortened in the direction of the twin axis; and where many occur in a series with parallel position, are often compressed into very thin plates, frequently not thicker than paper, giving to the surface of the aggregate a peculiar striated aspect.

Only a few twin crystals in the different systems can be noticed, chiefly as examples of this mode of formation. In the tesseral system, forms that unite with parallel axes produce intersecting macles like the pentagonal dodecahedrons of iron pyrites in fig. 70, and the tetrahedrons of gray-copper or fahlore in fig. 71, a similar formation also occurring in the diamond. In macles with inclined axes the two forms almost always unite by a face of the octahedron, and the two individuals are then generally apposed and shortened in the direction of the twin axis by one half, so that they appear like a crystal that has been divided by a plane parallel to one of its faces, and the two halves turned round on each other by an angle of 180°. In this manner two octahedrons of the spinel, magnetic iron ore, or automolite (fig. 72), are frequently united. The same law prevails in the intersecting cubes of fluor spar, iron pyrites, and galena,

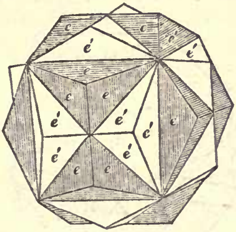


Fig. 70.

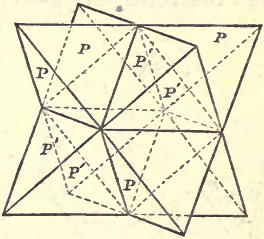


Fig. 71.

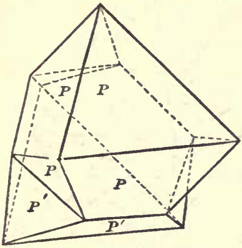


Fig. 72.

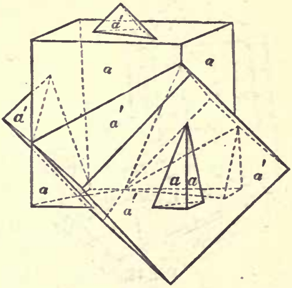


Fig. 73.

represented in fig. 73. In fig. 74 of zinc-blende, two rhombic dodecahedrons are united by a face of the octahedron.

In the Tetragonal system, twin crystals with parallel axes

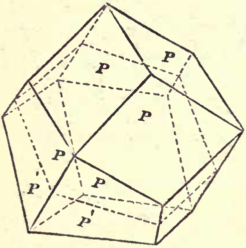


Fig. 74.

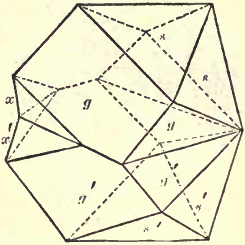


Fig. 75.

rarely occur, but are seen in chalcopyrite, and one or two other minerals. Where the axes are inclined the plane of union is very often one of the faces of the pyramid P∞, or one of those faces that would regularly replace the polar edges of the fundamental form P. The crystals of tin ore obey this law, as seen in fig. 75, where the individuals are pyramidal, and in the knee-shaped crystal (fig. 76), where

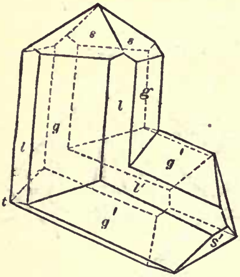


Fig. 76.

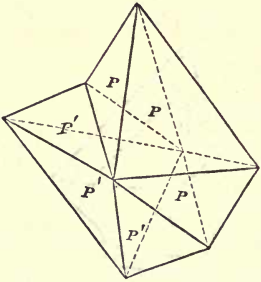


Fig. 77.

they are more prismatic. Hausmanite appears like fig. 77, in which the fundamental pyramid P prevails, on whose polar edges other crystals are often very symmetrically repeated, a central individual appearing like the support of all the others. Almost identical forms occur in chalcopyrite.

In the Hexagonal system, twin crystals with parallel axes are common, as in calc-spar, chabasite, hæmatite, and other rhombohedric minerals. In calc-spar they often form very regular crystals, the two individuals uniting by a plane parallel to the base, so as to appear like a single crystal, as in fig. 78, where each end shows the forms $\infty R . -\frac{1}{2} R$, but in a complementary position; or in fig. 79 of two scalenohedrons R^3 from Derbyshire. The rhombohedric crystals of chabasite often appear intersecting each other, like those of fluor spar in fig. 73. The purer varieties of quartz or

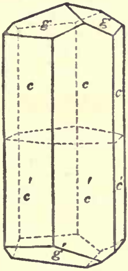


Fig. 78.

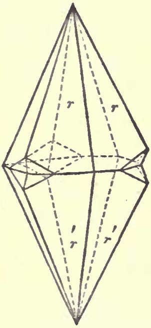


Fig. 79.

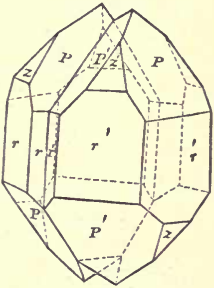


Fig. 80.

rock crystal, in consequence of the tetartohedric character of its crystallization, often exhibit twins. In these the pyramid P separates into two rhombohedrons *P* and *z*, which, though geometrically similar, are yet physically distinct. In fig. 80 the two individuals are only grown together, but more commonly they penetrate each other in an irregular manner, forming apparently a single crystal. Twins with oblique axes are also common, the plane of union being usually one face of the rhombohedron. Thus in calc-spar two rhombohedrons are often joined by a face of $-\frac{1}{2}R$, the two axes forming an angle of 127° 34′; occasionally a third individual is interposed in a lamellar form, as in fig. 81, when the two outer crystals become parallel.

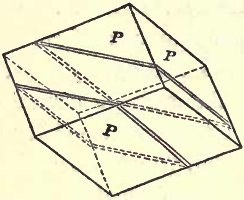


Fig. 81.

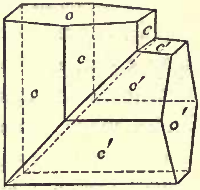


Fig. 82.

This latter arrangement is very common in the highly cleavable varieties of Iceland spar. When the crystals unite in a face of the rhombohedron R, fig. 82, they form an angle of 89° 8′, differing little from a right angle, by which the occurrence of this law is very easily recognized, especially in prismatic varieties.

In the rhombic system, twin crystals with parallel axes are very rare, but those with oblique axes common, the plane of union being one of the faces of the prism ∞P. Twins of this kind are very distinctly seen in arragonite,

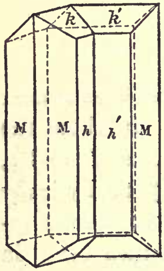


Fig. 83.

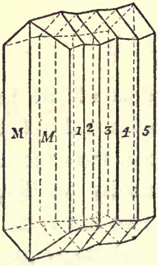


Fig. 84.

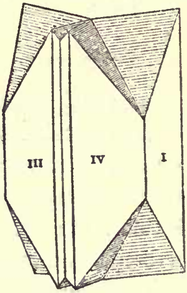


Fig. 85.

carbonate of lead, marcasite, stephanite, mispickel, and other minerals. In arragonite the crystals partly interpenetrate, partly are in mere juxtaposition, as in fig. 83, where the individuals are formed by the combination $\infty P(M)$. $\infty \breve{P}\infty$ (*h*), $\breve{P}\infty$ (*k*), and in figure 84 where several crystals of the same combination form a series with parallel planes of union; the inner members being so shortened that they appear like mere lamellar plates producing striæ on the faces $\breve{P}\infty$ and $\infty\breve{P}\infty$ of the macle. In fig. 85 four crystals, each of the combination ∞P . $2\breve{P}\infty$, having united in inclined planes, form a circular group, returning into itself. The carbonate of lead often occurs in macles in all respects similar. In staurolite, individuals of the prismatic combition ∞P . $\infty\breve{P}\infty$. $0P$, combine either, as in fig. 86, by a face of the brachydome $\frac{3}{2}\breve{P}\infty$, with their chief axes almost at right angles; or, as in fig. 87, by a face of the brachypyramid $\frac{3}{2}\breve{P}\frac{3}{2}$, the chief axes and the brachypinacoids (*o*) of the two single crystals meeting at an angle of about 60°. Finally, in fig. 88, two harmotome crystals of the most common combination $\infty\breve{P}\infty$. $\infty\bar{P}\infty$. P . $\breve{P}\infty$, intersect each other so nearly at right angles, that their principal axes seem to coincide, and the brachypinacoid (*q*) of the one crystal

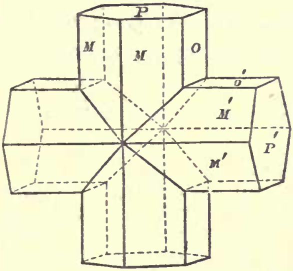


Fig. 86.

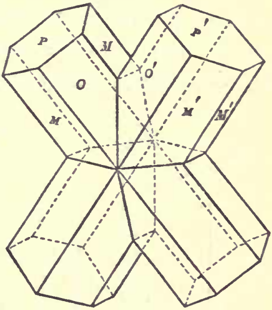


Fig. 87.

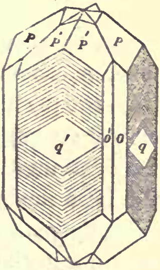


Fig. 88.

(with a rhombic striæ) is parallel to the macropinacoid (*q*) of the other.

In the monoclinohedric system the most common macles are those in which the principal axes and the chief sections of the two crystals are parallel to each other, and consequently the principal axis is also the twin axis. Usually the two individuals are united by a face parallel to the orthodiagonal chief section, as in figure 89 of gypsum, where two crystals of the combination $(\infty P \infty) . \infty P . -P$, shown in fig. 59, unite so regularly that the faces of the pinacoids (*P* and *P'*) form only one plane. In a similar manner the augite crystals of the combination $\infty P . \infty P \infty . (\infty P \infty) . P$, represented singly in fig. 60, are in fig. 90 united in a

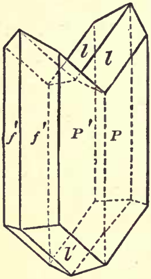


Fig. 89.

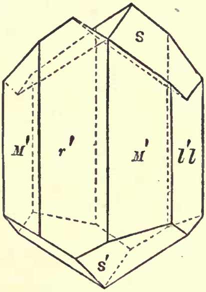


Fig. 90.

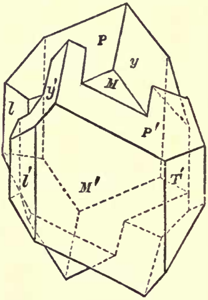


Fig. 91.

macle so very symmetrical and regular that the line of junction cannot be observed on the face of the clinopinacoid. The two hemipyramids P (*s*) (like —P (*l*) in the gypsum crystal above) form on one side a re-entering, on the other a salient angle. Hornblende, wolfram, and other minerals exhibit a similar appearance. In other cases the individuals partially penetrate each other, being, as it were, crushed together in the direction of the orthodiagonal. This mode of union is not uncommon in gypsum, and very frequent in orthoclase felspar. Two crystals of the latter, of the combination (∞P∞) . ∞P . 0P . 2P∞, as in fig. 61 above, are often pushed sidewise into each other, as shown in fig. 91.

In the triclinohedric system, some twin formations are of great importance as a means of distinguishing the triclinohedric from the monoclinohedric species of felspar. In one variety the twin axis is the normal to the brachydiagonal chief section. But in the triclinohedric felspars this section is not, as it is in the monoclinohedric species, perpendicular to the basis, and consequently the two bases form on one side a re-entering, on the other a salient angle; whereas in the monoclinohedric felspars (where the brachydiagonal chief section corresponds to the clinodiagonal), no twin crystals can be produced in conformity to this law, and the two bases fall in one plane. The albite and oligoclase very often exhibit such twins, as in figure 92, where the very obtuse angles formed by the faces of 0P, or *P* and *P′* (as well as those of $'\overline{P}'\infty$, or *x* and *x′*), are a very characteristic appearance, marking out this mineral at once as a triclinohedric species. Usually the twin formation is repeated, three or more crystals being combined, when those in the centre are reduced to mere plates. When very numerous, the surfaces *P* and *x* are covered with fine striæ, often only perceptible with a microscope. A second law

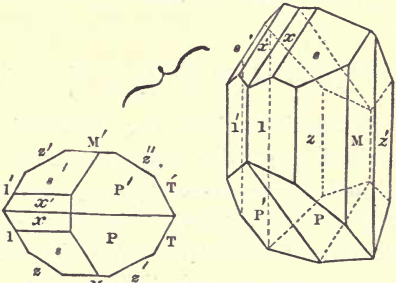


Fig. 92.

observed in triclinohedric felspars, particularly the albite and labradorite, is that the twin axis corresponds with that normal of the brachydiagonal which is situated in the plane of the base. In pericline, a variety of albite, these twins appear as in fig. 93, where the two crystals are united by a face of the basal pinacoid *P*, while the faces of the two brachypinacoids (*M* and *M′*) form edges with very obtuse angles (173° 22′), re-entering on the one side and salient on the other. These edges, or the line of junction between *M* and *M′*, are also parallel to the edges formed by these faces and the base, or those between *M* and *P*. In this case also the macles are occasionally several times repeated when the faces appear covered with fine striæ.

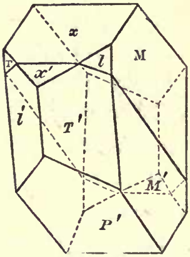


Fig. 93.

Irregular Aggregation of Crystals.

Besides the regular unions now described, crystals are often aggregated in peculiar ways, to which no fixed law can be assigned. Thus some crystals, apparently simple, are composed of concentric crusts or shells, which may be removed one after the other, always leaving a smaller crystal like a kernel, with smooth distinct faces. Some specimens of quartz from Beeralston in Devonshire consist apparently of hollow hexagonal pyramids placed one within another. Other minerals, as fluor spar, apatite, heavy spar, and calc-spar, exhibited a similar structure by bands of different colors.

Many large crystals, again, appear like an aggregate of numerous small crystals, partly of the same, partly of different forms. Thus some octahedrons of fluor spar from Schlaggenwald are made up of small dark violet-blue cubes, whose projecting angles give a drusy character to the faces of the larger form. Such polysynthetic crystals, as they may be called, are very common in calc-spar.

A similar, but still more remarkable formation, is where two crystals of distinct species are conjoined. Such unions of cyanite and staurolite have been long well known, and the graphic-granite exhibits a similar union between large felspar crystals and many smaller ones of mica and quartz.

Forms of Crystalline Aggregates.—Crystals have often been produced under conditions preventing the free development of their forms. They then compose crystalline aggregates, of which the following may be distinguished:—*Granular*, formed of grains, generally angular, but rarely rounded or flattened. *Lamellar* consist of broad plates, which are *tabular* when of uniform thickness, *lenticular* when becoming thinner on the edges, *wedge-shaped* when sharpened towards one edge, and *scaly* when the plates are very small. *Columnar*, in which the individuals are drawn out in one direction more than in the others; *bacillary* or rod-like, in which the columns are of uniform thickness; *acicular* or needle-shaped, in which they are pointed; and *fibrous*, in which they are very fine. In the broad-columnar the columns are, as it were, compressed, or broader in one direction than the other. The distinctions of large, coarse, small, or fine-granular; thick or thin scaly; straight, curved, or twisted-columnar; parallel, diverging, or confused-fibrous; and such like, are easily understood.

Aggregates which have been able to crystallize, at least, with a certain degree of freedom, have been distinguished by Mohs into crystal groups and druses: the former including all unions of several imbedded crystals; the latter those of crystals that have grown together on a common support. In the groups, crystals with their faces otherwise perfect are conjoined in various ways. Sometimes they radiate, as it were, from a common centre, and produce spheroidal, ellipsoidal, or other forms, frequent in gypsum, iron pyrites, and other minerals imbedded in clay. Where many such masses are united, they are named *botryoidal* when like bunches of grapes, *mammellated* where the spheres are larger and less distinct, and *reniform* or kidney-shaped where the masses are still larger. Some groups are partially attached by a small point; but the mass is generally free.

Crystals are often grouped in rows or in one direction, forming, when they are very small, capillary or hair-like, and filiform, thread, or wire-like forms, which are common among native metals, as gold, silver, copper, and bismuth, in silver glance and a few other materials. Sometimes the masses are dentiform, consisting of portions resembling teeth; as is very common in silver. Often these groups expand in several directions, and produce arborescent, dendritic, foliated, feathered, or other forms, very common in copper. In these groups, however, a certain dependence on the crystallographic character of the species may be observed. The lamellar minerals often form fan-shaped, wheel-like, almond-shaped, comb-like, or other groups. The fibrous types, again, are disposed in parallel or diverging bundles, or in radiating, stellar, and other masses. Coralloidal (like coral), fruticose (like cauliflower), and other forms, have also been observed.

In druses, many crystals rise side by side from a common support; sometimes only the granular mass composed of their united bases, at other times some distinct body. The form of a druse is determined by that of the surface on which it grows, and consequently is often very irregular or wholly accidental. Where completely inclosed they have been named drusy cavities, and when of a spheroidal form, geodes. A drusy crust, again, consists of a thin layer of small crystals investing the surface of a large crystal or of some other body.

The minute or cryptocrystalline minerals form similar aggregates. In the globular or the oolitic, the minute crystals often appear to radiate from a centre, or form concentric crusts. Somewhat similar are the stalactites and stalagmites, in which the mineral, especially rock-salt, limestone, chalcedony, opal, limonite, has been deposited from a fluid dropping slowly from some overhanging body. In this case the principal axis of the figure, generally a hollow tube, is vertical, while the individual parts are arranged at right angles to this direction. In other cases the mineral has apparently been deposited from a fluid mass moving slowly in a particular direction, which may be regarded as the chief axis of the figure, while the axes of the individual crystals may assume a different position.

By far the largest masses of the mineral kingdom have, however, been produced under conditions in which a free development of their forms was excluded. This has been the case with the greater portion of the minerals composing rocks or filling veins and dykes. The structure of these masses on the large scale belongs to geology, but some varieties of the texture visible even in hand specimens may be noticed. The individual grains or masses have seldom any regular form, but appear round, long, or flat, according to circumstances, and as each has been more or less checked in the process of formation. Even then, however, a certain regularity in the position of the parts is often observable, as in granite, in which the cleavage planes, and consequently the axes of the felspar crystals, are parallel. Where these grains are all pretty similar in size and shape, the rock is named massive when they are small, or granular when they are larger and more distinct. Sometimes the rock becomes slaty, dividing into thin plates; or concretionary, forming roundish masses; at other times the interposition of some foreign substance (gas or vapor) has rendered it porous, cellular or vesicular, giving rise to drusy cavities. These cavities are often empty, but have occasionally been filled by other minerals, when the rock is named amygdaloidal, from the almond-like shape of the inclosed masses.

Many of the above external forms appear also in the amorphous solid minerals, in which no trace of individual parts, and consequently of internal structure, is observable. They are not unfrequently disposed in parallel or concentric layers, of uniform or distinct colors; and may assume spherical, cylindrical, stalactitic, and other appearances.

Pseudomorphism.—When the substance of one mineral assumes the external form of some other mineral, it is named a pseudomorph. In some named incrusting pseudomorphs the original crystal is covered by a rough or drusy surface of the second mineral, frequently not thicker than paper. Occasionally the first crystal has been removed, and nothing but the shell remains; or the cavity has been filled by a distinct mineral species, or a crystalloid, as it may be named, forming an exact representation of the original, but of a different substance.

More commonly the new mineral substance has gradually expelled the old, and replacing it, as it were, atom by atom, has assumed its exact form. In other cases not the whole substance of the original crystal, but only one or more of its elements, has been changed, or the whole matter has remained, but in a new condition. Thus arragonite crystals have been converted into calc-spar, the chemical composition of both being identical; or gaylussite has been changed into calc-spar, andalusite into cyanite, by the loss of certain elements. On the other hand, anhydrite becomes gypsum, red-copper ore malachite, by addition of new matter. Or the elements are partially changed, as felspar into kaolin, quartz or pearl spar into talc, iron pyrites or iron glance into brown-iron ore, azurite into malachite, augite into green earth. The true nature of such bodies is shown by the internal structure, having no relation to the external form or apparent system of crystallization.

The process of petrifaction of organic bodies is in reality a species of pseudomorphic formation, and has been produced in all the above modes. External and internal casts of organic bodies are not uncommon. In other cases the original substance has been replaced by some mineral which has preserved not merely the external form, but even the minutest detail of internal structure; so that the different kinds of wood have been distinguished in their silicified trunks. The most common petrifying substances are silica and carbonate of lime. In encrynites, echinites, belemnites, and other fossils, the crystals of calc-spar often occur in very regular positions. In some varieties of petrified wood both the ligneous structure and the cleavage of the calc-spar are observable.

Different from the above are mineralized bodies, in which the original structure is still retained, but their chemical nature partially changed. In these a complete series may be often traced, as from wood or peat, through the varieties of brown coal, common coal, anthracite, and graphite, perhaps even to the diamond.

CHAPTER II.

PHYSICAL PROPERTIES OF MINERALS.

THE physical characters of minerals comprehend,—1*st.* Those properties derived from the nature of the substance itself, as coherence, mode of fracture, elasticity, and density or specific gravity; 2*d.* Those phenomena called forth in minerals by the influence of some external power or agent, as their optical, electric, or thermal relations; and, 3*d.* Other characters depending on the personal sensation of the observer—on his taste, smell, and touch. All these properties furnish useful characters in distinguishing and describing mineral species.

Cleavage and Fracture.

In many species there are certain planes at right angles to which cohesion seems to be at a minimum, so that the mineral separates along or parallel to these planes far more readily than in any other direction. This property is named cleavage, and these planes cleavage-planes. They have a strictly definite position, and do not show any transition or gradual passage into the greater coherence in other directions. The number of these parallel cleavage-planes is altogether indefinite; so that the only limit that can be assigned to the divisibility of some minerals, as gypsum and mica, arises from the coarseness of our instruments.

These minima of coherence or cleavage-planes are always parallel to some face of the crystal, and similar equal minima occur parallel to every other face of the same form. Hence they are always equal in number to the faces of the form, and the figures produced by cleavage agree in every point with true crystals, except that they are artificial. They are thus most simply and conveniently described by the same terms and signs as the faces of crystals. Some minerals cleave in several directions parallel to the faces of different forms, but the cleavage is generally more easily obtained and more perfect in one direction than in the others. This complex cleavage is well seen in calc-spar and fluor spar, and very remarkably in zinc-blende, where it takes place in no less than six directions. As in each of these the division may be indefinitely continued, it is clear that no lamellar structure in any proper sense can be assigned to the mineral. All that can be affirmed is, that contiguous atoms have less coherence in the normal of these planes than in other directions. When the cleavage takes place in three directions, it of course produces a perfect crystal form, from which the system of crystallization and angular dimensions of the species may be discovered, and is thus often of very great importance.

The common cleavage in the different systems is as follows, those of most frequent occurrence being put in italics. (1.) In the tesseral, *Octahedric*, O, along the faces of the octahedron; *Hexahedric*, $\infty O \infty$, along those of the cube, and Dodecahedric, ∞O. (2.) In the tetragonal system, Pyramidal, P or $2P\infty$; *Prismatic*, ∞P or $\infty P\infty$; or *Basal*, $0P$. (3.) In the hexagonal system with holohedric forms, Pyramidal, P or $P2$; *Prismatic*, ∞P or $\infty P2$; or *Basal*, $0P$; with rhombohedral forms, *Rhombohedric*, R; Prismatic, ∞R; or *Basal*, $0R$. (4.) In the rhombic system, Pyramidal, P; *Prismatic*, ∞P; Makro or Brachydomatic, $\bar{P}\infty$ or $\breve{P}\infty$; *Basal*, $0P$; Macrodiagonal, $\infty\bar{P}\infty$; or *Brachydiagonal*, $\infty\breve{P}\infty$. (5.) In the monoclinohedric system, Hemipyramidal, P or $-P$; *Prismatic*, ∞P; Clinodomatic $(P\infty)$; Hemidomatic, $P\infty$ or $-P\infty$; *Basal*, $0P$; *Orthodiagonal*, $\infty P\infty$; or *Clinodiagonal* $(\infty P\infty)$. (6.) In the triclinohedric system, Hemiprismatic, $\infty P'$ or $\infty {}'P$; Hemidomatic either along the macrodome or brachydome; *Basal*, $0P$; Macrodiagonal, $\infty\bar{P}\infty$; or *Brachydiagonal*, $\infty\breve{P}\infty$.

In some minerals the cleavage is readily procured; in others only with extreme difficulty. The planes produced also vary much in their degree of perfection, being *highly* perfect in some, as mica and gypsum; imperfect in others, as garnet and quartz. In a very few crystalline minerals cleavage-planes can hardly be said to exist. Cleavage must be carefully distinguished from the planes of union in twin crystals, and the division-planes in the laminar minerals.

Fracture surfaces are formed when a mineral breaks in a direction different from the cleavage-planes. They are consequently most readily observed when the cleavage is least perfect. The form of the fracture is named *conchoidal* when composed of concave and convex surfaces like shells, *even* when nearly free from inequalities. The character of the surface is *smooth;* or *splintery* when covered by small wedge-shaped splinters adhering by the thicker end; or *hackly* when covered by small slightly-bent inequalities, as in iron and other malleable bodies; or *earthy* when it shows only fine dust.

Hardness and Tenacity.

The hardness of minerals, or their power of resisting any attempt to separate their parts, is also an important character. As it differs considerably in the same species, according to the direction and the surface on which the trial is made, its accurate determination is difficult, and the utmost that can usually be obtained is a mere approximation found by comparing different minerals one with another. For this purpose Mohs has given the following scale:

1. *Talc*, of a white or greenish color.
2. *Rock-salt*, a pure cleavable variety, or semi-transparent *uncrystallizea gypsum*, the transparent and crystallized varieties being generally too soft.
3. *Calcareous spar*, a cleavable variety.
4. *Fluor spar*, in which the cleavage is distinct.
5. *Apatite*, the asparagus-stone, or phosphate of lime.
6. *Adularia felspar*, any cleavable variety.
7. *Rock-crystal*, a transparent variety.
8. *Prismatic topaz*, any simple variety.
9. *Corundum*, from India, which affords smooth cleavage surfaces.
10. The *Diamond*.

Two other degrees are obtained by interposing foliated mica between 2 and 3, and scapolite, a crystalline variety, between 5 and 6. The former is numbered 2·5, the latter 5·5.

To ascertain the hardness of a mineral, first try which of the members of the scale is scratched by it, and in order to save the specimens, begin with the highest numbers, and proceed downward, until reaching one which is scratched. Then take a fine hard file, and draw along its surface, with the least possible force, the specimen to be examined, and also that mineral in the scale whose hardness is immediately above the one which has been scratched. From the resistance they offer to the file, from the noise occasioned by their passing along it, and from the quantity of powder left on its surface, their relative hardness is deduced. When, after repeated trials, we are satisfied to which member of the scale of hardness the mineral is most nearly allied, we say its hardness (suppose it to be felspar) is equal to 6, and write after it H.=6·0. If the mineral do not exactly correspond with any degree of the scale, but is found to be between two of them, it is marked by the lower with a decimal figure added. Thus, if more than 6 but less than 7, it is expressed H.=6·5. In these experiments we must be careful to employ specimens which nearly agree in form and size, and also as much as possible in the shape of their angles.

Where the scale of hardness is wanting, or for a first rough determination, the following experiments may serve:

Every mineral that is scratched by the finger-nail has H. = 2·5 or less.
Minerals that scratch copper have H. = 3 or more.
Polished white iron has H. = 4·5.
Window-glass has H. = 5 to 5·5.
Steel point or file has H. = 6 to 7.
Hence every mineral that will cut or scratch with a good penknife has H. less than 6.

Flint has H. = 7, and only about a dozen minerals, including the precious stones or gems, are harder.

Precious stones have latterly been divided and arranged according to their hardness, in the following three classes·

1. HARD GEMS; OR THOSE HARDER THAN QUARTZ.

Diamond.
Sapphire.
Ruby.
Chrysoberyl.
Spinelle.
Topaz.
Emerald.
Hyacinth.
Essonite.
Garnet.

2. SEMI-HARD JEWELS.

Rock Crystal.
Amethyst.
Chalcedony.
Carnelian, and other similar ones.
Opal.
Chrysolite
Lazulite.
Obsidian.
Turquoise.

3. SOFT PRECIOUS STONES.

Those softer than Fluor-spar; Malachite, Amber, and Jet.

Closely allied to hardness is the TENACITY of minerals, of which the following varieties have been distinguished: A mineral is said to be *brittle* when, as in quartz, on attempting to cut it with a knife, it emits a grating noise, and the particles fly away in the form of dust. It is *sectile* or *mild* when, as in galena and some varieties of mica, on cutting, the particles lose their connection in a considerable degree; but this takes place without noise, and they do not fly off, but remain on the knife. And a mineral is said to be *soft* or *ductile* when, like native gold or lead, it can be cut into slices with a knife, extended under the hammer, and drawn into wire. From tenacity it is usual to distinguish *frangibility*, or the resistance which minerals oppose when we attempt to break them into pieces or fragments. This property must not be confounded with hardness. Quartz is hard, and hornblende comparatively soft; yet the latter is more difficultly frangible than the former. *Flexibility* again expresses the property possessed by some minerals of bending without breaking. They are *elastic*, like mica, if, when bent, they spring back again into their former direction; or merely flexible, when they can be bent in different directions without breaking, but remain in their new position, as gypsum, talc, asbestus, and all malleable minerals.

Specific Gravity.

The density or the relative weight of a mineral, compared with an equal volume of pure distilled water, is named its specific gravity. This is a most important character for distinguishing minerals, as it varies considerably in different species, and can be readily ascertained with much accuracy, and in many cases without at all injuring the specimen. The whole process consists in weighing the body, first in air, and then immersed in water, the difference in the weight being that of an equal bulk of the latter fluid. Hence, assuming, as is commonly done, the specific gravity of pure distilled water to be equal to 1 or unity, the specific gravity (G) of the other body is equal to its weight in air (w), divided by the loss or difference (G) of weight in water (or $G = \frac{w}{d}$). A simple and portable instrument for finding the specific gravity is a hydrometer of Nicholson, fig. 94. A delicate hydrostatic balance gives the gravity with far more

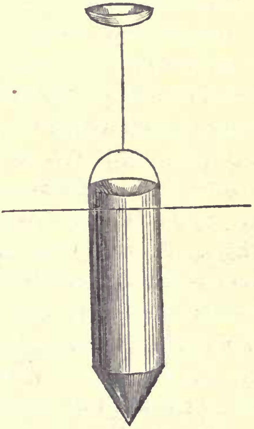


Fig. 94.

accuracy; and even a good common balance is often preferable. The mineral may be suspended from one arm or scale by a fine silk thread or hair, and its weight ascertained, first in the air, and then in water.

There are a few precautions necessary to insure accuracy. Thus, a pure specimen must be selected which is not intermixed with other substances, and when weighed in air it should be quite dry. It must also be free from cavities, and care must be taken that when weighed in water no globules of air adhere to its surface, which render it lighter. If the body imbibes moisture, it should be allowed to remain till fully saturated before determining its weight when immersed, and it is sometimes even necessary to boil the specimen in order to expel the air from its pores. Small crystals or fragments, whose freedom from mixture can be seen, are best adapted for this purpose. The specimen experimented on should not be too heavy; thirty grains being enough where the gravity is low, and even less where it is high. It is also of importance to repeat the trial, if possible with different specimens, which will show whether any cause of error exists, and to take the mean of the whole. A correction should be made for the variation of the temperature of the water from 60° Fahr., which is that usually chosen as the standard in mineralogical works. Where the difference, however, does not exceed ten or fifteen degrees, this correction may be neglected, as it only affects the third or second decimal figure of the result.

By determining the specific gravity of minerals with the hydrostatic balance, we proceed, for instance: an unknown mineral having been weighed first in the air, and then fastened by means of a hair and weighed in water. Such as in the air 17·65; in water 12·35. The loss in water is, therefore, 5·30; and this number indicates the loss of so much bulk of water displaced by the mineral putting the specific gravity of water 1·00: x dividing 5 into 17·65, make it equal to 3·53, which is the exact specific gravity of the mineral, and which is that of essonite. Instead of a hydrostatic balance, we may as well use Nicholson's hydrometer, a simple and very convenient instrument, consisting of a hollow glass cylinder (A), and two dishes (B and C) filled with lead, in order to keep the instrument upright. The hydrometer is put in a glass vessel (E), filled with water, and used as follows:

1st. The weight is determined which is required to sink the instrument to the mark D in water.

2d. The mineral is put in the dish A over the weight noted, that is required, in addition to the mineral, to sink the hydrometer to D.

3d. The same experiment is repeated by putting the mineral, after being moistened and washed with water, in the dish C; and now is A—B the weight of the mineral in the air, and B—b the weight of a quantity of water equal in volume to that of the mineral.

For instance, let

$$A = 32{\cdot}8$$
$$B = 7{\cdot}3$$
$$C = 15{\cdot}8$$

there is (A—b) 32·8—7·3=25·5 the weight of the mineral in the air.

(C—b) 15·8—7·3=8·5 the weight of an equal quantity of water, and proceed 8·5 : 25·5=1 : x

$$x = \frac{25{\cdot}5}{8{\cdot}5}$$

=3·00, which is the proper specific gravity. For determining the specific gravity of substances or minerals lighter than water, or which float in water, it is necessary to adhere to the same method by the hydrometer. A heavier body, such as lead, after determining the difference of weight, within or without the water, of both together, and then of the heavier body alone, the specific gravity of the lighter substance is the result. And for determining the specific gravity of liquids, by means of the hydrostatic balance, a glass ball is applied to one of the arms (its loss of weight in pure water being known), and, dipping the same in the liquid to be examined, any addition and abstraction will result in the specific gravity of the liquid. The hydrometers of Beaumé for the different liquids to be examined, are employed with satisfactory results.

That the specific gravity has been known as far back as the thirteenth century, and applied by the Oriental nations for determining the character of precious stones, is sufficiently proved by a work written in that century by Mohammed Ben Manner. In fact, the specific gravity is often, in connection with the color, quite essential in determining a gem.

Optical Properties of Minerals.

There are few more interesting departments of science than the relations of mineral bodies to light, and the modifications which it undergoes either when passing through them or when reflected from their surface. In this place, however, we can only notice these phenomena so far as they point out distinctions in the internal constitution of minerals, or furnish characters for distinguishing one species from another.

Minerals, and even different specimens of the same species, vary much in pellucidity or in the quantity of light which can pass through them. Some transmit so much light, that small objects can be clearly seen, or letters read when placed behind them, and are named *transparent.* They are *semi-transparent* when the object is only seen dimly, as through a cloud; and *translucent* when the light that passes through it is so obscured that the objects can be no longer discerned. Some minerals are only thus *translucent on the thinnest edges*, and in others even these transmit no light, and the body is named *opaque* or untransparent. These degrees pass gradually into each other, and cannot be separated by any precise line; and this is also the case in nature, where some minerals pass through the whole scale, as quartz, from the fine transparent rock-crystal to opaque dark-black varieties. Such minerals may be described generally as *pellucid*. This change often arises from some mixture in their composition, especially of metallic substances. Perfect opacity is chiefly found in the metals or their compounds with sulphur, though even these seem to transmit light when reduced to laminæ of sufficient thinness.

Double Refraction.—When a ray of light passes obliquely from one medium into another of different density, it is bent or refracted from its former course. The line which it then follows forms an angle with the perpendicular, which in each body bears a certain proportion to that at which the ray fell upon it; or, as definitely stated, the sine of the angle of refraction has a fixed ratio to the sine of the angle of incidence, this ratio being named the index of refraction. This simple refraction is common to all transparent bodies, whether crystalline, amorphous, or fluid; but some crystals produce a still more remarkable result. The ray of light which entered them as one is divided into two rays, each following different angles, or is doubly refracted. In minerals of the tesseral system this property does not exist, but it has been always observed in minerals belonging to the other systems, though in many only after they have been cut in a particular manner, or have been otherwise properly prepared. It is most distinctly seen in crystals of calc-spar, especially in the beautiful transparent variety from Iceland, in which it was first observed and described by Erasmus Bartholin in a work published at Copenhagen in 1669.

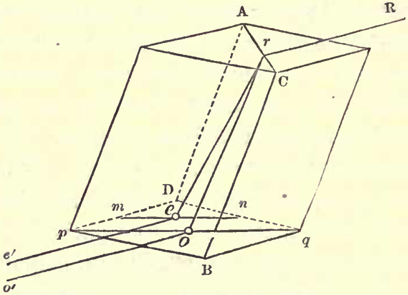


Fig. 95.

The subjoined figure will illustrate this singular property. It represents a rhomb of Iceland spar, on the surface of which a ray of light *R r* falls. As seen in the figure, this ray divides into two, one of which *r o ó* follows the ordinary law of refraction, or the sines of the angles of incidence and refraction maintain a constant ratio. This is named the ordinary ray O. The other, hence named the extraordinary ray E, does not obey the usual law of the sines, and has no general index of refraction. In the plane perpendicular to the axis it is most widely separated from the ordinary ray, but in others oblique to it approaches nearer to O, and in one at right angles coincides, or there is no double refraction. This plane, or rather direction, in which there is no double refraction, is named the optical axis of the crystal, or the axis of double refraction. Now, in certain minerals, it is found that there is only one plane with this property, whereas in others there are two such planes, and they have in consequence been divided into monoaxial and binaxial. To the former (monoaxial) belong all crystals of the tetragonal and hexagonal systems; to the latter (binaxial) all those of the three other systems. In the former the optic axis coincides with, or is parallel to, the crystallographic chief axis. In some crystals the index of refraction for the extraordinary ray E is greater than for the ordinary ray O; and in others it is smaller. The former are said to have positive (or attractive), the latter negative (or repulsive), double refraction. Quartz is an example of the former, the index of refraction, according to Malus, being for O=1·5484, for E=1·5582; and calc-spar of the latter, the index of O being=1·6543, of E=1·4833. The index of E is in both cases taken at its maximum.

According to Dufrenoy, the following table shows the index of refraction of a great number of minerals:

Chromate of lead		2·500 to 2·974
Diamond		2·439 to 2·755
Native sulphur		2·115
Carbonate of lead		2·084
Zircon		1·950
Garnet		1·815
Spinelle		1·812
Blue corundum (sapphire)		1·794
Red " (ruby)		1·779
White " (sapphire)		1·768
Adularia		1·764
Cymophane (oriental chrysolite)		1·760
Boracite		1·701
Carbonate strontia		1·700
Carbonate lime	ordinary ray	1·654
	extraordinary ray	1·483
Arragonite	ordinary ray	1·693
	extraordinary ray	1·535
Sulphate baryta	one of the rays	1·635
	the other ray	1·620
Yellow topaz	one of the rays	1·640
	the other ray	1·632
White topaz		1·610
Anhydrite	one of the rays	1·624
	the other ray	1·577
Euclase	ordinary ray	1·642
	extraordinary ray	1·663
Quartz	ordinary ray	1·548
	extraordinary ray	1·558

Rock salt	1·557
Chalcedony	1·553
Gypsum	1·525
Opal	1·479
Borax	1·475
Alum	1·457
Fluor spar	1·436

The higher the index of refraction, the more valuable appear to be the individual minerals, as may be seen by the corundum and topaz.

Double refraction, whether positive or negative, being inherent in the respective mineral substances, forms a very important distinctive character, and the following minerals are arranged according to this property:

CRYSTALS WITH ONE AXIS AND NEGATIVE DOUBLE REFRACTION.

Iceland spar.
Dolomite.
Carbonate iron.
Carbonate zinc.
Meionite.
Somervillite.
Edingtonate.
Wernerite.
Mica.
Phosphate lead.
Arseniate "
Molybdate "
Cinnabar.
Anatase.
Tourmaline.
Rubellite.
Corundum.
Emerald.
Phosphate lime.
Idocrase.
Mellite.
Arseniate copper.
Nepheline.
Red silver.
Dioptase.
Alum.

CRYSTALS WITH ONE AXIS AND POSITIVE DOUBLE REFRACTION.

Zircon.
Quartz.
Hydroxide iron.
Oxide tin.
Apophyllite.
Hydrate magnesia.
Rutil.
Oxahverite.
Calcareous Scheelite.
Iron.

It should be observed that the optic axes are not single lines, but directions parallel to a line, or innumerable parallel lines, passing through every atom of the crystal. It is also important to remark that this property divides the systems of crystallization into three precise groups,—the tesseral, with single refraction; the tetragonal and hexagonal, with double refraction, and monoaxial; the other three systems also double, but binaxial. It is therefore of use to determine the system to which a mineral belongs, but is not of great value as a character for distinguishing species.

Polarization of Light.—Intimately connected with this property is that of the polarization of light, which being more easily and precisely observable than double refraction, is in many cases of higher value as a mineralogical character. By this term is meant a peculiar modification which a ray of light undergoes, in consequence of which its capability of being transmitted or reflected towards particular sides is either wholly or partially destroyed. Thus, if from a transparent prism of tourmaline two thin plates are cut parallel to its axis, they will transmit light, as well as the prism itself, when they are placed above each other with the chief axis of both in the same direction. But when the one slip of tourmaline is turned at right angles to the other, either no light at all or very little is transmitted, and the plates consequently appear black. Hence, in passing through the first slip the rays of light have acquired a peculiar property, which renders them incapable of being transmitted through the second, except in a parallel position, and they are then said to be polarized. The same property is acquired by a ray of light when reflected, at an angle of 35½° (or angle of incidence 54½°), from a plate of glass, one side of which is blackened, or from some other non-metallic body. When such a ray falls on a second similar mirror at an equal angle, but so that the plane of reflection in the second is at right angles to that in the first, it is no longer reflected, but wholly absorbed.

When, on the other hand, the planes of reflection are parallel, the ray is wholly and at any intermediate angle partially reflected. A ray of light polarized by reflection is also incapable of transmission through a tourmaline slip in one position, which, however, is at right angles to that in which a ray polarized by passing through another slip is not transmitted.

In order to observe the polarization of light, a very simple instrument will be found useful (fig. 96). At one end of a horizontal board B a black mirror *a* is fixed. In the middle is a pillar to which a tube *c d* is fastened, with its axis directed to the mirror at an angle of 35½°. On the lower end is a cover *c*, with a small hole in the centre, and at the upper end another cover with a small black mirror *m* attached to it by two arms, as in the figure, and also at an angle of 35½°. With this instrument the mirror *m* can be so placed in relation to *a* that the planes of reflection shall have any desirable inclination to exhibit the simple polarization of light.

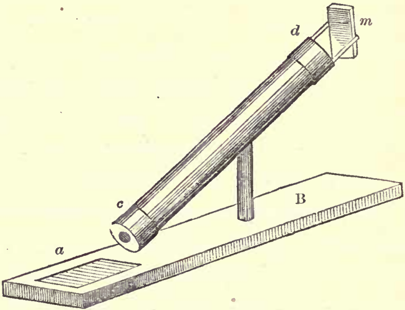


Fig. 96.

This instrument furnishes a simple test whether minerals that cleave readily into thin lamellæ are optically monoaxial or binaxial. Place the two mirrors with their polarization-planes at right angles, and fix a plate of the mineral with a little wax over the hole *c*, and then observe what takes place in the second mirror during the time that the cover *c* is turned round. If the mineral belongs to the bi naxial system, the light from the first mirror *a*, in passing through it, is doubly refracted and has its polarization changed, and consequently can be again reflected from the second mirror *m*, and in each revolution of *c* will show four maxima and four minima of intensity. If, on the contrary, the mineral is monoaxial, the ray will pass through the lamina unaltered, and will not be reflected from the second mirror in any position of *c*.

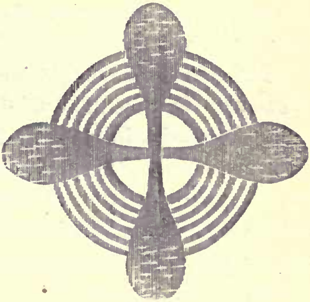


Fig. 97.

Another beautiful phenomenon of polarized light, in like manner connected with the crystalline structure of minerals, is the colored rings which laminæ of the doubly-refracting species, when of a proper thickness, exhibit in certain positions. These rings are

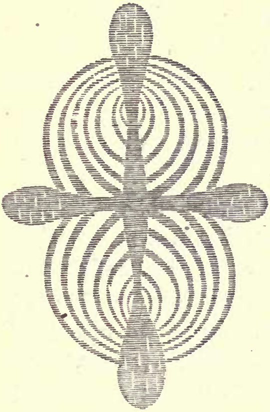


Fig. 98.

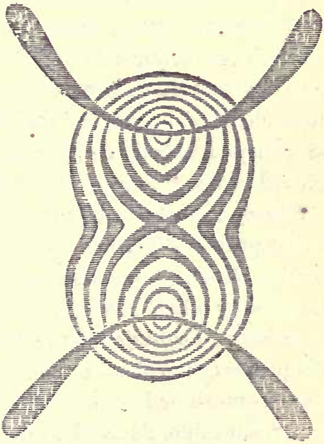


Fig. 99.

easily seen in the above apparatus by interposing a thin plate of gypsum or mica between the two mirrors. When the interposed plate belongs to a monoaxial mineral, there is seen in the second mirror a system of circular concentric colored rings intersected by a black cross (fig. 97). If the mineral is binaxial, one or two systems of elliptical colored rings appear, each intersected by a black stripe (fig. 98). In certain cases this stripe is curved, or the two systems of rings unite in a lemniscoidal form (fig. 99). When the planes of polarization are parallel, the black cross and stripe appear white (fig. 100), showing that in this direction the crystals act like singly-refracting minerals. Quartz, again, in close relation to its system of crystallization, exhibits a circular polarization of splendid prismatic colors, which, on turning the plate, change in each point in the order of the spectrum, from red to yellow, green, and blue. In order to produce these changes, however, in some specimens the plate must be turned to the right, in others to the left, showing a difference in the crystalline structure.

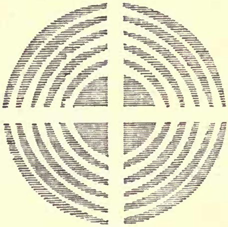


Fig. 100.

Pleochroism.—Closely connected with double refraction is that property of transparent minerals named pleochroism (many-colored), in consequence of which they exhibit distinct colors when viewed by transmitted light in different directions. Crystals of the tesseral system do not show this property; while in those of the other systems it appears in more or less perfection; and in the tetragonal and hexagonal minerals as dichroism (two colors), in the rhombic and clinohedric systems as trichroism (three colors). In most cases these changes of color are not very decided, and appear rather as different tints or shades than as distinct colors. The most remarkable of dichromatic minerals are the magnesian mica from Vesuvius, the tourmaline and ripidolite; of trichromatic, the iolite, the andalusite from Brazil, the diaspore from Schemnitz, and the axinite.

Change of Colors—Changing Colors—Iridescence.

Some crystalline minerals exhibit a very lively play or *change of colors* from reflected light in certain directions. It is well seen in many various hues on the cleavage-planes of Labrador felspar, and seems produced by a multitude of very thin quadrangular pores, interposed in the mineral like minute parallel laminæ. On the cleavage-planes of the hypersthene it appears copper-red, and is occasioned by numerous small brown or black laminæ of some foreign substance interposed in a parallel position between the planes of the hypersthene. The chatoyant, or *changing colors* of the sun-stone, arise from scales of iron-glance similarly interposed. The play of color in the noble opal seems to be produced very nearly in the same manner with that in the labradorite. A similar opalescence is seen in certain minerals when cut in particular forms. In the sapphire, cut hemispherically over the chief axis, it appears like a star with six rays; in certain varieties of chrysoberyl and adularia it has a bluish tint; and is also very remarkable in the cat's-eye variety of quartz. *Iridescence* often arises from very fine fissures, producing semicircular arches of prismatic tints, which, like the colors of thin plates in general, are referred to the interference of light.

Lustre and Color.

Though these properties admit of no precise or mathematical determination, they are of considerable value in mineralogy. One highly important distinction founded on them is that of minerals of metallic and non-metallic aspect or character. This distinction can hardly be described in words, and the student will best learn to distinguish metallic colors and lustre from non-metallic by observing them in nature. Transparency and opacity nearly coincide with this division, the metallic minerals being almost constantly opaque; the non-metallic more or less transparent. Minerals which are perfectly opaque, and show metallic color and lustre, are named metallic; those with only two of these three properties, semi-metallic or metalloid; and those with the opposite properties non-metallic.

Lustre has reference to the intensity and quality of the reflected light, considered as distinct from color. Several degrees in intensity have been named. (1.) *Splendent*, when a mineral reflects light so perfectly as to be visible at a great distance, and lively, well-defined images are formed in its faces, as galena, rock-crystal, or calc-spar. (2.) *Shining*, when the reflected light is weak, and only forms indistinct and cloudy images, as heavy spar. (3.) *Glistening*, when the reflected light is so feeble as not to be observable at a greater distance than arm's length, and the surface can no longer form an image. (4.) *Glimmering*, when the mineral held near the eye in full clear daylight presents only a number of small shining points, as red hæmatite and granular limestone. When, as in chalk, the lustre is so feeble as to be indiscernible, it is said to be *dull*.

In regard to the kind or quality of the lustre, the following varieties are distinguished:—(1.) The *metallic*, seen in much perfection in native metals and their compounds with sulphur, and imperfectly in glance coal. (2.) *Adamantine*, found in beautiful perfection in the diamond, and in some varieties of blende and carbonate of lead. (3.) *Vitreous* or glassy, seen in rock-crystal or common glass, or inclining to adamantine in flint-glass. (4.) *Resinous*, when the body appears as if smeared with oil, as in pitch-stone and garnet. (5.) *Pearly*, like mother-of-pearl, seen in stilbite, gypsum, mica. (6.) *Silky*, the glimmering lustre seen on fine fibrous aggregates like amianthus.

Color.—This property is not in all cases of equal value as a character. Thus some minerals are naturally colored, showing in all modes of their occurrence one determinate color, which is therefore essential, and forms a characteristic of the species. This class includes the metals, pyrites, blendes, with many metallic oxides and salts. A second class of minerals are colorless, their purest forms being white, or clear like water, as ice, calc-spar, quartz, adularia, and many silicates. But these minerals are occasionally colored—that is, accidentally tinged, sometimes from the chemical or mechanical admixture of some coloring substance, as a metallic oxide, carbon, or particles of colored minerals; at other times from the substitution of a colored for an uncolored isomorphous element. The colors of these minerals therefore vary indefinitely, and can never characterize the species, but only its varieties. Thus, quartz, calc-spar, fluor spar, gypsum, and felspar are often colored accidentally by pigments mechanically mixed; and hornblende, augite, garnet, and other colorless silicates, acquire green, brown, red, or black tints from the introduction of the isomorphic coloring elements.

Werner, who bestowed much attention on this portion of mineralogy, distinguished eight principal colors,—white, gray, black, blue, green, yellow, red, and brown,—each with several varieties or shades arising from intermixture with the other colors. He also divided them into metallic and non-metallic as follows:

METALLIC COLORS.

1. *White.*—(1.) Silver-white, as in leucopyrite and native silver. (2.) Tin-white; native antimony.

2. *Gray.*—(1.) Lead-gray; galena or lead glance. (2.) Steel-gray; native platina.

3. *Black.*—(1.) Iron-black; magnetite.

4. *Yellow.*—(1.) Brass-yellow; chalcopyrite. (2.) Bronze-yellow; iron pyrites. (3.) Gold-yellow; native gold.

5. *Red.*—(1.) Copper-red; native copper and nickeline.

NON-METALLIC COLORS.

1. *White.*—(1.) Snow-white; new-fallen snow, Carrara marble, and common quartz. (2.) Reddish-white; heavy spar. (3.) Yellowish-white; chalk. (4.) Grayish-white; quartz. (5.) Greenish-white; amianthus. (6.) Milk-white; skimmed milk, chalcedony.

2. *Gray.*—(1.) Bluish-gray; limestone. (2.) Pearl-gray; porcelain jasper, and rarely quartz. (3.) Smoke-gray or brownish-gray; dense smoke, dark varieties of flint. (4.) Greenish-gray; clay-slate and whet-slate. (5.) Yellowish-gray; chalcedony. (6.) Ash-gray; wood-ashes, zoisite, zircon, and slate-clay.

3. *Black.*—(1.) Grayish-black; basalt, Lydian stone, and lucullite. (2.) Velvet-black; obsidian and schorl. (3.) Pitch-black or brownish-black; cobalt ochre, bituminous coal, and some varieties of mica. (4.) Greenish-black or raven-black; hornblende. (5.) Bluish-black; fluor spar.

4. *Blue.*—(1.) Blackish-blue; dark varieties of azurite. (2.) Azure-blue; bright varieties of azurite and lapis lazuli. (3.) Violet-blue; amethyst and fluor spar. (4.) Lavender-blue; lithomarge and porcelain jasper. (5.) Plum-blue; spinel and fluor spar. (6.) Berlin-blue; sapphire, rock-salt, cyanite. (7.) Smalt-blue; pale-colored smalt, gypsum. (8.) Duck-blue; talc and corundum. (9.) Indigo-blue; earthy-blue iron or vivianite. (10.) Sky-blue; liroconite, some varieties of fluor spar and of blue spar.

5. *Green.*—(1.) Verdigris-green; amazon stone and liroconite. (2.) Celandine-green; green earth, Siberian and Brazilian beryl. (3.) Mountain-green; beryl, aqua-marine topaz. (4.) Leek-green; common actynolite and prase. (5.) Emerald-green; emerald, and some varieties of green malachite. (6.) Apple-green; chrysoprase. (7.) Grass-green; uranite, smaragdite. (8.) Blackish-green; augite and precious serpentine. (9.) Pistachio-green; chrysolite and epidote. (10.) Asparagus-green; the apatite or asparagus-stone from Spain and Salzburg. (11.) Olive-green; garnet, pitch-stone, and olivine. (12.) Oil-green; olive-oil, blende, beryl. (13.) Siskin-green; uranite, and some varieties of pyromorphite.

6. *Yellow.*—(1.) Sulphur-yellow; native sulphur. (2.) Straw-yellow;

pycnite and karpholite. (3.) Wax-yellow; opal and wulfenite. (4.) Honey-yellow; dark honey, fluor spar, and beryl. (5.) Lemon-yellow; rind of ripe lemons, orpiment. (6.) Ochre-yellow; yellow-earth and jasper. (7.) Wine-yellow; Saxon and Brazilian topaz and fluor spar. (8.) Cream-yellow or Isabella-yellow; bole from Strigau, and compact limestone. (9.) Orange-yellow, rind of the ripe orange, uran-ochre, and some varieties of wulfenite.

7. *Red.*—(1.) Aurora, or morning-red; realgar. (2.) Hyacinth-red; hyacinth or zircon, and garnet. (3.) Tile-red; fresh-burned bricks, porcelain-jasper, and heulandite. (4.) Scarlet-red; light-red cinnabar. (5.) Blood-red; blood, pyrope. (6.) Flesh-red; felspar and barytes. (7.) Carmine-red; carmine, spinel, particularly in thin splinters. (8.) Cochineal-red; cinnabar and certain garnets. (9.) Crimson-red; oriental ruby and erythrine. (10.) Columbine-red; precious garnet. (11.) Rose-red; diallogite and rose-quartz. (12.) Peach-blossom red; blossoms of the peach, red cobalt-ochre. (13.) Cherry-red; spinel, kermes, and precious garnet. (14.) Brownish-red; reddle and columnar-clay ironstone.

8. *Brown.*—(1.) Reddish-brown; brown blende from the Hartz, and zircon. (2.) Clove-brown; the clove, rock-crystal, and axinite. (3.) Hair-brown; wood-opal and limonite. (4.) Broccoli-brown; zircon. (5.) Chestnut-brown; Egyptian jasper. (6.) Yellowish-brown; iron flint and jasper. (7.) Pinchbeck-brown; tarnished pinchbeck, mica. (8.) Wood-brown; mountain wood and old rotten wood. (9.) Liver-brown; boiled liver, common jasper. (10.) Blackish-brown; mineral pitch and brown coal.

The accidentally-colored minerals sometimes present two or more colors or tints, even on a single crystal; very remarkable examples occurring in fluor spar, apatite, sapphire, amethyst, tourmaline, and cyanite. This is still more common in compound minerals, on which the colors are variously arranged in points, streaks, clouds, veins, stripes, bands, or in brecciated and ruin-like forms. Some minerals again change their color from exposure to the light, the air, or damp. Sometimes merely the surface is affected or *tarnished*, and then appears covered as with a thin film, producing in some minerals, as silver, arsenic, bismuth, only one color; in others, as copper pyrites, hæmatite, stibine, and common coal, various or iridescent hues. Occasionally the change pervades the whole mineral, the color sometimes becoming paler, or disappearing, as in chrysoprase and rose-quartz; at other times darker, as in brown spar, siderite, and rhodonite. In a few minerals a complete change of color takes place, as in the chlorophæite of the Western Isles, which, on exposure for a few hours, passes from a transparent yellow-green to black. These mutations seem generally connected with some chemical change. The tarnished colors sometimes only appear on certain faces of a crystal belonging to a peculiar form. Thus a crystal of copper pyrites (like fig. 35) has one face P′ free from tarnish; the faces *b* and *c*, close to P′, are dark blue; the remainder of *c*, first violet, and then, close to P, gold-yellow. The color of the powder formed when a mineral is scratched by a hard body is often different from that of the solid mass. This is named the *streak*, and is very characteristic of many minerals. It also often shows a peculiar lustre where the mineral is soft, as in talc and steatite.

Phosphorescence, *Electricity*, *Magnetism*.

Phosphorescence is the property possessed by particular minerals of producing light in certain circumstances without combustion or ignition. Thus some minerals appear luminous when taken into the dark after being for a time exposed to the sun's rays, or even to the ordinary daylight. Many diamonds and calcined barytes exhibit this property in a remarkable degree; less so, arragonite, calc-spar, and chalk; and in a still inferior degree, rock-salt, fibrous gypsum, and fluor spar. Many minerals, including the greater part of those thus rendered phosphorescent by the influence of the sun, also become so through heat. Thus some topazes, diamonds, and varieties of fluor spar, become luminous by the heat of the hand; other varieties of fluor spar and the phosphorite require a temperature near that of boiling water; while calc-spar and many silicates are only phosphorescent at from 400° to 700° Fahr. Electricity produces it in some minerals, as in green fluor spar and calcined barytes. In others it is excited when they are struck, rubbed, split, or broken; as many varieties of zinc-blende and dolomite when scratched with a quill, pieces of quartz when rubbed on each other, and plates of mica when suddenly separated.

Friction, pressure, and heat also excite *electricity* in minerals. To observe this property; delicate electroscopes are required, formed of a light needle, terminating at both ends in small balls, and suspended horizontally on a steel pivot by an agate cup. Such an instrument can be negatively electrified by touching it with a stick of sealing-wax, excited by rubbing, or positively when the wax is only brought so near as to attract the needle. When the instrument is in this state the mineral, if also rendered electric by heat or friction, will attract or repel the needle according as it has acquired electricity of an opposite or similar kind; but if the mineral is not electric, it will attract the needle in both conditions alike. Most precious stones become electrical from friction, and are either positive or negative according as their surface is smooth or rough. Pressure even between the fingers will excite distinct positive electricity in pieces of transparent double-refracting calc-spar. Topaz, arragonite, fluor spar, carbonate of lead, quartz, and other minerals show this property.

Heat or change of temperature excites electricity in many crystals, as in tourmaline, calamine, topaz, calc-spar, beryl, barytes, fluor spar, diamond, garnet, and others, which are hence said to be thermo or pyroelectric. Some acquire polar pyro-electricity, or the two electricities appear in opposite parts of the crystal, which are named its electric poles. Each pole is alternately positive and negative,—the one when the mineral is heating, the other when it is cooling. The poles that become positive during an increase of temperature are named analogue; those that become negative in the same condition, antilogue poles, as shown in this table:

Temperature.	Produces	Electricity.
+ or rising	in analogue poles	+ or vitreous.
− or falling		− or resinous.
+ or rising	in antilogue poles	− or resinous.
− or falling		+ or vitreous.

As already noticed, many polar electric minerals are also remarkable for their hemimorphic crystal forms. The number and distribution of the poles likewise vary. In many monoaxial minerals, as tourmaline and calamine, there are only two poles, one at each end of the chief axis; whereas boracite has eight poles corresponding to the angles of the cube. In prehnite and topaz, again, two antilogue poles occur on the obtuse lateral edges of the prism ∞P, and one analogue pole corresponding to the macrodiagonal chief section, or in the middle of the diagonal joining the obtuse edges. The power of retaining the electricity acquired by rubbing, for a longer time, varies in different minerals and gems; and as the latter are all electric, this property may sometimes be used as a distinguishing character as to the length of retaining the electricity. Abbé Haüy found, in his experiments, that many precious stones lose their electric power after a few moments, whereas some will retain the same for twenty-four hours longer. The Brazilian topaz affected the needle, even after thirty-two hours.

Magnetism, or the power to act on the magnetic needle, is very characteristic of the few minerals in which it occurs, chiefly ores of iron or nickel. It is either simple, attracting both poles of the needle; or polar, when one part attracts, and another repels the same pole. Some magnetic iron ores, or natural magnets, possess polar magnetism; while the common varieties, meteoric iron, magnetic pyrites, precious garnet, and other minerals, are simply magnetic. Most minerals are only attracted by the magnet, but do not themselves attract iron.

Smell, *taste*, and *touch* furnish a few characters of minerals. Most have no smell, but some give out a peculiar odor when rubbed: as quartz, an empyreumatic odor, or smell of burning; fluor spar, of chlorine; clay, of clay; some limestones and marls, of bitumen, or a fetid odor. Aluminous minerals acquire a smell when breathed on. Other odors caused by heat, and often highly characteristic, are noticed under tests by the blowpipe.

Taste is produced by all the salts soluble in water. Some are saline, like common salt; sweetish astringent, like alum; astringent like blue vitriol; bitter, like epsom salts; cooling, like saltpetre; pungent, like sal-ammoniac; alkaline, like soda; acid or sour, like sassoline, &c.

Touch.—Some minerals are distinguished by a greasy feeling, like talc; others feel meagre, like clay; others cold. The last character readily distinguishes true gems from their imitations in glass.

CHAPTER III.

CHEMICAL PROPERTIES OF MINERALS.

The consideration of the chemical nature of minerals,—that is, of the elements that enter into their composition,—of the manner in which these elements combine, and the variations in proportion which they may undergo without destroying the identity of the species, forms an important branch of mineralogical science. The methods of detecting the different elements, and the characters which are thus furnished for the discrimination of minerals, are also of much value. This is especially true of the metallic ores and other substances, sought not as objects of curiosity, but for their economic qualities.

Composition of Minerals.

At present about sixty elements, or substances which have not been decomposed, are known. These are divided into *metallic* and *non-metallic*, a distinction of importance in mineralogy, though not always to be carried out with precision. The non-metallic elements are rarely of semi-metallic aspect, and are bad conductors of heat and electricity. Some are commonly gaseous—oxygen, hydrogen, nitrogen, chlorine, and fluorine; one fluid—bromine; the others solid—carbon, phosphorus, sulphur, boron, selenium, and iodine. The metallic elements are, except mercury, solid at usual temperatures, have generally a metallic aspect, and are good conductors of heat and electricity. They are divided into *light* and *heavy* metals, the former with a specific gravity under 5, and a great affinity for oxygen, and again distinguished as either alkali-metals, potassium (or kalium), sodium (or natrium), lithium, barium, strontium, and calcium;—or earth-metals, magnesium, lanthanium, yttrium, glucinum, aluminium, zirconium, silicium. The heavy metals, with a specific gravity above 5, are divided into *noble*, which can be reduced or separated, from oxygen, by heat alone; and *ignoble*, whose affinity for oxygen renders them irreducible without other agents. Some of the latter are brittle and difficultly fusible,—thorium, titanium, tantalium (columbium), tungsten (wolframium), molybdenum, vanadium, chromium, uranium, manganese, and cerium; others are brittle and easily fusible or volatile—arsenic, antimony, tellurium, and bismuth; and others malleable—zinc, cadmium, tin, lead, iron, cobalt, nickel, and copper. The noble metals are,—quicksilver, silver, gold, platinum, palladium, rhodium, iridium, and osmium.

All the chemical combinations observed in the mineral kingdom follow the law of definite proportions; that is, two elements always combine either in the same proportion, or so that the quantity of the one is multiplied by two, three, four, or some other definite number seldom very large. As the same law prevails throughout the whole range of elements, by assuming any one, usually hydrogen or oxygen, as unity or 1, and determining from experiment the simple proportion in which the others combine with it, a series of numbers is obtained which also expresses the proportions in which all these elements combine with each other. These numbers, therefore, mark the combining proportions or equivalents, as they are named, of the elements. They are also named atomic weights, on the supposition that matter consists of definite atoms, and that its combinations consist of one atom (or sometimes two atoms) of one substance, with one, two, three, or more atoms of another. This theory is not free from difficulties, but the language is often convenient. To designate the elements, chemists generally employ the first letter or letters of their Latin names. These signs also indicate one atom or equivalent of the element. Thus, O means oxygen in the proportion of one atom; H, hydrogen in the same proportion; N, an atom of nitrogen; Na, an equivalent proportion of natrium or sodium. These signs and the equivalent weights are given in the table on next page, in one column of which hydrogen is taken as unity, in the other oxygen. The elements are arranged according to Berzelius, beginning with the most electro-positive, and ending with the most electro-negative.

All these elements occur in minerals, but not more than twenty are common, and only about twelve abundant. They are also very rare in their simple or uncombined state; only carbon in the diamond and graphite, sulphur, and about a dozen of the native metals, being thus known. More frequently minerals consist of two or more elements combined in accordance with those laws which prevail in inorganic compounds. The most important of these laws is that the combinations are binary; that is, that the elements unite in pairs, which may again unite either with another compound of two, or with a single element. Inorganic compounds also are generally distinguished from organic by their greater simplicity.

TABLE I.

Elements arranged in Electro-Chemical order.

Name.	Sign.	Atomic Weight.		Name.	Sign.	Atomic Weight.	
		H=1	O=100.			H=1	O=100.
Potassium	K	39·2	488·85	Glucinum	G	7	86·5
Sodium	Na	23·2	290·9	Aluminium	Al	13·7	*342·33
Lithium	Li	7	86·9	Zirconium	Zr	22·5	*840·4
Ammonium	NH^3	17	...	Thorium	Th	59·6	744·90
Barium	Ba	68·6	856·88	Cerium	Ce	46	575
Strontium	Sr	44	547·28	Lanthanium	La	36?	...
Calcium	Ca	20	251·5	Didymium	D	...	...
Magnesium	Mg	12·5	154·5	Uranium	U	60	746·36
Yttrium	Y	32	402·51	Manganese	Mn	28	345·89
Iron	Fe	28	350·53	Boron	B	11	136·2
Nickel	Ni	29	362·8	Titanium	Ti	25	303·68
Cobalt	Co	30	375	Tantalium	Ta	185	1153·715
Zinc	Zn	32·2	406·59	Niobium	Nb	...	...
Cadmium	Cd	56	696·76	Pelopium?	Pp	...	...
Tin	Sn	59	735·29	Wolframium	W	92	1150·78
Lead	Pb	104	1294·5	Molybdenum	Mo	46	575·83
Bismuth	Bi	208	*2600	Vanadium	V	66·6	855·8
Copper	Cu	31·7	395·69	Chromium	Cr	26·3	328·59
Mercury	Hg	100	1250	Tellurium	Te	64	802·12
Silver	Ag	108	1349·66	Antimony	Sb	122	1529·2
Palladium	Pd	53·3	665·84	Arsenic	As	75	*940·08
Rhodium	Rh	52	651·4	Phosphorus	P	31	*392·28
Ruthenium	Ru	...	....	Nitrogen	N	14	*175·06
Iridium	Ir	99	1233·26	Selenium	Se	40	494·58
Platinum	Pt	99	1233·26	Sulphur	S	16	200·75
Osmium	Os	99	1244·21	Oxygen	O	8	100
Gold	Au	168	*2458·83	Iodine	I	126	*1586
Hydrogen	H	1	*12·48	Bromine	Br	78·4	*999·62
Silicium	Si	15 22·2	†187·5 ‡277·31	Chlorine Fluorine	Cl F	36 18·7	*443·28 *233·80
Carbon	C	6	75·415				

* Double atoms.

† L. Gmelin, who considers silica as composed of one atom base and two oxygen.

‡ Berzelius.

The above list includes ammonium, usually considered a compound body, and omits the two new metals, erbium and terbium.

The following principles are observed in designating the combinations of these elementary substances: For those of the first order the signs of the two components are conjoined, and the number of atoms or equivalents of each expressed by a number following the sign like an algebraic exponent. Thus, SO, SO^2, SO^3, are the combinations of one atom sulphur with one, two, and three atoms of oxygen; FeS, FeS^2, of one atom of iron with one or two of sulphur. But as combinations with oxygen and sulphur are very numerous in the mineral kingdom, Berzelius, to whom science is indebted for this system of signs, marks the atoms of oxygen by dots over the sign of the other element, and those of sulphur by an accent; the above compounds being then designated thus—$\dot{S}$, $\ddot{S}$, $\dddot{S}$, and Fe', Fe''. In some cases two atoms of a base combine with three or five of oxygen or sulphur, as Al^2O^3, Fe^2S^3. In such cases Berzelius marks the double atom by a line drawn through the sign of the single atom; thus, $\dddot{\not{A}l}$ is two atoms aluminium with three of oxygen, or alumina; $\dot{\not{C}}u$, two of copper with one of oxygen, or oxide of copper. Where a number is prefixed to the sign like a coefficient in algebra, it includes both elements of the combination; thus $\dot{H}$ is one atom water, 2 H two; $\dot{C}a\dot{C}$ is one atom carbonate of lime, 2 $\dot{C}a\dot{C}$ two atoms, including, of course, two of calcium, two of carbon, and six of oxygen.

The most common and important binary compounds are those with oxygen, contained in the following table, with their signs, atomic numbers, and amount of oxygen in 100 parts. The more electro-negative are named acids, which are often soluble in water, and then render blue vegetable colors red. The more electro-positive are named oxides or bases, and show great affinity or attractive power for the former. The most powerful are the alkaline bases, which are colorless and soluble in water; less powerful are the earths, also colorless, but insoluble in water:

Name.	Sign.	Atomic Weight.		Oxyg. in 100 parts.
		H=1.	O=100.	
Alumina	$\dddot{\mathbf{Al}}$	51·4	642·33	46·70
Antimony oxide	$\dddot{\mathrm{Sb}}$	146	1829·2	16·40
Antimonious acid	$\overset{\cdot\cdot\cdot\cdot}{\mathrm{Sb}}$	154	1929·2	20·73
Antimonic acid	$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{Sb}}$	162	2029·2	24·64
Arsenious acid	$\dddot{\mathrm{As}}$	99	1240·08	...
Arsenic acid	$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}$	115	1440·08	34·72
Baryta	$\dot{\mathrm{Ba}}$	76·6	956·88	10·45
Bismuth peroxide	$\dddot{\mathrm{Bi}}$	232	2900·00	10·34
Boracic acid	$\dddot{\mathrm{B}}$	34·8	436·20	68·78
Carbonic acid	$\ddot{\mathrm{C}}$	22	275·0	72·73
Cerium protoxide	$\dot{\mathrm{Ce}}$	54	674·72	14·82
" peroxide	$\dddot{\mathbf{Ce}}$	116	1449·39	20 70
Chromium oxide	$\dddot{\mathbf{Cr}}$	76·6	956·78	31·35
Chromic acid	$\dddot{\mathrm{Cr}}$	50·3	628·39	47·74
Cobalt protoxide	$\dot{\mathrm{Co}}$	38	475	21·05
Copper suboxide (red)	$\dot{\mathbf{Cu}}$	71·4	891·39	11·12
" protoxide (black)	$\dot{\mathrm{Cu}}$	39·7	495·69	20·17
Glucina	$\dddot{\mathrm{G}}$	38	490·05	63·26
Iron protoxide	$\dot{\mathrm{Fe}}$	36	450·527	22·19
" peroxide (red)	$\dddot{\mathbf{Fe}}$	80	1001·054	29·97
" proto-peroxide (black)	$\dot{\mathrm{Fe}}+\dddot{\mathbf{Fe}}$	116	1451·581	26·08
Lead protoxide	$\dot{\mathrm{Pb}}$	112	1394·50	7·17
Lime or Calcia	$\dot{\mathrm{Ca}}$	28	351·489	28·45
Lithia	$\dot{\mathrm{Li}}$	15	186·9	53·50
Magnesia	$\dot{\mathrm{Mg}}$	21	254·50	39·30
Manganese protoxide	$\dot{\mathrm{Mn}}$	36	445·89	22·43
" peroxide	$\dddot{\mathbf{Mn}}$	80	991·77	30·25
" proto-perox. (red)	$\dot{\mathrm{Mn}}+\dddot{\mathbf{Mn}}$	116	1437·66	26·34
Molybdic acid	$\dddot{\mathrm{Mo}}$	70	875·83	34·28
Nickel protoxide	$\dot{\mathrm{Ni}}$	37	462 8	21·60
Nitric acid	$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{N}}$	54	675·06	74 07
Phosphoric acid	$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$ or $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathbf{P}}$	71	892·28	56·04
Potassa	$\dot{\mathrm{K}}$	47·2	588·856	16·98
Silica (Gmelin)	$\ddot{\mathrm{Si}}$	31	387·5	51·61
" (Berzelius)	$\dddot{\mathrm{Si}}$	46·2	577·31	51·96
Soda	$\dot{\mathrm{Na}}$	31·2	390·90	25·58
Strontia	$\dot{\mathrm{Sr}}$	52	647·29	15 45
Sulphuric acid	$\dddot{\mathrm{S}}$	40	500·75	59·91
Tantalic acid	$\dot{\mathrm{Ta}}$	209	2607·43	11·51
Thorina	$\dot{\mathrm{Th}}$	67·6	844·90	13·34
Tin peroxide	$\ddot{\mathrm{Sn}}$	75	935·29	21·38
Titanic acid	$\ddot{\mathrm{Ti}}$	41	503·68	39·71
Tungstic acid	$\dddot{\mathrm{W}}$	116	1450·78	20·67
Uranium protoxide	$\dot{\mathrm{U}}$	68	842·84	13·33
" peroxide	$\dddot{\mathbf{U}}$	144	1792·72	10 13
Vanadic acid	$\dddot{\mathrm{V}}$	92	1155 84	26·19
Water	$\dot{\mathrm{H}}$	9	112·48	88·89
Yttria	$\dot{\mathrm{Y}}$	40	502·51	19·90
Zinc oxide	$\dot{\mathrm{Zn}}$	40·2	506·59	19·74
Zirconia	$\dot{\mathrm{Zr}} - \dddot{\mathrm{Zr}}$	30·4	114·2	26·37

NOTE.—In this table double atoms are indicated by the black letters, or $\mathbf{Al}=\rlap{-}\mathrm{Al}$, $\mathbf{Fe}=\rlap{-}\mathrm{Fe}$, &c.

Similar to the compounds of oxygen are those with sulphur, usually named sulphurets, and considered analogous to the oxidized bases. A few of more electro-negative character, resembling acids, have been distinguished as sulphides. Some other compounds have been named haloid salts, and consist of certain electro-negative elements, combined with electro-positive ones, as bases.

Many of these combinations occur as independent species in the mineral kingdom, especially those with oxygen and sulphur. Thus the most abundant of all minerals, quartz, is an oxide, and corundum is of similar nature. Many oxides of the heavy metals, as of iron, tin, copper, and antimony; and some super-oxides, as of lead and manganese (pyrolusite), are very common. Compounds with sulphur also abound, either as sulphides, with the character of acids, like realgar, orpiment, and stibine; or as sulphurets, resembling bases, like galena, argentite, and pyrite. Less frequent are haloid salts, with chlorine and fluorine, as common salt and fluor spar; and still rarer those with iodine and bromine. On the other hand, metallic alloys, or combinations of electro-negative with electro-positive metals, are far from uncommon, especially those with arsenic, tellurium, or antimony.

Combinations of these binary compounds with each other are still more common, the greater number of minerals being composed of an acid and base. By far the greater number are oxygen-salts, distinguished by giving to the acid the termination *ate;* thus sulphate of lead, silicate of lime, and in like manner numerous carbonates, phosphates, arseniates, aluminates. The sulphur-salts (two metals combined with sulphur, and these again combined with each other) are next in number, and perform a most important part in the mineral kingdom. The hydrates, or combinations of an oxide with water, are also common, and much resemble the oxygen salts, the water sometimes acting as an electro-positive, at other times as an electro-negative element. Combinations of a higher order are likewise common, especially the double salts, or the union of two salts into a new body; and even these again with water, as alum and many hydrous silicates. The chemical formulæ for these compound salts are formed by writing the signs of the simple salts with the sign of addition between them: thus $\dot{Ca}\,\ddot{C} + \dot{Mg}\,\ddot{C}$, *i. e.*, carbonate of lime and carbonate of magnesia, or brown spar; $\dddot{\bar{A}}l\,\ddot{Si}^3 + \dot{K}\,\ddot{Si}^3$, or orthoclase; $3\ Na\ F + Al^2\ F^3$, or cryolite, composed of three compound atoms of fluorine and sodium united to one compound atom, consisting of three of fluorine and two of aluminium.

Influence of the Chemical Composition on the External Characters of Minerals.

That the characters of the compound must in some way or other depend on those of its component elements, seems, as a general proposition, to admit of no doubt. Hence it might be supposed possible, from a knowledge of the composition of a mineral, to draw conclusions in reference to its form and other properties; but practically this has not yet been effected. The distinction between the mineralizing and mineralizable, or the forming and formed, elements, lies at the foundation of all such inquiries. Certain elements in a compound apparently exert more than an equal share of influence in determining its physical properties. Thus the more important non-metallic elements, as oxygen, sulphur, chlorine, fluorine, are remarkable for the influence they exert on the character of the compound. The sulphurets, for example, have more similarity among themselves than the various compounds of one and the same metal with the non-metallic bodies. Still more generally it would appear that the electro-negative element in the compound is the most influential, or exerts the greatest degree of active forming power. After the non-metallic elements the brittle, easily fusible metals rank next in power; then the ductile ignoble metals; then the noble metals; then the brittle, difficultly fusible; and last of all, the metals of the earths and alkalies.

It is sometimes stated that each particular substance can crystallize only in one particular form or series of forms. This is, however, only partially true; and sulphur, for instance, which usually crystallizes in the rhombic system, when melted may form monoclinohedric crystals. This property is named *dimorphism;* and hence the same chemical substance may form two, or even more distinct bodies or mineral species. Thus carbon in one form is the diamond, in another graphite; carbonate of lime appears as calc-spar or arragonite; the bisulphuret of iron, as pyrite and marcasite. An example of trimorphism occurs in the titanic acid, forming the three distinct species, anatase, rutile, and brookite. Even the temperature at which a substance crystallizes influences its forms, and so far its composition, as seen in arragonite, Glauber salt, natron, and borax.

Still more important is the doctrine of *isomorphism*, designating the fact that two or more simple or compound substances crystallize in one and the same form; or often in forms which, though not identical, yet approximate very closely. This similarity of form is generally combined with a similarity in other physical properties. Among minerals that crystallize in the tesseral form, isomorphism is of course common and perfect, there being no diversity in the dimensions of the primary form; but for this very reason it is of less interest. It is of more importance among mono-axial crystals, the various series of which are separated from each other by differences in the proportion of the primary form In these, perfect identity is seldom observed, but only very great similarity.

The more important isomorphic substances are the following:

I. Simple substances:
  (1.) Fluorine and chlorine.
  (2.) Sulphur and selenium.
  (3.) Arsenic, antimony, tellurium.
  (4.) Cobalt, iron, nickel.
  (5.) Copper, silver, quicksilver, gold (?).
II. Combinations with oxygen:
  (1.) Of the formula R.
    (*a.*) Lime, magnesia, protoxide of iron, protoxide of manganese, oxide of zinc, oxide of nickel, oxide of cobalt, potassa, soda.
    (*b.*) Lime, baryta, strontia, lead-oxide.
  (2.) Of the formula $\dddot{\text{Ɍ}}$.
    (*a.*) Alumina, peroxide of iron, peroxide of manganese, oxide of chromium.
    (*b.*) Antimony oxide, arsenious acid.
  (3.) Formula $\ddot{\mathrm{R}}$. Tin-oxide, titanium-oxide.
  (4.) Formula $\overset{\cdot\cdot}{\dddot{\mathrm{R}}}$. Phosphoric acid, arsenic acid.
  (5.) Formula $\dddot{\mathrm{R}}$.
    (*a.*) Sulphuric acid, selenic acid, chromic acid, manganese acid.
    (*b.*) Tungstic acid, molybdic acid.
III. Combinations with sulphur:
  (1.) Formula R'. Sulphuret of iron Fe', and sulphuret of zinc Zn'.
  (2.) Formula $\text{Ɍ}'''$. Sulphuret of antimony $\text{S̶b}'''$, and sulphuret of Arsenic $\text{A̶s}'''$.
  (3.) Formula $\text{Ɍ}'$. Sulphuret of copper $\text{C̶u}'$, and sulphuret of silver $\text{A̶g}'$.

These substances are named vicarious, from the singular property that in chemical compounds they can mutually replace each other in indefinite proportions, and very often without producing any important change in the form or other physical properties. But there are numerous instances among the silicates, where the mutual replacement of the isomorphic bodies, especially when the oxides of the heavy metals come in the room of the earths and alkalies, exerts a most essential influence on the external aspect of the species, particularly in regard to color, specific gravity, and transparency. The varieties of hornblende, augite, garnet, epidote, and many other minerals, are remarkable proofs of this influence. This intermixture of isomorphic elements confers many valuable properties on minerals, and to it this department of nature owes much of its variety and beauty. Without the occasional presence of the coloring substances, especially the oxides of iron and manganese, the non-metallic combinations would have exhibited a very monotonous aspect. It is also remarkable, that in some silicates the substitution of a certain portion of the metallic oxides for the earthy bases seems to be almost a regular occurrence; while in others, as the felspars and zeolites, this rarely happens. This fact is of very great economic importance, as drawing attention to important elements often combined with others of less value. Thus iron oxide and chrome oxide, sulphuret of copper and sulphuret of silver, nickel and cobalt, may be looked for in connection. The general chemical formula for such compounds is formed by writing R (=radicle or basis) for the whole isomorphic elements; and in special instances to place their signs either one below the other, connected by a bracket, or, as is more convenient, to inclose them in brackets one after the other, separated by a comma. Thus the general sign for the garnet is $\dot{R}^3\,\ddot{S}i^2+\dddot{R}\,\ddot{S}i$, which, when fully expressed, becomes $\left.\begin{matrix}\dot{\text{C}}\text{a}^3\\ \dot{\text{F}}\text{e}^3\\ \dot{\text{M}}\text{n}^3\end{matrix}\right\}\ddot{\text{S}}\text{i}^2+\left.\begin{matrix}\dddot{\bar{\text{A}}}\text{l}\\ \dddot{\bar{\text{F}}}\text{e}\end{matrix}\right\}\ddot{\text{S}}\text{i}$; or $(\dot{\text{C}}\text{a}^3, \dot{\text{F}}\text{e}^3, \dot{\text{M}}\text{n}^3)\,\ddot{\text{S}}\text{i}^2+(\dddot{\bar{\text{A}}}\text{l}, \dddot{\bar{\text{F}}}\text{e})\ddot{\text{S}}\text{i}$, and the mineral forms many varieties, as the one or other element predominates.

Chemical Reaction of Minerals.

The object of the chemical examination of minerals is the discovery of those elementary substances of which they consist. This examination is named *qualitative* when the nature of the elements alone, *quantitative* when also their relative amount, is sought to be determined. Mineralogists are in general content with such an examination as will discover the more important elements, and which can be carried on with a simple apparatus, and small quantities of the substance investigated. The indications thus furnished of the true character of the mineral are, however, frequently of high importance. Two methods of testing minerals are employed, the one by heat chiefly applied through the blowpipe, the second by acids and other reagents in solution.

Use of the Blowpipe.

The blowpipe in its simplest form is merely a conical tube of brass or other metal, curved round at the smaller extremity, and terminating in a minute circular aperture not larger than a fine needle. Other forms have been proposed, one of the most useful being a cone of tin, open for the application of the mouth at the smaller end, and with a brass or platina beak projecting from the side near the other or broad end. With this instrument a stream of air is conveyed from the mouth to the flame of a lamp or candle, so that this can be turned aside, concentrated, and directed upon any small object. The flame thus acted on consists of two parts—the one nearest the beak of the blowpipe forming a blue obscure cone, the other external to this being of a shining yellow or reddish-yellow color. The blue cone consists of the inflammable gases not yet fully incandescent, and the greatest heat is just beyond its point, where this is fully effected. The blue flame still needs oxygen for its support, and consequently tends to withdraw it from any body placed within its influence, and is named the reducing flame. At the extremity of the yellow cone, on the other hand, the whole gases being consumed and the external air having free access, bodies are combined with oxygen, and this part is named the oxidating flame. Their action being so distinct, it is of great importance for the student to learn to distinguish accurately these two portions of the flame. This is best done by experimenting on a piece of metallic tin, which can only be kept pure in a good reducing flame, and acquires a white crust when acted on by the oxidating flame.

The portion of the mineral to be examined should not be larger than a peppercorn, or a fine splinter a line or two long. It is supported in the flame either by a pair of fine pincers pointed with platinum, or on slips of platinum-foil. or on charcoal. Platinum is best for the siliceous minerals, whereas for metallic substances charcoal must be employed. For this purpose solid uniform pieces are chosen, and a small cavity formed in the surface in which the mineral to be tested can be deposited.

In examining a mineral by heat, it should be first tested alone, and then with various reagents. When placed alone in a matrass or tube of glass closed at one end, and heated over a spirit-lamp, water or other volatile ingredients, mercury, arsenic, tellurium, often sulphur, may readily be detected, being deposited in the cooler part of the tube, or, like fluorine, acting on the glass. It may next be tried in an open tube of glass, through which a more or less strong current of air passes according to the inclination at which the tube is held, so that volatile oxides or acids may be formed; and in this way the chief combinations of sulphur, selenium, tellurium, and arsenic are detected. On charcoal, in the reducing flame, arsenic, and in the oxidating flame, selenium or sulphur, are shown by their peculiar odor; antimony, zinc, lead, and bismuth leave a mark or colored ring on the charcoal; and other oxides and sulphurets are reduced to the pure metal. On charcoal or in the platinum pincers the fusibility of minerals is tested, and some other phenomena should be observed—as whether they intumesce (bubble up), effervesce, give out fumes, become shining, or impart a color to the flame. The color is seen when the assay is heated at the point of the inner flame, and is—

Reddish-yellow, from soda and its salts;
Violet, from potash and most of its salts;
Red, from lithia, strontia, and lime;
Green, from baryta, phosphoric acid, boracic acid, molybdic acid, copper oxide, and tellurium oxide;
Blue, from chloride of copper, bromide of copper, selenium, arsenic, antimony, and lead.

The fusibility, or ease with which a mineral is melted, should also be observed; and to render this character more precise, Von Kobell has proposed this scale:—(1.) Antimony glance, which melts readily in the mere candle flame; (2.) Natrolite, which in fine needles also melts in the candle flame, and in large pieces readily before the blowpipe; (3.) Almandine (garnet from Zillerthal), which does not melt in the candle flame even in fine splinters, but in large pieces before the blowpipe; (4.) Strahlstein (hornblende from Zillerthal) melts with some difficulty, but still more readily than (5.) Orthoclase (or adularia felspar); and (6.) Bronzite or diallage, of which only the finest fibres can be rounded by the blowpipe. In employing this scale, fine fragments of the test minerals and of that to be tried, and nearly of equal size, should be exposed at the same time to the flame. A more common mode of expressing fusibility is to state whether it is observable in large or small grains, in fine splinters, or only on sharp angles. The result or product of fusion also yields important characters, being sometimes a glass, clear, opaque, or colored; at other times an enamel, or a mere slag.

The most important reagents for testing minerals with the blowpipe are the following: (1.) Soda (the carbonate), acting as a flux for quartz and many silicates, and especially for reducing the metallic oxides. For the latter purpose, the assay (or mineral to be tried) is reduced to powder, kneaded up with moist soda into a small ball, and placed in a cavity of the charcoal. Very often both the soda and assay sink into the charcoal, but by continuing the operation they either again appear on the surface, or, when it is completed, the charcoal containing the mass is finely pounded and washed away with water, when the reduced metal is found in the bottom of the vessel. (2.) Borax (biborate of soda) serves as a flux for many minerals, which are best fused in small splinters on platina wire. The borax when first exposed to the flame swells up or intumesces greatly, and it should therefore be first melted into a small bead, in which the assay is placed. During the process the student should observe whether the assay melts easily or difficultly, with or without effervescence, what color it imparts to the product both when warm and when cold, and also the effect both of the oxidating and reducing flames. (3.) Microcosmic salt, or salt of phosphorus (phosphate of soda and ammonia), is specially important as a test for metallic oxides, which exhibit far more decided colors with it than with borax. It is also a useful reagent for many silicates, whose silica is separated from the base and remains undissolved in the melted salt. (4.) Solution of cobalt (nitrate of cobalt dissolved in water), or dry oxalate of cobalt, serve as tests of alumina, magnesia, and zinc oxide.

In examining minerals in the moist way, the first point to be considered is their solubility, of which three degrees may be noted: (1) minerals soluble in water; (2) minerals soluble in hydrochloric or nitric acid; and (3) those unaffected by any of these fluids. The minerals soluble in water are either acids (almost only the boracic acid or sassolin and the arsenious acid), or oxygen or haloid salts. These are easily tested, one part of the solution being employed to find the electro-positive element or basis, the other the electro-negative or acid.

Minerals insoluble in water may next be tested with the above acids; the nitric acid being preferable when it is probable, from the aspect of the mineral or its conduct before the blowpipe, that it contains an alloy, a sulphuret, or arseniate of some metal. In this manner the carbonic, phosphoric, arsenic, and chromic acid salts, many hydrous and anhydrous silicates, many sulphurets, arseniates, and other metallic compounds, are dissolved, so that further tests may be employed.

The minerals insoluble either in water or these acids are sulphur, graphite, cinnabar, some metallic oxides, some sulphates, and compounds with chlorine and fluorine, and especially quartz, and various silicates. For many of these no test is required, or those furnished by the blowpipe are sufficient. The silicates and others may be fused with four times their weight of anhydrous carbonate of soda when they are rendered soluble, so that further tests may be applied.

Chemical Reaction of the more Important Elements.

It is not intended in this place to describe the chemical nature of the elementary substances, and still less to enumerate the whole of those marks by which the chemist can detect their presence. Our object is limited principally to the conduct of minerals before the blowpipe, and to a few simple tests by which their more important constituents may be discovered by the student.

I.—NON-METALLIC ELEMENTS, AND THEIR COMBINATIONS WITH OXYGEN.

Nitric Acid.—Most of its salts detonate when heated on charcoal. In the closed tube they form nitrous acid, easily known by its orange color and smell; a test more clearly exhibited when the salt is mixed with copper filings and treated with concentrated sulphuric acid. When to the solution of a nitrate, a fourth part of sulphuric acid is added, and a fragment of green vitriol placed in it, the surrounding fluid becomes of a dark-brown color.

Sulphur and its compounds, in the glass tube or on charcoal, form sulphurous acid, easily known by its smell. The minutest amount of sulphur or sulphuric acid may be detected by melting the pulverized assay with two parts soda and one part borax, and placing the bead moistened with water on a plate of clean silver, which is then stained brown or black. Solutions of sulphuric acid give with chloride of barium a heavy white precipitate, insoluble in acids.

Phosphoric Acid.—Most combinations with this acid tinge the blowpipe flame green, especially if previously moistened with sulphuric acid. The experiment must be performed in the dark, when even three per cent. of the acid may be detected. If the assay is melted with six parts of soda, digested in water, filtered, and neutralized with acetic acid, the solution forms an orange-yellow layer round a crystal of nitrate of silver. This solution, with muriate of magnesia, forms a white crystalline precipitate.

Selenium and *Selenic Acid* are readily detected by the strong smell of decayed horse-radish, and leave a gray deposit with a metallic lustre on the charcoal.

Chlorine and its salts. When oxide of copper is melted with salt of phosphorus into a very dark-green bead, and an assay containing chlorine fused with this, the flame is tinged of a beautiful reddish-blue color, till all the chlorine is driven off. If very little chlorine is present, the assay is dissolved in nitric acid (if not soluble it must first be melted with soda on platinum wire), and the diluted solution gives, with nitrate of silver, a precipitate of chloride of silver, which is first white, but on exposure to the light becomes gradually brown, and at length black.

Iodine and its salts, treated like chlorine, impart a very beautiful bright-green color to the flame; and heated in the closed tube with sulphate of potash, yield violet-colored vapors. In solution it gives, with nitrate of silver, a precipitate similar to chlorine, but which is very difficultly soluble in ammonia. Its surest test is the blue color it imparts to starch, best seen by pouring concentrated sulphuric acid over the mineral in a test tube which has a piece of paper or cotton covered with moist starch over its mouth.

Bromine and its salts, treated in the same manner with salt of phosphorus and oxide of copper, color the blowpipe flame greenish-blue. In the closed tube with nitrate of potassa they yield bromine vapors, known by their yellow color and peculiar disagreeable smell. Treated with sulphuric acid, bromine in a few hours colors starch pomegranate-yellow.

Fluorine is shown by heating the assay with sulphate of potassa, in a closed tube with a strip of logwood-paper in the open end. The paper becomes straw-yellow, and the glass is corroded. Another test is to heat the pulverized mineral with concentrated sulphuric acid in a shallow dish of platinum (or lead), over which a plate of glass covered with a coat of wax, through which lines have been drawn with a piece of sharp-pointed wood, is placed. If fluorine is present, the glass is etched where exposed.

Boracic Acid.—The mineral alone, or moistened with sulphuric acid, when melting, colors the flame momentarily green. If the assay be heated with sulphuric acid, and alcohol added and set on fire, the flame is colored green from the vapors of the boracic acid.

Carbon, pulverized and heated with saltpetre, detonates, leaving carbonate of potassa. Carbonic acid is not easily discovered with the blowpipe, but the minerals containing it effervesce in hydrochloric acid, and the colorless gas that escapes renders litmus-paper red. In solution it forms a precipitate with lime-water, which is again dissolved with effervescence in acids.

Silica, before the blowpipe, alone is unchanged; is very slowly acted on by borax, very little by salt of phosphorus, but with soda melts entirely with a brisk effervescence into a clear glass. The silicates are decomposed by salt of phosphorus, the silica being left in the bead as a powder or a skeleton. Most of them melt with soda to a transparent glass. Some silicates are dissolved in hydrochloric acid, and this the more readily the more powerful the basis, the less proportion of silica, and the greater the amount of water they contain. Sometimes the acid only extracts the basis, leaving the silica as a powder or jelly; or the silica too is dissolved, and only gelatinizes on evaporation. The insoluble silicates may be first melted with some carbonate of an alkali, when the solution gelatinizes, and finally leaves a dry residuum, of which the part insoluble in warm hydrochloric acid has all the properties of silica.

II.—THE ALKALIES AND EARTHS.

Ammonia, heated with soda in a closed tube, is readily known by its smell. Its salts, heated with solution of potassa, also yield the vapor, known from its smell, its action on turmeric-paper, and the white fumes that rise from a glass tube dipped in hydrochloric acid held over it.

Soda, imparts a reddish-yellow color to the external flame when the assay is fused or kept at a strong red heat. In solution it yields no precipitate with chloride of platinum or sulphate of alumina.

Lithia is best recognized by the beautiful carmine-red color it imparts to the flame during the fusion of a mineral containing it in considerable amount. Where the proportion is small, the color appears if the assay be mixed with 1 part fluor spar and 1½ parts sulphate of potassa. In concentrated solutions it forms a precipitate with the phosphate and carbonate of soda, but none with bichloride of platinum, sulphate of alumina, or acetic acid.

Potassa gives a violet color to the external cone, when the assay is heated at the extremity of the oxidating flame. The presence of lithia or soda, however, disturbs this reaction. It may still be discovered by melting the assay in borax glass colored brown by nickel oxide, which is changed to blue by the potassa. In concentrated solutions of potassa, the bichloride of platinum gives a citron-yellow precipitate; acetic acid, a white granular precipitate; and sulphate of alumina, after some time, a deposit of alum-crystals.

Baryta.—The carbonate of this earth melts easily to a clear glass, milk-white when cold; the sulphate is very difficultly fusible. Both strongly heated at the point of the blue flame impart a green tinge to the outer flame. When combined with silica it cannot be well discovered by the blowpipe. In solution, salts of baryta yield, with sulphuric acid or solution of sulphate of lime, *immediately* a fine white precipitate insoluble in acids or alkalies.

Strontia, the carbonate, even in thin plates, only melts on the edges, and forms cauliflower-like projections of dazzling brightness; the sulphate melts easily in the oxidating flame, and in the reducing flame is changed into sulphuret of strontium, which, dissolved in hydrochloric acid, and evaporated to dryness, gives a fine carmine-red color to the flame of alcohol. Strontia in solution gives a precipitate with sulphuric acid, or with sulphate of lime, but not *immediately*.

Lime.—The carbonate is rendered caustic by heat, when it has alkaline properties, and readily absorbs water. The sulphate in the reducing flame changes to the sulphuret of calcium, which is also alkaline. Sulphuric acid precipitates lime only from very concentrated solutions; oxalic acid even from very weak ones; and silico-hydrofluoric acid not at all. As baryta and strontia also form precipitates with the first two reagents, they must previously be separated by sulphate of potassa. Chloride of calcium tinges the flame of alcohol yellowish-red.

Magnesia, alone, or as a hydrate, a carbonate, and in some other combinations, when ignited with solution of cobalt, or the oxalate of cobalt, assumes a light-red tint. It is not precipitated from a solution either by sulphuric acid, oxalic acid, or silico-hydrofluoric acid; but phosphoric acid, with ammonia, throws down a white crystalline precipitate of phosphate of ammonia and magnesia.

Alumina alone is infusible. In many combinations, when ignited with solution of cobalt, it assumes a fine blue color. It is thrown down by potassa or soda as a white voluminous precipitate, which in excess of the alkali is easily and completely soluble, but is again precipitated by muriate of ammonia. Carbonate of ammonia also produces a precipitate which is not soluble in excess.

Glucina, *Yttria*, *Zirconia*, and *Thorina* are not properly distinguished by blowpipe tests, though the minerals in which they occur are well marked in this way. In solution, glucina acts with potassa like alumina; but the precipitate with carbonate of ammonia is again soluble, with excess of the alkali, and the two earths may thus be separated. Yttria is precipitated by potassa, but is not again dissolved by excess of the alkali. With carbonate of ammonia it acts like glucina. It must be observed, however, that the substance formerly named yttria is now considered a mixture of this earth with the oxides of erbium, terbium, and lanthanium. Zirconia acts with potassa like yttria, and with carbonate of ammonia like glucina. Concentrated sulphate of potassa throws down a double salt of zirconia and potassa, which is very little soluble in pure water.

III.—THE METALS.

Arsenic and its sulphuret on charcoal yield fumes, with a smell like garlic, and sublime in the closed tube. The greater number of alloys of arsenic in the reducing flame leave a white deposit on the charcoal; or, where it is in larger proportion, give out grayish-white fumes with a smell of garlic. Some alloys also yield metallic arsenic in the closed tube. In the open tube all of them yield arsenious acid, and those containing sulphur also sulphurous fumes. Many arsenic acid salts emit evident odors of arsenic when heated on charcoal with soda; and some sublime metallic arsenic when heated with pulverized charcoal in the closed tube.

Antimony melts easily on charcoal, emitting dense white fumes, and leaving a ring of white crystalline oxide on the support. In the closed tube it does not sublime, but burns in the open tube with white smoke, leaving a sublimate on the glass, which is easily driven from place to place by heat. Most of its compounds, with sulphur or with the other metals, show similar reaction. Antimony oxide on charcoal melts easily, fumes, and is reduced, coloring the flame pale greenish-blue.

Bismuth melts easily, fumes, and leaves a yellow oxide on the charcoal. In the closed tube it does not sublime, and in the open tube scarcely fumes, but is surrounded by the fused oxide, dark-brown when warm, and bright-yellow when cold. Its oxides are easily reduced. A great addition of water produces a white precipitate from its solution in nitric acid.

Tellurium fumes on charcoal, and becomes surrounded by a white mark with a reddish border, which, when the reducing flame is turned on it, disappears with a bluish-green light. In the closed tube tellurium gives a sublimate of the gray metal; and in the open tube produces copious fumes, and a white powder which can be melted into small clear drops.

Mercury in all its combinations is volatile, and yields a metallic sublimate when heated alone, or with tin or soda in the closed tube.

Zinc, when heated with soda on charcoal, forms a deposit, which, when warm, is yellow; when cold, white; is tinged of a fine green by solution of cobalt, and is not further volatile in the oxidating flame. In solution, zinc is precipitated by potassa as a white gelatinous hydrate, easily redissolved in the excess of the alkali.

Tin forms a white deposit on the charcoal behind the assay, which takes a bluish-green color with the solution of cobalt. The oxide is easily reduced by soda.

Lead forms a sulphur-yellow deposit with a white border on the charcoal when heated in the oxidating flame, and with soda is easily reduced. The solutions of its salts are colorless, but give a black precipitate with sulphuretted hydrogen; with sulphuric acid a white, and with chromate of potassa a yellow, precipitate.

Cadmium produces, with soda, a reddish-brown or orange-yellow ring, with iridescent border on the charcoal, and also on platinum-foil.

Manganese alone, melted with borax or salt of phosphorus on the platinum wire in the oxidating flame, forms a fine amethystine glass, which becomes colorless in the reducing flame. In combination with other metals, the pulverized assay mixed with two or three times as much soda, and melted in the oxidating flame on platinum-foil, forms a bluish-green glass. Potassa or ammonia throws down from solutions of its salts a white hydrate, which, in the air, becomes gradually dark-brown.

Cobalt, melted with borax in the oxidating flame, gives a beautiful blue glass. Minerals of metallic aspect must be first roasted on charcoal. The salts of protoxide of cobalt form bright-red solutions, from which potassa throws down a blue flaky hydrate, which becomes olive-green in the air.

Nickel, the assay, first roasted in the open tube and on charcoal, produces in the oxidating flame, with borax, a glass, which hot, is reddish or violet brown; when cold, yellowish or dark red; and by the addition of saltpetre, changes to blue. In the reducing flame the glass appears gray. With salt of phosphorus the reaction is similar, but the glass is almost colorless when cold. The salts in solution have a bright-green color, and with potassa, form a green precipitate of hydrated nickel-oxide, which is unchanged in the air.

Copper may in most cases be discovered by melting the assay (if apparently metallic, first roasted) with borax or salt of phosphorus in the oxidating flame, when an opaque reddish-brown glass is produced, a small addition of tin aiding in the result. In the reducing flame, the glass, when warm, is green; when cold, blue. With soda, metallic copper is produced. A small proportion of copper may often be detected by heating the assay, moistened with hydrochloric acid, in the oxidating flame, which is then tinged of a beautiful green color. Solutions of its salts are blue or green, and produce a brownish-black precipitate, with sulphuretted hydrogen. Ammonia at first throws down a pale-green or blue precipitate, but in excess produces a very fine blue color.

Silver in the metallic state is at once known, and from many combinations can be readily extracted on charcoal with soda. From its solution in nitric acid, silver is thrown down by hydrochloric acid as a white chloride, which in the light soon becomes black, is soluble in ammonia, and can again be precipitated from this solution by nitric acid as chloride of silver.

Gold, when pure, is readily known, and is easily separated from its combinations with tellurium on charcoal. If the grain is white, it contains more silver than gold, and must then be heated in a porcelain capsule with nitric acid, which gives it a black color, and gradually removes the silver, if the gold is only a fourth part or less. If the proportion of gold is greater, the nitro-chloric acid must be used, which then removes the gold. From its solution in this acid the protochloride of tin throws down a purple precipitate (*purple of Cassius*), and the sulphate of iron, metallic gold.

Platinum, and the metals usually found with it, cannot be separated from each other by heat. Only the *Osmium-iridium* strongly heated in the closed tube with saltpetre is decomposed, forming osmium acid, known from its peculiar pungent odor. The usual mixture of platinum grains is soluble in nitro-chloric acid, leaving osmium-iridium. From this solution the *platinum* is thrown down by sal-ammonia as a double chloride of platinum and ammonium. From the solution evaporated, and again diluted, with cyanide of mercury, the *palladium* separates as cyanide of palladium. The *rhodium* may be separated by its property of combining with fused bisulphate of potassa, which is not the case with platinum or iridium.

Cerium, when no iron-oxide is present, produces, with borax and salt of phosphorus, in the oxidating flame, a red or dark-yellow glass, which becomes very pale when cold, and colorless in the reducing flame. *Lanthanium* oxide forms a white colorless glass; *didymium*, a dark amethystine glass.

Iron, the peroxide and hydrated peroxide, become black and magnetic before the blowpipe, and form, with borax or salt of phosphorus, in the oxidating flame, a dark-red glass, becoming bright-yellow when cold; and in the reducing flame, especially on adding tin, an olive-green or mountain-green glass. The peroxide colors a bead of borax containing copper oxide, bluish-green; the protoxide produces red spots. Salts of protoxide of iron form a green solution, from which potassa or ammonia throws down the protoxide as a hydrate, which is first white, then dirty-green, and finally yellowish-brown. Carbonate of lime produces no precipitate. The salts of the peroxide, on the other hand, form yellow solutions from which the peroxide is thrown down by potassa or ammonia as a flaky-brown hydrate. Carbonate of lime also causes a precipitate.

Chromium forms, with borax or salt of phosphorus, a glass, fine emerald-green when cold, though when hot often yellowish or reddish. Its solutions are usually green, and the metal is thrown down by potassa as a bluish-green hydrate, again dissolved in excess of the alkali. The chrome in many minerals is very certainly discovered by melting the assay with three times its bulk of saltpetre, which, dissolved in water, gives with acetate of lead a yellow precipitate.

Vanadium, melted on platinum wire with borax or salt of phosphorus, gives a fine green glass in the reducing flame, which becomes yellow or brown in the oxidating flame, distinguishing it from chrome.

Uranium, with salt of phosphorus, forms in the oxidating flame a clear yellow; in the reducing flame a fine green glass. With borax its reaction is similar to that of iron.

Molybdenum forms in the reducing flame, with salt of phosphorus, a green; with borax, a brown, glass.

Tungsten or *Wolfram* forms, with salt of phosphorus, in the oxidating flame, a colorless or yellow, in the reducing flame, a very beautiful blue glass, which appears green when warm. When accompanied by iron, the glass is blood-red, not blue. Or melt the assay with five times as much soda in a platinum spoon, dissolve it in water, filter, and decompose the result with hydrochloric acid, which throws down the tungstic acid, which is white when cold, but citron-yellow when heated.

Tantalium, as tantalic acid, is readily dissolved by salt of phosphorus, and in large quantity into a colorless glass, which does *not* become opaque in cooling, and does *not* acquire a blue color from solution of cobalt. Or fuse the assay with two times as much saltpetre, and three times as much soda, in a platinum spoon; dissolve this, filter, and decompose the fluid by hydrochloric acid: the tantalic acid separates as a white powder, which does *not* become yellow when heated.

Titanium in anatase, rutile, brookite, and titanite, is shown by the assay forming, with salt of phosphorus, in the oxidating flame, a glass which is and remains colorless; in the reducing flame, a glass which appears yellow when hot, and whilst cooling passes through red into a beautiful violet. When iron is present, however, the glass is blood-red, but is changed to violet by adding tin. When titanate of iron is dissolved in hydrochloric acid, and the solution boiled with a little tin, it acquires a violet color from the oxide of titanium. Heated with concentrated sulphuric acid, the titanate of iron produces a blue color.

CHAPTER IV.

CLASSIFICATION OF MINERALS.

A MINERAL species was formerly defined as a natural inorganic body, possessing a definite chemical composition and peculiar external form. The account given of these properties shows that the form of a mineral species comprehends not only the primary or fundamental figure, but all those that may be derived from it by the laws of crystallography. Irregularities of form arising from accidental causes, or that absence of form which results from the limited space in which the mineral has been produced, do not destroy the identity of the species. Even amorphous masses, when the chemical composition remains unaltered, are properly classed under the same species, as the perfect crystal.

The definite chemical composition of mineral species must be taken with equal latitude. Pure substances, such as they are described in works on chemistry, are very rare in the mineral kingdom. In the most transparent quartz crystals, traces of alumina and iron oxide can be detected; the purest spinel contains a small amount of silica, and the most brilliant diamond, consumed by the solar rays, leaves some ash behind. Such non-essential mixtures must be neglected, or each individual crystal would form a distinct mineral species. The isomorphous elements introduce a wider range of varieties, and render the limitation of species more difficult. Carbonate of lime, for instance, becomes mixed with carbonate of magnesia or of iron in almost innumerable proportions; and the latter substances also with the former. Where these mixtures are small in amount, variable in different specimens, and do not greatly affect the form or physical characters of the predominant element, they may safely be neglected, and the mineral reckoned to that species with which it most closely agrees. Where, however, the mixture is greater, and the two substances are frequently found in definite chemical proportions, these compounds must be considered as distinct species, especially should they also show differences in form and other external characters.

Amorphous minerals with definite composition must also be considered as true species. But when they show no definite composition, as in many substances classed as clays and ochres, they cannot be accounted true mineral species, and properly ought not to be included in a treatise on mineralogy. Some of them, however, from their importance in the arts, others from other circumstances, have received distinct names and a kind of prescriptive right to a place in mineralogical works, from which they can now scarcely be banished. Many of them are properly rocks, or indefinite combinations of two or more minerals; others are the mere products of the decomposition of such bodies. Their number is of course indefinite, and their introduction tends much to render mineralogy more complex and difficult, and to destroy its scientific character.

In collecting the species into higher groups, and arranging them in a system, several methods have been pursued. Some, like Mohs, have looked only at the external characters, and asserted that they alone were sufficient for all the purposes of arranging and classifying minerals. Others, led by Berzelius, have, on the contrary, taken chemistry as the foundation of mineralogy, and classed the species by their composition, without reference to form or physical characters.

Neither system can be exclusively adopted, and a natural classification of minerals should take into account all their characters, and that in proportion to their relative importance. Among these the chemical composition undoubtedly holds a high rank, as being that on which the other properties will probably be ultimately found to depend. Next in order is their crystalline form, especially as exhibited in cleavage; and then their other characters of gravity, hardness, and tenacity. But the properties of minerals are as yet far from showing that subordination and co-relation which has been observed in the organic world, where the external forms and structures have a direct reference to the functions of the living being. Hence, even when all the characters are taken into account, there is not that facility in classifying the mineral that is presented by the other kingdoms of nature. Many, or rather most, of the species stand so isolated that it is scarcely possible to find any general principle on which to collect them into large groups, especially such groups as, like the natural families of plants and animals, present important features of general resemblance, and admit of being described by common characteristics. Certain groups of species are indeed united by such evident characters, that they are found together in almost every method; but other species are not thus united, and the general order of arrangement is very uncertain. Hence, though some classifications of very considerable merit have been proposed, no natural system of minerals commanding general assent has yet appeared.

The arrangement followed in this treatise is chiefly founded on that proposed by Professor Weiss of Berlin. We have, however, made considerable changes, which the progress of the science and the more accurate knowledge of many species require. This classification appears to us to come nearer than any other we have seen to a natural system, which in arranging and combining objects takes account of all their characters, and assigns them their place, from a due consideration of their whole nature, and is thus distinguished from artificial systems, which classify objects with reference only to one character.

Besides species, two higher grades in classification seem sufficient at once to exhibit the natural relations, and to facilitate an easy and complete review of the species composing the mineral kingdom. These are families and orders. In forming the families, those minerals are first selected which occupy the more important place in the composition of rocks, and consequently in the crust of the globe. Thus quartz, felspar, mica, hornblende, garnet, among siliceous minerals; calc-spar, gypsum, rock-salt, less so fluor spar and heavy spar, among those of saline composition, stand out prominently as the natural centres or representatives of so many distinct families. To these certain metallic minerals, as iron pyrites, lead-glance or galena, blende, magnetic iron ore, the sparry iron ore, and a few more, are readily associated as important families. But the minerals thus geologically distinguished are not sufficient to divide the whole mineral kingdom into convenient sections, and additional groups must be selected from the peculiarity of their natural-historical or chemical properties. Thus the zeolites are easily seen to form such a natural group. The precious stones or gems also, notwithstanding their diverse chemical composition, must ever appear a highly natural family, when regarded as individual objects. Their great hardness, tenacity, high specific gravity without the metallic aspect, their brilliant lustre, transparent purity, and vivid colors,—all mark them out as a peculiar group. Only the diamond, which might naturally seem to take the chief place in this class, differs so much, not only in elementary composition, but in physical properties, that it must be assigned to a different place.

Round these species thus selected, the other less important minerals are arranged in groups or families. It is evident that no precise definition of these families can be given, as the connection is one of resemblance in many points, not of identity in any single character. In other words, it is a classification rather according to types than from definitions, as every true natural classification must be. The same cause, however, leaves the extent of the families somewhat undefined, and also permits considerable license in the arrangement of species. But both circumstances are rather of advantage in the present state of the science, as allowing more freedom in the grouping of species than could be obtained in a more rigid system of classification.

In collecting the families into orders, the guidance of chemistry is followed rather than of natural history, though the latter is also taken into consideration. Chemical names are assigned to the orders, but still regarded *as names* derived from the prevailing chemical characters, and *not as definitions.* Hence it must not be considered an error should two or three mineral species be found in an order with whose name, viewed as a definition, they may not agree.

Guided by these and similar considerations, minerals may be divided into the following orders and families:

Order I.—The Oxidized Stones.

Families.—1. Quartz.
2. Felspar.
3. Scapolite.
4. Haloid stones.
5. Leucite.
6. Zeolite.
7. Mica.
8. Serpentine.
9. Hornblende.
10. Clays.
11. Garnet.
12. Cyanite.
13. Gems.
14. Metallic stones.

Order II.—Saline Stones.

Families.—1. Calc spar.
2. Fluor spar.
3. Heavy spar.
4. Gypsum.
5. Rock salt.

Order III.—Saline Ores.

Families.—1. Sparry iron ores.
2. Iron salts.
3. Copper salts.
4. Lead salts.

Order IV.—Oxidized Ores.

Families.—1. Iron ores.
2. Tinstone.
3. Manganese ores.
4. Red copper ores.
5. White antimony ores.

Order V.—Native Metals.

Form only one family.

Order VI.—Sulphuretted Metals.

Families.—1. Iron pyrites.
2. Galena.
3. Gray antimony ore.
4. Gray copper ore.
5. Blende.
6. Ruby-blende.

Order VII.—The Inflammables.

Families.—1. Sulphur.
2. Diamond.
3. Coal.
4. Mineral resins.
5. Combustible salts.

PART II.

THE GEMS.

PRECIOUS STONES OR GEMS.

Precious stones or gems are such minerals as, either from their beauty or other valuable properties, have become the subject of the arts or trade, and are used as ornaments, or employed by jewellers. In order to appreciate more fully such minerals as may possess superior virtue, it is our present object to consider them in reference to their scientific and practical value.

DIVISION OF GEMS.

Gems are generally classed as follows: 1st, real gems, or jewels; and 2d, semi-gems, or also precious stones. The first comprise such minerals as combine, within a small space, either vivid or soft and agreeable colors, with a high degree of lustre, usually termed fire, as well as hardness; the second possess these characters in a less degree, and occur often semi-transparent or translucent, and in larger formless masses. It is, however, impossible to draw a strict line between them, as the conventional value put upon the one or the other also affects their character; for very often some, which are generally considered as belonging to the second class, may be valued, for their peculiar properties, much higher than some of the first class.

Those species of minerals which are generally considered real gems are—

Diamond,
Sapphire,
Chrysoberyl,
Spinelle,
Emerald,
Beryl,
Topaz,
Zircon,
Garnet,
Tourmaline,
Rubellite,
Essonite,
Cordierite,
Iolite,
Quartz,
Chrysolite.

The rest are considered as semi-precious stones.

COLOR, GRAVITY, AND HARDNESS OF GEMS.

The precious stones possess the colors in their highest perfection, and their principal and intrinsic value depends mostly upon this property; and as most gems occur in various colors, the following table will exhibit them, along with their specific gravity and hardness:

LIMPID GEMS.

	SPECIFIC GRAVITY.		HARDNESS.
Zircon	4·41	to 4·70	7·5
Sapphire	3·9	4·20	7·
Diamond	3·5	3·6	10·
Topaz (Pebble)	3·49	3·56	8·
Rock Crystal (False Diamonds, Lake George, Trenton Falls)	2·69		7·
Beryl, Aquamarine	2·67	2·68	7·5

RED GEMS.

Zircon, Hyacinth	4·41	4·70	7·5
Garnet (Oriental Garnet)	4·0	4·2	6·5
Sapphire, Ruby	4·0	4·2	9·
Garnet, Bohemian Garnet. Pyrop	3·7	3·8	6·5
Spinelle, Ruby Spinelle, Ruby Balais	3·49	3·7	8·
Diamond	3·5	3·6	10·
Essonite	3·5	3·6	7·
Topaz. Brazilian Topaz (often burnt)	3·52	3·56	8·

	SPECIFIC GRAVITY.		HARDNESS.
Tourmaline, Siberite, Rubellite	3·0	to 3·30	6·5
Rose Quartz. Bohemian Ruby	2·50	2·63	7·
Carnelian	2·5	2·6	7·

YELLOW GEMS.

Zircon	4·41	4·50	7·5
Sapphire. Oriental Topaz	4·0		8·
Chrysoberyl	3·65	3·80	8·5
Topaz. Brazilian, Saxonian, and Syrian Topaz	3·50	3·56	8·
Diamond	3·5	3·6	10·
Beryl	2·67	2·71	7·5
Rock Crystal, Citron	2·60	2·69	7·
Fire-opal	1·90	2·12	5·5

GREEN GEMS.

Zircon	4·41	4·50	
Sapphire, Oriental Chrysolite, and Emerald	3·9	4·00	8·
Malachite	3·67		3·5
Chrysoberyl	3·59	3·75	8·5
Spinelle	3·58	3·64	8·
Diamond	3·5	3·6	10·
Topaz. Aquamarine	3·49	3·56	8·
Chrysolite	3·33	3·44	6·5
Idocrase	3·08	3·40	6·5
Tourmaline (Brazilian and Maine)	3·00	3·30	6·5
Emerald	2·67	2·73	7·5
Beryl	2·67	2·71	7·5
Prase	2·66	2·68	7·
Heliotrope	2·61	2·63	7·
Chrysoprase	2·58	2·60	7·
Felspar, Amazon Stone	2·50	2·60	6·

BLUE GEMS.

Sapphire	3·90	4·00	8·
Disthene (Kyanite)	3·50	3·67	5·
Spinelle	3·58	3·64	8·
Diamond	3·5	3·6	10·
Topaz. Brazilian Topaz	3·49	3·56	8·
Tourmaline, Indigolite	3·00	3·30	6·5
Turquoise	2·86	3·00	6·
Beryl, Aquamarine	2·67	2·71	7·5
Dichroite (Iolite)	2·58	2·60	7·

	SPECIFIC GRAVITY.		HARDNESS.
Hauyne	2·47		5·
Lazulite	2·30		5·

VIOLET GEMS.

Garnet	4·0	to 4·2	6·5
Sapphire, Oriental Amethyst	3·9	4·0	9·
Spinelle	3·58	3·64	8·
Axinite	3·27		6·5
Tourmaline	3·00	3·30	6·5
Amethyst	2·65	2·78	7·

BROWN GEMS.

Zircon	4·41	4·50	7·5
Garnet	4·00	4·20	6·5
Essonite	3·53	3·60	7·
Diamond	3·50	3·60	10·
Tourmaline	3·00	3·30	6·5
Smoky Quartz	2·69	2·70	7·

BLACK GEMS.

Diamond	3·50	3·60	10·
Tourmaline	3·00	3·30	6·
Rock Crystal, Morion	2·69	2·71	7·
Obsidian	2·34	2·39	6·5
Pitch Coal	1·29	1·35	2·
Cannel Coal	1·23	1·27	2·

GEMS DISTINGUISHED FOR THEIR VARIOUS SHADINGS OF COLOR AND LIGHT.

Garnet	4·00	4·20	6·5
Sapphire, Star Sapphire	3·90	4·00	9·
Chrysoberyl	3·70	3·80	8·5
Hypersthene	3·38		6·
Labrador Spar	2·71	2·75	6·
Dichroite	2·58	2·60	7·
Cat's-eye	2·56	2·73	7·
Adularia	2·50	2·60	6·
Felspar	2·50	2·60	6·
Precious Opal	2·00	2·10	5·5
Hydrophane	1·90	2·00	5·

A number of precious stones do not possess a local color, but merely a tinge or a shade of color; and these we distinguish by the following degrees of dark, high, light, and pale colored, or tinged. Another distinction may be detected in precious stones as possessing either one or more colors, or a variegated color; or as being spotted, painted, stained with the different colors. These latter characters are, however, more proper to the semi or common precious stones, than to gems.

CHEMICAL CHARACTERS.

Although mineralogy could not exist, as a science, without the aid of chemistry, and whole systems or classifications have been established, as well as the constituent parts of minerals determined, by the knowledge of chemical characters, still it is difficult to resort to chemical means for distinguishing the gems or precious stones, as they would be destroyed by such an examination, and we can, for that purpose, only employ splinters or fragments. The most simple mode of proceeding is to test—

1st, Their greater or less fusibility, with or without a flux;

2d, Their behavior before the blowpipe, an instrument highly convenient, and, indeed, indispensable to the mineralogist; and,

3d, The action of the acids upon them.

All of these means, however, have not an effect upon all gems, as many of them, for instance, are either infusible, or fusible with the greatest difficulty by the addition of a flux.

COMPOSITION OF GEMS.

The attention of writers, as far back as 1502, had been directed to the establishment of some hypothesis as to the composition and origin of the gems, and many fabulous views were entertained in respect to their formation.

There was also connected with some hypotheses a species of medical superstition as to their effect. Boyle (1672) thought that all gems were originally formed from clear limpid water, and that they received their color and other properties from their metallic spirit. Others considered a peculiar earth, called the noble or precious earth, as the principal ingredient of the precious stones. Bruckman (1778) recognized quartz as the principal of the gems. Bergman thought that gems were all composed of the same ingredients, such as alumina, silex, and lime, and that the different proportions produced the different species; and the older mineralogists determined the character of the gems by their hardness, lustre, structure, and resistance to acids. But modern chemistry has ascertained the component parts, and other characters of gems, with more certainty, and it is satisfactorily proved that the principles they contain are the earths, such as silica, alumina, and lime; that some contain a peculiar earth (such is the case with the zircon, emerald, and chrysoberyl), and that the diamond, at the head of gems, consists of pure carbon, &c.

THE ARTIFICIAL PRODUCTION OF GEMS AND MINERALS.

Professor Mitscherlich has produced, artificially, crystals of minerals by fusion at a high temperature of the scoria of furnaces containing silicates, with the addition of such oxides as form a component part of the respective minerals, exposed to a high heat. So successful was the result, that he produced more than forty species of the various crystalline minerals artificially, and corresponding with the natural productions, such as peridote, pyroxene, mica, felspar, protoxide of copper, iron pyrites, and others. Berthier devoted likewise some time in reproducing several minerals by fusion at a high temperature, and he has obtained crystals of peridote and pyroxene with iron and manganese bases, which were for a long time called silicate of manganese.

Mr. Gaudin has, by means of the compound blowpipe, been able to fuse alumina and quartz, and from potassa and ammoniacal alum he has produced well-formed corundum crystals, as also crystals of ruby, of rhombohedral form and triple cleavage, and which, according to Malagutti, consisted of ninety-seven alumine and two silicate of lime, the exact composition of ruby. By this process the potassa originally employed was volatilized in the high temperature; this was done in 1837. Becquerel employed electricity for this purpose in its most attenuated condition, and with two or three bodies, one of which in its dry and the other in liquid state, and required from one to two years to effect its object, as the case was with a dodecahedral pentagonal crystal of iron pyrites; he obtained sulphurets of copper and tin, which could not be distinguished from the native crystals. He has even obtained crystals of oxide of zinc, which were octahedral, transparent, refracting strongly the light, and hard enough to scratch glass, and altogether unknown in the mineral kingdom. His process was, on a silicate of potassa solution to let act slowly a voltaic current from a sheet of zinc, around which a copper wire was wound. The density of the liquid was 22° areometer; water was thereby decomposed with disengagement of hydrogen gas and formation of oxide of zinc, which was dissolved again, and after a fortnight, very fine brilliant crystals were visible on the zinc plate, which, after a lapse of two years, were the size of a millimeter.

Mr. Ebelman conceived the idea of obtaining artificial crystals from infusible silicates and aluminates, by replacing the water contained in many metallic oxides in high temperatures with boracic acid, borate of soda, phosphorus, and alkaline phosphates, and its final evaporation in high temperatures. He prepared certain oxides, calculating the proportions, such as alumina and silica, and exposed them in a platina capsule, at a high temperature, in his porcelain furnace of the Sèvres manufactory, of which he was the director, and with the mixture of boracic acid kept the mass in a fusion, and the corundum and crystallized silex were the results. He used boracic acid for this purpose, as he found it more convenient than the other dissolvents.

Mr. Ebelman has fused together, in order to obtain the spinelle (which is composed of 72 parts of alumina and 28 parts magnesia),

Alumina,	6	grammes.
Magnesia,	3	"
Fused boracic acid,	6	"
Green oxide of chrome,	0·10 to 0·15	grammes.

The latter was added for the purpose of rendering the mass of a rose color. This mixture, put into an uncovered platina capsule, was exposed to the heat of the porcelain furnace; after the baking was finished, the melted mass formed a rose-colored layer on the bottom of the capsule, and in the mass octahedral crystals of spinelle, quite identical with the natural crystals of the ruby spinelle, were taken out, which were exceedingly brilliant. The author received in 1851, while on a visit to Paris, from Mr. Ebelman, about thirty of those crystals, weighing about one grain, and which he submitted, on his return to the United States, to numerous chemical and mineralogical tests, both as to hardness, specific gravity, and lustre, and was extremely gratified as to its results.

Mr. Ebelman manufactured the blue spinelle, by substituting the same quantity of oxide of cobalt for the oxide of chrome; also by substituting the oxide of zinc for the magnesia, he obtained the garnet, which he prepared by

Alumina,	6	grammes.
Oxide of zinc,	5	"
Fused boracic acid,	6	"

The mass was brought slowly to a white-heat temperature, and kept from twenty-four to thirty hours in that condition. The boracic acid begins to evaporate during the last five hours.

The emerald was obtained artificially by a mixture of

Silex,	4	grammes.
Alumina,	1·60	"
Glucia,	1·40	"
Fused boracic acid,	4·06	"
Oxide chrome,	0·10	"

Mr. Daubrée has produced artificially the oxide of tin, by passing through a heated porcelain tube two currents of the vapors of the perchloride of tin and water, by which a double decomposition was effected, so that in the interior of the porcelain tube small crystals of oxide of tin were deposited, and hydrochloric acid gas passed off in the form of vapor. The crystals of tin were deposited at the orifice of the porcelain tube, where the temperature was scarcely 300°, while no crystals were deposited in the hottest part; the crystals of tin scratched glass easily, were infusible, and were not affected by acids, and had a specific gravity of 6·72.

The latest discoveries of Mr. Daubrée have brought to light many important facts in regard to the formation of rocks which contain crystalline substances, differing widely in their fusibility. By the action of chloride of silicium at red heat, and vapor on many bases which enter into various rocks he obtains in exchange, by decomposition, chlorine bases and free silica (silicic acid), which appears as quartz in crystals; if he desires an action of the chloride of silicium on chalk, magnesia, alumina, or glucia, he obtains crystals of quartz, wallastonite, peridote, and disthene; for the purpose of obtaining double silicates, he not only adds the bases for silicifying in proper proportions, but also in excess sufficient oxygen for forming silicic acid. A mixture of chalk or magnesia, for instance, to the chloride of silicium, produced crystals of diopside, perfectly colorless, with a characteristic slope of this mineral. He also obtained crystallized felspar by the mixture of 1 equivalent of alkali (potassa and soda), 1 equivalent of alumina, with 6 equivalents of lime under the influence of chloride of silicium. Similar mixtures have produced crystals of garnet, idocrase, phenakite, emerald, euclase, zircon, and wilhelmite. He also produced tourmaline in regular hexagonal prisms, which were grouped upon quartz crystals just as they are often observed in crystalline rocks of shorl. By the same method, but replacing the chloride of aluminum for action upon the bases, he obtained corundum crystals, spinelle crystals, and garnet crystals; by the contact of perchloride of iron with chloride of zinc he obtained fine crystals of franklinite; crystals of magnesia or periclase, like those from Mount Somma, were produced by the action of lime on chloride of magnesium, but remarkable enough, their production is just the counterpart of the origin of the native mineral, where constantly chlorine vapors are disengaged, and where it detaches itself from the dolomite geodes.

Mr. Durocher obtained, by the action of sulphuretted hydrogen gas upon the chlorides of iron and zinc, crystals of magnetic pyrites and blende; he also obtained, by the action of different vapors, sulphurets of antimony and arsenic, and the gray antimonial copper.

Mr. Senarmont obtains quartz crystals in perfect hexagonal prisms, with all the other specific characters, from the gelatinized silica, under a high temperature and the high pressure of thirty atmospheres.

The artificial production of the diamond has been latterly effected by the ingenious contrivance of Despretz, which consists in passing an electric current into an exhausted bottle, in the lower part of which is placed a small cylinder of charcoal, and from the upper part are suspended platina wires or platina foils; the sparks thereby obtained from the combustion of the charcoal are of a reddish-violet color; after the lapse of one month, during which the combustion continues, a little black layer of charcoal is deposited upon the platina; under the microscope they appear like very small octahedrons, quite analogous to the diamond; some were free from color, and very brilliant.

GEOLOGICAL CHARACTERS.

The origin, locality, and geological characters of gems are various; it was formerly supposed that the trap formation was their matrix; but it is ascertained that we find them distributed in rocks of different ages and kinds, either as accidental mixtures—such as garnet in gneiss and micaceous schiste—or in drusy cavities, such as the emerald, which occurs in druses of argillaceous slate and micaceous schiste; and many precious stones are found in gangues. Many gems are found at a distance from their original bed, on secondary or diluvial strata, or in the beds of rivers, mixed with their sand. Thus, zircon is found in Ceylon in regular beds; and likewise we find in Ceylon, after much rain, the topaz, zircon, and other gems. This happens more frequently in the beds of the rivers, and then the gems appear often in the shape of pebbles, showing that those hard stones, carried away from their original beds, have been rolled and rounded by the streams and rivers, although they retain sometimes their crystalline structure, on account of their hardness.

The discovery of diamonds in Russia, far from the tropical region, has excited much interest among geologists.

In the detritus on the banks of the Adolfskoi, no fewer than forty diamonds have been found in the gold alluvium, only twenty feet above the stratum in which the remains of mammoths and rhinoceroses are found. Hence Humboldt has concluded that the formation of gold-veins, and consequently of diamonds, is comparatively of recent date, and scarcely anterior to the destruction of the mammoths. Sir Roderick Murchison and M. Verneuil have been led to the same result by different arguments.

GEOGRAPHICAL DISTRIBUTION.

The locality of gems bears some highly interesting characters, inasmuch as we may sometimes judge, from their appearance, the climate of their locality; and it seems as if the countries of the torrid zone had been particularly favored by nature in producing the most precious gems, or that those hot-beds were more propitious to the formation of the blossoms of the inorganic world. Comparing, for instance, spinelles and zircons, from Siberia, with those of Ceylon and Peru, we find the first to be dark and of an impure color, as if emblematic of a cold, unfriendly, northern climate; whereas the latter glitter with full brilliancy, and possess all those properties and beauties for which gems are so highly esteemed. Often, too, we find the gems collected in particular countries, or isolated spots of our globe, such as the most precious gems from the East Indies and Brazil, where, singular enough, they occur with the precious metals; as, for instance, the diamond in company with gold and platina in Brazil. Some of the gems have likewise been hitherto discovered in a single spot on one continent only, and are then exhausted; such as the rubellite, in Maine, United States; the iolite in Connecticut, United States, and the lazulite in Persia.

PRACTICAL DIVISION AND NOMENCLATURE OF GEMS.

Artists have not profited, in their arrangement and nomenclature of gems, by the advanced state of mineralogy, as a science; and although they have been newly classified by mineralogists according to their scientific characters, the practical artist arranges them according to those properties that principally attract the eye: such as color, transparency, and lustre. Gems have, in consequence, received their names from their color: as ruby, from its red color; sardonyx, yellow onyx. Gems of different species, but of the same color, are often named from their color. For instance, the corundum, the spinelle, or the topaz, if of a red color, is called ruby; if blue, sapphire; if green, emerald; if yellow, topaz, and if violet, amethyst: and thus gems of the same color, but of different composition, are arranged under the same head. The artist confounds under the name of Brazilian ruby, either a light rose-red spinelle, or a topaz approaching to the red color. The name of a country or locality, is often sufficient to give a name to gems of the same color, but of different shadings, and of more or less vivid lustre. Thus, by Oriental chrysolite is meant a yellowish-green sapphire, and by Saxonian chrysolite, a pale wine-yellow topaz. Many gems have always been known under the name of Oriental gems, partly because they were first obtained in the East, and partly because they stood, from their excellent properties, in higher estimation than those from any other country. Those from the East were likewise called "Oriental," in opposition to others less valuable, which were called "occidental" gems. Subsequently, all gems of superior qualities were called Oriental gems, even when their locality was not in the East. Thus, for instance, that precious opal, so well distinguished for its beautiful play of colors, is called the Oriental opal, although it is never found there; likewise, the purest and most valuable emerald, which in great perfection only occurs in Peru, is known as the Oriental emerald.

HISTORY OF GEMS.

Those precious stones, which are now called gems, were known in ancient times but very little, if at all. The first notice given of them is in the Bible, where it is stated that the high priest wore one stone on his gold scarf, and twelve gems set in gold plate, called the Urim and Thummim, each of which represented a tribe. It appears that the Hebrews borrowed the names of their gems from the Egyptians, and few of the gems—with the exception of the sapphire—named in the holy Scriptures correspond in any respect with those at present known in our mineralogical books. The Greeks appear to have been but little acquainted with gems, as they did not use them as ornaments in the Trojan wars; and Homer, when speaking of the treasures of those times, does not make any mention of gems. Theophrastus and Pliny have described some gems of their time very imperfectly and confusedly; and their descriptions are so replete with vain fancies, that it is difficult to identify any from their descriptions. They attributed most wonderful powers to gems; gave fabulous descriptions, and the most singular and perverted views in regard to their origin; and it was said that they had great influence upon health and beauty, riches, honor, and good fortune. They were called, when worn, amulets. They were brought into connection with the planets, the twelve constellations, and the seasons of the year; and a certain gem was worn each month, which was said to have during the term, its peculiar influence and healing virtues. Such superstitious notions have been transmitted to our times. The gems corresponding to the different months, and also to the twelve Jewish tribes, are the following:

January	Hyacinth	Dan.
February	Amethyst	Gad.
March	Jasper	Benjamin.
April	Sapphire	Issachar.
May	Agate	Naphtali.
June	Emerald	Levi.
July	Onyx	Zebulon.
August	Carnelian	Reuben.
September	Chrysolite	Asher.
October	Beryl	Joseph.
November	Topaz	Simeon.
December	Ruby	Judah.

Artists have made certain changes in some of the gems corresponding to the months, and the tribes represented in the Urim and Thummim; they consider May to be represented by emerald:

June	by Chalcedony, Onyx, or Agate;
July	Carnelian;
August	Sardonyx;
October	Aquamarine;
December	Chrysoprase, Turquoise, or Malachite.

In the early ages similar views were entertained in the East, and many of them are yet prevalent. The Persians believe that spinelle affords joy, and protects them against bad dreams. The Indians believe in the efficacy of large diamonds to bring them back to their families. (The Rajah of Mattan, a district of Western Borneo, possessed a diamond of 367 carats.) The ruby is esteemed, in the East, as a talisman, which is never shown willingly to friends; it is considered ominous if it contains any black spots. The Chinese, on the contrary, present the same stone as a testimony of friendship. The Peruvians adore the emerald as their deity. Many of these fabulous notions were probably brought from the East to Europe; for we find, in the middle ages, similar views entertained by Marbodus, Bishop of Rennes, who wrote a book on the miraculous powers of gems. The twelve Apostles were likewise represented symbolically by gems, and they were called "the Apostle gems;" as—

Jasper	for St. Peter;
Sapphire	St. Andrew;
Chalcedony	St. James;
Emerald	St. John;
Sardonyx	St. Philip;
Carnelian	St. Bartholomew;
Chrysolite	St. Matthew;
Beryl	St. Thomas;
Chrysoprase	St. Thaddeus;
Topaz	St. James the Less;
Hyacinth	St. Simeon;
Amethyst	St. Matthias.

The ancients, induced by the beauty of gems—the pure and deep color of the emerald, the vivid and high lustre of the diamond, and the agreeable reflections of the opal—had commenced using them as ornaments and jewelry, and they took pains to adapt them to their purposes. Although they did not, in those times, understand the art of cutting and polishing them as practised at the present time, yet they endeavored to work them into all possible shapes, by rubbing off the corners, or polishing the natural faces. They generally fixed the gems on strings; they also tried to carve figures representing deities, religious costumes, historical events, exploits of celebrated generals. or the heads of great men.

SCULPTURE IN GEMS.

The art of carving was well known to the ancients, and those stones were called gems, in the proper sense of the word, which had figures or letters engraved on them in a very small compass, the workmanship of which we, at this day, cannot help admiring.

Gem-sculpture, or the glyptic art (or lithoglyptics), is the art of representing designs upon precious stones, either in raised work (cameos) or by figures cut into or below the surface (intaglios). The first were most natural to the rising art, and were used as seals; whereas the latter were used as ornaments, for which the most precious materials were employed, according to the state of the art. They did not understand engraving on diamonds, or many other gems: they employed only the softer stones, the common precious stones, such as carnelian, onyx, jasper, &c.; they also used paste, or artificial colored glass composition, for their engravings. Their mode of working was very simple: the polishers prepared their stones on a plate, by means of the powder of harder stones, either round, oval, flat, or in shield form, according to the designed subject, and then left to the sculptors the subject of the engraving, which was done by means of iron, or diamond splinters mounted in iron. It was not until the year 1500 that Ambrosius Caradossa first discovered the method of cutting the diamond. He prepared the figure of a patriarch for Pope Julian II. He also discovered the first traces of sculpture among the Jews, Persians, and Egyptians. In the traditions of the holy Scriptures, Moses, for instance, had the names of the twelve tribes of Israel engraved on the gems used by the high-priest. Solomon possessed a seal: Alexander presented his seal to Perdicas. Augustus had a sphinx engraved on his seal; but the Indians and

Persians engraved mostly mythological animals or priests in their gems; the Egyptians, beetles, which they adored, and which are called the scarabæi. "Abraxes" were the oldest gems, which had the representation of fantastical animals, with the above word in the Greek language, engraved on them.

The Phenicians, Hetrurians, and Greeks learned the art of carving from the Egyptians; and from them it was carried to the Romans, where it was lost, in the decline of the empire, in the fifteenth century, under the Popes Martin V. and Paul II. The art was revived again by some fugitive Greeks in Italy. Great merit is also due to the Medicians for the revival of the art; and Giovani was considered the first in Italy. The *talisman*, or carved gems bearing Arabian letters, belong to those times. Precious stones with layers and veins, or such as onyx, sardonyx, &c., were employed by the ancients, with great skill, in the carving of cameos, where we find the head of one color, and the hair and dress of a different color carved out of the other layer of the stone. Very often the subjects were mythological, and this mode of carving or sculpture has been imitated by modern artists. It is sometimes with difficulty that we are enabled to distinguish the ancient from the modern works, and the only authentic authority for the antiquity of the cameo or intaglio is its excavation from ancient monuments, except in a few instances, where we may be able to judge by comparison of the difference in antiquity; by observing whether or not they are unnaturally, or stiffly done; have large heads, hands, and feet, or stiff streaks resembling the hair, &c. We find that some gods, representing the peculiar gems (such we see all sculptures of Bacchus, and what relates to him), were executed in amethyst, being the color of wine; and all nymphs, Neptune, or fish, in aquamarine, &c., the color of water. We find also, in Germany, traces of sculpture in the fourteenth and sixteenth centuries; the oldest known artist, Daniel Engelhard, at Nuremburgh, died in 1552; also Lucas Kilian; and the best artist, Nater, died in 1705. England and France had likewise very distinguished artists in carving. A full history of gem-sculpture may be found in the Encyclopedia Americana, pp. 403–405.

ON GRINDING.

The art of grinding gems is of more modern origin; it consists in cutting the gems, and other precious stones, into figures, bounded by many planes, and by polishing the faces thus formed, increasing their lustre, transparency, and other valuable properties. This constitutes the work of the lapidary. In the year 1290 a society of lapidaries was formed at Paris, and in 1385 there were diamond-cutters at Nuremburgh; but it was not until 1456 that Ludwig Van Bergen invented the art of polishing the diamond with its own powder; gems were then cut according to mathematical principles; the art has been brought, in modern times, to the greatest perfection. There is a great difference in gems (which are mostly procured from the Indies in a rough or polished state), easily to be detected by their im-

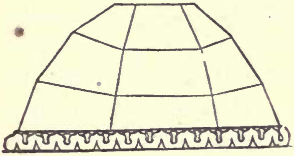


Fig. 1.

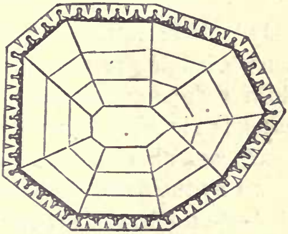


Fig. 1 *a*.

perfections. The Indians look more upon the size of the stone than upon the cut, which is generally irregular and devoid of symmetry. We observe this in the two celebrated diamonds of the Shah of Persia, the Dariainur—*brilliant sea*—(figs. 1 and 1 *a*), and the Kuinur—*brilliant mountain*—(figs. 2 and 2 *a*): the one is worn on the left arm, and the other on the right knee.

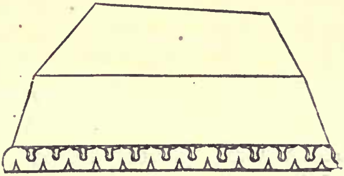


Fig. 2.

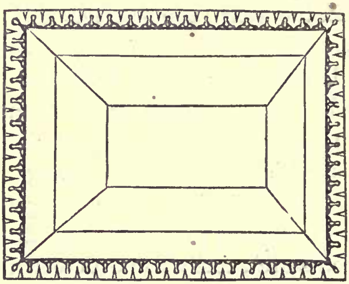


Fig. 2 *a*.

By looking at the subjoined representation of the diamond belonging to the crown of France (figs. 3 and 3 *a*), which weighs one hundred and thirty-six and a quarter carats, is fourteen lines long, thirteen and a quarter lines broad, and nine and a quarter lines thick, and which is known by the name of *Regent*, we can more distinctly discriminate the irregular and unmathematical cut.

The gem-grinders are divided into three classes: first,

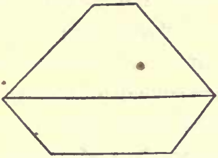


Fig. 3.

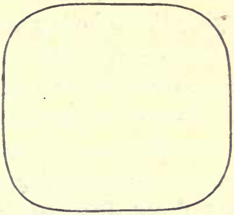


Fig. 3 *a*.

the diamond; second, the gem; and third, the jewelry grinders.

The diamond grinder divides his work into—*a*, slitting or cleaving; *b*, cutting; *c*, grinding; and *d*, polishing.

Before operating upon diamonds, some preliminary experiments as to their soundness are made: for very fine imperceptible fissures may, at the end of a laborious grinding, terminate either in cracking or spoiling the stone. An examination for this purpose is made in one of the two following modes: either the diamonds, or any other gems to be examined, are steeped in Canada balsam, or in oil of sassafras or aniseed, in which fluid they are well turned around, whereby the minutest fissure, on account of its changed refraction of light from that of the rest of the stone, may be detected; or the diamond is exposed to a great heat, and is then thrown into water, when it will crumble to pieces should any cracks exist within it. The diamond, although the hardest of all known substances, may yet, with facility, be cloven with steel tools, the blow being properly applied. The octahedrons are best fitted for cleaving: they are generally, however, somewhat rounded, and in order to cleave them, those planes which are to be cloven, are left bare, and the rest is coated with a composition of resin and brick-dust; the bare plane is now rubbed with another sharp-edged diamond until a furrow is obtained, which will render the planes suitable for applying the cleaving instrument, and this operation is repeated with every plane. Diamonds that are not fit for being cloven, are called by the Dutch, "*divelsteene*" (devil-stones). Large diamonds, which are too precious to be expose to a dangerous cleavage, are sawed by means of a fine steel wire, moistened with oil and diamond-powder.

The rough-cut diamonds, as they are brought from the Indies, are called *laboræ*.

Mr. Mawe gives the following description of the art of cutting and polishing diamonds:

"The object of cutting and polishing the diamond is twofold:

"First, to divide the natural surface of the stone in a symmetrical manner, by means of a number of highly-polished polygonal planes, and thus to bring out to the best advantage the wonderful refulgence of this beautiful gem; and, secondly, by cutting out such flaws as may happen to be near the surface, to remove those blemishes that materially detract from its beauty, and consequently from its value.

"The removal of flaws is a matter of great importance: for, owing to the form in which the diamond is cut, and its high degree of refrangibility, the smallest fault is magnified, and becomes obtrusively visible in every facet. For this reason, also, it is by no means an easy matter, at all times, to ascertain whether a flaw is or is not superficial; and a person with a correct and well-practised eye may often purchase, to great advantage, stones which appear to be flawed quite through, but are, in fact, only superficially blemished.

"The first thing the artist has to do, when a rough diamond is put into his hands, is to examine carefully in what direction the stone may be cut, so as to afford the greatest breadth, or *spread*, as it is technically termed, after the flaws, if any, shall have been taken out. So great a stress is laid, by modern fashion, on the superficial extent of a brilliant, that the old rules of proportioning its dimensions are now nearly obsolete: the best cutters have entirely discarded the use of measures, and, in forming the facets, trust wholly to an accurate and well-practised eye. The direction being determined on, the artist must be well aware which are the *hard points* and which the *soft ones;* the former being those solid angles of the original octahedron, which it is necessary to cut directly across, and the latter those solid angles which are to be obliquely divided. A degree of force which may be safely applied, and is even requisite in making a section through the former, will be very apt to flaw and tear up the laminæ when applied to latter. On these accounts it probably is, that the fatiguing and even painful process of performing this part of the business by hand, is not yet superseded by the use of machinery.

"These preliminary matters being settled, the diamond is imbedded in a strong cement, fixed at the end of a stout spindle-shaped stick, about a foot long, with that portion only projecting, the removal of which is to form the first facet. The instrument employed for this purpose is another diamond, fixed in a stick similar to the former, with one of the solid angles projecting. In order to collect the powder and shivers that are detached during the process, the cutting is performed over a strong box, four or five inches square, furnished with a false bottom perforated with excessively minute holes, in order to sift, as it were, the dust from the shivers; and also with two upright iron pegs, fixed on the sides, for the workman to support and steady his fingers against, while with a short repeated stroke, somewhat between scratching and cutting, he is splitting off, or more laboriously wearing away the diamond in that part where the facet is to be placed. This being done, the cement is softened by warming it, and the position of the diamond is changed, in order to bring a fresh part under the action of the cutting-diamond. When, in this slow laborious way, all the facets have been placed upon the surface of the diamond, the cutting is completed. The stone, if examined by a moderate magnifier, now presents ragged, rough edges; and a broken, foliated surface, with a glistening lustre on those facets that are nearly in the direction of the natural laminæ, and on the other facets a more even surface, but of a dull opaque grayish-white color.

"The shape of many diamonds is so irregular, that it is necessary to remove pieces of considerable magnitude in order to bring them to a form proper for cutting. Where the lines of these proposed sections coincide with the natural lamellar structure of the stone, the workman has recourse to the delicate, and perhaps somewhat hazardous, operation of splitting the diamond, by which a double advantage is obtained. In the first place, there is a great saving of time; and in the second place, the slices or shivers are themselves sufficiently large to admit of being cut and polished. The method of splitting is made a great mystery; thus much, however, may be mentioned, that when the direction in which the section is to be made has been determined on, it is marked by a very fine line, cut by the point of another diamond: the stone is afterwards fixed by strong cement in the proper position, in a block of wood, and then, by the application of a due degree of force, the section is effected.

"The diamond being thus, by the joint action of splitting and cutting, brought to the required form, the next object is to polish the facets, and at the same time to redress any little inequalities that may have taken place in the cutting. The polishing-mill is an extremely simple machine, consisting of a circular horizontal plate of cast-iron, fourteen or fifteen inches in diameter, called a *skive*, suspended on a spindle, and capable of being put into rapid motion by means of a larger wheel, five or six feet in diameter, and turned by an assistant. From the centre to the circumference of the iron plate, are lines or shallow grooves, formed by rubbing it in that direction with a fine grained gritstone: these grooves serve to retain the mixture of oil and diamond-powder with which the plate is charged. In order to keep the diamond perfectly steady while the polishing of each facet is going on, the following contrivance is had recourse to:—a copper cup, called a *dopp*, about three quarters of an inch in depth and in width, and furnished with a stem about four inches long of stout copper wire, is filled with plumbers' solder, which also projects in a conical form beyond the rim of the cup: in the apex of this cone, the solder being softened by heat, the diamond is imbedded with one of the facets projecting. The stem of the cup is now put into very powerful pincers, which screw up with a nut and a wrench or lever, and thus hold it perfectly tight. The handles of the pincers (made of wood, and called *tongs*) are broad, and terminate in two feet, about an inch high, so that when laid horizontally, they are supported exactly as a pair of candle snuffers are, the studs fixed to the handles of the snuffers representing ing the legs of the pincers, and the single stud near the point of the snuffers representing the inverted copper cup holding the diamond is placed on the plate, the pincers resting on their legs on the wooden bench or table that supports the plate, and pressing at the same time against an upright iron peg; the broad part of the pincers between the legs and the diamond, is then loaded with weights, both to steady the machine, and to increase the pressure of the diamond against the skive. Matters being thus ad justed, a little oil and diamond powder is dropped on the plate, it is set in motion at the rate of about two hundred revolutions in a minute, and the process of grinding down, and at the same time of polishing, is begun. The diamond is taken up and examined from time to time, and is adjusted so as to give the facet its true form. The heat occasioned by the friction is at all times pretty considerable, and when the pincers are heavily laden, it occasionally increases to such a degree as to soften the solder and displace the diamond. This is a serious accident, frequently occasioning a flaw in the diamond, and always tearing up the surface of the skive, so as to damage it very considerably. There is room on the skive for three or four diamonds at the same time; and to give each its proper share of attention, is as much as one person can well manage. The completion of a single facet often occupies some hours."

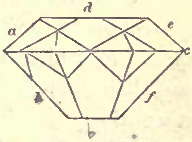
The polish is often produced by rubbing the diamond with a cloth or bare hand. The form which the gems have to receive from the lapidary varies according to the condition of the stones; and the skill of the artist consists in the right selection of a form which shall correspond with the natural structure of the gems. A good cut has the greatest influence on the lustre and beauty of gems; the colorless and limpid gems, for instance, require a different form from those which have a play of colors. With a diamond, the form must correspond as much as possible with its natural or original shape, in order to save the great trouble of grinding, and the waste thereby produced. Transparent gems ought not to be cut too thick; the rays of light might otherwise be refracted too much, or prevented from penetrating through them at all: in the first instance, the lower facets do not act in correspondence with the upper, and the rays are much distributed before reaching the eye. Gems of such description are called clotty. On the other hand, if the gems are too thin, their beauty, elements, and general value are likewise diminished. There is a definite proportion of thickness to the breadth of colorless or limpid gems, whereas the cut of the colored gems depends upon the intensity of the color.

FORMS OF THE DIAMOND.

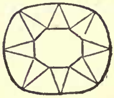
Diamonds were formerly cut according to their natural form, and mostly in the planes of the octahedron. They were called then point diamonds (*pierres de nature*, or *pointes ingénues*).

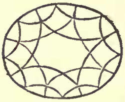
The following forms are now, more or less, adopted by the Dutch and English diamond-cutters:

A. The *Brilliant*. This cut displays to greatest advantage the lustre of the diamond: it may be considered as obtained by two truncated pyramids, united together by one common base, the upper pyramid being much more deeply truncated than the lower. It is formed —*a*, of the *crown*, or that part of the stone which remains visible after the stone is mounted; *b*, the *collet*, or lower part; *c*, the *girdle*, or the common base for the crown and collet; *d*, the *table*, the plane which is formed by the truncature of the upper pyramid; *e*, the *bisel*, that space which lies between the girdle and table; and *f*, the *collet-side*, the space between the girdle and collet. The English lapidaries cut the girdle sharp, whereas the Dutch leave it broad: the crown amounts to one third, and the collet to two thirds of the whole height of the diamond; the table amounts to four ninths of the diameter of the brilliant, whereas the collet only needs one fifth of the size of the table. The table and collet are regular octagons, and the facets occupied by the bisel are



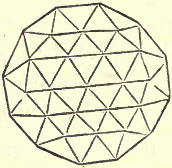
eight lozenges, with twenty-four triangles, and are called the *star-facets;* the facets occupied by the collet-side are four irregular pentagons, alternating with as many irregular lozenges, radiating from the collet as a centre, and are bordered by sixteen triangular facets adjoining the girdle, and are generally called the *pavilion* or *cross* facets. According to the number of facets, the brilliants receive their names, either of *double* or *treble* brilliant: the double brilliant is surrounded by two rows of facets on the bisel, which are triangular, and meet each other; the treble brilliant has fifty-eight planes, fifty-six facets, table and collet, thirty-two facets of which are in the bisel in three rows; the star and pavilion facets are triangular, the intermediate ones are four-sided, and on the collet-side are twenty-four facets.



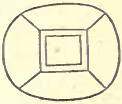


The English double brilliant consists of twenty-four facets, table and collet, sixteen of which terminate in the form of a star in the bisel.

Brillionets, or half-brilliants, are those diamonds, the spread of which is too great in proportion to their depth, and the crown is only cut like a brilliant, but the collet-side is wanting.



B. The *Rose-Diamond* has a crown, but no collet; it is formed of equilateral triangles, and consists of two rows of three-sided facets; those on the girdle are pavilion, and the others star facets. But there are variations in the number of facets: the Dutch roses have eighteen pavilion and six star facets; others have six pavilion and six star facets, or twelve pavilion and six star facets; and some, also, have twenty-four three-sided pavilion and twelve star facets. The rose-diamond is only that diamond, the proportion of whose breadth to its depth is too much extended, and which would not, without much loss, make a good brilliant. There are fragment rose-diamonds, which are very small, and ear-drop roses.



C. The *Table-Diamond* is that stone which is very flat and of little depth, and which reflects but little lustre. They have a table with four planes and eight facets, and, in order to make the best of their lustre, they receive a brilliant cut.

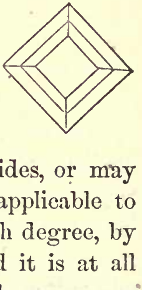
D. The *Bastard-Diamond* is that diamond whose cut is mixed up from the above forms.

There are a few more forms given to those diamonds which are found unfit for any of the above cuts, such as the thick-stones, the portrait-diamonds, the senail-diamonds, which are, however, all unfit for the above cuts.

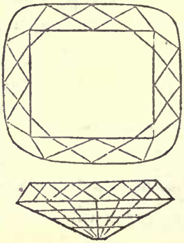
FORM OF GEMS.

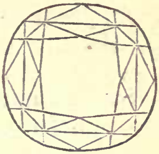
The gem lapidary occupies himself not only with grinding the common and rare gems, but also pastes, &c. He uses likewise wheels, but of different material from those for diamonds. His wheels are either of copper, if for very hard stones, or of lead or pewter for softer stones; he has likewise polishing wheels. If a wheel is too soft for very hard stones, he cuts furrows in it, which are then filled out with rotten-stone or tin-ashes; or if very hard stones, such as sapphire, are to be ground, the diamond powder is used for the same. Tin wheels are used for hard stones; water, or oil of vitriol, is used for moistening the wheels. The gems (in order to grind them or to give their facets) are cemented into a handle, at the end of which is a composition of resin and brickdust. Particular attention is required in grinding the colored gems, as the greatest effect may be produced by their thickness; pale-colored gems require to be left thicker than darker ones; on the other hand, they ought not to be left too thick, as they will appear too dark, and thereby lose their lustre. The same proportion in the manner of cutting the crown and collet of the colored gems has to be observed as with the brilliant; namely, the crown ought to be one third and the collet two thirds in size of the depth of the whole stone; if the gem be of a pale color, the collet ought to be three fourths of the size; and if of a darker color, much less; the table of those colored gems which require to be heightened ought to be waved somewhat, whereas it ought to be even in darker gems. The forms received by the colored gems in cutting resemble, in many instances, those of the diamond; but the following are the additional ones they receive, according to the nature of the shape and color of the stone:

A. The *Step* or *Pavilion cut.* The planes, which are long and small, decrease towards the table and collet, and terminate in steps; the crown has usually two, and the collet four or five facets on each side; the form of the stones may be of four, six, eight, or twelve sides, or may be long or round. This cut is particularly applicable to colored gems, as it reflects the light in a high degree, by which the play of color is much raised; and it is at all events to be preferred in the collet of colored gems, even to those brilliants in pavilion: the crown may be of any form whatever.

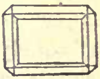


B. The *Mixed facet cut* is a compound of brilliant and pavilion cuts, the first being on the crown; it is a very favorite cut for colored gems, and contributes much in raising the lustre.

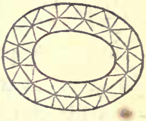




C. The *Elongated Brilliant facet cut*, which, if the brilliant facets are on the crown elongated, and the collet has a pavilion cut, is very appropriate to long and thin stones.

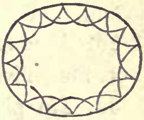


D. The *Table cut*, having either an uneven or conchoidal table, with one or two rows of facets, in a circular form, around it: a very useful form for seal-stones.



E. The *Double facet cut*, the crown having two rows of facets, and the collet the pavilion form; this cut is well adapted to such stones as require the concealment of any faults, flaws, or fissures.

F. The *Cabochon cut*, is either flat, convex, or double-convex—that is, arched; it may be on both sides, or only on one. This cut is particularly applicable for semi-transparent gems, or those which display their peculiar colors, such as the opal, moonstone, &c.; or collect the light in a small space, on one or several points, according to the convexity they have received. The cabochon cut may have one, two, or more rows of facets, and opaque stones receive with advantage the facets over the whole surface. Garnets, for instance, which are generally of a dark color, are cut *en cabochon*, the lower plane excavated in a circular form, and the upper plane all around with facets. Other gems, the interior faults of which cannot be concealed, may be improved by this cut, giving them more transparency, vividness of color, and a greater degree of fire.



A judicious choice of the form in which any particular gem shall be cut, depends on the skill and discrimination of the artist.

COMMON LAPIDARY.

Such common precious stones as are suitable to be cut for snuff-boxes, rings, grinding mortars, seals, and ear-rings, are wrought by the common lapidary, by means of copper or iron wheels revolving vertically. The tools are generally of iron, and sometimes brass; some are flat like chisels, gouges, ferrules, and some others have conicular heads. The polish is given with rotten-stone, on a tin plate, or with crocus martis, on a wooden plate covered with felt. The cuts applied by the workmen are either even, cup-shell form, excavated, elevated, or quite simple; facets are not used by him.

Mr. Mawe describes a lapidary's apparatus, fit for polishing minerals, shells, &c., and which may be placed in a parlor, where every operation of polishing, on a scale sufficiently large, may be effected, and pebbles may be slit of three or four inches diameter. It consists of the following mills:

1st. A lead mill, or wheel, to be used with emery and water, for grinding down substances preparatory to polishing.

2d. A pewter mill, to be used with rotten-stone a little wet, for polishing.

3d. Tin plate, properly prepared, the edge of which is to be used with diamond powder, to slit or cut hard stones asunder.

4th. Wood mills, covered with leather, &c., for polishing marble, alabaster, shells, or other soft substances.

ENGRAVING.

The value of many precious stones is increased by engraving them. The common gems have, for several centuries, been used in heraldry. In Italy, Germany, and England, we find the coat of arms of distinguished or noble families engraved on stone. The machine used for such purposes is like that of the glass cutters, with this difference, that finer and harder instruments, and sometimes diamond splinters, are required for this work. Before the stone can be cut or engraved, its surface, after having received the proper shape and form required, is rubbed with emery, glass, or leaden wheels. The artist now makes his drawing with a brass pin, and executes it afterwards with his tools. On hard stones he uses diamond powder; on soft, emery and oil.

The engraving of armorial bearings, single figures, devices, &c., on any gem, is performed by means of a small iron wheel, the ends of the axis of which are received within two pieces of iron in a perpendicular position, that may or may not be closed as the operation requires; the tools are fixed to one end of the axis, and screwed firm; the stone to be engraved is then held to the tool, the wheel set in motion by the foot, and the figure or device gradually formed.

Difficult works are executed after models of plaster of Paris, of clay, or other substances; the polish is afterwards given on wheels, provided with brushes or with rotten-stone. The semi-transparent and opaque stones are more used for engraving than the transparent gems, because the drawing will not show distinctly through them, on account of the great refraction of light; the same is the case with iridescent or shining stones. The engravings are generally bas-relief or raised; those having layers are mostly preferred for cameos; for instance, the onyx, sardonyx, and chalcedony; also wood-opal, which is constantly exported from Germany for the Italian artists in Rome.

SAWING AND DRILLING GEMS.

Gems and precious stones often require to be sawed in different directions, which operation is performed on a machine like that of a lapidary, with the exception of a polishing plate, for which is substituted a cutting plate having sharp ends, or by fastening the stone on a stand, and moving continually a fine iron or copper wire stretched in a bow, which is moistened with emery and oil. Care has, however, to be taken, not to let the stone grow too hot, as the heat may crack or make it spotty. The Chinese use strings spun over in preference to the wire, they having the advantage of keeping the emery sticking to them, and of accelerating thereby the operation. For drilling gems or other precious stones, a diamond set in steel is made use of, to move to and fro by a bow, or the common engraving machine, the drilling instrument of which consists of an iron point, to which is fastened a diamond splinter, which is pressed upon the stone while it is revolving upon the plate.

GRINDING AND POLISHING MATERIALS.

The materials for grinding and polishing vary according to the hardness of the gem. The diamond powder is obtained by grinding real diamonds, which are unfit for use, with each other in a hollow cylinder of cast iron, in which another one exactly similar is used for the most costly and the hardest gems. Corundum, sapphire, topaz powder, and emery powder, are commonly used for grinding and polishing the diamond. It is well to remark that emery is often adulterated by a mixture of quartz and oxide of iron, or by garnet or iron powder. Emery fit for the use intended requires to be properly pulverized and levigated.

According to Hawkins, the following method is pursued in England: The emery is pulverized in an iron mortar and passed through different sieves, one finer than the other; the first is levigated with oil, which keeps it in better suspension in water; according to the time in which the powder settles, the different numbers are obtained.

For polishing the different precious stones, hard and soft gems, the diamond powder and emery are mostly used. Rotten-stone, tin-ashes, pumice-stone, oxide of iron, English jewellers'-red, are all used in their finest pulverized state. A great deal depends upon the polish which a gem has received; all its other superior qualities being thereby called forth.

HEIGHTENING THE COLOR OF GEMS.

Since color is one of those characters which is the most tempting in the sale of gems and jewelry, all means are ployed for heightening the same, and covering any real defect. Foil of small thin metallic substances, colored or uncolored, either of fine silver or copper, is placed under the gem in the back of the mounting, which heightens the color and lustre, particularly of the transparent gems. Almost all gems were formerly set in black-colored backs, composed of burnt ivory-black and gum mastic, but are now mostly set *à jour*, which is, leaving the lower part of the stone uncovered in setting, and only mounting around the girdle—an old method, and very applicable to perfect stones, where no defects require concealment.

Foiling materially heightens the lustre of gems. The rose-diamond always requires it on account of its flat form. There are many gems which would not produce any effect without the foil; it is therefore used whenever a pale or impure color is to be raised, or when the gems are to be protected against dust or moisture in order to produce a uniform shade of color; the foil forms then a suitable application.

The coloring of the foil is generally performed by the jewellers. Isinglass, first dissolved in water and afterwards boiled in spirits of wine, and then strained, is the mass or body to which the colors are afterwards added, which are also soluble in water.

For producing a red color, the best material is carmine,
" " blue " " litmus,
" " yellow " " saffron.
To produce the different shades and varieties of color, the above are mixed in different proportions with each other. Very clear stones, such as chrysoprase, carnelian, &c., are sometimes painted on the back. The Paris jewellers are very skilful in painting stones of inferior value so as to deceive even professional men; it is for this reason that gems when set ought not to be purchased; the valuable gems which have a foil on their back are mostly set in such a manner that they may be examined without the same. Foiled gems may likewise be distinguished by holding the table of the set gem on the nail of the thumb and observing the passage of light through the crown.

In the East, rubies are never set with foil, but a cavity is made in the lower part and filled with finely polished gold, which raises their lustre remarkably.

Fissures, flaws, or veins, in the interior of gems, are mostly concealed by the foil, and when near the girdle, are covered by the mounting.

The defects of stones are sometimes concealed by coloring the case with mastic and ivory-black, and according to circumstances leaving blank the spot of the faulty stone, or covering only the spot, so as to produce a uniform color. Another, and not unusual method of concealing fissures, flaws, or other faults, is to cut those stones that have many faults—the momentary detection of these faults being thereby prevented from the play of the refracting light and the lustre. The color of many gems is raised by fire, which acts in a peculiar manner on them; thus the *Brazilian topaz* assumes a very fine pale-red color, by burning. The process of effecting this coloring is very simple, viz: after wrapping the topaz in a sponge, ignite the same and keep it burning until consumed.

The *zircon* sometimes assumes a better color after having been subjected to a high degree of heat. *Amethysts* having dark spots may be calcined for a short time in a crucible containing sand and iron filings, under which process they mostly lose those faults; but if exposed to an excess of heat, they will lose their color altogether, and become as white as quartz. The *Oriental carnelian* assumes, after burning, a fine color, and in Hindostan those carnelians which are found detached in the mines are cut up and burnt on the spot. Very fine cracks are sometimes produced in mounting stones, which may be repaired and concealed successfully by means of garlic juice. When stones are broken by the same operation they may be cemented by gum mastic.

SETTING OF GEMS.

The gems are generally fastened or set at the girdle in a box or rim of metal: limpid and faultless gems are always set *à jour*, i. e., without backs, since they appear then to the best advantage, and if the gem is intended to display its full size and color, the *à jour* setting is only fastened by small shanks or claws. The good setting of a gem very much increases its value and beauty. The material for mounting the limpid gems is silver, which displays them to more advantage than gold. In order to increase the color or lustre of large gems, they are often surrounded by smaller gems, such as small roses, rubies, emeralds, garnets, turquoise, &c.

The jewellers' wax used for mounting gems is made of three parts rosin, one part beeswax, and four parts fine brickdust.

CLEANING THE GEMS.

The following composition I have found to be the best for thoroughly cleaning gems, particularly when set: Take one part flowers of sulphur and two parts of rotten-stone or bone-ashes, which, when mixed, is used by rubbing it on a piece of buckskin, and with that and a stiff hair-brush, alternately rubbing the gems, finishing with a softer skin or cloth to remove the dust.

IMITATIONS OF GEMS.

Pliny mentions the imitation of jewels by glass fluxes, and it is sufficiently proved that the ancients were far advanced in this art. The Egyptian mummies were provided with glass buttons of green and blue color, and during the reign of the Roman empire, colored glass was very general; and we find antique cameos carved in various colored glass, representing the onyx; likewise colored glass cemented with real onyx; but they never attained such perfection in their art as to set at defiance the skill of the artist and jeweller to distinguish between the genuine and spurious ones. The imitation of gems may be divided into three classes:

A. The *Pastes.* The basis of these imitations is a fine, pure, and white glass composition, called *strass*, after its inventor, Strass of Strasburgh, in the seventeenth century, who first conceived the importance of imitating the real gems as respects their hardness, specific gravity, and refraction of light. He accomplished the task so far that in many instances, either all three, or one or the other of his objects, were attained. The strass is composed of silex (quartz, flint, or pure sand), potash, borax, red lead, and sometimes arsenic. To 300 parts of silex add 96 parts potash, 27 parts borax (prepared from the boracic acid), and 514 parts of white lead, and 1 part arsenic; or according to another method, mix 7 ounces and 24 grains of quartz with 10 ounces and $7\frac{1}{2}$ drachms red lead, 3 ounces and 6 drachms pure pearlashes, $3\frac{27}{30}$ drachms borax, and 12 grains arsenic. The mixture is put into a covered Hessian crucible, and kept at a great heat in a pottery furnace for twenty-four hours. The longer the mass is kept in a fluid state the harder and clearer it will be when turned out and cooled. This discolored strass is used by the lapidaries for imitating the diamond, rock-crystal, and white topaz.

For imitating the colored gems various colored ingredients are employed. To obtain that intensity of color approaching nearest to the original gem, it is experience alone which can guide the manufacturer. In order to imitate the uniform and intense colors, the strass coloring ingredients are to be of the finest powder, and very intimately mixed; the mass is then to be exposed to a very great heat, and in that state left for nearly thirty hours, so that the cooling may be gradual. Numerous establishments in Germany and France are now engaged in the manufacture of the strass and colored pastes, each of which possesses secrets, acquired by experience, for producing these articles in the greatest perfection.

A. *Artificial Topaz.* Take of perfectly white strass one ounce and six drachms, glass of antimony thirty-seven grains, and cassius purple one grain; or add to six ounces of strass half a drachm of crocus martis.

B. *Artificial Ruby.* This may be obtained from the preceding mixture for the topaz by the addition of eight parts more of strass, and left for thirty hours in fusion; when taken out and fused before the blowpipe, it yields a most beautiful Oriental ruby. Five ounces strass and one drachm oxide of manganese may be employed for the same purpose, but will not make so fine a ruby. Or by calcining ammoniacal alum with chromate of potash and lampblack, which forms the composition of

97 parts alumine,
1 " oxide of chrome,
2 " silica and lime.

C. *Artificial Emerald.* To one pound of strass add one drachm of verdigris and fifteen grains crocus martis.

D. *Artificial Sapphire.* Add to eight ounces of strass fifty-two grains pure oxide of cobalt.

E. *Artificial Amethyst.* To eight ounces of strass add thirty grains oxide of manganese, twenty-four grains oxide of cobalt, and forty grains cassius purple; or to one pound of strass, twenty grains oxide of manganese, and one grain oxide of cobalt.

F. *Artificial Aquamarine.* To six ounces of strass add twenty-four grains glass of antimony, and one and a half grain oxide of cobalt.

C. *Artificial Syrian Garnet.* To one thousand grains of strass add five hundred grains glass of antimony, four grains cassius purple, and four grains oxide of manganese.

Messrs. Bouillette, Hyrclin & Co., Rue St. Avaye; Savany & Mosbach, Rue Vaucauson, in Paris; and Henrys & Co., of London, have contributed to the great London Exhibition, in 1851, a great display of their manufactures in artificial stones, such as diamonds, emeralds, sapphires, and pearls. The latter were particularly brought to perfection by Mr. Constant Valès, Rue St. Martin, Paris, as the imitation pearls by that gentleman were superior to any thing the author had ever seen before, and were, to appearance, quite equal to the natural pearls.

The following table, taken from Booth's Encyclopedia, shows the proportions of the various ingredients for the different colored pastes:

	Topaz.	Ruby.	Amethyst.	Garnet.	Sapphire.	Aq. Mar.	Emerald.
Colorless Paste......	1000	1000	1000	1000	1000	1000	1000
Antimony Glass......	40	..	..	500	..	7	..
Oxide of Manganese..	..	25	8	4	..	..	..
Gold Purple.........	1	..	1/5	4	..	..	..
Oxide of Cobalt......	..	..	5	..	15	2/5	..
Oxide of Copper......	..	..	..	..	..	..	8
Oxide of Chrome.....	..	..	..	..	..	..	1/5

Colored glass is also very frequently cut in forms and shapes so as to resemble gems, and the various colors are produced by melting the best qualities of glass materials with the following oxides:

Yellow is produced by charcoal, antimonite of potassa, silver, and oxide of uranium.

Blue, by oxide of cobalt, and a mixture of copper and iron.

Green, by oxide of copper or of chrome, or by antimonite of potassa, litharge, and cobalt.

Red, by gold, suboxide of copper, and oxide of iron.

Violet, by manganese.

Black, by protoxide of uranium, iridium, platinum, and by a mixture of manganese, copper, iron, and cobalt.

White, by oxide of tin, arsenic, and bone-ashes.

By combining one or more of these oxides various shades and hues may be obtained; the yellow glass of antimony may be shaded more into orange by the use of a little oxide of iron; the purple-red of gold passes into carmine by employing silver with gold; the blue of cobalt may be shaded into purple by a little gold; into green by antimony, or other yellow colors; a rich grass-green is obtained from oxide of chrome, with a little antimony and litharge; a brilliant emerald-green from a mixture of oxide of uranium and nickel; oxide of nickel alone yields a hyacinth-red.

The Bohemian garnet is prepared by fusing together 100 parts quartz, 150 parts red lead, 30 parts potash, 20 parts fused borax, 5 parts crude antimony, 5 parts manganese, and 6 parts fulminating gold ground up with oil of turpentine.

Turquoise is imitated by oxides of copper and cobalt. Opal, by adding oxide of tin and bone-ashes to the glass, in small quantities.

The following colored pastes were recommended by me twenty years ago, to the American manufacturers of colored glass, and have all proved successful:

Strass.

This is the basis for all pastes; it is very hard, and gives sparks when rubbed on steel.

1 ounce of powdered glass,
3 drachms “ quartz,
3 “ “ red lead,
2 drachms burnt borax,
40 grains of saltpetre,
30 “ white arsenic.

This composition is exposed to a white heat in a covered crucible for thirty hours.

Ruby.

1 ounce of powdered rock-crystal or quartz,
½ ounce of dried carbonate soda,
4 drachms of burnt borax,
1½ “ saltpetre,
3 drachms of red lead,
15 grains of cassius purple,
8 “ metallic antimony,
8 “ oxide manganese.

Or by taking—

1 ounce of powdered rock-crystal,
½ “ dry carbonate soda,
80 grains of burnt borax,
40 grains saltpetre,
15 “ purple cassius,
1 drachm of sal ammonia.

Sapphire.

Take—

1½ ounce of ground rock-crystal,
6 drachms of dry soda,
2 “ “ borax,
2 drachms of red lead,
1 “ saltpetre,
1 grain of carbonate cobalt.

Or mix—

1 ounce of rock-crystal,
½ “ dry soda,
3 drachms “ borax,
1½ “ red lead,
½ drachm of saltpetre,
¼ grain of carbonate cobalt,
15 “ “ copper.

By means of the carbonate of copper.

1½ ounce of rock-crystal,
6 drachms of soda,
1 “ borax,
1 drachm red lead,
½ “ saltpetre,
½ “ carbonate of copper.

Emerald.

Take—

1½ ounce of rock-crystal,
6 drachms of dry soda,
2 “ “ borax,
2 “ red lead,
1 drachm of saltpetre,
20 grains of red oxide of iron,
10 “ green carbonate of copper.

Green Color.

1½ ounce of rock-crystal,
½ “ dry soda,
2 drachms of dry borax,
2 “ red lead,
40 grains of saltpetre,
1½ “ carbonate cobalt,
10 “ “ chrome.

Canary.

9 drachms of rock-crystal,
3 “ dry soda,
2 “ red lead,
1 “ saltpetre,
80 grains of oxide of uranium,
3 “ carbonate of copper,
3 “ oxide of tin,
3 “ white b'nt bone-ashes.

Chrysoprase.

1½ ounce of rock-crystal,
½ “ dry soda,
3 drachms of burnt borax,
2 “ red lead,
20 grains of saltpetre,
2 drachms of white bone-ashes,
2 grains of carbonate of copper,
4 “ red oxide of iron,
6 “ oxide of chrome.

Opal.

9 drachms of rock-crystal,	15 grains of saltpetre,
3 “ dry soda,	1/10 “ cassius purple,
2 “ burnt borax,	1½ “ bone-ashes,
1½ “ red lead,	2 “ muriate silver.

Aquamarine.

1½ ounce of rock-crystal,	1 drachm of saltpetre,
½ “ dry soda,	6 grains of red oxide of iron,
8 drachms of burnt borax,	2 “ carbonate of copper.
2 “ red lead,	

Hyacinth.

The above mixture, with the addition of ten grains of the oxide of manganese.

Garnet.

9 drachms of rock-crystal,	40 grains of saltpetre,
3 “ dry soda,	5 “ oxide of manganese,
2 “ burnt borax,	3 “ “ iron,
1½ “ red lead,	1 “ cassius purple.

Rubellite, Red Tourmaline.

1 ounce of rock-crystal,	1½ drachm of red lead,
½ “ dry soda,	1½ “ saltpetre,
3 drachms of burnt borax,	8 grains of oxide of nickel.

Indigolite, or Blue Tourmaline.

The above mixture, with the addition of the carbonate of cobalt.

Chrysolite.

6 drachms of rock-crystal,	1 drachm red lead,
2 “ dry soda,	10 grains of saltpetre,
1½ “ burnt borax,	2 “ oxide of manganese.

Amethyst.

But 1 grain of the oxide of manganese to each ounce of the mass.

Turquoise.

In the above mixture use instead of the manganese—

5 grains of dry verdigris,	20 grains of bone-ashes.
3 " powder blue,	

Lazulite.

By adding to former mixtures,

2 grains oxide cobalt,	1 drachm of burnt bone-ashes.

Agate.

By mixing together several frits and adding oxide of iron, several varieties of agate are obtained.

It will now be necessary to show the distinguishing characters between the real and artificial gems, as they so closely resemble each other that a superficial inspection will not always enable the examiner to discriminate between them; they are as follows:

1. The hardness; which may be tested on the grinding machine; with fine quartz sand it will immediately attack the pastes, or by scratching with a real onyx, to which the pastes will immediately yield.

2. The small air-bubbles in the pastes, may more or less be detected with a good magnifying glass.

3. The cold touch will never remain for any length of time on the pastes as it will on the real gem.

4. The breath remains much longer on the pastes, on account of their bad conducting power, than on real gems. The specific gravity and electricity, may likewise indicate the difference,—but I never depended on them alone, and I will mention that I once examined the specific gravity of an artificial topaz which fully corresponded with that of a Brazilian topaz. Electricity will indicate the difference between real and artificial gems by the length of its con-

tinuance; for real gems retain, after being rubbed, their electricity for from six to thirty-two hours, whereas, the artificial ones only retain it from forty to sixty minutes.

B. The *Doublets.* This mode of imitating real gems is called doubling, when a quartz, cut and polished, is cemented by means of gum mastic to another colored paste, whereby the whole stone assumes the color of the lower paste. When a real gem is employed instead of quartz (as the surface and the quartz or paste is cemented below), it is called *half doubling.* This adulteration is carried on to a very great extent in the East Indies, where they paste any thin gem to a paste corresponding in color.

The *concave doubling* is effected by excavating the inside of a quartz or paste. The cavity being filled with a colored fluid, and the other part afterwards cemented on it, will, when well executed, present so uniform a color that it is difficult even for a judge to detect the deception. The surest method of detection is to put the specimen in question in hot water or alcohol, by which the gum mastic will be dissolved. When set, the only way of finding out the adulteration, is to put it reversely on the nail of the thumb, when the false refraction of light or the rainbow colors will, with certainty, determine its identity.

C. The *Burning.* This mode of adulterating the real gems, is performed by coloring cut and polished quartz specimens and throwing them into a solution of permanent pigments, such as a solution of indigo, decoction of cochineal, solution of ammoniacal copper; the small cavities produced by the heat will absorb the fluids. The topaz is burnt by itself, with or without the absorption of a pigment, as also the spinelle, and the quartz; chalcedony is, however, frequently burnt to imitate the onyx, and to engrave thereon cameos and intaglios.

It may be remarked, however, that since the introduction of colored pastes, very few adulterations of this kind are now practised, and we see but rarely such doublets and burnt stones.

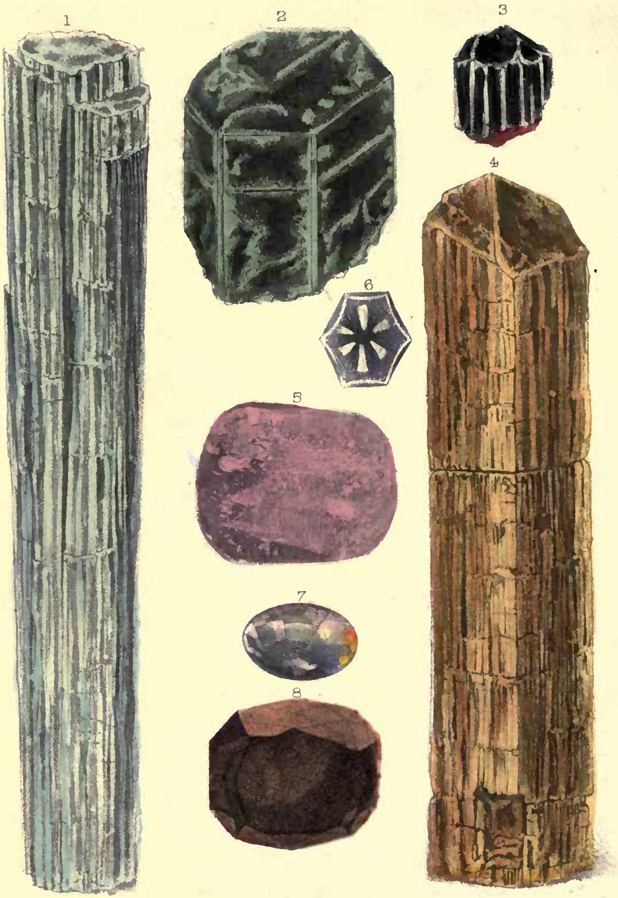
PRICE OF AND TRADE IN GEMS.

It is difficult to determine the price of gems without reflecting upon all the circumstances relating to them, such as beauty and uniformity, the play, the lustre, and the vivacity of the colors, and also on the perfection of the cut, the polish, the rare locality, the size of the individual gems. It depends upon the trade of the various countries whence they come, and what quantity of such valuable gems may be had at one time at any of the great cities: we find that diamonds are often sold at a much less price in London and Paris than in Brazil. The principal trade, however, is as yet carried on in Brazil and the East Indies, although it is in no comparison so prosperous as in former years. The gems are sold by weight, as carat and grain. One carat is equal to four grains, and forty-four carats are equal to one ounce. The name carat is derived from the word *kuara*, the coral-tree (erythrina), the red pods of which, when dry, were formerly used for weighing gold dust, and each of them weighs four grains, which is equal to one carat.

GEMS FOR OPTICAL PURPOSES.

A few years ago, Messrs. Trecourt and Oberhauser laid before the Parisian Academy lenses of the diamond, sapphire, and ruby, which were used in connection with glass lenses in microscopes; they were of nine-tenths millimetre, in diameter. The diamond lens magnified two hundred and ten times, that of sapphire, two hundred and fifty-five times, and that of ruby, two hundred and thirty-five times, in linear extension.

A letter was lately published from Sir David Brewster, on a curious optical phenomenon that had occurred in the construction of a diagonal lens. The diamond, previous to working, had all the appearance of internal brilliancy; but, after being polished, it presented a series of stratified shades, which rendered it useless for the required purpose. It afterwards appeared that lapidaries were acquainted with this appearance, which rendered them extremely unwilling to take the risk on themselves, of cutting up diamonds for optical purposes. On a minute examination of this phenomenon, it appeared that these different shades occurred in regular strata, each section being about the one-hundredth part of an inch, and each stratum having a different focus, and being of a different degree of hardness and specific gravity. The inferences drawn from the above facts were:—that the diamond was a vegetable substance, and that its parts must have been held in solution and subjected to different degrees of pressure at different stages of existence. If, on the contrary, as it has been generally believed, it is subject to the laws of crystallization, its crystals must necessarily be homogeneous.



1 Sib. Beryl. 2 Emerald. 3 Rubellite. 4 Brazil Topaz. 5 Ruby. 6 Star Sapphire.
7 Opal. 8 Hyacinth.

Heliographic Engraving Co. N.Y.

PART III.

CONSIDERATION OF THE INDIVIDUAL GEMS.

DIAMOND.

Diamond: Diamant (German), Adamant (of the ancients), Almas (Oriental), Diamant (French). The name Diamond is derived from the Greek, Adamas, meaning invincible, and referring to the hardness of the gem. The Syrians are said to have first known the diamond, and it was in early ages the subject of trade to the people of the East. The Carthaginians are said to have carried on their trade with the Etrurians, who procured diamonds from the interior of Africa. Pliny mentions six species of diamonds, among which, however, the Indian are to be considered the true, in contradistinction to the quartz crystals, which were likewise called diamonds in those times. The diamond was highly esteemed, and many medicinal virtues were attributed to it, particularly against mania, and as an antidote for poisons; it was worn in the rough state. The art of cutting it with its own powder was discovered in 1476, by Lewis Van Berghen. In the beginning it was cut in the table-form, with one row of facets on the surface; afterwards, in 1520, the rhomb cut was adopted: the form of brilliants was invented in the reign of Louis XII. Cardinal Mazarin was the first who had diamonds polished in this form, some of which yet belong to the crown of France. For a long time philosophers vainly speculated as to the nature of the diamond; first it was considered as a mineral, consisting of silica; but Newton was the earliest (1675) who expressed himself as to the constitution of diamonds. He judged, from the great refraction of light, that it must be a combustible body, and a series of experiments with it, tested afterwards by different naturalists, proved the same to be pure carbon. The first trial was made in 1694, by the members of the Academy at Florence, by whom diamonds were volatilized within the focus of a mirror. Bergman first classified the diamond among combustible bodies, and mentions having cut off the head of the gems.

Various views existed in regard to the origin of the diamond: some considered it as a secretion of a vegetable substance; others as originating from volcanic or plutonic revolution. The Indians believe diamonds are continually regenerating and growing to this date; and the inhabitants of Pharrah, in Hindostan, affirm that the quantity of diamonds by no means decreases, but on the contrary, the soil will yield a new supply fifteen or twenty years from the time it is exhausted.

Numerous experiments have been instituted to produce an artificial diamond from several substances which contain carbon, and by the application of a high degree of heat. The late Dr. Hare, in Philadelphia, succeeded in melting down mahogany charcoal so as to produce a metallic appearance, by his deflagrator. Professor Silliman likewise made similar experiments with plumbago, which produced small globules, some of which were so transparent that they could not be distinguished from the genuine diamond. Professor Vanuxem, who examined the globules obtained from fused charcoal, found them to contain iron and carbon, which led him to the conclusion that the charcoal had not undergone a real fusion. Cagniard de Latour pretended to have discovered the ingredients for imitating diamonds of some size; but Thenard proved those small crystals of the appearance of diamonds to be some silicates of peculiar composition, which, according to Arago, polarized light in a different angle from that of diamonds. All speculative experiments to imitate this most precious gem by the various compounds of carbon, have hitherto proved abortive.

The diamond is found crystallized mostly in the form of an octahedron (composed of two four-sided pyramids, united by their bases), or rhombic dodecahedron, rarely of a cube; but the planes of the angles are often rounded or bevelled. The simple octahedron is pretty rare, and still more so the cube; but the dodecahedron, either simple or complicated, is very frequent; the crystals are sometimes hemitrope. In the museum of the School of Mines are some fine macles, composed of two crystals crossing each other at right angles. The foliated passages are distinctly parallel to the faces of the octahedron, in which direction they may always be split. The fracture is conchoidal; surface smooth, often rough or striped, and sometimes covered with a scaly crust; it is transparent, also semi-transparent; of an exceedingly vivid lustre, called the diamond or adamantine lustre, and when polished, of splendid fire; it is limpid, and likewise passing into the greatest variety of shadings from white and gray, sometimes from yellow, green, and brown.

The diamond being the hardest of all substances, yields to no file; scratches all other minerals, and is not touched by any. This character has become the most important of the diamond since the late discovery of the amorphous or compact diamond. It is very frequently tinged light-green, but more rarely with orange, red, blue, or black; but in setting, these shades disappear, particularly in the smaller diamonds; but there are also known diamonds of rose and pistachio-nut green colors. The blue color is very rare. The blue diamond of Mr. Hope, of London, is one of extreme beauty and rarity, and is of immense value; the yellow diamond in the Museum of Natural History, in Paris, is likewise very remarkable for its color and size. The black diamond, which is perfectly black, although plainly crystallized, occurs most frequently in small bristled balls, but crystalline points; the crystals are very small, grouped together in an irregular manner, and extremely refractory to the cut; it is considered the hardest of all diamonds. The green diamond is also very rare, but I have seen some beautiful specimens in the Jardin des Plantes and in Freiberg, the first in the cabinet of Abbé Haüy, and the latter in the cabinet of Werner. Its streak powder is white or grayish; it becomes phosphorescent by the rays of the sun, and electric by rubbing, which property it retains for half an hour; its specific gravity is 3·5–3·6; it does not alter before the blowpipe; it burns, however, at a high degree of heat, and in atmospheric air with a bluish flame; its touch is very cold; it consists of carbon. The diamond bears the same name in trade, but is changed according to its cut; the blackish and brownish diamonds are called the Savoy diamonds (Diamants Savoyards). The compact and amorphic diamond was first brought to notice by the experiments of Mr. Dufrenoy, about five years ago, as being the transition from the crystallized to the compact condition, on account of its hardness and specific gravity, and has become a great article of commerce; it cuts glass, scratches quartz and topaz, has a specific gravity of 3·27–3·52, and is completely consumed in oxygen gas; it occurs in kidney-shaped and irregular angular masses, but not in pebbles; the exterior is generally black, sometimes resembling the graphite; somewhat resinous lustre, and frequently its form is very singular, the outside coating being black and resinous, the interior forming a crystalline kernel, vitreous and lamellar, like the diamond; it is reduced to powder, and used for polishing and assisting in the cutting of the diamond. The largest specimen of the compact diamond weighs about 46 carats, and belongs to Mr. Hemerdinger; and a compact diamond in the Museum of Natural History at Paris, weighing about seventeen carats, is valued at fifteen hundred francs. The original bed of the diamond is not yet known, and on this point opinions are much divided. In the East Indies we find it in a conglomerate of sandstone, consisting of quartz grains, and disintegrated by the ferruginous sand; and in the mountain chain Ralla-Malla, in Hindostan, between 95° and 98° E. L. Some of the celebrated diamond mines consist of a breccia from argillaceous slate, quartz, lime, and sandstone; the boulders and the sand of deserts and rivers yield diamonds mostly rounded or in a granular form. The richest diamond mines are those of Roalcorda, at the junction of the rivers Bimah and Ristna; Golconda, along the shore of the Pennar, Sumbhulpra, and Bundelkened, in the neighborhood of Pannah, where one thousand laborers are kept employed. Visapur, Hydrabad, &c., on the island of Borneo, likewise yield diamonds; and, according to Jameson, diamonds were found in the Indies in the coal formation.

In Brazil, they were discovered, in 1728, by chance, having been always thrown aside with the flint and other refuse of the washings of gold, until an inhabitant, who had some knowledge of rough diamonds, collected a large number, and carried them to Portugal, and acquired by their sale a great fortune. Another, who was informed of the operations of the first, shared an equally good fortune. The government's attention was drawn to the matter, and it was declared, in 1730, that all diamonds found there belonged to the crown.

Diamonds are found in the talcose chlorite schist, and in a breccia, consisting of ferruginous clay, quartz pebbles, sand, and oxide of iron fragments; and also in a secondary bed, accompanied by gold, platina, topaz, beryl, chrysoberyl, tourmaline, kyanite, amatose, spinelle, corundum, and garnet. They are found particularly in the valley ot Sejues, along the rivers Jequetinhonha and Pardo, which run into the diamond district. These carry most diamonds by. The dykes and brooks of the district contain more or less rich diamonds, which are found there in recent and older beds. Beyond the diamond district, the diamond is likewise found in the province of Minas Geraes on the Serro de St. Antonio, in the Serro Frio, and in the rivers Aboite, Andaja, da Saneno, da Prata, and several other places, such as the right bank of the Rio San Francisco, and Matto Grosso, and in the beds of Rio Pardo and Rio Velhas; in the mines of Riven and Cuithe, and all along the valley of Peruguado river, in the province of Bahia, in some of the tributaries of the Rio Doce, on the banks ot the Cachoine. The rocks in which recently diamonds have been found consist of the itacolumite, a micaceous sandstone, accompanied by mica-schist, accidentally traversed by quartz veins. This is the prevailing rock in the Serro de St. Antonio, in which the Jequetinhonha rises in the Serro da Matta da Corda, on the eastern slope of which the tributaries of the Rio Francisco rise; and in the diamond district of Tibagy, very rarely in the alluvials of ancient rocks. The gold, diamonds, and other fine stones, are always imbedded in the lower part of the alluvium. Experience has shown the richest localities to be in Curranlinho, Datas, Mendanho, Cavallo-Morte, and Caxoeira de Inferno, where the alluvial soil is from eight to twenty feet thick, and is composed almost entirely of silicious sand, strongly colored by argillaceous iron, which forms a species of cement of pebbles of quartz, milky quartz, and itacolumite, which form a coarse pudding-stone, called casoelho, and which is considered by the diamond-washers a sure sign of the diamond. Dr. Cliffe, the proprietor of a diamond mine in Brazil, has given much information on this subject.

In Russia, the first diamond was discovered in July, 1829, by Humboldt and Rose, when on their journey to Siberia, on the west side of the Uralian mountains, in the gold-washing establishments of Krestowosdwisheaski, belonging to Count Schuwalow. The locality, in connection with the other circumstances of the place where the diamond was found, bears a striking resemblance to the diamond district of Brazil. The predominating rock of the spot on the Uralian mountains is a quartzose chlorite, talcose schist (itacolumite), with an admixture of iron pyrites and mica, wherein we find beds of red oxide of iron, talcose schist, limestone, and dolomite. In the valley of Poludenka and Aedephskoi the diamonds are found among the debris of the mountains, accompanied by quartz, itacolumite, brown hematite, talcose slate, dolomite, chalcedony, anatase, gold, and platina; it is not yet decided to what formation this rock originally belongs. The production of diamonds is twofold; either they are dug out from the earth, or they are collected in the sand of rivers. If in the latter way, they are more or less rounded, wedged, and rubbed off; whereas the former appear coated with an earthy, pale gray, yellow, or rose-red, rarely with a blue or green crust. Many valuable mines have been relinquished in the East Indies since the discovery of diamonds in Brazil. The locality of the finest diamonds is at present in the neighborhood of Sumbhulpore. Two tribes, called the Thata and Tora, living in sixteen villages, occupy themselves particularly with searching for diamonds, beginning in the month of November, and continuing until the mencement of the rainy season, more especially in the bed of the Mahanudi on its left shore, where some other small rivers, Maund, Reloo, Eeb, &c., empty into it. Four or five hundred individuals, consisting of men, women, and children, are examining continually all the spots of the river from Cauderpoor to Longpoor, a distance of about one hundred and twenty miles, till the stream is impeded by the rocks; and likewise all excavations or other cavities of the beds where any alluvial deposits may be traced. All their implements consist of a pickaxe (ankova), a board five feet in length, excavated three inches in the middle, but provided with its border (daer), and a smaller similar implement, called by them kootla, both of the shape of a shovel. The process is very simple: they first dig the earth with the axe, and let it accumulate in heaps along the shore; the women afterwards take it on their large shovels, and allow the water to run over the earth; they then pick the flints and coarse gravel out of it, and removing the residue on smaller shovels, spread it out, and examine it very carefully, separating from it the diamonds and grains of gold. Another method pursued in the East Indies is to surround a small plain where the diamonds are expected to be found, with a wall two feet high, under which water is permitted to run by several openings; after having thrown a good deal of earth within the wall, and having allowed the water to pass through two or three times, the larger stones are picked out, the residue dried, and the diamonds selected as before.

The washing establishments of the diamond in Brazil, particularly in the celebrated district Tejuco, on the Rio San Francisco and its adjoining smaller rivers, are conducted in the following manner:

In order to get at the bottom, or soil of the river, means are used for leading the water at a certain spot in a different direction, and then that part of the bed of the river is allowed to dry out, and the sediment consisting of a conglomerate of quartz pebbles, kept together by oxide of iron, is brought to one place for washing. It is a large bench of triangular form, so as to keep from twenty to thirty negroes busy: in the middle of this bench is a gutter, with which is connected a trough, inclined somewhat, in order that the water may run down voluntarily, but so that it may be stopped by putting loam at the end; and another gutter with a trough is joined further down. The negro who has collected in the dry season a large quantity of the sediment, is occupied in the rainy season in putting from fifteen to eighteen pounds at a time into the trough, spreading it there, and allowing so much water to run over it, until it runs off quite clear from the lower trough, but at the same time keeping the trough continually moving. He then begins to pick out the larger stones from the earthy part, and afterwards the smaller, until he comes to grains, which he examines with the greatest care, on account of the diamonds. As soon as a negro has found one, he must make it known by clapping his hands, and the surveyor, who is seated on an elevated chair, so that he can oversee the work, takes and deposits it in a dish filled with water, in which all those found during the day are collected. They are then delivered over to the superintendent, who counts and weighs them, and enters the result, with other particulars, in a book kept for that purpose: he keeps them in a bag until he delivers them, which he does twice a week, to the government at Tejuco.

Every superintendent has to live in the neighborhood of the principal washing-establishments, which were formerly leased for a certain sum by the government; but the impositions practised were so great, that it took the superintendence upon its own account in 1722, and has guarded the diamond districts along their lines by strong sentinels, who will not allow strangers to pass through without the permission of the general superintendent; and even the inhabitants, when crossing the line of the diamond districts, have to procure written permissions from the above authority; and everybody must, on leaving the district, submit to a personal and strict examination and search by the soldiers; foot-passengers are always arrested by sentinels and spies continually on the alert. St. Antonio de Tejuco, forty leagues from Villa Rica, is the capital of the diamond district, and the seat of the superintendence of the Junta Diamontina, consisting besides of a confiskal, two cashiers, one inspector-general, and a book-keeper. All the diamonds procured are delivered up yearly to the government at Rio Janeiro.

From four to five thousand negroes were engaged in the years 1772 to 1775; in the year 1818 but one thousand: among them were the feitores or surveyors, one hundred in number, in the latter year; likewise ten superintendents, whose business it is to conduct the mining department and the collection of the diamonds.

In order to encourage the negroes, presents of tobacco, cloth, &c., are awarded, according to the price of the diamonds which they find; the one who finds, for instance, an eighth (seventeen carats and two grains) receives his entire liberty; they are severely punished for any offence, and if repeated are not allowed to be at this work. Notwithstanding the most rigorous regulations and the most watchful attention of all the officers, the frauds in stolen diamonds are very considerable; and it is estimated that the smuggling amounts to one third of the whole income. The smugglers, who are runaway slaves, examine the most remote parts of the district, or steal the diamonds at night from the working establishments; others, again, who understand it, will take the stolen diamonds from the negroes, and devise means of escaping with them, either in the soles of their boots, or in hollow canes, &c.; and it is a remarkable fact, that all diamonds obtained from the smugglers are invariably larger and more beautiful than those which are brought into market by the government. The thieves practise all manner of tricks and impositions, even in the presence of the surveyors: for instance, they conceal the good diamonds, during the washing hours, between the fingers, the toes, in the ears, in the mouth, or in the hair; they also throw them away with other stones, in order to pick them up in the night; they often even swallow them.

The soldier who arrests any smuggler, receives a reward; the property of the latter is confiscated, and he is sent to Angola as a prisoner, for upwards of ten years.

The pure transparent diamond, which is cut in the different forms already mentioned, loses generally one third to one half of its original weight by this operation.

The following table shows the original weight of the rough diamonds, and that after being cut; viz.:

Regent,	when rough,	weighed	410	carats, and	when cut,	$136\frac{14}{16}$	carats.
Grand Mogul,	“	“	$780\frac{1}{2}$	“	“	$279\frac{9}{16}$	“
Ko-hi-noor,	“	“	$186\frac{1}{2}$	“	“	$82\frac{12}{16}$	“
South Star,	“	“	$254\frac{1}{2}$	“	“	$124\frac{4}{16}$	“
Nassak, once cut,		“	$89\frac{3}{4}$	“	“	$78\frac{10}{16}$	“

It will be perceived, therefore, that the skill of the diamond-cutter has made great progress in modern times, inasmuch as the weight of the Ko-hi-noor and South Star was only reduced to one half of the original weight.

In purchasing rough diamonds, every precaution ought to be used to prevent getting false diamonds instead of real ones, and faulty ones instead of pure diamonds. The officers of the Junta Diamontina test the rough stones by holding them whilst rubbing together, close to the ear, and listening to the tone produced, which gives them ample satisfaction of their being genuine, as it is only to be observed in real diamonds. It requires, however, considerable practice to distinguish them with accuracy by this test. Strangers particularly, are imposed upon by the negroes in Brazil, by purchasing from them gems cut and polished with the facets, resembling those of the diamond; and although any one acquainted with the diamond will soon detect the imposition by the want of specific weight, the peculiar lustre, fire, and hardness, he requires to be on his guard. If, however, the diamond is ascertained to be genuine, we have to examine particularly its purity, color, form, and size, these being the qualities by which the price of a rough diamond is to be determined.

It requires considerable experience to determine from a rough diamond whether any of its faults are at the surface or in the interior, whereby often the diamond, in removing all its faults, may be diminished to half its size. We often, however, judge the rough stones by their color; those turning towards the green color are considered to be the best; those of a reddish color to be good stones; the black color indicates a hard stone; and we judge a yellowish or grayish color as making bad diamonds. The natural form of a diamond, likewise, gives a characteristic to the purchaser of rough stones; for a flat, thin, or triangular stone would lose much in the grinding, and not be so high as to give it sufficient fire; and likewise we are not sure of the result of the cutting, and the hemitrope crystals are very difficult to work. The best forms of diamonds for cutting are the octahedron, which is principally found in the East Indies, and is called Pint by the diamond-grinders; and the rhombic dodecahedron, which is found principally in Brazil: cheese-stones is the name given to amorphous diamonds by the diamond-grinders.

According to the quality of the diamonds, they are divided in Sumbhulpur into four classes, which correspond with the deities of the Hindoos—the Bramins, Tschettri, Wassiers (Bysh), and Tschadrie. The native jewellers are very expert in estimating the value of these diamonds.

The value of the polished diamonds depends on the following conditions:

1st. *Color.* The limpid diamonds command the highest price, and twice as much as those that are colored; the blackish, brownish, yellowish, brown, steel-gray, and impure bluish ones, stand in no value, and are often rejected for working.

2d. *Purity, Faultlessness, and Transparency.* The diamonds ought to be, according to the technical terms of the jewellers, free from ashes, gray spots, rusty or knotty places, veins, fissures, scratches, feathers, flaws, sand, grains, and faint yellow or vitreous spots. The Brazilian diamonds exhibit sometimes, in their interior, designs resembling mosses, like those of the Mocha stones and agates; and we may often observe it in the green diamond; if a limpid diamond plays somewhat in the brown color, it is called *shrugging*, and this diminishes its value: *paunched*, are those diamonds which are neither pure nor clear.

The transparency and clearness of the diamond are divided into three degrees, viz:

A, *of the first water*, as in those diamonds which are free from even the slightest faults, and stand highest in price.

B, *of the second water*, as in those diamonds which, although clear and limpid, are marred by some dark spots, clouds, or flaws.

C, *of the third water*, as in those diamonds having a gray, brown, yellow, green, blue, or blackish color; or those that are limpid, but are injured by several material faults.

In order to determine accurately the nature of diamonds, it is well to breathe on them, whereby they lose for a moment their lustre, and the eye is then better enabled to examine them and distinguish their faults. The real diamond becomes clear much sooner than the false.

3d. *The Cut.* The perfect and regular cut of the diamond increases its value considerably; a brilliant, for instance, of one carat, is worth twice as much as a rough diamond of equal weight. It depends upon the proportions of the height to the circumference of the diamond, and that the planes and facets stand in a regular proportion, for should this not be the case, the diamond would lose much of its fire. Likewise, the form of the diamond influences the price. A brilliant is dearer than a rose-diamond, and this again is dearer than the thick and table-stone. The facets of the brilliant also influence the price: *once cut* is a brilliant that possesses no cross-facets on the lower part of the stone; *twice cut*, there is one row of facets on the collet side; *thrice cut*, the brilliant possesses the facets on the bizel and collet side, according to the rule of cutting. The more rows of facets a brilliant displays, the higher price is put upon it.

4th. *The Size and Weight.* The price of a diamond depends considerably upon its size; those diamonds which are of great splendor and size are called Paragons or Nonpareils, the Ne Plus Ultra; the less weighty ones are valued according to their actual weight. The weight employed in Sumbhulpur is the rutta and masha. Seven rutts is equal to one mash, and one rutt is equal to two grains. In Brazil the weight is specified by carats (quilates). Seventeen and a half quilates are equal to one drachm (octava); thirty-two vintenes are equal to seventy grains (graos); one carat is equal to four grains.

The price of diamonds is determined in trade by examining accurately their character as above stated, and then the price is fixed; the weight of the diamond is at first multiplied by itself, and the sum obtained multiplied again by the price of one carat. A brilliant, for instance, would weigh two carats, and on examining its properties, if good, its price would be found to be forty-four francs. We proceed in the following manner to get at the full value of the diamond: $2 \times 2 \times 44 = 176$ francs. We do not always, however, arrive at the correct result. If the brilliants are very large, and exceed the weight of eight or ten carats, it is difficult to arrive at a standard. I will endeavor to give below a table of the prices of the diamond in Holland, France, England, Germany, and the United States, as far as ascertained, and as near to the actual price current as I could obtain.

Rough diamonds fit for cutting are worth ten or twelve francs per carat; any diamond exceeding the weight of one carat is estimated by the square of its weight multiplied by eleven or twelve francs as the average price.

Rose-diamonds of first water and one carat,	20 francs.
“ second “ “	13 “
Table-stone,	14 “
Brilliants, 30 to 35 pieces to the carat,	22 “
“ 20 “ “ “	40 “
“ 10 “ “ “	38 “
“ 5 “ “ “	35 “
“ 4 “ “ “	36 “

Brilliants of three grains are in much demand, and are worth fifty francs per carat. Those of three carats, used for centre-pieces in necklaces, are sometimes worth four hundred francs. Rose-diamonds for mounting, and forty to the carat, are worth twenty francs the carat; if a little larger, thirty-five francs per carat.

Diamonds unfit for cutting, and used by glass-cutters or glaziers, are worth from ten to fifteen francs per carat, and still smaller ones are worth less; they are now employed by lithographers for their engravings and etchings.

In 1837, according to Netot, Pujoux, and Lucas, the price of diamonds of the first water was three hundred francs per carat; and second water, one hundred and fifty.

Diamonds of one grain and less,	96	francs	per carat.
The double cut, first water,	125	"	"
" 6 to a grain,	150	"	"
Of two grains,	170	"	"
Of three grains,	200	"	"
Of one carat,	260–280	"	"
A diamond of 6 grains,	600	"	"
" 8 "	1000	"	"
" 10 "	1400	"	"
" 12 "	1800	"	"
" 15 "	2400	"	"
" 18 "	3500	"	"
" of 6 carats,	5000	"	"

The above prices are from Brard's *Minéralogie appliquée aux Arts.*

The price of diamonds (in 1855), according to Mr. Achard, a celebrated dealer in Paris:

Glass-cutters' diamonds, less than a grain,	50	francs, or	$10 00	per carat.
Diamonds to reduce to powder,	12	"	2·50	"

These are the natural diamonds.

Diamond powder for polishing,	8	francs, or	$1 75	per carat.
Compact diamond, called carbonite,	4–6	"	1 50	"
" in powder,	6	"	1 50	"

Diamonds of 1 carat are worth	250	francs, or	$50 00
" 2 " "	800	"	160 00
" 3 " "	1,500	"	300 00
" 8 " "	10,000	"	2000 00

According to Barbot, the present (1858) price current of diamonds of good quality, and in relation to their weight and various forms, is the following:

A diamond	of 1 carat	is worth,	per carat,	300	francs, or	$60 00
“	3 grains	“	“	240	“	48 00
“	2 “	“	“	210	“	42 00
“	1 “	“	“	180	“	36 00
“	recut, 8 to the carat,		“	180	“	36 00
“	“ 16 “	“	“	190	“	38 00
“	not recut, 8 to the carat,		“	140	“	28 00
“	“ 16	“	“	150	“	30 00
“	“ 20	“	“	160	“	32 00

ROSES FROM HOLLAND.

A rose of	1 carat	is worth,	per carat,	-	200	francs, or	$40 00
“	3 grains	“	“	-	170	“	34 00
“	2 “	“	“	-	160	“	32 00
“	1 “	“	“	-	140	“	28 00
A rose of	8 to the carat		“	-	160	“	32 00
“	16 “		“	-	165	“	33 00
“	50 “		“	-	180	“	36 00
“	100 “		“	-	200	“	40 00

If 2–500 stones to the carat, they are sold, on an average, in quantities, at one franc twenty centimes, or twenty-five cents, per piece; if 1000 to the carat, twelve and a half cents, per piece. In Antwerp the roses are sold at one hundred francs per carat, and from two grains upward they are sold, when mixed in quantities, at sixty to eighty francs per carat.

In the United States, the price of diamonds, in 1859, depending on their perfection, is about the following:

1 carat stones, - - - - - -	$85	to $100	per carat.
¾ “ - - - - - - -	70	80	“
Melee or mixed stones, from ⅛ to ½ carat stones, - - - - - - -	50	60	“

¼ carat stones the same as the melee.
½ “ from $10 to $15 more than the melee stones.

A good white and perfect diamond of two carats weight is worth from - - - - -	$300 to	$350
A 3 carat stone, - - - - - - -	500	600
4 " - - - - - - -	900	1000
5 " - - - - - - -	1000	1200

Spread diamonds, meaning flat stones, so as to display a large surface, whereby the collet is shorter than the crown, are generally sold much cheaper; they do not, however, display their elements with the brilliancy of a diamond having two thirds of the collet and one third of the crown in size.

At a most extensive sale of diamonds, which took place in the summer of 1837, at the auction of Rundell & Bridges, London, there were twenty-four lots put up, which produced the sum of *forty-five thousand eight hundred and eighteen pounds*, *nearly two hundred and twenty-nine thousand dollars!* Some of the prices were as follows: The celebrated Nassak Diamond, which weighs three hundred and fifty-seven and a half grains, and is of the purest water, was purchased for thirty-six thousand dollars. It is considered to have been sold at a price considerably under its value. A magnificent pair of brilliant ear-rings, weighing two hundred twenty-three and a half grains, formerly the property of Queen Charlotte, were bought for fifty-five thousand dollars, a price infinitely below their usually estimated value. A sapphire, seventy-five and a half carats, set with brilliants for a brooch, two thousand four hundred and sixty-five dollars. Brilliant ear-rings, three thousand seven hundred and fifty dollars. A brilliant necklace, four thousand three hundred dollars. Drop emerald ear-rings, two thousand three hundred and twenty-five dollars. Brilliant ear-rings, four thousand two hundred and fifty dollars. A Turkish dagger, mounted with brilliants and rubies, four thousand dollars. A single brilliant, eight hundred dollars. A brilliant drop, seventy-nine and a half grains, five thousand nine hundred dollars. An oblong brilliant, one hundred fifty-one and a quarter grains, fourteen thousand dollars. A brilliant necklace, eight thousand dollars. Brilliant ear-rings, twelve thousand five hundred dollars. Brilliant necklace, twelve thousand five hundred dollars. Brilliant drops, formerly belonging to Marie Antoinette, eight thousand eight hundred and seventy-five dollars. A rose-diamond, eight thousand five hundred dollars. A brilliant drop, ten thousand five hundred dollars. A round brilliant, seventeen thousand five hundred dollars. A lozenge brilliant, three thousand five hundred dollars, &c.

Frauds in diamonds are practised by dealers, and the purchaser must be guarded. The white spinelle crystallizes also in regular octahedrons, but is not as hard, and is therefore scratched by the diamond. The angle under which the light is polarized in either of the other gems is very different.

On comparison with the prices of those now in market, it is certain they have much declined, which is partially to be attributed to the immense stock which has been brought from their native locality. According to Spix and Martius, there have been produced in Brazil, from 1772 to 1818, 1,298,037 carats of diamonds—that is, in the time of the Royal Administration; but that during the Lease, only 1,700,000 carats were produced, which together make 2,998,037 carats, or 1301¼ pounds, thus averaging from fourteen to fifteen pounds per year; those brought into market by contraband being excepted. The value of the above diamonds (8000 reis per carat), produced in Brazil, amounts to 23,984,276,000 reis, or about 40,000,000 francs. This sum bears no comparison to the expense of procuring them, since the government lately paid forty francs fifty centimes per carat, whereas they only yielded from eighteen to nineteen francs. On this account the administration at Rio de Janeiro has been induced to lease the mines to private individuals. Owing to this decrease in the production, the number of laborers is reduced. The richest production was in 1784, when 56,145 carats were washed out; and the poorest in 1818, when they procured but 9396 carats. In Brazil, large diamonds are much rarer than in the East Indies, where they are in general of much better quality than in Brazil. In the latter country, from 1772 to 1811, they found but thirty-six diamonds weighing upward of seventeen carats, and from 1812 to 1818, but eighty-three diamonds weighing over eight carats. In the East Indies, according to Breton, from the year 1804 to 1818, there were found in Mahanues twenty large diamonds, the aggregate weight of which amounted to four hundred and thirty-six carats and one grain. The largest was found in 1809, and weighed six hundred and seventy-two grains, but was of the third water; another of three hundred and eight grains, and another of two hundred and eighty-eight grains.

As it has already been stated that the artist and amateur have to be on their guard against imposition in the purchase of diamonds, it may be well to state that there is the one-half brilliant, having the form of a brilliant above (the upper pyramid), but no lower pyramid; or another stone is pasted on by means of mastic. The character of the stone is readily detected when taken out of the mounting.

Sapphires, hyacinths, emeralds, and topazes are sometimes slightly calcined and sold for diamonds. The first two are heavier than the diamond; they are, however, harder, and possess more fire. The topaz is distinguished by its property of becoming electric when heated, which lasts for several hours.

Rock-crystal is much lighter, but brilliant and hard; and the same character is applicable to the strass.

The following list shows the size and weight of the most interesting diamonds in the possession of different sovereigns.

The largest diamond is in the possession of the Grand Mogul, and according to Tavernier, resembles in form and size, half a hen's egg. Its weight is two hundred and ninety-seven and three sixteenths carats. It was found in 1552, in the mine of Colore, a short distance to the east of Golconda, and is valued at 11,723,000 francs. It is cut as a rose-diamond, and is perfectly limpid, with the exception of a small flaw at the end of the girdle.

The diamond in the possession of the Rajah of Mattan, in Borneo, weighs three hundred and sixty-seven carats: it was found on that island. It is of an egg form, has a cavity towards the thinner end, and is of the first water.

The *Orlow*, the diamond belonging formerly to Nâdir Shah, sultan of Persia, and now in possession of the Russian crown, weighs one hundred ninety-four and three fourths carats. It is of the first water, without flaws or faults of any kind. Its form is that of a flattened oval, about the size of a pigeon's egg—it formed the eye of a Braminian god—cut in a pyramidal form; it is one inch three lines in diameter, and ten lines high. It was purchased by the Empress Catharine for about ninety thousand pounds, cash, and an annuity of four thousand pounds, but is considered of more value.

The diamond in the treasury of Rio Janeiro, was found in 1771, at Rio Abaite, by three criminals, who delivered it to the government, for which they were pardoned. It weighs one hundred and thirty-eight and a half carats.

The Austrian crown possesses one which weighs one hundred and thirty-nine and a half carats, and is valued at one hundred and nine thousand two hundred and fifty pounds. It is beautiful and well formed, but its color turns towards the yellow.

There is another belonging to the crown, which was formerly in the possession of Charles the Bold, of Burgundy, who lost his all in the battle of Granson. This diamond was at that time the largest in Europe. A Swiss soldier, who was the robber thereof, sold it for a crown dollar to a priest; and after passing through several hands, it was purchased by Pope Julian II. for twenty thousand ducats.

The *Regent*, or Pitt diamond, belonging to the crown of France, is said to have been found in Malacca, and was purchased by Mr. Pitt, then governor of Bencoolen, in Sumatra, and sold by him to the Regent, duke of Orleans, by whom it was placed among the crown-jewels of France. It weighs one hundred and thirty-six and three quarters carats; is cut in the form of a brilliant, and is of the first water, being absolutely faultless. When rough, it weighed four hundred and ten carats, required two years' labor in cutting, and is worth, according to the value put by the commission of jewellers, in 1791, twelve millions of livres. It was much admired in the exhibition of Paris, in 1855, among the crown-jewels of France.

The *Sancy*, belonging to the crown of France, is one of the celebrated diamonds, although not as large as the last mentioned, still a very beautiful stone; it is of a pear-shape, is cut as a double rose-diamond of an oblong figure, and weighs fifty-six and a half carats (thirty-three and twelve sixteenths, according to Barbot), and it cost 600,000 livres, but is now valued at double that sum.

A very curious history is attached to this stone, which may not be uninteresting to the reader, for its peregrinations are wonderful and are well worth relating. At first it was seen glistening in the casket of Charles the Bold, the last duke of Burgundy, who lost it in the battle of Granson; it was found by a Swiss, who sold it to a priest for two francs, he resold it for three francs; it is then lost sight of until in the year 1589, King Anthony, of Portugal, pledged the same among other stones to M. de Sancy, then Treasurer of the King of France, who retained it by paying 100,000 francs for it. Henry III., after a lapse of time, borrowed it for the purpose of pledging it to the Swiss government, but the servant that was to convey it to that country disappeared, and was not heard of for a long time; at last it was discovered that the messenger was assassinated by thieves; but the faithful servant rather than deliver the jewel to the thieves preferred swallowing it. The spot where the body was interred was discovered; being disinterred, on dissecting the stomach the diamond was found. The Baron de Sancy disposed of it to James II., while at St. Germains, and from him it fell into the hands of Louis XIV. for 625,000 francs, and has ever since been the property of the crown of France. The same stone was lost in 1792, with the greater part of the other jewels: it was found again by the police in the Champs-Elysées, through an anonymous letter.

The Regent, the blue diamond, the celebrated onyx known by the name of Abbé Sugen's communion-cup, with other diamonds to the value of several millions of francs, were then stolen, and but few of them recovered.

The blue diamond of the crown-jewels of France, is of a rich sky-blue color, and weighs sixty-seven and one eighth carats; it was valued at 3,000,000 francs, but was stolen among the other jewels, in 1792, and not recovered. It is said, however, that it was sold in 1835, by an agent of the Bourbon family, to a purveyor of the Emperor of Russia, for the sum of 500,000 silver roubles; since which time it has been in the hands of the Princess Paul Demidoff.

Russia is said to be the richest country for diamonds; her crowns are of immense value; that of Ivan Alexiowitch contained 881 brilliants; that of Peter the Great, 847; that of Catharine, 2536, and the present emperor has purchased for his crown an immense amount of brilliants.

The *Shah* is another of the great diamonds belonging to the Russian crown; it is an irregular prism, of fine water, and weighs ninety-three carats; it belonged formerly to the Emperor of Persia, and then to Nadir-Shah, and was stolen by the revolting soldiers.

The *Polar Star* belongs to the Princess Youssoupoff, is cut into a brilliant, and weighs forty carats.

The Prince Esterhazy, as colonel of a fine regiment in the service of Austria, wears, in his uniform of state, a diamond valued at twelve millions of francs.

The Pacha of Egypt has a diamond cut in facets, which weighs forty carats, and cost 700,000 francs.

The *Piggot* weighs eighty-two and a half carats; is not very fine; was sold by lottery, in 1801, for 750,000 francs, and belonged, in 1818, to the jewellers Rundell & Bridges.

The *Nassak* belonged formerly to the East India Company; weighs eighty-nine and three quarters carats; has since been recut by order of the Marquis of Westminster; weighs at present but seventy-eight and five eighths carats, and is valued at 800,000 francs.

The *Holland Diamond* weighs thirty-six carats, and is valued at 260,000 francs.

The *Hope Diamond*, which weighs forty-four and one eighth carats, is of a beautiful color like sapphire; is suspected of being the same stone which was stolen among the French jewels, in 1792. Owing to its beauty it was purchased for 450,000 francs, but is worth more.

The Dresden Treasury has a beautiful green diamond, like emerald, which weighs thirty-one and one quarter carats.

The value of the crown-jewels of France, has always been 29,000,000 francs; among them are comprised—

Diamonds	16,730,203	francs.
Pearls (506 in number)	996,700	"
Colored Stones—		
230 Rubies	360,604	"
134 Sapphires		
150 Emeralds		
71 Topazes		
3 Amethysts (Oriental)		
8 Syrian Garnets		
8 Other fine stones		
Mounted jewelry	5,834,490	"
Ornaments and trinkets	5,144,390	"
Total	29,066,487	"

The great treasures which were stolen on the 17th September, 1792, and not recovered, contained over 1000 carats of brilliants and roses of various sizes and qualities. In 1810 the Emperor Napoleon I., after purchasing over the Continent all the diamonds and jewels which were formerly stolen from the treasury, had another inventory made out.

A very black diamond, which belonged to Mr. Papst, who sold it to Louis XVIII. for 24,000 francs; it is of dark-brown color, but a fine lustre. It came from the collection of Dagni; but it is not known what has become of it.

A fine rose-diamond of fifteen carats, in the possession of Prince Rioria, at Naples, in 1830.

Mr. Halphen owned a diamond, in 1838, of twenty-two and one half carats weight, of a magnificent and rare water.

The *Nizam* belonging to the King of Golconda, is a magnificent rough diamond; it weighs 340 carats, and is valued at 5,000,000 francs.

There are two rough diamonds, belonging to the King of Portugal, one of which weighs 215 carats; they were found in the river Abayté, which runs through the Province of Minas Geraes, in Brazil.

A magnificent pyramidal cut diamond, in Brazil, is valued at 872,000 francs.

A rough diamond, found in the river Abatio in Brazil, is in the possession of the Prince Regent of Portugal, which weighs an ounce Troy.

The two large diamonds belonging to the Shah of Persia have already been mentioned in the first part, with accompanying figures.

The Turkish crown has two very large diamonds; one of eighty-four carats, and the other of one hundred and forty-seven carats. The latter is valued at eighty thousand ducats.

One found in Brazil, in 1780, weighs seventy-two carats and three fourths of a grain. Another, found in 1803, weighs seventy carats. They are both at Rio Janeiro.

The largest of all known diamonds is said to be in the possession of the King of Portugal. It was found in Brazil, in the diamond district, and is as yet in its rough state. It is of the size of a chicken's egg, weighing one thousand six hundred and eighty carats (above eleven ounces), and is estimated in value at fifty-seven million pounds sterling. It is now the general opinion of jewellers and mineralogists that this is a white topaz.

The *Koh-i-noor*, of which there is an exact representation on the frontispiece of this work, in its present form, belongs to the Queen of England; it is translated as the Mountain of Light, and is a very remarkable gem, both for its size as well as its history. It belonged formerly to the Grand Mogul, from whom it passed into the hands of the sovereigns of Cabul. Runjeet Sing, the king of Lahore, became possessed of it in 1813, after a victorious war against the Shah Shuja. At the death of Runjeet Sing, the East India Company took possession of his estates, and this relic fell into their hands, and by the latter was presented to the Queen of England. Its original weight was one hundred and eighty-six carats; it was of an elongated form, which led to the supposition that it is a part of an octahedral crystal; this opinion has been repeatedly expressed, and more particularly by Mr. Tennant, who believes it to be a fragment of the Grand Mogul's diamond described by Tavernier. Its awkward shape and bad polish induced the queen to have it recut, which was done by Mr. Gaword, who gave the Koh-i-noor the form of the Regent Diamond, and lost thereby nearly one third of its original weight. It is now a beautiful diamond, and is valued at two millions of pounds sterling.

The *Star of the South*, a Brazilian diamond, found in July, 1853, is at the present day the largest in Europe, coming from Brazil. It belongs to Mr. Halphen, a private gentleman, and weighs two hundred fifty-four and a half carats; as a crystal, was a dodecahedron; it has a specific gravity of 3·529. On account of a deep cavity of an octahedric form, by which it appears to have been attached, at a previous stage, to another crystal, it is ascertained by the French lapidaries that this diamond will lose nearly half its weight, so that after being cut and faceted, it will weigh about one hundred and twenty-five carats, but will still rank as a princely diamond. It was found by a negress employed in the mines of Begagem, one of the diamond districts in the province of Minas Geraes.

Another large Brazilian diamond was found in the river

Abaite, and is said to weigh about one hundred and twenty carats.

The *Nassak* diamond belongs to the East India Company, and weighs eighty-nine carats. A beautiful green diamond is shown in the royal collection (grüne gewolbe), weighing forty-eight carats.

Among the American diamonds may be mentioned one in the possession of Capt. Dewey, having been found in Virginia, and a perfect crystal—a rhomboidal dodecahedron, with curved faces, of greenish-white color, and perfectly transparent—weighing about twenty-five carats. It reflects strongly the light, and has a brilliant adamantine lustre. Smaller diamonds have been found in Alabama, three of which belong to Mr. Barnett Phillips of Philadelphia, weighing one, two, and three carats respectively, and likewise perfect octahedrons. In Rutherford County, North Carolina, a diamond of one and a half carats was in the possession of Mr. T. G. Glemson. In Hall County, Georgia, diamonds have been found several times; in California some diamonds are said to have been found.

The black diamond, which has lately been found in Mexico, in the Sierra Madre, is also attracting the attention of lapidaries, being harder than any other diamond.

Description of the Crown-Jewels of Queen Victoria I., worn at her Coronation, 28*th June*, 1838.

The crown in which her majesty appeared at the ceremony of the coronation was made by Messrs. Rundell & Bridges. It is exceedingly costly and elegant; the design is much more tasty than that of the crown of George IV. and William IV., which has been broken up. The old crown, made for the former of these monarchs, weighed upwards of seven pounds, and was much too large for the head of her present majesty. The new crown weighs little more than three pounds. It is composed of hoops of silver, inclosing a cap of deep purple, or rather blue, velvet; the hoops are completely covered with precious stones, surmounted with a ball, covered with small diamonds, and having a Maltese cross of brilliants on the top of it.

The cross has in its centre a splendid sapphire; the rim of the crown is clustered with brilliants, and ornamented with fleurs-de-lis and Maltese crosses equally rich. In the front of the Maltese cross which is in front of the crown is the enormous heart-shaped ruby, once worn by the chivalrous Edward the Black Prince, but now destined to adorn the head of a virgin queen. Beneath this, in a circular rim, is an immense oblong sapphire. There are many other precious gems, emeralds, rubies, and sapphires, and several small clusters of drop pearls. The lower part of the crown is surrounded with ermine. It is, upon the whole, a most dazzling and splendid crown, and does infinite credit to those by whom it has been designed and put together. Her majesty has expressed herself highly pleased with it.

The following is an estimate of the value of the jewels:

20 diamonds round the circle, £1500 each	£30,000
2 large centre diamonds, £2000 each	4,000
54 smaller diamonds placed at the angles of the former	100
4 crosses, each composed of 25 diamonds	12,000
4 large diamonds on the tops of the crosses	40,000
18 diamonds contained in the fleur-de-lis	10,000
18 smaller diamonds contained in the same	2,000
Pearls, diamonds, &c., on the arches and crosses	10,000
141 diamonds on the mound	500
26 diamonds on the upper cross	3,000
2 circles of pearls about the rim	800
	£111,000

The following list of jewelry exhibited at the London

Industrial Exhibition, in 1851, by some French and English manufacturers, comprises but a small part of the immensely valuable treasures therein collected: The Queen of Spain allowed the manufacturer, Mr. G. Lemonnier, of Paris, to show two sets of her jewels. The first consisted of a diamond necklace, in the form of a ribbon, interlaced with foliage of emeralds; the stomacher and shoulder knots, from which were suspended very large emeralds, with clusters of brilliants. A bonquet was formed of lilies of brilliants, the leaves of emeralds, and ribbons of brilliants with pendants of pearls. The crown was in the same style, with aiguillettes in the form of flowers, having stamens in pearls. The bracelet was likewise a ribbon of brilliants, interlaced with emeralds. Another set of jewels, made entirely of diamonds and sapphires; the crown, composed in the heraldic style, held in the centre of diamond flowers a large sapphire; and a stomacher and necklace, with a wreath of brilliants and sapphire centres, were all scrupulously matched, and attracted the attention of thousands of spectators while the exhibition lasted.

The Russian jewellers, Messrs. Jahn & Bolin, of St. Petersburgh, exhibited a sparkling diadem, containing 11 very beautiful opals, 67 rubies, 1811 brilliants, and 1712 roses. A bracelet of turquoises and diamonds, and a brooch in the shape of a knob, composed of 750 turquoises, with a pair of ear-rings of small turquoises, 709 in number.

The English jewellers, Messrs. Hunt and Roskell, exhibited such a profusion of gems, valued at about two hundred and fifty thousand pounds sterling, that it would require a lengthy description to give but a faint idea of them —from the rough diamonds of all sizes, by the hundreds, to the most exquisite cut and polished gems. A bouquet of diamonds, which was as rich as it was elegant, was made so as to be entirely taken to pieces, even to the petals of the flowers, for the purpose of cleaning, and for forming into seven broaches. They had some particularly beautiful bracelets: one in emeralds and diamonds; another in opal and emerald, with white enamel.

Messrs. R. & S. Garrard & Co., of London, made a similar exhibition of gems and pearls, with a profusion of brilliants and rubies, which would occupy a full page to describe.

In the collection of Mr. Herz, in London, both in the London Exhibition—exhibited by Mr. Thistlethwayte—as well as in his private residence, I examined a very costly and unique collection of gems. The diamonds he possesses are of every shade and color, such as I have only seen in the celebrated Wernerian cabinet at Freiberg, and Abbé Haüy's, at the Jardin des Plantes, in Paris, where they were in their natural state, while those of Mr. Herz are cut, and many of them set. He had a bouquet of brilliants and rubies, valued at four thousand five hundred pounds sterling, quite magnificently set; a bracelet of splendid white and large diamonds, and in the centre a yellow brilliant of five carats weight, which he valued at five thousand pounds sterling.

Messrs. Blogg & Martin, the diamond brokers of London, kindly opened their treasures to me, and my eyes were dazzled by three bags, weighing about five pounds each, of diamonds; most of them cut in the East Indies, and weighing from ten to twenty carats each. They were not put in market, but kept as reserve, and the value of that lot could not have been less than half a million pounds sterling. I beheld many unique curiosities in hemitrope crystals and macle diamonds; many thousand carats of rough crystals of diamonds, from one grain to twenty carats, all assorted in packages, besides the immense valuable supply of perfect rubies of ten carats and upward. The scarcity of these gems in general, and the high price at which the rubies were then sold in market, formed a very singular contrast while viewing so large a stock in one establishment. I only recollect from memory what I saw in 1851, at Messrs. Blogg & Martin's; the sight of so many valuable gems had, however, made a lasting impression on me.

CORUNDUM.

The above name was applied to a different species from that of sapphire, but these terms are now generally acknowledged to be synonymous; not so, however, the emery, which does not belong to this species.

Both occur in rhomboids; often, too, in crystals of secondary form. They scratch all other gems except the diamond; their streak and powder are white, and the specific gravity is 3·9–4; they acquire electricity by rubbing, which is retained for several hours; they are not fusible before the blowpipe; with difficulty, by means of borax, they form a clear, limpid glass; acids have no effect on them; their chemical constituents are alumine, silica, and oxide of iron.

SAPPHIRE.

This name is derived probably from the Hebrew, as it is often mentioned in the Bible. It is not certain whether the ancients were acquainted with the blue variety only of this gem, and were ignorant of other blue stones, such as lazulite, fluor spar, &c. It was not used by them as a gem, probably on account of the difficulty of working it; but as a medicine, many peculiar virtues were ascribed to it. This species has hitherto been usually divided according to its different colors. The name of ruby has reference to a red color, and was applied by the ancients to the carbuncle. Sapphire occurs in crystals, in rounded grains, and pebbles. It is generally transparent, but sometimes only translucent, or displays a shine of light of six rays, resembling the form of a star. It possesses double refraction in a slight degree, and a vivid vitreous lustre, which sometimes turns to that of mother of pearl. Its fracture is from conchoidal to uneven. Its principal colors are blue and red, with their various shadings; sometimes white, gray, yellow, green, brownish-green, and black.

If the red sapphire (ruby) is exposed to a great heat, it becomes green, but when cold, returns to its original color; the green sapphire undergoes no changes.

The various names given to sapphire, according to its color, are—

1st. Ruby (Oriental ruby), of a dark crimson red, cochineal or carmine, and rose-red, mostly inclining to violet-blue.

a. Oriental hyacinth, aurora-red.

2d. Oriental amethyst, palish violet-blue; playing sometimes in rose and purple red, like the common amethyst, except in its superior lustre.

3d. White sapphire, limpid and perfectly transparent; vivid lustre, resembling the diamond.

4th. Sapphire, Oriental sapphire, from the darkest to the lightest blue, with different shadings, whence it is denominated by different terms, such as *male sapphire*, of a perfectly clear Berlin or smalts blue; *female sapphire*, full blue, with a tinge of white—sometimes sky-blue, with streaks or specks; *water sapphire*, very pale-blue, and sometimes discolored; *cat sapphire*, blackish or greenish blue, often not transparent.

5th. Oriental topaz; lightly yellow, lemon, or brownish straw yellow, sometimes playing into green; it is distinguished from the common or true topaz by color and lustre, but it occurs likewise much larger, and is seldom less free from faults than any other species of sapphire.

6th. Oriental aquamarine; greenish blue, pure and transparent, possessing a higher lustre and greater hardness than the common aquamarine.

7th. Oriental chrysolite, or peridote; yellowish-green, resembling in color the chrysoberyl, but may be distinguished from it by its higher lustre.

8th. Oriental emerald; green, more or less dark, inclining to yellow; it does not equal in color the real emerald, but possesses a higher lustre, and is at the same time very rare.

The sapphires which sometimes display a peculiar play of light are divided into—

1st. Star sapphire (asteria, opalescent, or chatoyant sapphire). Some translucent sapphires display, if held before the sun, or a burning taper, a white light running in six rays, resembling three white planes, or stripes crossing themselves at one point. This property is thus visible when the sapphire is cut convex (or cabochon), and when the principal axis of the crystal stands perpendicular to the base of the convex cut stone; these star sapphires are either called ruby-asteria, sapphire-asteria, or topaz-asteria, according to the color they bear.

2d. Girasol sapphire, Oriental girasol, sunstone sapphire, or ruby cat's-eye, have a yellowish, reddish, or bluish shine, or reflection of light, generally of a lighter color than the stone itself, displayed when moved or turned on the convex surface.

Sapphire is composed of pure alumina; the opaque contains about one per cent. oxide of iron and one per cent. silica; before the blowpipe it is unaltered; fuses with borax and salt of phosphorus, but is not attacked by the strongest mineral acids; friction excites electricity, and in the polished specimens the electrical attraction continues for a considerable length of time. The perfect and colorless sapphire has a brilliant lustre, so that the same may be confounded with the diamond; its hardness is inferior to the latter. The specific gravity of the blue sapphire is 3·979; of the ruby, 3·909; of the green (Oriental emerald), 3·949; of the violet (amethyst), 3·921.

The sapphire was well known to the ancients. Pliny gave a description of the star sapphire, under the name of asteria. The sapphire possesses the double refraction in an indifferent degree, and its fracture is unequal and conchoidal. The finest ruby sapphire occurs in the Capelan mountains, near Syrian, a city of Pegu, in the kingdom of Ava; also in the sand of the Expaillie river, in Auvergne. Blue sapphires are brought from Ceylon. Large masses of blue sapphire, of opaque color, have been found in North Carolina, as well as some isolated crystals in Buncombe County, North Carolina; but there are many more localities in the United States, such as New Jersey, New York, and Connecticut. Sapphires are mostly found in the sands of rivers, or in boulders, with garnets, zircons, kyanite, and in basalt. It has been observed that the blue sapphires are frequent in Ceylon, but not the rubies, and that in Pegu it is the reverse. The most celebrated mines of sapphire are at Mo-gaot and Kyat-Pyan, five days' journey from Ava. The Boa, or Emperor of the Birmans, retains all the larger sapphires.

For cutting a sapphire an iron mill is used, and for polishing, a copper mill, or one made of alloy of lead and tin, to which a horizontal motion is given by a very simple machinery; its surface is charged with diamond powder and oil, or with fine emery and water. A thick peg or gauge of wood, pierced with small holes in all directions, is set upright on the lapidary's bench, close to the mill. The stone, being placed on the surface of the mill, and the opposite end of the stick to which it is cemented being inserted in one of the holes of the gauge, the mill is put in motion by turning a winch, and the stone kept steady on it.

When the stone has all the facets, the cutting mill is taken out and replaced by one of brass, on which the polishing is performed by means of fine emery and rottenstone, in the same manner as before. A good judgment is required in determining the form and proportions best adapted to set off any particular stone to the best advantage. If the color is full and rich, its transparency perfect, and its refractive power considerable, the best form to give it is the brilliant. If, on the contrary, the color is dilute, the most advantageous method of cutting it is, to cut the table side (pavilion) brilliant fashion, and the collet side (culasse) in steps; by this means the table itself will be left dark, while all the light reflected from the steps on the under side of the stone will be thrown up into the facets, by which the table is surrounded. The French lapidaries cut the most perfect sapphires in a square or octagon form, with a single delicate step between the table and the girdle, and three or four steps between the girdle and the collet.

If the sapphires possess a varying chatoyant lustre, or are of a small size, their form is always hemispherical or elliptical, without any flat facets; the flatter the ellipse the more the varying lustre is diffused over the surface of the stone; whereas with a high ellipse it is condensed on a single spot.

In setting sapphires we always use foil answering to their color. The ruby is set with a reddish gold foil, or a foil of copper or red glass; the blue sapphire with a silver foil, or blue-colored foil, or with feathers of blue ducks, pigeons, or peacocks; and the water sapphire in a black back: but all perfectly pure sapphires are set *à jour*.

Many sapphires may be deprived of their specks by a careful calcination in a crucible filled with ashes or clay, and they assume then a more agreeable and purer color and greater transparency.

Sapphires are very favorite gems, and are extensively used by jewellers for setting in pins, rings, &c. In China, the ladies' slippers are mounted with rubies.

The blue sapphires have of late been employed as lenses for microscopes with great success. According to Brewster, it is, for its refracting power, second only to the diamond, and superior to all other gems. A new use has lately been made of the sapphire for drawing wires—it being cut in the form of a wedge, through which, by means of a diamond-point, a circular hole is drilled and then fastened on a brass plate; the wire is drawn through the smaller aperture of the sapphire towards the wider, by which process it is reduced to a thinness never otherwise attained.

The price of sapphires is very relative, but their proportional value is next to that of the diamond. The Oriental ruby stands highest in value, and when perfect, and exceeding three carats, is generally as dear as a diamond of equal weight and quality. After the ruby, blue sapphire stands next in value; and as this is not so rare, and occurs in large specimens, it is not so high in price. Some put the price of the blue sapphire equal to that of the colored diamonds; others put the price at half that of a brilliant under similar circumstances. Sometimes the value is fixed by multiplying half the price of a sapphire weighing a carat, with the square of its weight. It is therefore very difficult to come at an exact price-current, and the following average prices come nearest to their commercial value:

RUBY.

Of 1 grain weight	2	francs.
2 “ “	5	“
3 “ “	12	“
1 carat “	20	“
2 “ “	60	“
3 “ “	150	“
4 “ “	250	“
5 “ “	350	“

BLUE SAPPHIRE.

1 carat	10	francs.
2 “	20	“
3 “	30	“
4 “	45	“
5 “	60	“
6 “	80	“
8 “	100	“
10 “	200	“
Smaller stones 8 to 1 carat are worth	8	“
“ 12 to 1 “ “	6	“
“ 16 to 24 to 1 “ “	4	“

In order to show the various prices of rubies, we cite the sale at auction of the Marquis de Drée's collection, at Paris

For a cherry-red Ruby of	2	carats,	1000	francs.
For a darker Ruby of	1½	“	400	“
For a bluish-red Ruby	2½	“	1400	“
For a lighter Ruby	3	“	1200	“
For a blue Sapphire	6	“	1760	“
For an indigo-blue Sapphire	6¾	“	1500	“
For a light-blue Sapphire	4	“	123	“
For a white Sapphire	4½	“	400	“
For an Oriental Amethyst	1½	“	400	“
For a fine yellow Topaz	6½	“	620	“
For a lighter Topaz	6¼	“	71	“

There are numerous faults and defects to which sapphi are subject, and which always influence their price, such as clouds, milky or semi-transparent specks, like chalcedony, white stripes, fissures or knots, &c. The sapphire, particularly the red and blue varieties, being great favorites in commerce, are often imitated, not only by means of other colored gems resembling them, but also by substituting pastes. Instead of ruby, we sometimes get the spinelle, garnet, hyacinth, red quartz, calcined amethyst, red-burnt Brazilian topaz, red tourmaline; and instead of the blue sapphire, we get the disthene, kyanite, and the cordierite,—hardness is the best test.

NOTICE OF SOME LARGE SAPPHIRES.

Tavernier describes two large rubies said to have belonged to the King of Visapur, one of which weighed fifty and three quarters carats, and the other seventeen and a half carats. The first was valued at sixty thousand francs, the other at seventy-four thousand five hundred and thirty francs.

The prettiest sapphire at present in the Imperial Museum of France, in Paris, is without fault or defect; it weighs $132\frac{1}{16}$ carats, and is estimated at 100,000 francs. This sapphire was found in Bengal by a poor man who dealt in wooden spoons. It belonged afterwards to the mercantile house of Rospoli, in Rome, who sold it to a German prince; he again sold it to the jeweller Perret, of Paris, for 170,000 francs.

Two great sapphires belonging to Miss Burdett Coutts, of London, and valued at 750,000 francs, were much admired at the Paris exhibition in 1855.

The crown-jewels of France contain about 150 sapphires, of an aggregate weight of 350 carats, and are valued at 600,000 francs.

Several sapphires with engravings are seen in Rome, such as Hercules; in Turin, in the collection of Genevasio, of a Tiberius' head, on white sapphire; in St. Petersburg, and in the French museum.

Wahls quotes a ruby of 436 carats; and Furetière saw a ruby in Paris of 240 carats; and Tavernier quotes a ruby of half the size of an egg, with the engraving of Scheik Séphy.

The King of Aracan possesses a crystal of blue sapphire of an inch in diameter; and Sir Abram Hume possesses a distinct crystal of three inches in length.

The star sapphire on the frontispiece, was formerly in the cabinet of Mr. Gilmore in Baltimore.

The large blue sapphire in Hunt & Roskell's case at the London Exhibition, was extremely beautiful, and the largest I ever saw.

The ruby-sapphire of the East India Company, in London, is certainly the largest in the world.

In the collection of Messrs. R. & S. Garrard & Co., in the London Exhibition, rubies were in great profusion—mostly set with brilliants and pearls.

The price of rubies depends upon fineness and color; they are sold in the United States at from three to twenty dollars per carat.

A fine ruby is worth about the same price as a one carat diamond; and a two carat stone, if perfect, is worth more than a two carat diamond.

The King of Pegu and the monarchs of Siam monopolize the fine rubies, as the sovereigns of the peninsula of India have done the diamonds.

The finest ruby in the world is in the possession of the first; its purity has passed into a proverb, and its worth, when compared with gold, is inestimable.

The Subah of the Deccan is also in possession of a prodigiously fine one, a full inch in diameter.

The Empress Catharine, of Russia, possessed one ruby of the size of a pigeon's egg, presented to her by Gustave III., king of Sweden, in 1777.

Blue sapphires are described by the English embassy to Ava, of the weight of nine hundred and fifty-one carats. Mr. Mawe saw a blue sapphire of three hundred and ten carats. In the crown-jewels of France, there is one rhomboidal crystal of one hundred and sixty-six carats.

A beautiful ruby-asteria, in a breastpin, is worn by Mr. W. J. Lane, of New York.

COMMON CORUNDUM, DIAMOND SPAR.

This mineral was formerly brought from China only, when not so well known as at present, and bore the name of common corundum, but it is now considered as belonging to the general family of corundum. It occurs in crystals, which are generally coated with some crust; it has a conchoidal fracture, is translucent, and has a lustre between unctuous and mother of pearl, either gray, red, blue, green, brown, or whitish in different shadings. It is mostly inclosed in granite, mica slate, dolomite, or magnetic iron, and is found in Piedmont, Cananore, Campo Longo, the East Indies, and Sweden.

All the corundums, possessing fine and pure colors, are used and cut as jewels, and the impure pieces are pulverized and used for cutting and polishing harder stones, or glass and metals, particularly so in the East Indies and China, and it is called, in Madras, the grinding-spar.

It may be remarked that the Chinese corundum, which is crystallized in prisms of six sides, bears much resemblance to the emerald; the hardness and infusibility of both these minerals, and their geological position in the middle of old rocks increases their similarity; but the emerald cleaves in one direction parallel to its base, while the corundum cleaves in three directions of its primitive angles; the emerald has a less specific gravity, as three to four; the phosphate of lime and the tourmaline are also found in six-sided prisms; but in all these cases are the cleavage, hardness, and specific gravity the distinguishing characters. The transparent colorless corundum may be confounded with the diamond, topaz, aquamarine, white spinelle, and quartz; in these cases the specific gravity is the principal distinguishing character; the white corundum weighs 3·970, the diamond 3·520, aquamarine 2·7, spinelle 3·64, the topaz 3·4, and the quartz 2·654.

The emery or granular corundum is of an ash-gray, bluish-gray, and sometimes brown color; is massive, and opaque or slightly translucent on the edges; is very hard, and scratches easily glass and quartz; is found in a bed of talc, in mica slate, in rounded masses, in Naxos, Italy, and Spain, and in great abundance on the summit of Gunnechdagh, near Gumeschkeny, about twelve miles to the east of Ephesus, and between Eskihissar and Males, in Asia Minor, and in Ochsenkop, near Schwarzenberg, in Saxony. It has been elaborately described by Professor J. Lawrence Smith, of Louisville, Ky., as to its power as a polishing material. He has ascertained that they all contain more or less water, and that their specific gravity as well as their hardness depends upon the percentage of water therein contained; but the specific gravity of a sapphire, ruby, or emerald, which contains no water, is 4·06 to 4·08, and that they generally contain from 1·60 to 3·90 per cent. of water. This difference does not result from a decomposition of the mineral but from their formation; he proves that the presence of water in these minerals which influences their hardness or specific gravity, was existing while they were on the point of crystallization, and his experiments with the emery from China and Asia Minor, have led him to a scale of hardness to be used in the application of emery in polishing the surfaces of certain substances,—such as a slab of stone, or a plate of glass, or any other material upon which emery is generally applied for polishing. Professor Smith's process consists in the following method: he reduces the emery to a fine powder in a steel mortar, similar to the one the diamond-grinders use; the powder is sifted very fine through a sieve. One gramme of this fine powder he employs upon a glass plate of 0·10 inch diameter, and by means of an agate pestle he rubs the powder circularly and rapidly, until the powder meets with no resistance and makes no scratching noise; the quantity of glass-powder which is hereby taken up by the emery gives the index, or the power, of the emery under trial.

CHRYSOBERYL, CYMOPHANE.

The name of this gem is derived from the Greek, and is expressive of its color; it is also called cymophane. It was formerly classed with the beryl family, but was separated from that by Werner.

It occurs, crystallized, in a prismatic form, also in boulders and grains; is transparent to translucent, and possesses double refraction in a high degree; its lustre is between unctuous and vitreous; exhibits trichroism; fracture conchoidal; its color asparagus and olive green, with a tinge of brown, yellow, gray, or white. Some specimens display, sometimes, a milky or bluish-white lustre. Chrysoberyl scratches topaz and rock-crystal very distinctly, but is attacked by sapphire; the streak-powder is white, specific gravity, 3·68—3·75;

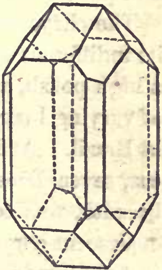


Fig. 4.

hardness, 8·5. It becomes electric by rubbing, and retains this property for several hours: it is infusible by itself before the blowpipe, but is slowly fusible into a glass bead with borax. Its component parts are alumina, silica, and glucia, with some oxide of iron and titanium. In commerce, chrysoberyl is called Oriental chrysolite, and that displaying lustre is called opalescent chrysolite. Mr. Ebelman has produced, artificially, the chrysoberyl from its ingredients.

Chrysoberyl is mostly found in loose crystals or in boulders in the sand of rivers associated with other gems, such as spinelle, sapphire, topaz, beryl, &c. In Brazil, particularly in the diamond district, and more frequently in Termo Minas Novas, Pegu, Ceylon, and Siberia: likewise in Connecticut (at Haddam), and in New York (at Saratoga), imbedded in coarse granular granite, and accompanied by garnet and beryl.

The chrysoberyl is cut on a brass wheel with emery, and polished on a pewter wheel with rotten-stone; it is very often cut in cabochon and, if perfectly pure and transparent, in other respects, is set with gold foil, and used for rings and pins.

The chrysoberyl is in no great estimation, on account of its indifferent fire and color, but those specimens that take a high polish, and occur transparent and pure in color, and of varying lustre, are of some value; it is particularly worn in Brazil. At Paris a chrysoberyl of fine green color, oval cut, seven lines in length, and five and three quarters in breadth, was sold for six hundred francs; and a very fine opalescent chrysoberyl nearly five lines long and four broad, cost six hundred and three francs.

For chrysoberyl have been substituted apatite, fluor spar, and pastes; but it is harder than any of these substances. Chrysolite bears a great resemblance to chrysoberyl in its external appearance, but is much lighter and softer. A green chrysoberyl was found in Termo Minas Novas, which weighed sixteen pounds, the largest known. It is in the possession of the government at Rio de Janeiro.

SPINELLE.

This gem was called by the ancients, carbuncle. It only occurs crystallized, and mostly in the form of an octahedron, and its modifications. The crystals are smooth, solitary, or grown together as hemitropes, loose, often rounded like grains (figure 5 is a macle form of the spinelle ruby); its fracture is conchoidal; it is transparent and translucent; it possesses simple refraction of light; is of a highly vitreous lustre; and its color is red, turning into the greatest variety of shadings of blue, brown, and yellow. We find, likewise, blue, black, and green spinelles, which, however, have no commercial value, on account of their impure color and want of transparency.

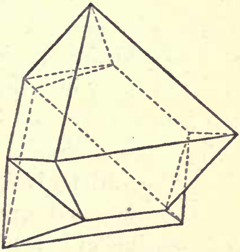


Fig. 5.

Spinelle scratches quartz, and is attacked by sapphire; becomes electric by rubbing; its specific gravity=3·523, hardness=7·56; is infusible before the blowpipe. According to Berzelius, the spinelle of Ceylon when heated, grows first brown, then black, and then opaque, which, on cooling, passes into green and limpid, and ultimately into its original red. Acids do not affect it; its component parts are magnesia and alumina. The spinelle is classed by jewellers and lapidaries according to its various colors.

1. Ruby spinelle, or spinelle ruby; of a light or dark

red, and no milky lustre; shows, if held near the eye, a tinge of rose-red color.

2. Ruby balais, or balais ruby; pale-red or rose-red, sometimes with a tinge of brown or violet.

3. Almandine ruby; of a cochineal-red color, bordering on blue, violet-blue, and reddish-brown. It is distinguished from the garnet, likewise called the almandine, by its lighter color, stronger lustre, and greater hardness.

5. Goutte de Sang is a fine cochineal or blood-red spinelle.

Spinelle is found in clay, and in the sand of rivers, with sapphire, garnet, tourmaline, and other gems. The red variety occurs in isolated crystals and grains, in alluvial soil, and in the sand of rivers—Ceylon, Ava, and Mysore—also imbedded in gneiss and granite, in Ceylon; the blue varieties occur imbedded in granular limestone at Aker in Sweden, Rohleta and Lojusoken in Finland, Straskau Moravia, in the dolomite of Nalande, and Candi in Ceylon; the white variety is found at La Ricia, near Rome, with black garnet and green augite; the grass-green variety (chlorospinelle) is found in the chlorite slate of Slatoust, in the Ural. The black and brown varieties have numerous localities; those from Orange county, New York, are very large and perfect octahedrons: one in my possession was twelve inches in diameter. Spinelle is cut on an iron or brass wheel, with emery or pulverized diamond, and is polished either on the same or on a copper wheel, with oil of vitriol.

Spinelle is cut in the same form as the diamond, and is set with a foil of copper or gold. Its color is often made more intense, and its faults, such as flaws and specks, removed, by calcining it carefully.

Lustre, color, and hardness have made the spinelle a very favorite gem, which is used in a great variety of ways, as in rings, pins, necklaces, &c.

The price of spinelles it is difficult to determine with accuracy, as much depends on their properties; if perfect and exceeding four carats, they are usually worth half the price of diamonds equally large. The spinelle ruby and balais ruby are the most esteemed spinelles, and if of twenty-four to thirty carats, are worth from two hundred to four hundred francs; and such gems are often sold for true rubies (sapphire).

Zircon is of greater specific gravity and less hardness than the spinelle, and shows strong and double refraction of light. Calcined topaz is distinguished by its electric properties. Burnt amethysts are lighter, and are scratched by spinelle. Pastes are likewise substituted for the spinelle, such as glass colored with gold-purple; but as the spinelles are always harder and heavier, the adulterations may soon be detected.

According to Mr. Ebelman, the artificial spinelle is obtained by the following mixture, which is put into a platina capsule and exposed to the heat of a porcelain furnace:

Alum, - - - -	6 grains.
Magnesia, - - -	3 "
Fused boracic acid, - -	6 "
Oxide chrome, - -	0·10 to 0·15.

TOPAZ.

It is not determined whether the ancients meant by topaz the same gem as we describe, since the Greeks understood the topaz to be of a transparent gold-yellow, and the Romans, of a transparent green-yellow. The name, which, according to Pliny, is derived from Topazos, an island in the Red Sea, has no reference to its color. Topaz was, in former times, thought to possess great medicinal virtues; for example, as a remedy for mania, and as a strengthening medicine. The topaz occurs crystallized in a rhombic prism, but mostly in very complicated forms, particularly the Brazilian, Siberian, and Saxonian: it is often found in boulders. Its fracture is conchoidal; it is transparent and translucent; possesses some double refracting powers; a very vivid vitreous lustre; clear, straw, sulphur, wine, and gold yellow colors, sometimes with a tinge of violet-blue, greenish, and white. Topaz scratches quartz distinctly, but is attacked by sapphire. Its streak-powder is white; specific gravity, 3·49 to 3·56; it is phosphorescent when heated, with a bluish or yellowish lustre, in small fragments. It becomes electric either by rubbing, heating, or by pressure, and retains the property for more than twenty-four hours. Before the blowpipe, at a strong heat, it is covered with many small bubbles, and partly loses its color. It is dissolved, fusing slowly with borax, into a white bead; acids have no effect upon it. Its component parts are alumina, silica, and fluoric acid.

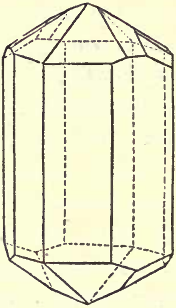


Fig. 6.

In commerce, topaz is distinguished by the following names:

1. Water drops, pebbles (gouttes d'eau), clear, limpid.
2. Siberian topaz, white, with a bluish tinge.
3. Brazilian topaz, gold-yellow, with a touch of red.
4. Saxon topaz, pale wine-yellow.
5. Indian topaz, saffron-yellow.
6. Brazilian ruby, light rose-red.
7. Brazilian sapphire, light-blue.
8. Aquamarine, sea and mountain green.

Topaz belongs to primitive rocks, and is found in chlorite slate, gneiss on gangues, argillaceous schist, &c. In Brazil, it is found in a decomposing chlorite slate (and is there called malacheta), within brown hematite cavities or quartz gangues, which are of one inch to one and a half feet thick, and are overlaid by indurated talc and white and brown kaolin, and sometimes intermixed with quartz crystals and micaceous iron, which are the surest indications of topaz. Such topaz localities are at Villa Rica, Capao, and Lana. Little attention is paid during the dry season to the digging of topaz; but with the beginning of the rainy season, the searches for topaz are undertaken, and the operation for washing and procuring them is performed like that of the diamond, mentioned under its proper head.

In places where the topaz is found in company with tin ore, it is picked out; but where it forms a part of the rock, it is wrought by mining operations, as in Saxony.

Topaz is cut on a leaden wheel, either with emery or pulverized topaz, and is polished on a copper wheel with rottenstone. Care has to be taken in slitting the foliage. The forms which it is to receive depend upon its qualities and purposes. The white topaz is cut in brilliant form, with a small table; the bluish topaz, however, is cut with a mixed form, but it is to be observed that the table side requires to be higher than usual, the table smaller, and the collet side, with its steps, must be attentively wrought in proportional distance. The yellow topaz is mostly cut as brilliant or table-stone, and in setting, its back is supplied with a gold foil, and the pale with a red-colored foil. Many species of topaz are set *à jour.* Topaz assumes, by calcining, a different color, and also by coloring fluids, as stated in a former chapter.

The topaz is in general use by jewellers for setting in rings, pins, ear-rings, seals, or necklaces. Its fragments are pulverized and used for grinding the softer precious stones; this is effected by calcining them first, then throwing them into water, and afterwards pulverizing them.

By heat the topaz assumes a pink or red hue, so nearly resembling the balais ruby that it can only be distinguished by the facility with which it becomes electric by friction.

Topazes from New South Wales, Brazil, and Scotland, sometimes contain cavities, in which Sir David Brewster discovered two fluids, one of which has an index of refraction=1·211, and expands 0·25 of its original volume on being heated, from 10° to 27°.

The topaz is found green, blue, and colorless at Alabaschkka Meersinsck, Miask, and Adum Tschelon in Siberia; Kamtschatka, Peru, and Rozena in Moravia, with lepidolite; Mucla in Asia Minor, Peneg in Saxony, and at Schneckenstein, near Auerbach, in Saxony, of a wine-yellow color; at Villa Rica, in Brazil, of a deep-yellow color; with tin ore at Geyer, Ehrenfriedersdorf, and Altenberg in Saxony, Schlackenwald in Bohemia; with tin ore and apatite in veins of granite at St. Michael's Mount and Huelkind, near St. Agnes in Cornwall; in granite in the Morne mountains in Ireland; in the United States, at Trumbull and Middletown, Connecticut.

The less transparent variety (pyrophysalite), with fluor in granite veins, at Tinbo, near Fahlun, in Sweden; in boulders at Braddbo, in Sweden; in gneiss at Fossun, in Norway.

Topaz is generally of less value now than formerly, owing to the yearly supplies obtained from Brazil, which is about forty pounds. The mine at Capao has yielded about twelve thousand dollars' worth, and the supply has been accumulating at Rio de Janeiro and Bahia to such a degree, that it is disposed of at a less price there than at the mines.

Those most esteemed are the rose-red and the white, or water drops, *pingos d'agoa*. A topaz of the size of a bean is sold at Chapada, in the Termo Minas Novas, at one dollar; one of one carat is disposed of at an average rate, for eight dollars; a yellow one for three dollars; and a yellow burnt one for five dollars. In Brazil, very large, fine, and lustrous ones, bring thirty dollars.

The Saxonian topazes are less valued, yet good yellow or crimson colored ones, nine lines long and seven broad, bring four hundred and twenty francs.

Aquamarine and chrysolite are sometimes substituted for topaz; but it may easily be distinguished from them, not only by its hardness, fracture, and specific gravity, but more especially by its property of becoming electric by rubbing. This will prevent the substitution of either of the above, or those most resembling them; such as the yellow quartz, chalcedony, or other yellow-colored stones.

According to the account of Tavernier, the Grand Mogul possessed an octangular polished topaz of one hundred and fifty-seven and three quarters carats weight, which has been purchased for sixty thousand dollars.

M. d'Eshwege notices a topaz crystal ten inches in length and four inches in diameter. The United States (Connecticut) yield topazes of an opaque color, pale, dark orange, and yellow, twelve inches in length. One of the finest Brazilian topazes I have seen is in the rare collection of Robert Gilmore, Esq., of three inches length, and perfectly terminated. The Brazilian topaz on the frontispiece was exhibited in the London Palace by Mr. Tennant. Some very splendid cut Oriental topazes I saw at Mr. Stephen H. Palmer's; they were of wine-yellow color and good size.

In the French Imperial Bibliothèque there are several engraved topazes—Philip II. and Don Carlos in white topaz, and engraved by Jacques de Trezzo; and in a very large and deep yellow topaz, an Indian Bacchus, in the Vatican. The House of Orleans had a Mercury seen in profile, on an Oriental topaz, with eight facets.

In Turin, in the Generosio collection, was a topaz intaglio, representing Victory in a chariot drawn by two horses.

Caire possessed an Oriental topaz of twenty-nine carats, pierced lengthwise, with the following words in Arabic letters: "God only will accomplish." It was an amulet, known by the Arabs as *gri-gri.*

The ancient *τοπαζον* was found on an island in the Red Sea, which was often surrounded with fog, and therefore difficult to find; it was hence named *τοπαζα*, to seek. This name, like most of the mineralogical terms of the ancients, was applied to several distinct species. Pliny describes a statue of Arsinoe, the wife of Ptolemy Philadelphus, four cubits high, which was made of *τοπαζον*, but evidently not the topaz of the present day, nor chrysolite, which has been supposed to be the ancient topaz. It has been conjectured that it was a jasper or agate; others have imagined it to be a prase or chrysoprase.

EUCLASE.

Monoclinohedric figures; cleavage clinodiagonal, highly perfect, very brittle and fragile; conchoidal fracture; hardness, 7·5; specific gravity, 3·; transparent; splendid vitreous pale mountain-green, passing into yellow, blue, or white. When heated before the blowpipe, it intumesces, and melts in thin splinters to a white enamel; is not acted upon by acids; is composed of 44·7 silica, 31·8 alumina, and 23·5 glucine, with 1 to 2·2 peroxide of iron, and 0·4 to 0·7 oxide of tin. It is found in chlorite slate at Boa Vista and Capao, near

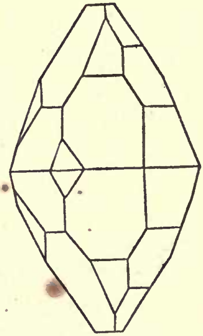


Fig. 7.

Villa Rica, in Brazil; in Peru, and is said to have been found in Siberia. It is very rare, and for this reason not much used as a gem; it resembles much the aquamarine when cut.

EMERALD.

The emerald proper and the beryl belong to this mineral species, and are distinguished by their color and crystalline form. The emerald occurs in six-sided prisms with their modifications; it scratches quartz, and is scratched by topaz. The streak-powder is white; its hardness is 7·5 to 8·0; specific gravity, 2·73 to 2·76; it becomes electric by rubbing; it is rounding before the blowpipe, and forms an opaque black, but becomes a green or limpid glass, having the hardness of borax. Its constituents are glucia, alumina, and silica.

THE EMERALD PROPER.

The emerald appears to have been known in the most remote ages, and was the third stone, according to Calmet's arrangement, on the high priest's breastplate of judgment, with the name of Zebulon inscribed on it. In the time of Pliny, this stone was held in such high estimation that it was seldom if ever engraved upon. The moderns, however, did engrave on the same, as we find in the royal collection at Paris a head of Henry IV., and one of Louis XIV. It has been excavated from the ruins of Rome, and from Herculaneum and Pompeii. But the ancients often included under this name other gems of the same color; such as the green fluor, aquamarine, jasper, malachite, &c. They appear to have obtained the emerald from Egypt. Cailloud has in modern times succeeded in finding the old emerald mines in the Theban deserts, on the Arabian Gulf —which have been noticed by the ancient authors, and by the traditions of the Arabs, as coming from the mountains of the Sahara—when sent on an exploring expedition by the Pasha of Egypt. He mentions having found subterranean mines, capable of allowing four hundred men to work; and he likewise found tools, ropes, lamps, and other utensils. He judged from the ruins of the architecture of the temples of a city which he discovered, that they were of Egyptian or Grecian form, and about one thousand years old.

Among the church treasures of the ninth and tenth centuries, we find the emerald, which came into particular notice after the conquest of Peru, where an emerald the size of an ostrich egg is said to have been idolatrized by the savage inhabitants. The emerald was formerly used as medicine, and was worn as a preventive against epilepsy.

The emerald occurs in somewhat depressed six-sided prisms; the lateral faces of which are smooth; the fracture is conchoidal to uneven; it is transparent to translucent; displays double refraction in a slight degree; has a vitreous lustre; is green and emerald-green with its different shades.

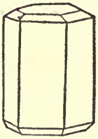


Fig. 8.

According to Mr. Ebelman, the true emerald is prepared artificially by

Silica	7·	grains.
Alumina	1·60	"
Glucia	1·40	"
Fused boracic acid	4·06	"
Oxide chrome	0·10	"

It is scratched by an English file, and scratches strongly white glass, and slightly quartz. Its specific gravity is 2·73 to 2·77. Its color is owing to the oxide of chrome. An emerald when calcined, and thrown into water, crumbles into pieces of different colors. The purest emeralds are called the Peruvian.

The emerald is found in micaceous schist at Salzburg, in the Sahara mountains, in gangues in Peru, in the argillaceous and in hornblende slate. Formerly, the finest emeralds came from Warta, in Peru; but the mine is either exhausted, or the Indians filled up the mines before they left them at the conquest. The best are now found in the valley of Tunca, in Santa Fé, where they occur in granite. The emerald has lately been discovered in Siberia, in the micaceous schist, and is equal to the Peruvian in every respect.

The emerald is sawed into pieces with emery, cut on the copper wheel, and polished on a finer wheel with rottenstone, pumice-stone, tin-ashes, and water. The step-cut, and the mixed step-cut, or the table-cut, are mostly used, yet it is sometimes cut as a brilliant or rose-cut. They are set with a green foil or green satin on their back; or sometimes in a back colored with mastic, and very black; but if perfectly pure, and of fine color, they are set *à jour*. On exposure to air, emeralds grow by degrees paler.

The emerald is, on account of its agreeable green color, a very favorite ornament, and is used for the most expensive kinds of jewelry. Its value depends altogether upon its pure and fine color, vivid lustre, and the size of the specimen. The price of emeralds was much higher before than it has been since the discovery of Mexico; the product of the mines of Peru reduced their price considerably; now they are getting dearer again, and always command a good price. A small box of fair emeralds from Peru, which I saw a few years ago, at the office of the American and Foreign Agency, in this city, which weighed from three to four pounds, was sold afterwards at Paris for nine thousand francs. A good emerald, of fine color, is worth twelve dollars per carat; and the price increases according to its interior qualities. The price of the best emeralds of

4 grains is	- - -	18 dollars.
8 "	- - -	30 "
16 "	- - -	200 "
24 "	- - -	300 "
48 "	- - -	1000 "

Good emeralds, meaning good color and quite free from flaws, are very rare, and have nearly as much value as the ruby.

An emerald of twenty-four grains, and good color, was sold at the auction of the Marquis de Drée, for two thousand four hundred francs. Emeralds of indifferent pale color, are sold for two dollars per carat. The faults to which emeralds are subject, are inequality of color and transparency, dark or white spots, fissures, and feathers.

For emeralds, there are sometimes substituted the green tourmaline and apatite; the former is easily detected by its property of becoming electric by heating; but in general all these stones do not possess the lustre and hardness of the emerald. The pastes in imitation of the emerald, are so well manufactured that it is often difficult to discriminate the genuine from the false. The following yields the best imitation of the emerald:

1000	parts of	discolored strass,
8	"	pure oxide of copper,
·02	"	oxide of chrome.

An emerald is said to have been at the Chapel of our Lady at Loretto, in Italy, larger than a man's head, and for which an Englishman offered ninety thousand crowns.

The Sultan of Oude, in the East Indies, is said to have given to the King of England, among other presents, an emerald of the size of a hen's egg.

The treasury of Vienna is said to contain an emerald of two thousand two hundred and five carats, valued at three hundred thousand crowns.

The most magnificent specimen of emerald was presented to the cathedral of Loretto, by one of the Spanish kings. It consists of a mass of white quartz, thickly implanted with emeralds, more than an inch in diameter.

An emerald belonging to the crown of Russia, is noticed in the *Mémoires du règne de Catherine, Impératrice de Russie*, as being of the size of a hen's egg.

A fine crystal in the matrix, is in the museum at Dresden, which I examined in 1827.

Among the large emeralds stands foremost the magnificent crystal belonging to the Duke of Devonshire, as represented on the frontispiece of this work; it is a regular six-sided prism, perfectly well formed; two of the parallel faces are more developed than the others, so that the hexagonal base of the crystal has one side larger than the rest; the dimensions of the base are 2·36 inches, by 1·97 in diameter, and it weighs eight ounces and eighteen pennyweights; it is of a fine green color and perfectly clear in the upper part, it was found in a vein of dolomite, which traverses a hornblende rock at Muso, near Santa Fé de Bogota, in New Grenada.

A prettier but smaller specimen, weighing but six ounces, is in the possession of Mr. Hope, of London.

Mount Zalora, in Upper Egypt, affords a less distinct variety, and was the only locality which was known to the ancients.

At the New York Exhibition, in 1853, quite a number of emeralds were shown from the New Grenada mine.

Dr. J. R. Chilton, of New York, has a very beautiful crystal of emerald in the matrix in his private cabinet, of one inch in length.

The largest cut emeralds and in great profusion, set in bridles, saddles, and in the girdle of an apron, about the size of pigeons' eggs, were in the East India Company's collection. From forty to fifty of that size were set together, some of them not well cut and polished, but all transparent and of beautiful green color, they were certainly very valuable.

Mr. Herz, of London, has a beautiful polished emerald of 112 carats.

Mr. Stephen H. Palmer, jeweller of this city, has some very fine cut emeralds, one of which weighs four and seven eighths carats, for which he asks $350.

The prettiest cut emerald is in the imperial cabinet of St. Petersburg; it weighs thirty carats; is of pure color, and a perfect stone; it has a round form with too many facets.

The emerald has been very successfully imitated, so much so that the most experienced eye may sometimes be deceived.

BERYL, AQUAMARINE.

This gem was likewise known to the ancients, who considered and described it as a sea-green precious stone, and called the yellow varieties of this mineral the chrysoberyl. It was used by the Romans as ornaments for cups, also for cameos. The crystals of the beryl are six-sided, terminated by six-sided pyramids, they also taper gradually from one end to the other; the lateral faces are striated; the fracture is conchoidal or uneven; they are transparent or translucent at the angles, with indistinct double refraction, and vitreous lustre: the colors are green, bluish-green, yellowish-green, or greenish-white; bluish, sky, smalts, or indigo blue; straw, wax, or honey yellow; all pale colors: hardness,7·5; specific gravity, 2·67 to 2·71. According to its color and transparency, it is designated the common and precious beryl: under the first are generally comprised the greenish and blue varieties, which are also called the aquamarine; whereas the yellowish varieties are exclusively called the beryl, and are generally divided thus:

1. Aquamarine, pure pale sky-blue.
2. Siberian aquamarine, pale greenish-yellow, of a vivid lustre, faint color.
3. Aquamarine chrysolite, greenish-yellow, and yellowish-green, vivid lustre.

The beryl belongs to the primitive formation, is found in quartz veins and granite (graphic granite), and is associated with garnets, quartz, chrysoberyl, schorl, topaz, &c. The most magnificent beryls come from Siberia, Rio de Janeiro in Brazil, Aberdeenshire in Scotland, and Limoges in France. The common and translucent beryl occurs all over the globe, and in the United States in great abundance, where it is without mercantile value. The granite rocks of New Hampshire (at Acworth), have brought forth gigantic beryls, perfect six-sided crystals, three feet in length and four feet in circumference, and weighing upwards of three hundred pounds, and some with a distinct termination of the crystals. Specimens of this description may be seen in the collection of the Lyceum of Natural History, New York, in Mr. Gilmore's collection at Baltimore, and in the author's collection. Large quantities of beryl crystals have also been found in Chester county, Pennsylvania.

The beryl is cut on a leaden plate with emery, and polished with rotten-stone on a tin plate, and generally of the brilliant cut, on account of its not possessing much lustre in the interior.

The foil that is required in mounting, depends upon the color of the stone: the greenish variety, for instance, is set with a greenish-blue foil; the pale is set in a black ground, like the diamond, or on a silvery foil.

Beryl is employed in jewelry for rings, pins, ear-drops, seals, &c.: but on account of its softness it is rendered less lasting, and as by wearing it loses all its beauty, it does not command a high price in market, being much below that of the emerald.

A beryl of a carat, averages about one dollar and fifty cents, and the price increases in the same ratio with the number of carats. The beryl is subject to such faults as spots, feathers, and fissures.

For the beryl, is sometimes substituted chrysolite, which is softer, however; it is also imitated by paste, which is likewise softer than beryl.

One of the largest transparent beryls, weighing five hundred and ninety-five carats, was once in the possession of a mineralogist at Vienna. In 1811, a beryl of fifteen pounds, pure, was discovered in Brazil. In 1825, a beautiful rounded Brazilian beryl, of four pounds weight, was offered for sale for six hundred pounds sterling.

Mawe describes a pure transparent beryl, altogether free of faults, seven inches long and three quarters of an inch thick.

In 1827, a superb aquamarine, weighing thirty-five grammes, was found in the borough of Mowzzinskaia, in Siberia, which the Russians are said to value at six hundred thousand francs. A very remarkable aquamarine, of extraordinary size, ornamented the tiara of Pope Julius I.

There is also a very fine aquamarine in the Imperial Library of Paris, on which there is a well-executed engraving, by Erodus, of Julia, daughter of Titus.

There is, according to Caire, another aquamarine in London, weighing five hundred and forty carats. In the Mineralogical Museum, of Paris, there is an aquamarine weighing one hundred and thirty-three grains; and another one in a rough state, and extremely beautiful, weighing over twenty carats, for which 15,000 francs were offered.

There are many of the intaglios of the ancients in the aquamarine.

Pliny speaks of the finest beryls as those "qui viridatem puri maris imitantur," and hence the term aquamarine is applied to those beryls which have beautiful shades of sky-blue or mountain-green colors.

The aquamarine was much employed by the ancients for engraving: there is one by Quintillius, of Neptune mounted on marine horses; another of a drunken Hercules, by Hyllus.

A similar intaglio, with terrestrial instead of sea horses, is the treasure of Odescalchi.

The specimen of beryl on the frontispiece was the property of Baron Struve, Russian ambassador at Hamburgh; it was of grass-green color, fifteen inches long and two inches in diameter. A similar, but smaller, specimen, and more yellowish-green in color, was in the case of Mr. J. Tennant, of London, at the Exhibition of 1851. Both are Siberian beryls. The most splendid specimen, weighing eighteen and a half pounds, which formerly belonged to Don Pedro, in size and form, resembles the head of a calf, and exhibits a crystalline structure on one side only; the rest is water-worn, perfectly transparent, and without a flaw, and of a fine pale bottle-green color. Beryls are frequently obtained in Brazil and Siberia of one foot in length, but they are commonly very deeply striated longitudinally.

Mr. Francis Alger, of Boston, informed the author of having obtained a huge beryl crystal nearly perfect, of one thousand pounds weight, from Acworth, in New Hampshire, about fifteen miles from Bellows' Falls. Beryls occur there in extensive veins of granite, traversing the gneiss. The localities of beryl are very numerous in the United States.

In graphic granite, associated with black tourmaline, good clear crystals are found in Bocodoniham, and Tapham, Georgetown, Parker's Island, and at the mouth of Kenebec river, in the State of Maine; at Goshen and Chesterfield, Mass., in irregular crystals of a pale-green color; and transparent, at Monroe, in Conn., in a granite vein; in Haddam, Conn., at the chrysoberyl locality, where the beryls of yellow and yellowish-green colors are imbedded with crystals of chrysoberyl and columbite.

ZIRCON, HYACINTH, JARGON.

Zircon and hyacinth were regarded as distinct minerals until the improvement in chemical analysis proved the same constituents to exist in both, particularly zirconia, a peculiar earth: they are now considered as two varieties of one and the same mineral. Zircon is also called jargon, and this name is either of Ceylonese or French origin. The ancients denominated hyacinth, the gem which is now known by the name of carbuncle; their true hyacinth was a dark amethyst. The zircon was formerly used as a celebrated medicine.

Zircon crystallizes in four-sided prisms, terminated by four-sided pyramids, with various modifications;* the crystals are smooth, rough, or uneven; it occurs likewise in rounded pebbles; it is transparent and translucent; possesses double refraction in a great degree; and has a vivid vitreous lustre, approaching sometimes to adamantine. Color, from hyacinth-red to yellow and brown; also, red, gray, white, brown, and greenish-gray. It slightly scratches

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* See in the frontispiece, a beautiful American zircon, from the cabinet of Dr. J. R. Chilton, of New York. It was found in Buncombe county, North Carolina.

quartz, but is attacked by the topaz; its streak yields a white powder; specific gravity is 4·00 to 4·70; hardness, 7·5; it becomes electric by friction; is infusible before the blowpipe, but loses its color at a low heat, the yellowish-brown, however, becomes redder; acids do not act upon it. Its chemical constituents are zirconia and silica, with about two per cent. oxide of iron, which is the coloring principle.

1st. Zircon, called by jewellers Ceylonian zircon,—fire-red, yellow, yellowish-green, and gray.

2d. Hyacinth is called by jewellers the Oriental hyacinth, which is of a hyacinth-red, deep red, with a touch of the brown, and sometimes orange-yellow color. Zircon occurs in primitive rocks, and forms a part of the zircon sienite of Norway and other countries. It is also found in gneiss, granite, amygdaloid, and basalt. It is likewise found in the beds of rivers; and there are localities in Ceylon, Pegu, Madras, France, Bohemia, Saxony, Italy, Siberia, Silesia, Scotland, the Canadas, &c. Very fine crystals, loose or attached to felspar, are found in Buncombe county, North Carolina.

The zircon is cut with diamond-powder, or emery, on a copper wheel, and is polished with rotten-stone on a tin plate, and is generally cut in the rose, table, or thick-stone, and sometimes the brilliant form. The foil generally used in mounting, is that corresponding to its color; or it is mounted in a black ground. If zircon is calcined in a crucible filled with lime, it loses its color almost entirely, and has then the appearance of a pale straw-yellow diamond, for which it may also be substituted. It is employed in jewelry for rings, breastpins, ear-rings, or for ornamenting watch-cases and snuff-boxes; also, for jewelling watches and for supporting fine balances. The value of zircon depends principally upon the purity of the color, but the color of hyacinth is preferable to that of zircon; a carat of the former is worth from fifteen to twenty dollars. Zircon is imitated by pastes, which may easily be detected by their lustre, hardness, and specific gravity; burnt topaz may be substituted for it.

The jargon is a variety of zircon, being composed of the same constituents, and differing merely in color from the first. It is mostly of white, grayish-white, and greenish-white colors, with tinges of green, blue, red, and yellow; but generally of a smoky white color. It usually occurs in worn angular pieces, or in small, detached crystals, of an octahedral form. The crystals are smooth, and of a bright adamantine lustre; have a conchoidal fracture, and double refraction; seldom quite transparent; is harder than quartz, and of a specific gravity of 4·3; loses its color when exposed to the blowpipe flame, but is infusible. It occurs chiefly in the sand of a river in Ceylon, accompanied by sapphire, spinelle, tourmaline, &c.

On account of its peculiar adamantine lustre, it has often been substituted for the diamond, and a century ago it was regarded as an inferior variety of the true diamond, and few of the precious stones were in more request, especially for mourning ornaments, for which the dark tone of its color, combined with its lustre, was supposed peculiarly appropriate. It has no value, at present, in market, although it is still seen in the cabinet and in the collections of jewellers.

Hyacinth differs from jargon and zircon only in color, being of a red orange color, very bright and transparent; it is much more employed for setting than zircon. It occurs also in the sand and alluvial deposits of some rivers in Ceylon; at Espaillie, near Puy, in France; at Ohlapian, in Transylvania; occasionally in volcanic tufa, in Auvergne, and at Vesuvius. Siberia affords crystals as large as walnuts. Splendid specimens occur also in Greenland and Norway.

Hyacinth is not highly prized by the jeweller. A large hyacinth of two hundred and fifty carats, in the collection of Mr. Herz, of London, was offered at a nominal sum of fifty pounds. Wm. J. Lane, Esq., of New York, has a beautiful seal-stone of hyacinth, which the author has much admired. Mr. Herz has also a cut zircon of forty-six carats, which he values very highly.

It is very doubtful whether the modern hyacinth is one of the number of stones called hyacinths, *ὑάκινθος*, by the ancients. It is supposed that the name was applied to the amethyst or sapphire.

GARNET.

Garnet was well known to the ancients, who considered the carbuncle as the same mineral, representing the whole species. It has been found among the ruins of Rome, in a variety of cut forms. But the name garnet is of modern origin, and probably was bestowed on this mineral from being found mostly in grains.

The garnet crystallizes in dodecahedral forms, with many modifications; the crystals are sometimes flattened into tables; it is also found in round angular grains, and massive; the structure is imperfectly lamellar; fracture, more or less conchoidal, sometimes uneven and brittle; lustre, shining vitreous; it is transparent and translucent; the color is blood, cherry, or brownish red, but almost invariably with a violet or blue tinge; sometimes, however, we find garnet of a yellow, green, brown, or black color.

The red garnet scratches quartz faintly, but is attacked by topaz, and even by the file; its powder is reddish-green; hardness, 6·5 to 7·5; specific gravity is from 3·10 to 4·30;

it becomes electric by friction; heated by itself, the garnet grows darker, but resumes its color when cooled; it fuses before the blowpipe into a black pebble. Its chemical constituents are silica, alumina, and the protoxides of iron and manganese.

Garnet has names according to the different shadings of color:

1st. Syrian garnet, which is also called the Oriental and precious garnet, almandine, carbuncle; this is of a blood-red, dark crimson color.

2d. Bohemian, or Ceylonese garnet, called the pyrope; wine-red, nearly orange-yellow, deep colored.

3d. Vermeille, or Aplome, having a deep shade of orange-yellow.

Pliny describes vessels of the capacity of a pint, formed from carbuncles—"non claros ac plerumque sordidos ac semper fulgoris horridi"—devoid of lustre and beauty of color, which probably were large common garnets. The garnet is also supposed to have been the hyacinth of the ancients.

Pyrope is described as presenting a dark blood-red color by reflected light, but yellow by transmitted light. Pyrope was so called from *πυρ*, fire, *οπτομαι*, to see, in allusion to its color.

The almandine, or precious garnet, is transparent and brownish-red, while pyrope is blood-red. The red garnet occurs imbedded in mica slate, granite, and gneiss, rarely in limestone, chlorite slate, serpentine, and lava, and is found in the greatest perfection in Ceylon, in the sand of rivers; and in the alluvial soil of Pegu, Hindostan, Brazil, and Greenland; in Bohemia, in alluvium, near Collin; in gneiss at Zbislau; in Tyrol, in the Oetzthal, and on the Greiner, in Carinthia, Styria; in Switzerland; at Ariolo, Canaria, Maggia; in Hungary, Sweden, Norway, Scotland, Spain; and in the United States, in North Carolina, Georgia, Massachusetts, and New Hampshire. Professor Edward Hitchcock once exhibited to the author some beautiful cut precious garnets from Berkshire county, Massachusetts; the Hon. Mr. Clingman, U. S. Senator from North Carolina, has some very handsome transparent garnets from his district in Buncombe county, North Carolina.

The common garnet is met with in dodecahedrons, from three to four inches in diameter, at Fahlun in Sweden, Arendal and Kongsberg in Norway, and the Zillerthal in Tyrol; in Moravia, Silesia, and Siberia; in granular limestone at Haslan, near Eger, in Bohemia; beautiful crystals of a rich brownish-red color, disseminated in hornblende gneiss, are found in Hanover, New Hampshire, in the United States; dark blood-red and splendid dodecahedrons, with peached and truncated edges, at Franconia, New Hampshire, in geodes, in massive quartz, calcareous spar, and magnetic iron ore; at Carlisle, Massachusetts, beautiful geodes of crystals of transparent cinnamon color, accompanying scapolite in white limestone; at Monroe and Haddam, Connecticut, imbedded in mica slate, also associated with chrysoberyl, beryl, automolite, and columbite; large dodecahedral crystals, two inches and more in diameter, of a dark brownish-red color, at New Fane and Marlborough, in chlorite slate; also in mica slate, in Chesterfield, Massachusetts.

Colophonite is a granular brown variety, and is found in Arendal, Norway, and forms a large vein in gneiss at Willsborough, New York, on Lake Champlain; a finer graded variety of yellow and red colors is found on Rogers' Rock, at Lake George. The colophonite is composed of coarse, roundish particles, oil-green and honey-yellow colors, and often possesses a fine iridescence.

Allochroite is similar to colophonite, but the particles are impalpable and strongly coherent.

Grossular has a pale gooseberry-green color (whence its name); in serpentine, with idocrase, in the Wilni river, in Kamtschatka.

Topazolite is a honey-yellow garnet, in veins in serpentine; has small yellow crystals; found on the Mussa Alp, in Piedmont.

Aplome presents the form of the dodecahedron, but the facets are striated, parallel to the shorter diagonal; its color is brown, sometimes greenish; from Sahla, in Sweden.

Melanite, from μελας, black, occurs in black dodecahedrons, sometimes modified in volcanic rocks, on Monte Somma, in matter ejected by Vesuvius; Frascati, Albano, near Rome, the Brisgau, in beds on the older rocks at Arendel, in Norway.

Pyrenaite is found in minute, black, symmetrical dodecahedrons, and was so called from its locality in the Pyrenees, and at the Pic Eves Lids, near Barèges.

Ouwarowite bears a close resemblance to the green garnet. It occurs in transparent emerald-green dodecahedrons, with a hardness of 7·05—harder than the garnet. It occurs at Bissersk, in Russia.

The several varieties of garnet are quite different in their composition; they all contain silicate of alumina, and variable proportions of the silicates of lime, iron, and manganese, which substances have the property of replacing one another without causing a change of crystalline form. The varieties of garnet are often classed as distinct species, such as almandine, pyrope, dodecahedral garnet, melanite, grossular, topazolite, aplome, essonite, cinnamon-stone, Greenlandite, pyrenaite, colophonite, allochroite, Romanzovite, carbuncle, and ouwarowite. It is proper that garnet be divided into precious and common; the first being the transparent, and the latter the opaque variety. The precious garnet, is again divided, according to its transparency, into almandine and pyrope. As already stated, the different varieties differ very little, and as the only important species, possessing characters more distinctive than others from the garnet, is the cinnamon-stone, or essonite, the author has seen fit to separate it from the garnet, and to describe it under its proper head; moreover, essonite is more used by jewellers, when cut, than any of the other species of garnet, and as it has of late become fashionable, it may be well to give a fuller description of the same.

Garnet was the carbunculus of the ancients. This term was probably applied also to the spinelle and Oriental ruby. The alabandic carbuncles of Pliny were so called, because they were cut and polished at Alabanda; hence the name almandine, now in use.

In Bohemia, where there is a considerable trade in garnets, they are separated from the earth by levigation, then assorted into different sizes, afterwards washed again, and assorted as to color and quality, and according to the quantity required for balancing a certain weight, as half an ounce, they are called 32, 40, 76, 100; very seldom do they find them 16 to 20, weighing together half an ounce.

The larger garnets are cut on the leaden wheel with emery, or their own powder, and polished with rotten-stone or oil of vitriol, on a tin plate, in the form of brilliants, roses, table-stones, or in cabochon, or with two rows of facets at the girdle; and very often garnets are brighter and more agreeable by excavating them circularly on the bottom; they are then called garnet-cups. I have in my possession several large excavated garnets, and I saw at Berlin, in 1828, such garnets of two and three inches size.

Fine garnets are set *à jour;* others are set with a gold or violet foil at the base. Smaller garnets are wrought on a large scale in manufactories for that purpose. They are perforated with the diamond, first, by means of a small point, then of a larger, and at last a finer point; one hundred and fifty garnets may be perforated daily.

The best garnets are cut in brilliant form, and with regular facets, on a plate of fine sandstone, with sweet oil and emery. One man can finish thirty such garnets in one day. The polishing on wooden or leaden plates, with rotten-stone or oil of vitriol, is performed by women and children. More than twenty thousand garnets are yearly carried to market from a single manufactory.

Garnets are much worn in jewelry, as rings, breastpins, ear-rings, and necklaces; and sometimes snuff-boxes are cut out of the larger ones from Greenland, Syria, or Tyrol; the inferior pieces, unfit for cutting, are calcined and reduced to powder, and employed as material for polishing other gems.

The value of garnets is determined by their degree of perfection, as well as color, purity, and size. On account of their peculiarly deep color they must be cut very thin; and all such garnets as retain their fine color, without being cut too thin, are held in high estimation, and stand in value near the sapphire. A Syrian garnet eight and a half lines long, and six and a half lines broad, and cut octangular, was sold at the auction of the Marquis de Drée for three thousand five hundred and fifty francs. A fire-red oval Ceylonese garnet, eleven lines long and seven broad, was sold for one thousand and three francs. They are generally sold by the pound, containing from sixty to four hundred, valued at about eight to ten dollars per pound; but a set of one thousand of the best selected garnets, well cut, is sold at about sixty dollars. Garnet is harder than idocrase or oxide of tin, but the latter is heavier.

In the Mineralogical Museum of the Jardin des Plantes, in Paris, are some very fine garnets with engravings; one is a mask of Silene, crowned with vine leaves; another is Calphurnia's restlessness on the fate of Cæsar; also the bust of Adrian, from the cabinet of Odescalchi; the dog Syrius; a head of Augustus, belonging to the Prince of Orange.

Garnet is very well imitated by pastes, which are, however, softer and lighter, and differ in many other respects.

The following composition yields a superior imitation of the Syrian garnet:

To 1000 parts strass, add
500 " glass of antimony,
4 " cassius purple,
4 " oxide of manganese.

ESSONITE, CINNAMON-STONE.

This gem was formerly considered identical with *hyacinth*, under which name it yet passes in commerce and among manufacturing jewellers, and in France it is called *hyacinth de Ceylon;* it is also called, in mineralogical works, cannel or cinnamon stone, which name it received from the Dutch gem-dealers, on account of its resemblance to the oil of cinnamon. Werner was the first who gave this stone the above name.

Essonite occurs in crystals and grains; its fracture is conchoidal and uneven; it is transparent and translucent; has simple refraction of light; the lustre is between vitreous and resinous; its color is deep-red, hyacinth-red, or orange-yellow; it scratches glass and quartz indifferently, but is attacked by topaz; its powder is white; specific gravity is 3·5 to 3·6; it becomes electric by rubbing; acts sometimes on the magnetic needle; fuses easily before the blowpipe into a clear greenish glass; borax and acids do not affect it.

Essonite is found in the sand of rivers, and in the primitive rocks of Ceylon, in considerable masses; also in Scotland.

It is treated like garnet, by being cut on a copper plate with emery, and polished on a tin wheel with rottenstone. It also receives the form of other gems, and when set, it is mounted with a foil answering to its color.

It is used for rings and breastpins. Essonite is distinguished from zircon by inferior hardness, smaller specific gravity, diminished lustre, and simple refraction of light. Garnet is heavier, and idocrase is lighter than essonite.

TOURMALINE, RUBELLITE, SIBERITE.

This mineral is as yet very little known among jewellers and the trade in general, although it has been in commerce for a number of years past, but under other names, such as red tourmaline, or siberite, brought from Siberia, and sold in the trade as Oriental ruby.

Tourmaline was first introduced as a gem by the Dutch, who imported it from Ceylon. Tourmaline occurs in crystals and crystalline masses, and its forms are six, nine, and twelve sided prisms, with various truncations and terminations, which commonly differ in the number and size of the faces at the two ends. The crystals are long, striated, and complete, or aggregated into irregular masses; the fracture is conchoidal and uneven, semitransparent to opaque. It has double refraction of light, which, however, is only visible in small pieces; it has a

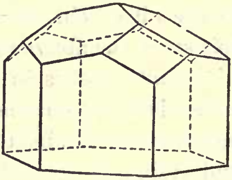
Fig. 9.

vitreous lustre; the colors are blue, red, green, and brown, of different shades. Several colors may often be observed in one and the same crystal, as, for instance, in the rubellite from Paris, in Maine, and Chesterfield, Massachusetts, inclosed by the green tourmaline; and the color often varies in its different layers.

Tourmaline scratches glass slightly, but is scratched by topaz; its powder is white; its specific gravity is 3·0 to 3·3; it becomes electric by rubbing, that end having the greatest number of faces being positive, the other negative. When tourmaline is heated it exhibits polarity, the most modified extremity becoming positive and the other negative. In this particular it resembles other hemihedrically modified crystals. At a certain temperature it loses its polarity, but exhibits it again on cooling; its polarity continues with the decrease of temperature until it reaches 32° Fahr.; a continued increase of cold re-excites the electric polarity, though with reversed poles; if the excited crystal be broken, each part thus produced will equally possess polarity, and even in the powdered state it retains its pyroelectricity. Before the blowpipe it intumesces more or less, does not fuse, but vitrifies on the edges; turns green, then yellow, then red, then milk-white, then blue, and then black. Borax dissolves it pretty easily into a clear bead.

The chemical composition of tourmalines varies greatly: they are composed of alumine, silica, oxide of iron, oxide of manganese, and boracic acid; those from different localities contain either potash, soda, lithia, or calcia. The following are the different varieties, not including, however, the white, yellow, and black tourmaline, or schorl, they not being used as gems:

1. Siberian tourmaline (siberite, rubellite, apyrite), which is of a carmine or hyacinth red, purple or rose red, passing

into violet; sometimes, by looking through in one direction, the red color changes into a blue color.

2. Indicolite (Brazilian sapphire), of an indigo, lazulite, or Prussian blue color.

3. Brazilian tourmaline (Brazilian emerald), of a grass-green or olive-green color.

4. Ceylonian tourmaline (Ceylon chrysolite), of a greenish-yellow color.

5. Electric schorl, of a yellowish, reddish, liver, or blackish brown color.

Tourmaline occurs in rocks, such as granite in layers and gangues, and in boulders; it also occurs in the beds of rivers, and the localities are Siberia, St. Gothard, Ceylon, Brazil, Sweden, Saxony, and Moravia. In the United States, tourmalines are abundant, but there are very few localities of the better varieties, as those at Paris in Maine, and Chesterfield and Goshen in Massachusetts.

The specimen of a crystal of rubellite, from Paris, Me., on the frontispiece, is a perfect prism, is dark red on the inside and dark green on the outside, and belongs to Prof. Charles U. Shepard, of New Haven, who exhibited it in the New York Exhibition in 1853. There are several beautiful green and red transparent tourmaline crystals, from the same locality, in the mineralogical museum of Yale College, from the collection of the late Baron Lederer, Austrian consul in this city.

The yellow tourmaline, from Ceylon, is but little inferior to the real topaz, and is often sold for that gem. The green tourmaline, when transparent, is often highly prized.

The Siberian red tourmaline, called siberite, is cut in cabochon, and exhibits then a milk-white chatoyant lustre.

The black tourmaline is called schorl. The localities of tourmaline are quite numerous: large size black tourmalines are found in Greenland at Hovelberg, in Bavaria near Bodenmays, at Karinbrida in Sweden, and near Bovey in Devonshire. Small brilliant crystals are met with, imbedded in decomposed felspar, at Andreasberg, in the Hartz mountains, forming the variety called aphrigite. Rubellite occurs in a species of lithomarge, near Ekaterinenburg in Siberia; pale yellowish-brown crystals are found in talc at Windisch Kappell, in Carinthia; white and variegated colored specimens come from St. Gothard and Siberia, the first imbedded in dolomite.

In the United States, some magnificent specimens of red and green tourmalines were found in 1829 at Paris, State of Maine; some transparent crystals from that locality exceed two inches in diameter, and very frequently one inch, and present a clear red color internally, surrounded by green, or are red at one extremity and green at the other. Blue and pink varieties, most commonly imbedded in lepidolite, are yet occasionally found in this locality.

Red and green tourmalines occur also at Chesterfield, Mass., in a narrow vein of granite traversing gneiss; the crystals are commonly small and curved, nearly opaque, and exceedingly frangible. Green crystals often contain distinct prisms of a red color, especially when they occur in smoky quartz; blue tourmalines also occur at this locality, and are accompanied by albite.

The Russian Mineralogical Museum was supplied, in 1832, by its minister, Baron Crudner, with specimens of fifty pounds weight, containing the rock of green and red tourmalines, from the Chesterfield locality.

At Goshen, Mass., similar varieties occur, and the blue tourmaline is met with in greater perfection; very perfect crystals, of a dark-brown color, occur imbedded in mica slate, at Monroe, Conn.; the crystals are commonly from one to two inches long, and nearly as broad, and uniformly they are perfectly terminated at the two extremities.

Haddam, Conn., also affords fine black crystals, and some of large size; they are profusely mingled in a mica slate, and associated with anthophylite and hornblende. A cinnamon-brown variety is met with at Gouverneur, N. Y., imbedded with quartz, and also associated with scapolite, apatite, and sphene, in granular limestone. These crystals are very often highly modified, and occasionally exhibit the faces of a scalene dodecahedron in addition to the terminal planes. Similar specimens occur at Grenville, Lower Canada, and Newton, N. J., associated with corundum, spinelle, and rutil; and at Kingsbridge, N. Y., and Carlisle, Mass., with garnet.

The red tourmaline, when transparent and free from cracks and fissures, admits of a high polish, and forms a most beautiful and costly gem.

It has been supposed that tourmaline was known to the ancients under the name of lyncurium (*λυγκούριον*), which is described as having electrical properties; this name, however, was more probably applied to some variety of amber, which was so called from its supposed origin from the urine of the lynx. The identity of the red tourmaline with the hyacinth of the Greeks is more probable; the other varieties were either unknown, or possibly connected under a common name with other species of the same color.

Tourmaline received no attention from the moderns till Lemery, in 1717, published his discoveries. The word tourmaline is a corruption of the name for this mineral at Ceylon, whence it was first brought into Europe.

The name schorl, which has been applied to the black tourmaline and some other mineral species, is reported to have been derived from Schorland, the name of a village in Saxony, which afforded specimens of this variety.

Tourmaline is cut on a brass or leaden wheel with emery, and polished with rotten-stone on a tin plate; it receives various forms, such as the step and table cut. If of a pure color, it is set *à jour*, otherwise with a foil corresponding to its color; but the electric schorl is sometimes set so that it can be removed from its mounting to be used in performing experiments. The value of tourmaline depends upon its color, purity, and size. The siberite and rubellite stand highest in estimation. A siberite, as large as five lines, is worth about one hundred and fifty dollars; and one of four to twelve lines, good color and pure, is worth about fifteen hundred dollars. The rubellite from Paris, Maine, has become very rare, and it is much to be regretted that no more attention is paid to obtaining a fresh supply, as the crystals are of an exceedingly fine purple color, and perfectly transparent. I have a few polished rubellites and green tourmalines in my cabinet, which I value equally as high as any gems.

The dark-green tourmalines, six lines long and four broad, are sold in Paris for eighty francs, and the light-green, of the same size, for forty francs. The most splendid siberite is at the British Museum, having been presented by the King of Ava to Colonel Symes; it is valued at one thousand pounds sterling.

Tourmalines may be readily distinguished from other gems or pastes, which are sometimes substituted for them, by their property of assuming polaric electricity after being heated.

QUARTZ.

This mineral is diffused all over the globe. Its varieties are very numerous, and many of them are employed in jewelry and for divers ornamental purposes. It occurs massive, in concretions, in confused crystalline masses, and in crystals, of which the form is the six-sided prism, terminated by six-sided pyramids; also the dodecahedron, or double six-sided pyramid. Quartz scratches glass and felspar, but is attacked by topaz. Its hardness is 7·0, and its specific gravity, 2·5 to 2·7; it is transparent, and possesses a vitreous lustre; becomes electric by rubbing; is infusible before the blowpipe. Acids, except the fluoric acid, do not act upon it. Silica is the only essential component part of quartz, but some varieties contain iron, alumine, or lime.

ROCK CRYSTAL.

This mineral was known in early ages. It was highly esteemed by the Greeks on account of its purity and very regular formation. Theophrastes states that it was cut principally as seals, and the ancients made great use of it for ornaments, particularly before the art of making glass had reached much perfection. Among the many vessels which were cut in the form of cups, vases, &c., were two fine bowls and chalices in the possession of the tyrant Nero, who purchased them at a large sum. Rock crystal was also used as a medicine.

It is found crystallized, in the primitive form, which is the rhomboid, extended to a six-sided prism; and in a great variety of forms and modifications, such as with a truncation or replacement of the edges, or solid angles, &c. It is frequently found in groups, also in the cavities of other minerals, or in incrustations, as small, but very perfect crystals, the pyramidal terminations of which have a high polish, and the specimen appearing as if it were studded with gems. Many specimens of this description were brought from Vermont a few years ago, and were eagerly purchased by the jewellers of this city for rings, earrings, and breastpins. Rock crystal has a conchoidal fracture; is translucent and transparent; possesses a double refraction of light; a perfect vitreous lustre; is limpid, white, brown, black, or yellow; scratches glass; specific gravity, 2·65. The electricity acquired by rubbing lasts for thirty minutes. Before the blowpipe, when colored, it becomes limpid. The following varieties of it are made known by their names and characters:

1. The pseudo diamond (Bohemian or occidental diamond), which is the limpid, colorless rock crystal, cut and polished.

2. The iridescent quartz is that variety of rock crystal, the interior of which is replete with fissures and cracks, so that the refraction of the rays of light produce the rainbow colors.

3. Citron (Bohemian topaz, occidental topaz, yellow quartz, Scotch pebble), which is of a pale, ochry, gold, whitish, lemon, or brownish yellow color. The false cairngouram of Brazil is a beautiful variety of yellow quartz.

4. Smoky topaz (cairngouram or true Scotch pebble, brown quartz, smoky quartz) is of a smoky or brown color.

5. Morion is of a charcoal-black or brownish-black color.

6. Hair or needle stone, or such rock crystal as has, in its interior, foreign substances, as rutil (red oxide of titanium), manganese, iron, chlorite, amianthus, or asbestos. When the stone is so cut as to represent the hair or needles in an upright position, they are called either Venus' hair (*cheveux de Vénus*), or Love's arrows (*flèches d'amour*).

Rock crystal occurs in gangues, or rock cavities, in the oldest geological formations; it is also occasionally found in some modern rocks.

The mountain of Cairngouram, in Aberdeenshire, Scotland, has furnished, and still continues to afford, many fine specimens of smoky quartz. The lapidaries of Edinburgh always meet with a ready sale of this far-famed stone among the Scottish gentlemen, as the native produce of their country. Many very beautiful sets of the Cairngouram were exhibited in the London Exhibition.

A group of rock crystal, in the museum of the university of Naples, weighs nearly half a ton.

The black limestone of Quebec affords fine crystals of quartz. In the State of New York, quartz crystals, remarkably clear and perfect, from the size of a pin's head to four inches, are found in many localities. Diamond Island, in Lake George, is a famed spot; Gouverneur, N. Y., affords splendid dodecahedral crystals, associated with an iridescent crystallized specular iron. At the Notch of the White Mountains, N. H., and at the locality of tourmaline at Paris, Maine, handsome crystals of brown and smoky quartz have been obtained.

At Trenton Falls, in the State of New York, very perfect and completely terminated transparent crystals are found, with their endless modifications, some of them five inches long, and some containing drops of water. It is also found at Windham, Vermont, where the drusy variety occurs, which is extremely beautiful, and of variegated colors. About twenty years ago it had a great many admirers, and was generally worn in brooches, rings, &c. It is also found in Maryland, Massachusetts, and on the Catskill mountains.

Rock crystal is obtained in Switzerland, and some other countries, by mining; those cavities geologically or mechanically traced from the quartz veins, are sounded by miners in granite veins or other rocks, by means of instruments, and when hollow, extensive preparations are made for procuring the whole produce of the cavities, which sometimes amounts to several tons. It is likewise procured from the sand of rivers, and it passes then under the name of flints; also, from gangues or veins of other minerals. The smaller and clearer transparent ones are generally employed in jewelry and for ornaments; but the larger specimens are first assorted and then split or cleaved, and the smaller pieces are sawed through with a copper wire, emery, and oil, into the desired sizes, when they are ready for being cut on copper or leaden discs, with emery and water, and polished on tin plates with rotten-stone, putty, bole, or other fine powder; or they may be polished on wooden wheels, lined with fur or leather. The forms which they generally receive from the lapidary, are the brilliant, rose, or table. The iridescent quartz, and the hair or needle stones, are only cut concave. Those specimens that have a full pure wine-yellow color, are best cut in steps. When mounted, they are either *à jour*, or with a black foil. Those which are spotted, or of an irregular color, may be discolored by careful calcination in crucibles, with lime, sand, or pearlash, which process likewise increases the lustre. The crystal may be bored with a diamond point, also engraved, and figures may be etched in it by means of fluoric acid. It is mostly used for pins and rings; also, for the base of doublets; likewise, for a very great variety of ornaments, such as seals, gems, snuff-boxes, cane-heads, &c.; also for imitating the real gems, by being colored and immediately immersed in a solution of coloring water, whereby the color is very closely imitated. It is moreover the base of all the pastes or strass.

Its value is by no means so high as formerly, when the demand for it was great for setting in buckles, buttons, &c. Articles made of large pieces of it, or those containing slender needles, hair, moss, incrustation, or imitation of other substances, are yet somewhat esteemed. In their natural state, if quite clear, as they are received from Madagascar, Switzerland, and Brazil, they are sold for from one to ten dollars per pound; but when cut for seal-stones, or breastpins, they are sold mostly by the jewellers of this country as white topaz, and command a fair price. Well-cut seal-stones are sold at from five to twenty dollars. Those of the brilliant-cut are sold at from fifty cents to a dollar a piece. The largest rock crystal is said to be in the collection of M. Rafaelli, artist, at Rome,—and a large candelabra of iridescent quartz, is in the Vatican. The proprietors of the American Museum of this city, can boast of having one of the largest specimens of rock crystal from Brazil. It weighs two hundred and twelve pounds, is two feet and a half high, and one foot in diameter, and is a perfect six-sided prism.

Two large crystals of quartz, attached by one of the vertical faces, the crystals being each two and a half feet high by eight inches in diameter, were exhibited by the Duke of Devonshire, at the London Exhibition, in 1851. The pyramidal summits of these crystals, which rise nearly a foot above the prism, are completely transparent, but the prisms are cloudy. These magnificent crystals were obtained from the Alps, having been discovered during the formation of the road over the Simplon, in a cutting made through the old rocks. I saw a most magnificent chandelier of rock crystal in the Tuileries, which is said to have cost one hundred thousand francs. The clearest rock crystal comes from the island of Madagascar, in blocks weighing from fifty to one hundred pounds. In Switzerland, and the province of Auvergne, in France, very fine specimens may be had. The Bristol, Buxton, Cornish, and Irish diamonds, which are all pyramidal crystals of quartz, are known all over the world.

A specimen of rock crystal in the Museum of Natural History, at Paris, measures three feet in diameter, weighs nearly eight hundred pounds, and was found at Fischbach, in France.

Rock crystal may be easily distinguished from white paste, called strass, as the latter is heavier, on account of the metallic oxides contained in the composition.

A very remarkable phenomenon in quartz is exhibited by the fluid drops which are contained in many specimens. They occupy small cavities, and evince their presence, on turning the specimens, by the motion of the accompanying air-bubble, like the bubble in a spirit-level. These cavities are sometimes of considerable size. Jacobson, of Copenhagen, possesses a geode of quartz an inch and a quarter long, which contains at least half a cubic inch of fluid. Mr. Allen also describes a crystal of amethyst in his collection, which contains four cavities partially filled with this peculiar fluid. At a temperature of eighty-three degrees the fluid dilates and entirely fills all the cavities, and as it re-appears on cooling, an ebullition is apparent. Sir David Brewster has ascertained that the fluid is not, as was supposed, water, but of an oleaginous nature, from twenty to twenty-five times thinner than water. A considerable number of specimens containing the fluid were carefully examined, and he found that one part of the fluid is volatile at twenty-seven degrees, and the other was a fixed oil. Prof. Dana has lately named the former, cryptoline, and the latter, brewsterline. There is a great difference in the specific gravity of both liquids. The more dense yields a transparent yellow resinous globule, which absorbs the humidity of the atmosphere, is insoluble in water and alcohol, but dissolves in hydrochloric and nitric acids.

Occasionally a bituminous fluid, resembling napththa, is contained in the cavities of quartz.

A very peculiar gelatinous substance, appearing to be silica in solution, has been observed on breaking open geodes, and the production of a species of chalcedony from the subsequent evaporation, has also been observed. But the nature of the solvent of silica is not yet fully ascertained. It is, however, held in solution in the hot waters of the Geysers of Iceland, whose solvent power is supposed to be due to the presence of a small quantity of alkali and their high temperature. The Geysers have covered the part of Iceland in their vicinity with a silicious sinter.

The pseudomorphous quartz, from North Carolina, contains fluids in large quantities in its cavities.

Two pieces of quartz rubbed together in the dark, emit a phosphorescent light and a faint empyreumatic odor.

AMETHYST.

This gem has been known since the earliest ages of Greece and Rome; the name is of Greek origin. The ancients believed that wine drank from an amethyst cup would not intoxicate; hence its name, expressive of that belief—αμιθυστος, from α, not; μεθυω, to intoxicate. As regards the color, Pliny says: "ad riciniam crystalli descendet albicante purpuræ defectu," purple gradually fading into white. This is not, however, the only amethyst of the ancients; the violet-colored sapphire, the violet fluor spar, ("sculptaris faciles," easily graven—Pliny,) and some other purple species were designated by the same name. It has also been supposed that garnet came under the same denomination. This name occurs in Scripture, being that of the ninth stone in order on the high priest's breast plate of judgment, with the name Issachar engraved thereon. Amethysts were always used for engraving. The bust of Trajan, in the Royal Library, at Paris, and the Apollo Belvidere, the Farnese Hercules, and the group of the Laocoon, are splendid specimens of it. It occurs massive in boulders, or in hexahedral prismatic crystals, terminated by hexahedral pyramids. Its crystals are rarely as distinct as those of quartz, being, for the most part, latterly aggregated by the whole prism, the terminal pyramids alone being separated from each other; its fracture is from conchoidal to splintry; it is transparent to translucent; of a vitreous lustre; color of a high and dark violet blue, and from its richest tinge to almost colorless, in one and the same specimen. It scratches white glass, gives fire with steel, but yields to the file. Its specific gravity, 2·75; becomes electric by rubbing, which lasts, however, but half an hour. Before the blowpipe it loses its color. Its component parts are pure quartz, colored by manganese and iron. It occurs in veins of the older formations, studding the interior of agate balls or geodes in the amygdaloid and trap rocks of Hungary, Silesia, Saxony, Tyrol, Oberstein; and as boulders of splendid specimens in Ceylon, Siberia, and Brazil. It is wrought in the same manner as rock crystal, being cut on a copper wheel with emery, and polished on a tin plate with rotten stone. In order to raise its lustre, many facets, and very frequently those of a rose-diamond, are given to it in cutting. It is sometimes cut in the form of a brilliant, and when set is supplied with a blue or red foil, provided the amethyst is pale, for the deep-colored ones do not require any artificial assistance. It is used in almost every description of jewelry, such as rings, ear-rings, and breastpins; but it is set in necklaces to the best advantage, and is the only colored gem which may be worn with mourning, an advantage which adds to its value. The amethyst is no longer held in such estimation as formerly, but the color, when intense and uniform, as also the size, contribute greatly to its value; and good well-cut amethysts, of one carat, are worth from three to five dollars, and so on, in proportion to their size; an amethyst fifteen lines long and eleven lines broad, exquisitely fine, was valued at five hundred dollars.

The best amethysts now in commerce come from Ceylon, Siberia, and Brazil; the first are commonly called Oriental amethysts, which, however, must be carefully distinguished from a much more valuable gem, the true Oriental amethyst, which is the violet sapphire. I have in my collection a quantity of the Brazilian amethysts, which are of an intense violet color, and of a very large size.

Amethysts occur also at Pic Bay, and at Gorgontwa, Lake Superior, crystallized in trap; also at Bristol, Rhode Island, and occasionally throughout the trap region of Massachusetts and Connecticut.

The amethyst is valued by the jeweller in proportion to the depth, richness, and uniformity of its color, and its perfect transparency; it forms, then, a stone of exquisite beauty, its color being, perhaps, more generally attractive than that of any other gem, especially as it may be obtained of as large a size as can be conveniently worn. It is worn by priests, bishops, and pontifical dignitaries as a ring-stone set with brilliants. Like many other stones, it is less brilliant by candle-light, and it appears at all times to best advantage when surrounded with pearls and set in gold.

Amethyst has lately been employed by the cameo-cutters of Paris, for cameos and intaglios; the head is cut at the collet, which is the thick part of the stone, and the crown having diamond facets produces a fine effect.

The amethyst is often imitated by fluor spar or violet-blue lime spar; both, however, are softer than amethyst; the lime is lighter, and the fluor is heavier than amethyst. But it is imitated very strikingly by pastes, so that with great difficulty the real is to be distinguished from the imitation; the latter, however, is somewhat heavier, on account of the metallic oxides contained in the composition. The following is the best receipt for imitating the amethyst:

1000 parts of strass,
8 " oxide of manganese,
0·2 " purple of cassius, and
500 " oxide of cobalt.

One of the largest geodes of amethyst was brought into England in 1819, weighing one hundred and fifty pounds; it was two feet long and fourteen inches broad, and contained most magnificent crystals, of the deepest violet color. On account of having been set down at too low a price at the custom-house, which was sixty-five pounds sterling, it was confiscated.

COMMON QUARTZ.

But a few varieties of the common quartz are used in jewelry, which are: the *Rose Quartz*, the *Cat's-eye*, the *Prase*, and the *Avanturine.*

Rose Quartz.

This mineral generally occurs massive; it is semi-transparent, and translucent on the edges; has a vitreous lustre; conchoidal and splintry fracture; is of a rose-red color; sometimes giving a lustre of mother-of-pearl. It scratches glass; has a specific gravity of 2·64 to 2·67; its color, which is derived from the oxide of manganese, becomes paler before the blowpipe.

Rose quartz occurs in gangues of granite and gneiss, particularly fine in Sweden, Bavaria, Bohemia, and Siberia; also a beautiful dark color in New-Hampshire and Massachusetts.

Rose quartz is cut and polished for jewelry; such as rings, breastpins, and snuff-boxes; it is cut on a copper wheel with emery, and is polished with rotten stone and putty, on a tin plate, receiving the form of a cabochon or table, and when set requires a foil, colored by carmine or solution of gold, as it fades when exposed a long time to the light. The rose quartz is not held in great estimation; the color as well as the lustre of faded rose quartz may be resuscitated by being left for some time in a moist place.

A vase of rose quartz was in the possession of the Marquis de Drée, nine inches high and two inches in diameter.

Cat's-eye.

The name of this mineral is derived from the peculiar play of light perceptible on its surface, by which it resembles the rays of light in the eyes of a cat; it is not ascertained whether the ancients knew this mineral, and whether it was comprised in their asterias; but it is well known that cat's-eye is in high estimation among the Malabars and Moors; and it is worn throughout the whole East, where it is employed as an amulet, being believed to possess the virtue of enriching the wearer.

Cat's-eye occurs massive, and in more or less roundish pieces; has a conchoidal fracture; is translucent and transparent sometimes on one end; it has a shining lustre, between vitreous and resinous; gray and brown, green, red and yellow color; it presents a peculiar floating light, which is particularly visible if cut in high cabochon, as it usually is when brought to market; it scratches glass; has a specific gravity of 2·56 to 2·73, and contains 95 silex, 1·75 alumina, 1·50 lime, and 0·26 oxide of iron. In many specimens, there may be observed small parallel white fibres, which are supposed to be the cause of its peculiar play of light; but the semi-transparent varieties, which are equally chatoyant as the more opaque ones, present no such appearance. This leads to the conclusion that amianthus in its finest fibres occasions the phenomenon, and the chemical analysis of the latter corresponds with the additional constituents of the cat's-eye. By exposure to a strong heat, it loses its lustre and transparency; and, in small fragments, is fusible before the blowpipe. Cat's-eye is found in fragments of gangues and boulders, of very small size, never larger than a hazel-nut, in Ceylon, on the coast of Malabar, in the Hartz mountains, Bavaria, and in this country, (in Vermont, New-York, &c.) Ceylon, where the finest cat's-eyes are found, sends them abroad already cut and polished in cabochon; but very often they are cut over again on a copper wheel, with emery, and polished on a tin plate; they receive in setting a gold foil. The value depends principally upon its intrinsic properties, size, color, and degree of play of light. Of the nearly opaque varieties, the red and the almost white are the most esteemed, and such are sold usually from ten to twenty dollars; and a stone of the size of a square inch, and otherwise perfect in its properties, is worth from eighty to one hundred dollars.

In the imperial cabinet of Vienna, a cat's-eye, five inches in length, of a yellowish-brown color, may be seen.

The Indians attribute to cat's-eye wonderful virtues, and the largest and prettiest stones are said to possess them in a high degree.

Jean Ribeiro quotes, in his "History of Ceylon," a cat's-eye, belonging to the Prince of Ura, which was perfectly round and of the size of a pigeon's egg, possessing magnificent chatoyant colors; changing, on the least movement of the stone, its beautiful reflections.

Prase.

This mineral is mentioned by Pliny; but it is not certain whether he meant the same substance that we do:

more probably he alluded to the emerald; for the same mineral is at the present time called the emerald mother or matrix by jewellers. Prase occurs massive and crystallized; it has a conchoidal fracture; is translucent on the edges; between vitreous and resinous in lustre; and of a garlic-green color, the cause of which is, that actinolite is intermixed with the silex. It scratches glass; has a specific gravity of 2·66 to 2·88, and is composed of silex, alumina, and oxides of iron and manganese. It is found in Saxony, Tyrol, Styria, Hartz, and the island of Elba. It is used for rings and pins; also for snuff-boxes and other jewelry, and is cut in cabochon, and set with a gold foil at the base, by which its color is heightened, and rendered more agreeable. It is used in mosaic works, for foliage; and likewise in the mounting of rubies, in order to raise their color. Prase does not stand in great estimation; for although it assumes a very good polish, it loses the same on long exposure to the air, and grows spotty.

Avanturine.

This mineral received its name from bearing a resemblance to a glass paste, formerly manufactured in Italy. It is a brown or red quartz, which is massive and translucent, or opaque; it has a resinous lustre, and its fracture is splintry and uneven; it is penetrated with gold or brass-yellow glistening fissures, caused by the refraction of light, or by innumerable mica leaves. It scratches white glass; has a specific gravity of 2·64 to 2·68; silex, with some alumina and water, are its constituents.

The avanturine is found in the Uralian mountains, Styria, Cape de Gata, near Madrid, Nantes, Scotland, &c. It is used for ring-stones, ear-rings, and snuff-boxes. It is cut on a copper wheel, with emery, and polished with rotten-stone on a tin plate; it is cut semi-lenticular or oval, does not take easily a good polish, but may be improved by rubbing the stone with oil of almonds. The value of avanturine is much depreciated of late, and its imitation by glass paste, called *goldstone*, is by far superior to the real stone, which has nothing but hardness in its favor. This paste is manufactured in great quantities in France, by throwing the finest impalpable powdered brass into a quantity of colorless strass, or into a composition of

105 parts quartz,
85 " purified potash,
230 " tin and lead alloy,
50 " brass powder.

The artificial avanturine, as made in Italy, is a silicious oxide of copper. The mode of manufacturing the best quality, which is done very extensively in Italy and France, is still kept a secret; that the copper is reduced first to a sub-oxide, and nearly to its crystalline metallic state, may be inferred on examining with a microscope the common artificial stone, which has a most splendid appearance. The best avanturine is manufactured in Venice, by M. P. Bibaglia, who alone appears to have the secret of excelling the natural stone. Messrs. Fremy and Clemendot, expert French chemists, have succeeded in approximating the Venetian manufacture, by heating 300 parts ground glass with 40 parts of protoxide of copper and 80 parts of oxide of iron, and allowing the mass to cool very slow.

Large blocks of the factitious avanturine, with a great variety of manufactured ornaments, were admired in the Paris Exhibition, in 1855.

JASPER.

This mineral is of Oriental origin, and is very often mentioned in the Bible. It was the sixth stone in the plate of the high-priest. Jasper was well known to the Greeks and Romans, and according to Pliny, who has described several varieties, the best came from Scythia, Cypria, and Egypt, on the banks of the Nile. The lapidaries formerly made use of it in their works, particularly the Egyptian jasper, which afforded them abundant material. The column of Memnon and the foundation of the column of Pompey were constructed of it, and we find daily, among the excavations of Herculaneum and Pompeii, fragments of ruins, composed of Egyptian jasper.

Jasper occurs in enormous masses; has a conchoidal fracture; is opaque; its lustre is slightly resinous, like wax, often dull; it is of white, red, yellow, green, blue, brown and black colors; it scratches glass, but yields to rock crystal; its specific gravity is 2·31 to 2·67.

It is usually found in gangues, seldom in strata, in Egypt, Bohemia, Saxony, Tyrol, Hungary, France, Italy, Spain, Siberia, Corsica; in the United States, principally in Florida, North Carolina, Massachusetts, &c.; also, in Nova Scotia.

A fine yellow jasper is found at Vourla, bay of Smyrna, in a low ridge of limestone, to the right of the watering-place, between the harbor and the high hills that commence their rise about a mile back; it is here associated with a beautiful opal, coarse carnelians, chrysoprase, and hornstone, and these minerals seem to occupy in the limestone the place of the hornstone, which is found in various parts of the adjoining country, and also at Napoli di Romania, in Greece. The plains of Argos are strewed with pebbles of red jasper.

The jasper and quartz rocks of Siberia are well known materials of extreme hardness, worked only in the Russian empire, and are rarely met with, except as imperial presents to princes and distinguished foreigners. A group of very remarkable objects was exhibited among the Russian goods in the London Exhibition. The material of some of these vases is quartz rock, but most are of a kind of pseudo jasper or pseudo jasper lava, of greenish color, and extreme toughness and hardness, resisting almost every tool, and requiring to be cut with emery, like the hardest gems. These rocks chiefly exist in Siberia, beyond the Oural, and are in great abundance and variety. The vases of jasper were worked at the imperial manufactories of Ekaterinenburg and Kolyvan. There almost the whole work is performed by manual labor; the only machine used is a simple lathe, on which the object to be turned is placed, and worked by iron tools and emery. No tool will touch these stones, both chisels and files of the hardest temper turning without producing any effect. The time for furnishing vases of considerable magnitude is often many years, and their value is calculated by the cost of the large establishment kept at constant work. A large vase, measuring three feet on each side, in a square form, was exhibited, hollow under the rim, with foliage in the same, and was one of the great curiosities in the Exhibition. Smaller vases, an olive-green jasper urn, decorated with admirably worked foliage in relief, from the imperial manufactories, were likewise exhibited, all of which excited the admiration of the spectators; and since the times of the Greeks and Romans no such gigantic works, both in dimensions and weight, have been wrought. The quantity of intaglios and cameos from the ancient Greeks and Romans is too numerous for giving them a space in this treatise, for it would fill a whole book to specify the antiques which are scattered around the world, in the various museums of Rome, Vienna, Paris, London, Berlin, Dresden, and the private cabinets which have for centuries existed in noble families.

According to their varieties, which are very numerous—

that is, in color and structure—they receive their names; but they may still be classified into the following two divisions:

1. *Egyptian Jasper*, (Egyptian pebble,) which occurs in spheroidal pieces, of a gray-brown and red color, the form of which is cut and polished in annular representations around its centre. It is found in Baden, Upper Egypt, and other places; among the pebbles of the river Nile it is frequently discovered; and in the year 1714, it was found near the village of Incheric, by Paul Lucas.

2. *Ribbon or Striped Spar.* It occurs in masses, with nearly conchoidal fracture, around which parallel, straight, or twisted stripes of a gray, green, yellow, red, or brown color may be perceived; it is principally found in Siberia, the East Indies, Corsica, Tyrol, and the Hartz mountains; some of the West India islands produce most splendid specimens.

Jasper is principally used for seals, snuff-boxes, vases, table-plates, and for some architectural purposes.

When in lumps, it is divided by means of copper saws and fine sand, and then cut on copper or leaden wheels with emery, and polished on tin plates with rotten stone, colcothar, or charcoal; or it may first be polished on wood with pumice stone, and lastly on a tin plate with rotten stone and water.

The yellow jasper is often employed in mosaic works in Italy, and the striped jasper as cameos. Jasper has no great value in trade, unless it be of exquisite quality, and fine objects be made of it. It generally commands the best price in China, where the emperor has a seal cut of it. A vase of red Jasper, with white veins, and one of black jasper, with yellow veins, may be seen in the Vatican. Chatouilles and other boxes of considerable size are frequently found in the jewelry stores of France, England, and the United States.

HORNSTONE.

Hornstone occurs massive, globular, stalactiform, and in pseudo-morphous crystals of carbonate of lime, and also in the form of petrified wood, (wood-stone or agatized wood.) Its fracture is either conchoidal or splintry; it is opaque or transparent on the edges; has a dull or shining lustre; deep gray, brown, red, yellow, or green, and rarely a pure color. Often it has several colors in one and the same specimen, such as points, spots, and stripes. It scratches glass, and has a specific gravity of 2·53 to 2·65.

It is mostly found in the gangues of the older formation; also in the old red sandstones and alluvial formations, in Bohemia, Saxony, Sweden, Siberia, Hungary, and a number of other places; in the old red sandstone of Thuringia. I have traced one stem of the red agatized wood eighteen feet in length and two feet in diameter. The price of hornstone is very low; it is used for snuff-boxes, seals, crosses, mortars, and principally as knife and fork handles. It is now used by silversmiths to mount butter and dessert knives and forks, which are imported from Germany in considerable quantities.

CHALCEDONY.

This mineral was held in great estimation by the ancients, who received their principal supplies from Egypt and other parts of Africa. In Rome, much use was made of it for cameos, many of which may yet be seen in collections. The inhabitants of Iceland are likewise said to value it very highly, and to attribute many medicinal properties to it.

It is found in crystals, such as cubes, but mostly massive, botryoidal, stalactiform, globular, or reniform, &c. The fracture is even, sometimes running into conchoidal or splintry; it is semi-transparent or translucent, of little lustre, or dull; of white, gray, blue, yellow, brown or green colors, which are all of a light shade, and variously figured, striped, spotted, &c.

It scratches white glass, and has a specific gravity of 2·58 to 2·66. It is distinguished into the following varieties, viz.:

1. Chalcedony proper, or chalcedonyx, wherein white and gray stripes alternate with each other.

2. Mocha, or tree stones, are such chalcedonies as display black, brown, or red dendritical figures.

3. Rainbow, or agate chalcedony, is chalcedony of thin and concentric structure, which, cut across and kept towards the light, displays an iridescence.

4. Cloudy chalcedony, has a light gray and transparent base, with dark and cloudy spots.

5. Plasma, dark grass-green. This mineral was very often employed by the ancients for cutting.

6. Semi-carnelian, or ceregat, is generally called the yellow chalcedony.

7. Sappharine, is the sky or sapphire blue chalcedony.

8. St. Stephen's stones, is the white chalcedony, with blood-red spots.

There are many more varieties, and in my own collection I have polished chalcedonies, among which, perhaps, as many again may be enumerated.

Chalcedony was originally procured from Chalcedon, in Asia Minor, whence its name.

Chalcedony is found in gangues, and in the cavities of many rocks; also in boulders and pebbles. Localities exist in Saxony, Hungary, Faroe Islands, Ceylon, on the shores of the Nile, in Nubia, Nova Scotia, the United States, (in Connecticut, Massachusetts, Pennsylvania, Ohio, New-Jersey, Missouri, Florida,) and in other countries; but the best specimens are brought from Oberstein, Iceland, and the Faroe Islands.

The finest specimens are employed in jewelry, for rings, pins, bracelets, necklaces, and seals; the more common for snuff-boxes, vases, buttons, &c. The larger masses are cut by means of a copper wire, with emery and oil on a copper wheel; they are polished on a tin plate with rotten stone, putty-powder, and pumice stone. The cutting is generally done on a large scale, like that of agate. Many are susceptible of receiving figures artificially, by means of the nitrate of silver. By Oriental chalcedony is generally understood the better qualities; those chalcedonies of two or three divisions, called onyx, are used for cameos.

The value of the chalcedony depends on its quality, such as purity, color, and the figures and drawings displayed on it; and among all the varieties of chalcedony, the mocha stone stands the highest in price, and also the onyx, which is principally employed for cutting cameos, and according to its size, commands a high or low price. Mocha stones are sold in France at from five to eight francs. The cabinet of Dresden contains a plate of onyx, about three inches broad and long, which is estimated at twenty-five thousand dollars.

CARNELIAN.

This stone was known to the ancients by the name of Sarda; which, according to some, is derived from a place in Lybia or Sardinia, or, according to others, from the Arabic word *sarda*, meaning yellow; it has been employed very frequently for cutting intaglios or bas-relief gems.

Carnelian occurs massive or in pebbles; its fracture is conchoidal; lustre resinous; it is semi-transparent and translucent; of a blood-red, yellow-brown, or yellow color; frequently dark at the outside, growing paler towards the inside; the colors are sometimes changing striated; it scratches white glass, and has a specific gravity of 2·59 to 2·63. There are two varieties known by lapidaries and jewellers which are better than the others; those having a pale color or yellowish tinge, and those having a dark-red color; the latter are in the highest estimation, and are called by the French *cornalines de vieille roche.*

Sardonyx is called a carnelian, having as its principal color the dark-brown or orange-yellow, interchanged with layers of a white color.

Carnelian onyx has a blood-red base, marked with white stripes. The finest carnelians come from Siberia, India, Arabia, Nubia, Surinam, Oberstein in Germany, and Tyrol; they occur mostly as pebbles or in cavities of rocks. In the United States they are found on Lake Superior in large quantities, in Missouri, and in Massachusetts. The carnelian is used for numerous articles in jewelry, such as seals, rings, watch-keys, &c.; it is cut on a leaden plate with emery, and is polished on wood with pumice stone, and obtains its highest polish on a plate composed of lead and tin with rotten stone and water. The form of its cutting is that of pavilion or step cut, on the upper part, and either quadrangular, hexagonal, octangular, or round; and for raising its lustre or color it is furnished with a silver or gold foil, or with red paint on its base. The color of the carnelian is also improved by calcination; the yellowish kind, for instance, by calcining it in a moderate heat and cooling it slowly, may assume a good red color. It is said that the ancients boiled the carnelian in honey in order to heighten its color. Colored figures or drawings may successfully be represented by a mixture of white-lead, colcothar, or other metallic oxides, and gum-water, which is the material for drawing on it, and by burning the same under a muffle.

Carnelian is divided into Oriental and occidental; the first is found in the old rocks, and is generally very hard, rich in color, clear and transparent, and takes a high polish, is brought from Surat, in the Indies, and valued at ten francs the kilogramme; the occidental carnelian is softer, of a yellower red and less brilliant.

Stygmite is a beautiful variety with variegated colors, of reddish-yellow or yellowish-red, with many white lines passing through the stones.

The ancients, particularly the Romans, were very partial to engraving on carnelian, and some very remarkable stones are still in existence in the imperial library at Paris. The seal of Michael Angelo, which is valued at 50,000 francs, is said to have been engraved by Maria de Descias after the original of Praxiteles; the bust of Ulysses, Hercules killing Diomede, Jupiter, Mars, and Mercury.

The great scarabee in carnelian, in the Prussian cabinet, which represents the five heroes of Thebes, is a master-piece of Etruscan art.

The crown jewels of France contain some very costly carnelian engravings of very large size.

The faults of the carnelian are fissures, unequal color, and flaws from other stones. Carnelian is, on account of its being less brittle, more useful for engraving and cutting cameos; the white layers are generally used for the figures of cameos and the red for the base. Sometimes such carnelians as are cut with bas-relief objects, are filled out with colored strass; and we receive from India, very frequently, cameos with the most singular drawings, and which are made by the inhabitants in the following manner: the whole carnelian is covered with carbonate of soda, and then exposed to the fire for a few minutes, whereby a strass is formed, upon which the figures are cut. The value of carnelian is much higher than chalcedony, but yet depends on all its qualities of color, transparency, equal division of color, and freedom from faults, such as fissures, clouds, dark spots, &c. For a perfect sardonix, a very high price is generally given, particularly when the layers are very distinct and run quite parallel, and are pretty thick, so that they are fit for cutting cameos or intaglios. The blood-red is second in value, and the pale-red third; but the cheapest are the yellowish, brownish, or whitish kinds; the prices vary from twenty dollars to twenty cents per piece. There exists a cameo of sardonyx, representing the portrait of the celebrated Father Fontanarosa, having his face white, with the base, cap, and cloak black, so that it may distinctly show the Dominican monk.

HELIOTROPE, BLOODSTONE.

This stone derives its name from the Greek language, having been used in ancient times for observing the sun. Pliny speaks of heliotrope. It occurs in massive and obtuse angular lumps, of a conchoidal fracture, is translucent on the edges, of a resinous lustre, and leek-green color, with red and yellow spots. It scratches white glass; has a specific gravity of 2·61 to 2·63. Heliotrope is found among amygdaloid, in Tyrol, in the United States, (in New-York, near Troy,) Scottish Islands, Siberia, Faroe Islands, Egypt, Barbary, Tartary, &c. It is principally employed in rings and seals, watch-keys, snuff-boxes, and other articles of jewelry,—also for sword and dagger handles; and is wrought like chalcedony, but sometimes cut on brass plates; its forms are various: as cabochon and pavilion.

Heliotrope has been greatly admired in modern times; its price depends upon the color and quantity of red spots contained in it. From one to twenty dollars is the usual price for good and large specimens.

It is said that superstitious people in the middle ages valued the heliotrope, with many red spots, very highly, thinking that Christ's blood was diffused through the stone.

AGATE.

This stone was well known to the ancients, under the name of achates, and was used for various purposes of jewelry. In Rome, it was principally used for cutting cameos from the striped kind, the onyx. It has also been worn as an amulet, with different characters engraved upon it. Its name is derived from a river in Sicily, where the ancients procured it. Agate is a mixture of several species of quartz, which are variously combined; chalcedony or carnelian usually forms the principal part, and is mixed with hornstone, jasper, amethyst, quartz, heliotrope, cachelong, and flint; and according to the predominating substances, it is sometimes called chalcedony, jasper, or carnelian agate. Its color, as well as its other characters, depends upon the nature of the mixed parts; likewise its hardness; but it usually scratches white glass, and has a specific gravity of 2·58 to 2·66 at the utmost.

According to the different figures represented in agate, it receives its various names.

1st. Ribbon, or striped agate, representing layers variously colored, and alternating with one another. *Onyx*, or agate onyx, are such agates as have the colors beautiful and distinct, and whose layers run in a parallel direction with the larger surface; whereas the common ribbon agates display their various layers on the surface, without being parallel. If the stripes run together around the centre, it is called the circle agate, and if in the same stone the centre shows more colored spots, it is called the eye agate, or *eyestone.*

2d. Fortification agate is that brownish agate, the various colored stripes of which run in a zig-zag, or irregular lines and angles, representing the ground plan of fortifications.

3d. Rainbow agate; the curved stripes have the property of displaying rainbow colors when held towards the sun, or candle-light, and the more distinctly if the stone is cut very thin.

4th. The cloud, landscape, dendritic, figure, moss, punctated, star, petrifaction, shell, coral, tube, fragment, and ruin agates are all the various forms in which the agate is displayed, according to its figure or drawing. A ruin or fragment agate may be pasted together from the fragments of a common ribbon agate, so as to make it represent old walls, whereby it receives the name of breccia agate; sometimes the rainbow agate occurs in connection with the shell agate, where the moss surrounding the petrified shells forms the rainbow agate.

The royal collection at Dresden contains a table service of German agate; at Vienna, in the imperial cabinet, there is an oval dish twenty-two inches in length, formed from a single stone.

The achates of the Greeks were so called from the river Achates, in Sicily, whence, according to Theophrastus, these stones were originally brought.

Jaspachates corresponds to our jasper agate; sardachates contained layers of the sarda, or carnelian; dendrachtes, from δενδρον, a tree, corresponding to our moss agate; hæmachates, from ἅιμα, blood, which was an agate sprinkled with spots of red jasper.

Among the crown-jewels of France is a very valuable set of agates,—ten cups and saucers, four urns, four chandeliers, four busts, two ewers, two basins, two vases, two bowls, two salvers, one decanter, and one candlestick; the whole set is valued at 500,000 francs.

At the French Exhibition in 1855, a magnificent Oriental agate, by Froment Maurice, belonging to the Princess Mathilde, was exhibited, having the engravings of the three infatuations,—the amorous, the poetical and sad, most tastefully represented. It is the Benvenuto Cellini of our day.

The most celebrated cameo in Oriental agate, is the bust of Alexander the Great, which is a perfect gem; the head is quite independent in color from the base of the stone, and the execution without a blemish.

The Orleans collection contained two agates: one representing the death of Cleopatra, as a half-body; the other, Lysimachus, the head girdled with a diadem.

A large black agate, particularly remarkable for its perfection and the complication of its workmanship, represented a captive followed by two generals on horseback, and several other persons, one showing a trophy, and another a laurel branch.

An intaglio of Neptune, belonging to the Sabatini Museum, was also exhibited.

Agate is found in gangues, in gneiss, porphyry, or amygdaloid; also, as boulders and pebbles, in rivers, &c. It is found in Baden, Oberstein, Saxony, Bohemia, Hungary, the Faroe Islands, Siberia, the West Indies, and in the United States, (Massachusetts, Rhode Island, New Jersey, Indiana, Missouri, Maryland, Georgia.) Those occurring in amygdaloid are mostly in the form of geodes, or balls, hollow inside, and coated with quartz or amethyst; when the rock begins to disintegrate, these balls, becoming loose, fall scattering around the soil, and are then collected by persons who make a business of either selling or cutting them.

The agate is used not only for various purposes of jewelry and ornaments, such as seals, snuff-boxes, crosses, cases of various descriptions, ear-drops, &c., but also for numerous other useful purposes, on a large scale; such as slabs, mortars, vases, instruments, knife and fork handles, playballs, &c. The manufacturing of them forms a considerable branch of industry in a part of Germany. The agate, after having been reduced to suitable sized pieces, by means of a saw, chisel or hammer, is then cut on a copper wheel by means of emery, powdered garnet or topaz, and is afterwards polished on a tin plate with rotten stone, putty or pumice stone.

Oberstein, a small place in Rhenish Bavaria, in the north of Germany, has five large manufacturing establishments for the sole purpose of cutting and polishing the common gems or semi-precious stones, and it is the only place where this branch of business is carried to any great extent. Twenty mills are constantly driven by water, and more than one hundred thousand dollars worth of work is turned out yearly for export; a sum which is small in comparison with the enormous quantity of goods manufactured and set afloat, but pretty considerable for such places, where labor is so cheap, and the best of workmen may be had for one dollar and fifty cents per week. At Oberstein the business is divided into two branches; the one is devoted to the cutting and polishing of the agate, and the other to the boring; the workmen are called agate lapidaries and agate borers. The cutting is performed in the large agate mills, on sandstone; each mill has generally five large sandstones, five feet in diameter and fourteen to fifteen inches in thickness, fastened upon a shaft, which causes them to revolve vertically, and which are continually moistened by a stream of water. The workman leans with his body upon a peculiar bench, the seat of which is called the cuirass, and with his feet presses himself against a pole, whence he continually pushes the larger lumps of the agate towards the mill-stone; this, however, is often made so smooth from the friction, that it is often necessary to make it rough by knocking it with a sharp hammer, according to the kind of work, whether fine or coarse. The stones are either polished on sandstone or on wood, by means of fine clay or powdered chalk; they are polished sometimes, also, on wooden wheels, covered with lead or tin. Snuff-boxes and other articles of agate, which are hollow, are polished on smaller sandstone wheels, which diminish in size as the work advances. Agates which require to be bored belong to a particular branch, distinct from the other. The boring is performed by means of a diamond point, and is described by Mr. Mawe. The onyx varieties are mostly employed for cutting cameos, and are prepared there in such a manner that the darker layer is cut for the base, and the lighter for the intended objects.

There is in Siberia, at Katherineburgh, an extensive manufactory for grinding and polishing agate and other gems.

Many varieties of agate are used for engraving other stones, and also for the Florentine or stone mosaic work. Since agate has always been, and is yet, a favorite stone, it has been attempted to improve either its color or other external appearance by artificial or mechanical means; this is done either by the use of metallic solutions or by boiling in oil of vitriol. The color has often been improved by giving to the stone, before it is polished, several strokes in succession, the small fissures thereby produced displaying an iridescence or some other phenomenon, if held towards the light; this operation, however, may easily be detected by wetting the stone, when the water, entering the fissures, will destroy the effect; it will show itself again when dry. On some agates black and white layers are produced, in order to use or sell them in the place of real onyx; this operation is performed by the lapidaries, who boil certain varieties in oil of vitriol, which changes the color of some very soon to black, and renders others clear or still paler. Only polished agates are used for this purpose, and the cause appears to lie in the oil absorbed by them during the operation of polishing, on which account agates are by some first boiled in oil before submitting them to the operation of the oil of vitriol.

The value of agate, although much reduced in comparison to former days,—a great deal depending upon the purity and perfection of color and peculiar figures,—commands a pretty good price in the market; it is particularly the onyx which is yet at high prices, and on that account it is imitated by pasting thin plates of chalcedony, jasper, agate, &c., together, and making them, by their different colors, appear like real onyx; this deception may, however, be easily detected by putting it into hot water, which disengages the plates one from another; the onyx is likewise imitated by pastes, and very happily, but may readily be distinguished from them by the hardness and other characters prominent in the real stones.

Onyx, which, as already stated, is a variety of agate, and most frequently of chalcedony, possesses in its intrinsic characters a regular alternation of layers, which are more or less thick, and of distinct different colors, usually the grayish white, brown, and black predominating; while *sardonyx* indicates one layer or more to be of carnelian, and this is in higher estimation. It was this stone particularly which the ancients mostly sought after for engraving the heads of celebrated persons, their deities, and their idols; the fawn-colored variety, which is neither yellow nor red, was the highest in value. Both onyx and sardonyx were purchased in Arabia and the Indies, and the harder the stones and finer the grain, the more valuable they were for the purpose of cutting. The title of Oriental onyx was always given to the finest qualities of the stones, regardless of the locality from whence they were brought.

The Imperial Library at Paris possesses some of the most antique cameos and intaglios of onyx, such as Germanicus, Marcus Aurelius, Faustina, and Tiberius; the dreadful Jupiter is an onyx in two layers; Venus on a marine bull, surrounded by cupids, are personifications of the highest perfection in the art.

The superb fragment existing in Rome, and representing Antilochus announcing to Achilles the death of Patrocles, is another master-piece; the cameo has a black ground, with a white layer above, and the expression of grief on the three faces has secured to this cameo the decided supremacy of the ancient over the modern art.

The bowl of Capo di Monte, in the Royal Museum of Naples, and the great cameo of Alexander and Olympia, belong to Mr. Bracciano, at Naples.

The French Museum contained the great cameo of Antonius and Faustina, engraved in different colors, but not parallel lines, it is not inferior to any other: the ground, which is of agate of brownish color, is Antonius, and above, in a white layer, is the pleasant figure of Faustina, whose drapery and hair ornaments are exceedingly well executed in a lilac color.

The sardonyx is also called sarde, and if of a dark sable color, was preferred by the ancients for cutting intaglios.

Mars and Venus when surprised by the gods, is executed by Valerio Vicentine; it represented nine figures. The Nuptials of Cupid and Psyche contains five figures.

In the inventory of curiosities belonging to the crown of France, made in 1791, are mentioned two vases of sardonyx, valued at sixty-four thousand francs; six sets, at one hundred and sixty-seven thousand francs; two cups at sixteen hundred francs; one decanter at thirteen hundred francs; one urn at six hundred francs; but one remarkable sardonyx, of a grayish yellow mixed with brown, on which a Medusa head was engraved, was valued at twelve thousand francs.

The *onicolo* or *nicolo* is another variety of onyx; it is of brown ground with a band of bluish white; it is distinguished from onyx, by the lower layer being always thinner than the upper; it is not so highly valued as either the onyx or sardonyx. The Mineralogical Cabinet at Paris possesses several cameos of this material; one represents military piety; also a cameo of Adonis, by Coinus. The stone is probably the *ægyptilla*, described by Pliny.

The real sardonyx is the rarest mineral among that class of stones, on account of the multiplicity of layers, of which there are as many as ten, all, however, from the same substances, but differently colored: such as chalcedony, jasper, agate, white, gray, red, and brown, opaque, translucent, bluish, or yellowish; they are highly prized, particularly those from the Orient.

The finest cameo of the real Oriental sardonyx is in the imperial cabinet of Vienna, it is said to come from Dioscorides; it was obtained by Rudolph II., the German emperor, for 12,000 ducats.

In the crown-jewels of France are some unique cameos of sardonyx, such as the triumph of Bacchus and Ariadne, valued at 7000 francs, and eleven other cut stones valued together at 60,000 francs.

Great collections of antique onyxes, engraved as cameos and intaglios, are in Vienna and Berlin; in the first is to be seen the apotheosis of Augustus, which is ten lines broad and six high, and contains twenty perfect figures; this was purchased by the Emperor Rudolph at Frankfort-on-the-Maine, for fifteen thousand ducats.

The celebrated cameo in the Vatican Museum, at Rome, is of agate, and represents Augustus. Italy has always been the great emporium for genuine antique onyxes and cameos, and occasionally we still behold fine specimens of art in the possession of travellers coming from Europe. A very fine collection of antique cameos and intaglios in precious gems and antique pastes, likewise cameos and intaglios of modern artists, I have seen in this country, in the possession of Thomas G. Clemson, Esq., of Philadelphia.

I have in my collection a good onyx of the Emperor Vitellius; a splendid cameo of Bacchus, of two and one fourth inches long and one half inch thick; one of Antony and Cleopatra; also a splendid intaglio.

In Paris are several celebrated cameos, worthy the notice of travellers going to Europe: the Brunswick Vase was cut from a single stone, and has the form of a cream pot, about seven inches high and two and a half broad on its outside, which is of a brown color; there are white and yellow groups of raised figures, representing Ceres and Triptolemus in search of Proserpine; Agrippina and her two children, composed of two layers, brown and white; the Quarrel of Minerva with Neptune, which consists of three layers; Venus on a sea-horse, surrounded with cupids, &c.

The Museo Borbonico at Naples contains an onyx measuring eleven inches by nine—the apotheosis of Ptolemy on one side, and the head of Medusa on the other; both are splendid specimens of art, and supposed to be the largest in existence.

Two very beautiful flower-vases of black onyx, colored with natural white veins, two large cups of red chalcedony colored, long square links of chalcedony, connected together without joints, and alternating in colors, also a very beautiful snuff-box of green jasper, were seen at the London Exhibition, manufactured by Wild & Robinson, in Oberstein.

Some modern works of cameo, from the hand of the celebrated Puckler, are in the collection of Robert Gilmore, Esq., at Baltimore, and in that of W. J. Lane, Esq., of this city, who possesses also a Washington head of black and white onyx, by Isler, which is extremely beautiful; also a very fine modern cameo in onyx, two inches in length, I saw in Stephen H. Palmer's establishment.

CHRYSOPRASE.

The ancients by this name designated a stone of a green color, with a yellowish tinge; but it is not certain whether that which goes by this name, at the present day, is the same. We find, in the fourteenth century, this stone used as ornaments in churches and other places, but it was not known by the above name until 1740, when it was discovered by a Prussian officer in Silesia. Frederick the Second ornamented his palace Sans Souci with this mineral.

The common people of Silesia wear the chrysoprase around the neck as a charm against pains.

Chrysoprase occurs massive and in plates; the fracture is even and splintery; it is translucent; lustre, resinous; sometimes dull apple-green, grass-green, olive-green, and whitish-green color; it scratches white glass distinctly, but is not so hard as true chalcedony; specific gravity, 2·56; it is infusible before the blowpipe, but loses its color when heated; it consists of silex, with a little carbonate of lime, alumina, oxide of iron, and nickel; its color is imparted by the latter substance. This mineral is found in the serpentine of Silesia; also, in Siberia, and in the United States (in New Hampshire).

Chrysoprase is used in jewelry and for various ornamental purposes, such as breastpins, rings, bracelets, necklaces, seals, &c.; and the larger masses are used for snuff-boxes, cane-heads, table-plates, &c. The cutting is pretty difficult, and the greatest care is required for finishing the same with facets, as it is easily fissured; it is done on tin or lead plates with emery, keeping the first constantly wet with water; it is polished on a tin plate with rotten-stone, but the lapidary has always to be cautious not to let it become hot, as it easily splinters, and grows opaque and gray. The usual cut is the table or cabochon, with facets on the border; in setting, a foil of green satin is often used for a back, but when pure and of good color, it is mounted *à jour*. Inferior specimens are painted on the back with a mixture of verdigris, white lead, and gum mastic, or with sap-green.

The chrysoprase loses its color by wearing; heat and sunlight likewise cause it to fade, and render it dark and cloudy; but the color may be restored by keeping it in a wet or moist place, such as a cellar, in wet cotton or sponge, or even by dipping it in a solution of nitrate of nickel, which serves likewise to improve the inferior qualities.

Very fine imitations in paste may be made by mixing

1000 parts of strass with
5 " of oxide of iron, and
8 " of oxide of nickel.

The chrysoprase is subject to a great many faults, such as fissures, either natural or received in cutting; oily whitish spots, pale gray flaws and stripes, and sometimes small grains of clay of reddish color, intermixed in the interior of the stone; but when pure, the chrysoprase has always been a great favorite. A good seal or ring stone may be worth from twenty-five to thirty dollars, and smaller specimens from one to five dollars. The apple-green variety is most valued, and a specimen one line long by one half broad, has been sold at from fifty to one hundred and fifty dollars. At Paris, an oval chrysoprase, eight lines long and seven lines broad, was sold for three hundred and ten francs. The price generally has decreased of late, on account of the great quantity cut from the mines, which have recently been covered up, in order to raise its value again. At the royal palace of Potsdam, in Prussia, are two tables of chrysoprase, the plates of which are three feet long, two feet broad, and two inches thick.

CHRYSOLITE, PERIDOT, OLIVIN.

The name of this stone is of Greek origin, and was well known to the ancients, although it is undecided whether they designated the same mineral by this name that we do at the present time, for they make it in their writings to be either the topaz or goldstone, or the transparent gold-yellow stone.

The chrysolite occurs in prismatic forms, generally a right prism with rectangular bases; also, in angular rounded crystalline grains or massive; the fracture is conchoidal; it is transparent and translucent; it possesses powerful double-refracting power; its lustre is vitreous and resinous; the lateral planes of the crystals are sometimes striated; the color is olive-green, turning to yellowish and brownish; it scratches glass indistinctly, and is attacked by topaz; hardness, 6·5;

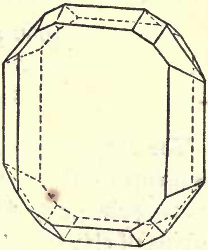
Fig. 10.

specific gravity, 3·33 to 3·44; becomes electric by rubbing; is infusible by itself before the blowpipe, but is dissolved into a transparent pale-green bead with borax; acids do not affect it; it consists of magnesia, silica, and oxide of iron. Chrysolite is found particularly in basalt, trap, greenstone, porphyry, and lava; sometimes in alluvial deposits and the sands of rivers.

The perfectly crystallized chrysolite is brought from Constantinople, but its true locality is unknown; less distinct crystallizations occur imbedded in lava at Vesuvius and the Isle of Bourbon; imbedded in obsidian at Reel del Monte, in Mexico; among sand at Expaillie, in Auvergne, in pale-green transparent crystals.

Egypt, Natolia, and Brazil are the principal localities for the prismatic chrysolite; the olivin is more frequently found in imbedded crystals and granular aggregations, in the basalts of the Habichtswald, the Eiffel, the Upper Palatinate, Geysingburg near Altenburg, Kapfenstein in Styria, and in the sienite at Elfaden in Sweden. The brown variety (hyalosiderite) is found at Sabbach and Iringen on the Kaiserstahl, and in dolorite, near Freiburg in Baden. Crystals of olivin, several inches in length, occur in greenstone, at Unkle near Bonn, on the Rhine, and it is a frequent ingredient of meteoric stones.

The word chrysolite is derived from *χρυσος*, gold, and *λιθος*, stone, in allusion to its color.

The dark-colored peridots, which take a high polish, are now much worn in Europe; they lose, however, their gloss very soon, on account of their softening.

The ligurite is a species of chrysolite of an apple-green color, is transparent and of uneven fracture; hardness, 5·3; specific gravity, 3·49. Its primary form is an oblique rhombic prism; the ligurite contains some alumina and lime in addition to the composition of the chrysolite; it is considered a superior gem to chrysolite, both in color and transparency. It occurs in a talcose rock on the banks of the Stura, in the Apennines of Liguria; it does not become electric by heat or friction.

The bottlestone of Moravia is likewise a species of chrys olite, of dirty-green and grayish-green colors, does not occur crystallized, but in flat pieces of about an inch in size; some specimens which the author collected in his youth, in Moravia, were fair specimens suitable for cutting, their color being dark-green.

The chrysolite is cut on a leaden wheel with emery, and is polished on a tin plate with rotten-stone or oil of vitriol. Sometimes pale stones are finally polished with some olive oil, which raises the color considerably: this last operation is applied to restore its lustre, after the chrysolite becomes dull by wearing. The form is that of a rose or table cut; also in pavilion; and when set, gold foil is used for its base: the pale-colored chrysolite looks well with a green-colored copper foil; dark chrysolites may be rendered clearer by a careful calcination.

The chrysolite is used for rings and pins, but does not stand in high estimation, not possessing either a distinguished color, strong lustre, or great hardness, and losing its polish by wearing; on account of its softness, it wears off at the edges. Very good specimens of peridot from Brazil were brought into this country from France, and commanded a good price, a few years ago, viz: from ten to fifteen dollars a carat.

Chrysolite was much esteemed by the ancients; Queen Berenice received a chrysolite as a present from Philemon, lieutenant of King Ptolomeus.

Cleopatra likewise gave one to Antony. Louis XIII. brought chrysolite into fashion at his court.

Among the engravings in chrysolite is one of the Emperess Sabine, which is in the cabinet of Crispi, at Ferrara. Among the most extraordinary engravings in chrysolite, is one representing Ptolomeus-Oulet, king of Egypt, and the Nuptials of Cupid.

IOLITE.

This mineral has for a long time been brought from Spain, but has lately been made known and brought into notice by Cordier, after whom it received the name *cordierite;* it is called likewise *steinheilite*, and has several other names, which I will mention, in order that the reader may not be confused when the same mineral is presented as a gem, under different names; the most appropriate name is *dichroite*, from its property of displaying two colors when held in different directions; it is also known as *peliom* and *prismatic quartz.*

It occurs in regular six and twelve sided prisms; also, in crystalline grains, massive, and in pebbles; its fracture is conchoidal and uneven; it is transparent, exhibiting an indigo-blue color when held in the direction of its axis, or viewed by transmitted light, and appearing brownish-yellow when held at right angles; it possesses some double-refracting power. Sometimes a ray of light, resembling that of the star-sapphire, may be perceived in iolite, particularly when cut; it has a vitreous lustre; its colors are violet-blue and indigo-blue, sometimes with a tinge of black and bluish-gray. It scratches glass, and is attacked by topaz; its streak-powder is white; hardness, 6·5; it has a specific gravity of 2·88. By rubbing, it becomes electric, and assumes polarity by heating; it is difficult to

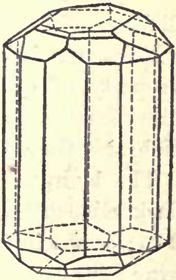

Fig. 11.

fuse on the edges, and becomes then a grayish-green enamel: borax fuses it into a diaphanous glass; acids have no effect upon it; it consists of magnesia, alumina, and silica, with some oxide of iron and water.

It is often found under the names of lynx and water sapphire, the first of a pale and the latter of a darkish blue color. It is found in primitive rocks; also, in blue clay, in copper pyrites, in quartz or felspar, and in small detached masses; the localities are at Baldenmays in Bavaria, occasionally in perfect crystallizations, but usually massive; it is associated with magnetic pyrites. The variety from this locality has been called peliom, from its peculiar smoky-blue color, from πελιος. It occurs in quartz, at Ujordlerosoak, in Greenland; in granite, at Cape de Gata, in Spain; at Arendal, in Norway; at Orrijervi, in Finland; at Tunaberg, in Sweden, &c. Ceylon affords a transparent variety in small rolled masses of an intense blue color. At Haddam, Connecticut, it is associated with garnet and anthophyllite in gneiss. It is occasionally employed as a gem, and when cut exhibits its dichroism, or different colors in different directions. The name iolite is derived from ιον, a violet, and λιθος, stone, in allusion to its color. From its property of exhibiting different colors according to the direction in which it was viewed, it has also been named dichroite, from δις, double, and χρόα, color.

The hydrous iolite, from Sweden, of grayish-brown or dark olive-green color, is a very soft mineral; hardness, 3·75; occurs in red granite, accompanied by a light bluish-gray iolite.

If the stone is perfectly pure, it is used for rings and breastpins; is cut on a copper wheel with emery, and polished on a tin plate with rotten-stone, and receives the form of a cabochon, in order to let it display its proper colors, and in a cube form. Its price is not very high; the jewellers value it as an inferior quality of the sapphire, without paying any regard to its phenomena of light. Good-sized specimens are sold at about eight to ten dollars each; at Paris, a good iolite, ten lines long and eight and a half broad, was sold for one hundred and sixty francs. When, a couple of years ago, the iolite was discovered by Professor Mather, at Haddam, Connecticut, it promised to be a valuable acquisition to American gems; but the supply was very scant, and its original locality appears to be exhausted. Professor Torrey possesses a fine seal, in the form of a cube, from that locality, which displays its properties to the greatest perfection.

A blue quartz is occasionally sold for iolite, but it may easily be distinguished by its colors and hardness. Sapphire is considerably harder than the iolite.

OPAL.

The precious variety of this mineral was known to the ancients, and received its name on account of the play of colors which it has. The opal has a great many varieties, which are all considered more or less gems, and find their application in jewelry; they will therefore be treated separately. But, as general characters, it may now be mentioned that opal scratches glass but slightly, while it is marked by rock-crystal; it has a specific gravity of 2·06 to 2·11; it is infusible before the blowpipe, but decrepitates and falls into splinters; it also dissolves with borax. Opal consists of silica with water, some oxide of iron, and sometimes alumina.

PRECIOUS OPAL.

This gem derives its name from the Greek word signifying the eye, for the ancients believed that this stone had the power of strengthening the eye. It was highly esteemed by them, as we learn from Pliny, who thought that the play of color originates from the beautiful colors of the carbuncle, amethyst, and emerald.

The phenomenon of the play of colors in the precious opal has not yet been satisfactorily explained. Haüy attributes it to the fissures of the interior being filled with films of air, agreeably with the law of Newton's colored rings, when two pieces of glass are pressed together. Mohs contradicts this theory upon reasonable grounds, which are, that the phenomenon would present merely a kind of iridescence. Brewster concludes that it is owing to fissures and cracks in the interior of the mass, not accidental but of a uniform shape, and which reflect the tints of Newton's scale; but it is, in my opinion, sufficiently plausible, that the unequal division of smaller and larger cavities, which are filled with water, produces the prismatic colors, and for the simple reason that the opal which grows, after a while, dull and opaque, may be restored to its former beauty if put for a short time in water or oil.

Although the precious opal was never found in the East, yet it bears the name of Oriental opal among jewellers: for in former times opals were carried by the Grecian and Turkish merchants from Hungary, their native locality, to the Indies, and brought back by the way of Holland to Europe, as Oriental opals. The precious opal is found, in small irregular gangues, nests of the trachytic porphyry formation and its conglomerates, in Hungary, particularly in the neighborhood of the village of Czerwinecza; also, in the Faroe Islands, Saxony, and South America. The Hungarian opal is found of various qualities, and is obtained from mines which have been wrought for several centuries; and, according to the archives of that part of the country, there were, in the year 1400, more than three hundred workmen engaged at the mines near the above village; whereas there are but thirty at present engaged there, on account of the scarcity of large suitable specimens.

The precious opal is principally used for rings, ear-rings, necklaces, and diadems; the smaller specimens for mounting snuff-boxes, rings, chains, &c. It is ground on a leaden wheel with emery, and is polished with rotten-stone and water on a wooden wheel; and, in order to increase its lustre, it is lastly rubbed with putty, by means of buckskin, or a woollen rag and red chalk. Its form is generally that of a semicircle, lens, or oval; sometimes of a table, and then also with some facets; but great care has to be taken that the edges, on account of the softness of the stone, do not wear off. It is also apt to spring in a temperature suddenly changing. When mounted, it receives a colored foil, or a variegated silk stuff, or a peacock-feather on the back, but it looks best in a black casing.

Cracks and fissures may be removed by leaving the precious opal for some time in oil. Very frequently the precious opal is distributed in small particles in the matrix, called mother of opal, which is cut by the jewellers as boxes, and other ornaments; and very often, too, this matrix is plunged into oil, and exposed to a moderate heat, whereby the base grows blacker, and the true precious opal retains its ray of colors. In order to preserve the surface of the precious opal against wear and tear, it is covered with a thin plate of quartz crystal. The precious opal still stands in very high estimation, and is considered one of the most valuable gems. The size and the beauty displayed by its colors determine its value; those playing in the red and green colors bear the highest price. Its value has latterly increased on account of the scarcity of the larger specimens. Formerly, a solitary large precious opal, playing in the red color, was sold for two to three hundred ducats; and one playing in both red and green colors, about five lines long, was sold at Paris for two thousand four hundred francs; and lately a single opal, of fine colors, and the size of a dollar, was sold near the locality for three hundred thousand florins; in this country precious opals are sold by the importers at the rate of four to ten dollars per carat, and single specimens, suitable for pins or rings, from two to twenty dollars. The mother of opal is, however, much cheaper; one of five lines size is sold for three to five dollars.

All experiments for imitating the precious opal have hitherto proved fruitless; they were made either by preparing an enamel and adding several metallic oxides, or by affixing to the back of a clear or common opal or enamel, a polished thin plate of the mother of pearl, which may sometimes deceive the ignorant.

The precious opal, when large and exhibiting its peculiar play of colors in perfection, is a gem of considerable value; it was used as an ornament among the Greeks and Romans, and was called *opalus*; also *paederos* (*παιδερως*), in allusion to its color and lustre as expressed in the Orphic poem: "*ἱμερτοῦ τερενα χρόα παιδὸς*,—having the delicate complexion of a lovely youth." The most magnificent Hungarian opal in the London Exhibition, called "the mountain of light"—a very appropriate name—weighed 526½ carats, and was estimated at 4000 pounds sterling.

From Honduras, at Gracias á Dios, large quantities of opals have been imported into this city for the last ten years, at first by the late Mr. De la Raye, and latterly by Mr. Aaron C. Burr; and many large and beautifully cut specimens are in the possession of Mr. B. Palmer, of this city; they are by no means inferior to the Hungarian opal. A very large opal, cut and polished by himself, which he values at four thousand dollars, is one and three quarters inches long by one and a quarter inches wide; another, one and a quarter inches long by one inch wide, he prizes at seven hundred and fifty dollars; and a third, one and one eighth inches long by one inch wide, he values at four hundred and fifty dollars.

The ancients held the opal in great estimation, and the anecdote of the Roman senator, Nonius, is well known—that he preferred exile to parting with a magnificent opal which Marc Antony coveted.

In the French crown-jewels are two very large and beautiful opals. One is set in the centre of the Order of the Golden Fleece, and the other forms the clasp of the imperial cloak. They were purchased for 75,000 francs. The Empress Josephine possessed the unique opal which was called "The Great Fire of Troy," on account of the great fire sparkles.

The Vienna Cabinet possesses a very large opal, but unfortunately it is cracked. Count Walewski, who is a great amateur of gems, possesses a very beautiful opal, which is oval, the size of a franc-piece, and is said to be extraordinarily brilliant.

The Imperial Mineralogical Cabinet at Vienna, contains the most celebrated specimens of precious opal; one, particularly, may be mentioned here: it is four and three quarter inches long, two and a half inches thick, and weighs seventeen ounces. It was discovered about 1770, at the above locality, and transported to Vienna. It displays the most magnificent colors; is perfectly pure, and not accompanied by any matrix. Half a million of florins were offered for it by a jeweller of Amsterdam, and refused on account of its uniqueness; and the Viennese have not yet dared to put even any approximate value upon it.

FIRE OPAL.

This mineral was first brought into notice by Baron Humboldt, who found it in Mexico.

It occurs massive; has a conchoidal fracture; is transparent; of strong vitreous lustre; color, hyacinth-red, running into honey, wine-yellow, showing carmine-red and greenish reflections; sometimes containing dendritic drawings. Its specific gravity is 2·02; loses one and a half per cent. by calcination, and leaves pale flesh-red fragments. It is found in the trachytic porphyry, in Mexico, and in the amygdaloid of the Faroe Islands.

As the fire opal is very little known, it has not yet been employed in jewelry, but bids fair to find applications. It is ground on a leaden wheel with emery, and polished with rotten-stone on a wooden wheel. The forms of cabochon, table, or pavilion, might suit very well as ring-stones.

The cabinet of the university of Bonn possesses a very large and fine fire opal, of the size of the fist. The largest specimen I have seen is in the royal mineralogical cabinet at Berlin, which was deposited by Baron Humboldt on his return from South America, and which, if I recollect it well enough from the year 1827, must be at least six inches long and four inches thick. This is the largest specimen he ever found. A collection of six shades of fire opal, with six more varieties of the other opals, was presented to me in the year 1828, when in Berlin, by the Counsellor Bergeman, who received at that time a considerable quantity of polished specimens from the Faroe Islands, but all of small size. A splendid collection of fire opals was brought from Guatemala some years ago to this country. It is also called girasol, from its bright hyacinth-red tints.

COMMON OPAL.

This mineral occurs massive and in rolled pieces; also as stalactites; has a conchoidal fracture; is translucent and semi-transparent; has a strong vitreous and resinous lustre; its colors are milky, yellow, reddish, greenish-white, honey-yellow, wine-yellow, flesh, brick-red, and olive-green; sometimes dendritic (moss opal). Its specific gravity is 1·9 to 2·1.

The wax or pitch opal is subordinate to this variety. It is found in the same rocks as the precious opal, in Hungary; in the hematite rocks of Saxony; in the serpentine of Silesia; in cavities of trap and the amygdaloid rocks of Iceland; Faroe Islands; and in the United States (Pennsylvania and Connecticut).

It is used for rings, pins, and cane-heads; but is, on the whole, not a favorite among jewellers, and has no great value, because it is soft and brittle; the paste, which may be made from white enamel, is sometimes much prettier than the real stone.

HYDROPHANE.

The name of this variety of opal has reference to its peculiar property of becoming transparent and opalescent after immersion in water. The ancients called this stone *lapis mutabilis*, and *achates oculus mundi*. It is a common or precious opal, of porous texture; adheres strongly to the tongue; is translucent, and absorbs water with avidity, giving off at the same time air-bubbles; it thus assumes a high degree of transparency, and sometimes the property of displaying the finest prismatic colors, equal to the precious opal. This phenomenon tends strongly to explain the display of the prismatic colors of the precious opal; the more so, as the hydrophane loses this property on getting dry.

It has, when dry, a white, yellowish, or reddish color, and a specific gravity of 1·95 to 2·01; and according to Haüy, a hydrophane, having been immersed for four minutes in water, gained thirty-four centigrammes.

The hydrophane is found in the porphyry of Hungary, France, Iceland, and the Faroe Islands. Large pieces of good and fine specimens of hydrophane are wrought and used in the same manner as the precious opal.

It is said that the hydrophane becomes much quicker transparent in warm than in cold water; the quickest in spirits of wine; after which, it loses this property the sooner; but when boiled in oil, it retains it, to a certain extent, for years.

If the hydrophane is well dried and soaked in melted white wax, or spermaceti, it assumes the property, when warmed, of becoming translucent, and of displaying brownish-yellow or gray colors; it is then called pyrophane.

The hydrophane was formerly colored violet or red, by means of a decoction of logwood and alum.

The price of hydrophane is very high, on account of its great scarcity, and because it is very seldom found in large lumps.

SEMI-OPAL.

This variety of opal was formerly considered to be a pitch-stone, and if it assumes the form of petrified wood, it is called wood opal. It has a conchoidal and even fracture; it is translucent and opaque; of a resinous and vitreous lustre; its colors are yellowish, grayish, and brownish, the colors running mostly into one another; sometimes the colors divide themselves ribbon-like. The wood opal is mostly brownish, and displays, more or less, a ligneous aspect, with the form of branches.

The semi-opal is found in gangues, in the trachytic porphyry in Hungary, in the serpentine in Silesia, in the amygdaloid in Iceland and the Faroe Islands; likewise in Moravia, Saxony, France, Greenland, and in the United States (Maryland and Pennsylvania).

The semi-opal, on account of its taking a high polish, is used for many purposes in jewelry. There is an establishment for manufacturing snuff-boxes from wood opal, in Vienna, and lately the varieties of wood opal, with layers of chalcedony, or semi-opal, have found a useful application for the cutting of cameos. The semi-opal is ground and polished like the precious opal, but with more difficulty, on account of its being more brittle. The form which it easily receives is in cabochon, but without facets. The price of the semi or wood opal is low.

CACHELONG.

According to Blumenbach, the name of this mineral is of Mongolian derivation, meaning "a pretty stone;" and according to Phillipps it receives its name from the river Cach, in Bucharia, on whose shores it occurs frequently in loose conglomerates. This mineral has been arranged under the head of chalcedony, but properly belongs to opal.

It occurs massive, as a covering of other minerals, rarely reniform, often traversed with fissures in different directions. It has a conchoidal fracture; is opaque, and of a pearly lustre; milky-white, turning sometimes to a yellow or red color, and exhibits dendritic figures of manganese or green earth. It scratches white glass; has a specific gravity of 2·2; it decrepitates when first brought before the blowpipe, but yet undergoes no change; dissolves with borax, slowly, at a white heat.

It is found in the same manner as chalcedony, sometimes incrusting or penetrating it, in the amygdaloid of Iceland, Greenland, the Faroe Islands, the hematite of

Carinthia, the United States (Massachusetts), and Nova Scotia; in Bucharia, in the sand of the river Cach, it is found loose.

Cachelong being generally constituted of layers of different degrees of hardness, the sculptors of cameos profit thereby, for the purpose of producing better bas-reliefs.

In the Imperial Library, at Paris, is a very fine cameo, representing Valentine III.

Cachelong is much used in jewelry, for rings, seals, &c. The Calmucks of Bucharia manufacture of it tools and other domestic articles. It is cut on a copper wheel with emery, in cabochon, and receives the polish on lead plates by means of rotten-stone and putty. The price of the cachelong is pretty considerable, on account of its beauty and scarcity, as the specimens most frequently found in the above localities are seldom in layers of more than one quarter of a line, alternating with chalcedony.

JASPER OPAL.

This mineral stands between jasper and opal; and, although considered by Werner as belonging to the first, ought, nevertheless, more properly to be arranged with the opal, on account of its containing water in its composition.

The jasper opal occurs massive, in specks, stalactiform, and in geodic masses; it has a conchoidal fracture; is translucent on the edges, or opaque; is of a strong resinous lustre; its colors are gray, yellow, red, and brown. Its specific gravity is 2·0 to 2·1. It consists of silica, water, and oxide of iron, amounting to forty-seven per cent. It is found in the trachytic breccias of Hungary; also, in Saxony and Siberia. The best light and pure specimens are used for dagger and sword handles in Turkey. The price of jasper opal is low.

OBSIDIAN.

This mineral was familiarly known to the ancients, and its name is said to be derived from a Roman, who first brought it to Rome from Ethiopia. Pliny states that the Romans manufactured mirrors and gems from it; the Mexicans and Peruvians manufactured their knives, razors, and sword-blades from obsidian, which appears to have served as a complete substitute for other materials with those nations, who were yet unacquainted with the use of iron for weapons and utensils of various kinds. Baron Humboldt says that Cortez mentioned, in his letter to the Emperor Charles V., having seen razors of obsidian at Tenochittan; and the above naturalist likewise discovered, on the Sierra de las Nabajaz, in New Spain, the old shaft that was used for raising the rough obsidian, with relics of the tools and half-finished utensils.

The inhabitants of Quito manufactured magnificent mirrors from obsidian, and those of the Azores and Ascension islands, and Guiana, used splinters of obsidian as points for their lances, razors, &c.

Specimens of arrows and other articles, such as octangular wedges, were presented a few years ago to the New York Lyceum of Natural History, being relics from the ruins of Palenque. In the collection of Columbia College are some razors, or sacrificial knives, the gift of the Hon. J. R. Poinsett.

Obsidian occurs massive, in roundish or obtuse lumps, balls, and grains; has a conchoidal fracture; is semi-transparent and translucent on the edges; it has a strong vitreous, and sometimes even metallic lustre; its colors are either pure black, grayish, brownish, greenish-black, yellow, blue, or white, but seldom red; it sometimes displays a peculiar greenish-yellow shine, when it is called the iridescent obsidian; there is rarely more than one color in the same specimen with stripes and specks. Obsidian scratches white glass indifferently, but is scratched by topaz; its streak-powder is white; it has a specific gravity of 2·34 to 2·39. Obsidian is sometimes magnetic, so that small pieces show their magnetic poles. Before the blowpipe, the black variety is fusible with much difficulty; and even at a white heat it does not melt into a solid glass; but the gray and brown variety (marekanite) swells readily into a spongy mass.

Obsidian consists of silex, alumina, with a little potassa, soda, and oxide of iron.

The names, Iceland agate, lava, black-glass lava, volcanic lava, are all synonymous, and the mineral called bottle-stone, in round grains of the size of a pea, is nothing but a green obsidian.

Obsidian, sometimes, forms the cement of whole mountain chains, often forms deposits in the trachyte and the streams at the foot of some volcano; also, among the volcanic ejections, and occurs in loose lumps in the sand of rivers, and at the foot of mountains. It is found in Iceland, Teneriffe, the Lipari Islands, Peru, Mexico, Sicily, Hungary, Asiatic Russia, the Ascension Islands, and on all the volcanoes of former and present times.

In the New York Lyceum of Natural History are several interesting specimens, presented by Don Correa, of Tabasco, from the ruins of the city of Palenque; such as concave or triangular wedges, and other masses of obsidian, from various localities.

It is employed for several useful and ornamental purposes; such as the making of ear-rings, necklaces, brooches, snuff-boxes, knife handles, &c. It is particularly worn as mourning jewelry; it requires, however, much care in working, being extremely brittle. It is ground on lead wheels with emery, and polished with rotten-stone. It is kept in favor by the jewellers, on account of its high polish; but its value is very indifferent, excepting that of the iridescent obsidian, which commands a high price, and is sometimes seen cut in cabochon, and set in rings.

There is no doubt but that obsidian is of volcanic origin, being mostly found in the neighborhood of volcanoes, and that it is a glass, produced by volcanic fire, as it is a combination of silex and alkaline substances. The Neptunian theorists have endeavored to prove that it is occasionally found with the remains of decomposed granite, gneiss, and porphyry, with which it even alternates in layers.

AXINITE.

The name of this mineral is derived from a Greek word, signifying an axe, and was applied to it on account of the resemblance of its crystals to that implement; it is also called by some English mineralogists, thumer-stone, from its first locality.

Axinite occurs in a variety of crystalline forms, which are reducible to the rhombic, viz: an oblique rhomb, or four-sided prism, so compressed that the edges appear sharp, like the edge of an axe; likewise, massive and in specks; its fracture is uneven; it is translucent on the edges, or sometimes transparent; has simple refraction of light; its lustre is vitreous, also, resinous; its colors are violet-blue, brown, gray, and yellow; it scratches white glass, but is scratched by topaz; has a white streak-powder; its specific gravity is 3·27; it becomes electric by rubbing or heating; before the blowpipe it fuses into a grayish-brown glass; acids have no effect upon it; it consists of lime, alumina, and silex, with oxide of iron and manganese. It occurs in gangues and layers of various formations, principally the primitive; and is found in Dauphiné, the Pyrenees, Gothard, Saxony (Thum), Norway, &c.

This mineral takes a very high polish, particularly those specimens from Dauphiné, but has hitherto, on account of its scarcity, not found much application in jewelry, but will hereafter be a great acquisition, as it may be used for rings, pins, and other small ornaments

FELSPAR.

The varieties of this mineral are mostly crystallized, and in very numerous forms; but they are all distinguished by two great characters, which are, the foliated structure and peculiar lustre; the principal form is an oblique prism with unequal sides. Felspar scratches glass and is scratched by rock crystal; its streak-powder is white; it has a specific gravity of 2·5 to 2·6; before the blowpipe it fuses with difficulty; on charcoal it becomes vitreous and white; fuses with difficulty on the edges to a translucent white enamel; acids have no effect upon it; it consists of potash, alumina, and silex.

ADULARIA.

This mineral occurs in crystals (oblique prisms and rhomboidal faces), crystalline fragments, and solid masses; its fracture is uneven; it is translucent on the edges; has double refraction of light; the lustre is vitreous and pearly, more especially when cut and polished; it throws out greenish and bluish-white chatoyant reflections from the interior; it cleaves in two directions; the crystals often present the hemitrope form, which in polished specimens becomes obvious from the different directions of the laminæ; its colors are limpid-white, greenish, grayish, and bluish, frequently with a peculiar pearly shine, and sometimes it is iridescent. Specific gravity, 2·5; and softer than quartz.

In commerce, adularia goes under various names, such as moon-stone, sun-stone, girasol, fish-eye, and Ceylon or water opal. In the moon-stone the color is white, with small bluish or greenish shades, but the base is semi-transparent and milky; whereas the sun-stone shows a yellow and reddish play of colors. Adularia is found in gangues and cavities of granite, gneiss, and limestone, and in pebbles from Ceylon, Greenland, Bavaria, St. Gothard, Tyrol, Dauphiné, and in the United States,—particularly at Ticonderoga, near Lake Champlain, New York, Maryland, Pennsylvania, Connecticut, and Massachusetts. The adularia from St. Gothard is found in very large masses: I saw, in 1827, in the cabinet at Zurich, in Switzerland, groups of crystallized adularia, measuring two feet in length and one foot in thickness, the splendor of which dazzled my eyes.

Adularia, displaying a good color, and strong pearly reflections, is now much used in jewelry, for rings, pins, and other smaller ornaments. Generally specimens which possess these qualities are cut out of large lumps, then ground on a lead wheel, in cabochon form, and polished with rotten-stone; they are, in general, mounted in a black case, whence it best shows its reflections. The moon-stone commands a good price; exquisitely fine specimens, of the size of a bean, are worth from five to ten dollars, and some of them were sold at Paris, of six lines diameter, for seven hundred and five francs, and four lines for two hundred and three francs.

The largest moon-stone, in a brooch, three fourths of an inch in length, I have seen, is in the possession of Francis Alger, Esq., of Boston; and rough specimens, with most splendid reflections, I have admired in the collection of the late Dr. M. Gay, of the same city. Both these gentlemen are fortunate in possessing uniques in this country, which are of no ordinary scientific and commercial value.

Among the varieties of felspar may be named *ice-spar*, which is found in volcanic rocks, occurs crystallized in the Vesuvian lavas, and is of a white color.

Murchisonite is a yellowish-gray variety of felspar, from Dawlish and Arran.

Leclite, or the *hellefliata* of the Swedes, has a peculiar waxy lustre and a deep flesh-red color, and is found at Gryphyttan, in Sweden.

Conazeranite is a grayish-black or blackish-blue variety, from the steep defiles of Salleix, in the Pyrenees; it occurs imbedded in limestone.

Variolite is a dark-green variety of felspar, containing lighter globular particles; originally found in Drac river, in France, but of late also in Piedmont, Switzerland, and Scotland; in the Alps large blocks of several thousand pounds are found. This stone, when polished, takes a high gloss, equal to the most precious gems. Its name is derived from the peculiar spots flashing around the stone.

The name adularia is derived from Adula, the ancient name of St. Gothard, where the prettiest specimens were first discovered.

A very curious variety has been found in Siberia, of a yellowish color, but with innumerable gold spots disseminated throughout the whole surface of the mineral; these reflections of light appear to be owing to very small fissures or cracks, or to a confusion of its lamellar system. The prettiest specimens, which are invariably cut in cabochon, look much like a reflection of a star, diverging from the centre; they are very rare, however. This variety of moon-stone has often been confounded with the Oriental avanturine, but on examination may at once be detected.

The Ceylon variety ought only to be called Oriental moonstone, from the peculiarity that it is more uniform, not striated like that from St. Gothard, and having also a brighter lustre; its chatoyant qualities are therefore more prominent.

Sun-stone contains minute scales of mica, and reflects a pinchbeck-brown tint.

COMMON FELSPAR.

This felspar occurs in crystals, massive, and disseminated; its fracture is uneven and splintery; is translucent; has a pearly and vitreous lustre; its colors are white, gray, red, yellow, and green, in their various shades, sometimes with a variegated bluish, greenish, or reddish play of colors; its texture is compact, or minutely foliated.

The amazon-stone, or green felspar, is from Siberia; likewise splendid grass-green felspar has been found in the United States, at Southbridge and Hingham, Massachusetts, and Cow Bay, New York; of apple-green color, at Topsham, and near Baltimore, Maryland. Also, the American glassy or vitreous felspar, found in Delaware, which ought properly to be quoted as a distinct species, is arranged with this variety.

Felspar is widely diffused all over the globe, and with a few exceptions is more common than any other mineral; it forms a constituent part of most primitive rocks, such as gneiss, granite, &c.; is the principal ingredient of the sienites, porphyry, and, in fact, with a small percentage of other minerals, forms whole mountain ranges and chains in various parts of the globe: such we see in Siberia, the north and west of Scotland, &c., all of which are surrounded by felspar. Immense beds exist in the United States: around Wilmington, in the State of Delaware, is an inexhaustible deposit of exquisite and perfectly pure felspar; and in

Connecticut and on the North River we see beds of the foliated felspar extending for miles. Sweden, Norway, and Greenland are likewise great depositories of the common felspar.

The amazon-stone is used in jewelry for rings, pins, seals, snuff-boxes, &c. It is principally cut at Ekaterinenburg, Siberia, where it is ground on a leaden wheel with emery, and polished with rotten-stone on a wooden wheel; its form is that of cabochon, and sometimes that of the mixed pavilion-cut, when the table is to be cut pretty large, and arched, in order to display more distinctly its peculiar colors.

Common felspar is of no great value, and only the amazon-stone is used in jewelry, which commands a good price. Cut specimens, suitable for ear-rings or brooches, are worth from three to five dollars.

A very fine specimen of the amazon-stone, in its rough state, may be seen in the New York Lyceum of Natural History. The imperial cabinet of St. Petersburg possesses two vases of this stone, which are nine inches high and five and one half inches in diameter. Although our vitreous felspar has not yet been brought into use for the purposes of jewelry and other ornaments, yet it bids fair to contribute, at one day, much to the national wealth of this country, for it is the best material for porcelain, china, and earthen-ware. Already have many cargoes of this beautiful mineral been shipped to France and England (six hundred tons of the Connecticut, Middletown, felspar were, according to Professor Shephard, last year shipped to Liverpool, and one hundred tons to the Jersey porcelain manufactory), where the manufacturer appears to appreciate better the purity of ingredients for the purposes just mentioned. Instead of receiving, as hitherto, the manufactured goods from abroad, made of our own raw material, it is earnestly to be hoped that we will shortly acquire skill, and exert sufficient industry to compete with foreign manufacturers in the art of making porcelain, with the superior material which nature has so abundantly lavished on this continent. I possess a splendid slab of the vitreous felspar, of one square foot, free from any admixture, and imposing in appearance.

LABRADOR.

This mineral was heretofore considered as a variety of felspar; but it has latterly been separated from it, and ought, therefore, no more to be called labrador felspar, the name by which it is known in all mineralogical works.

Labrador was first discovered by the Moravian missionaries on the island of St. Paul, on the coast of Labrador; and, according to others, by Bishop Launitz, in 1775, when it was first brought to Europe. Labrador occurs in crystalline masses, massive, and in boulders; it is of an uneven and conchoidal fracture; its lustre is vitreous, and in one direction pearly; it is translucent; its colors are gray, with its various shades, such as blackish or whitish-gray, with spots of an opalescent or iridescent vivid play of colors, consisting of blue, red, green, brown, yellow, or orange, according to the direction in which light is falling upon the specimen; sometimes several of these colors are perceptible at the same instant, but more commonly they appear in succession as the mineral is turned towards the light. These colors are said to originate in fissures which intersect the texture of the mineral, as they are only perceptible from that side where they fall together with the foliated structure, and not like the opal, whose mass is supplied with fissures running in all directions.

Labrador scratches white glass, is scratched by rock-crystal, and is somewhat less hard than felspar; its specific gravity is 2·71 to 2·75; before the blowpipe it fuses with difficulty, and is said to lose its play of colors; it consists of silex, alumina, lime, soda, with some oxide of iron and water. Labrador is found as a rock and boulder, in St. Petersburg, Norway, Bohemia, Saxony, Sweden, St. Paul's Island on the coast of Labrador, and in the United States, in Essex county (New Jersey), at the mouth of the North River, and near Lake Champlain, New York, where, according to the description given me by Archibald McIntyre, Esq., its splendid colors are seen on both sides of the water, but a few yards apart, and the effect of the rays of the morning sun falling upon the rock and water at the same time, is said to equal that of the prismatic spectrum thrown into a dark room.

Labrador is used for rings, pins, buttons, snuff-boxes, letter-holders, cane-heads, and other ornaments, such as vases and larger articles; but care has to be taken in grinding, that the direction where the play of colors is visible is kept straight, and that it is cut in cabochon. The price of labrador is not very high, but soon after its discovery, a Doctor Anderson, having described the mineral as displaying all the variegated tints of color that are to be seen in the plumage of the peacock, pigeon, or most delicate humming-bird, and specimens having been carried to England, so great was the avidity to possess it, that small pieces were sold for twenty pounds sterling. The present price of good specimens is from two to ten dollars; and a few years ago I purchased some letter-holders, which are beautiful specimens, for which I paid four dollars each. The largest specimens of labrador are in the collection of the Mineralogical Society, and in the museum of the Academy of Sciences at St. Petersburgh, which were found on the shore of the Pulkouka; one of them weighs ten thousand pounds. I have in my possession a rough specimen of the labrador of this State, merely rubbed off on the surface, and its colors, I venture to say, equal, if they do not indeed excel, in every respect, those of the specimens from St. Paul's Island; and I anticipate the day when the citizens of New York will take as much pride in possessing labrador table and mantel slabs, as they now do in employing the Italian and Irish marble for these purposes; for the resources appear to be inexhaustible in the rocky county of Essex. We do not see many specimens brought from the coast of Labrador, and I was informed by Mr. Audubon, on his return from that quarter, that he could not find any specimens. Mr. Henderson, of Jersey City, who presented me the above-mentioned rough specimen, had likewise splendid small polished specimens in breastpins, displaying all the properties in their full beauty. The same gentleman, who travelled last summer in company with several scientific State geologists, mentions that they picked up beautiful specimens at the height of five thousand seven hundred feet above the level of the sea.

In the collection of Columbia College is a fine specimen of labrador, brought from Gaspé, Lower Canada, by the Hon. Mrs. Percival.

In 1799, it was announced that in Russia a labrador spar was discovered, where a perfect drawing and image of Louis XVI. could be distinctly traced, his head surrounded by a colored crown of pomegranate, with a rainbow border, and a silvery plume of azure color; it was what may be called a *lusus naturæ.* Count de Robassomé, formerly in the Russian service, was the possessor of this singular stone, and he demanded for the same, the sum of 250,000 francs.

There were some magnificent specimens, tables, and other ornaments, in the London Exhibition.

In the New York Exhibition, were likewise fine specimens exhibited from Labrador and the New York locality.

HYPERSTHENE.

This mineral was formerly annexed to hornblende, but has latterly been separated; its name is derived from the Greek, and means of superior strength, in reference to the great hardness and specific gravity which it possesses.

Hypersthene is found in crystalline masses; it has an uneven fracture; it is opaque, and its colors are dark-brown, red, and greenish or grayish black; the cleavage is parallel to the sides, and shorter diagonals of a rhombic prism; its lustre is metallic, and when viewed in one certain direction, copper-red, light-brown, or gold-yellow, and in others it has a greenish play of colors. It scratches glass, has a darkish-green streak-powder, and has a specific gravity of 3·38; it is easily fusible before the blowpipe on charcoal into a grayish-dark bead; acids have no effect upon it; it consists of magnesia, silex, alumina, and lime, with some water.

It is found forming a constituent of the labrador rock, on the coast of Labrador, Greenland, and in the United States, on Brandywine creek in Pennsylvania, and in Essex county, New Jersey; fine specimens have been found in Hingham, Massachusetts. The French jewellers have lately begun to introduce this mineral for rings, pins, and other ornaments, on account of its high polish and beautiful color. The best-colored pieces are cut out of the mass, and ground on a lead wheel with emery in cabochon, and polished with rotten-stone. Beauty of color and other qualifications determine the price of this stone; at Paris a hypersthene, in cabochon cut, eight to ten lines long and six lines broad, was sold for one hundred and twenty francs.

The mineral is, however, pretty rare, and has not yet been fully introduced.

IDOCRASE.

This mineral occurs mostly crystallized, in the form of a four-sided prism, terminated by four-sided pyramids; also, massive; its cleavage is parallel to all the planes of the prism; it is transparent and opaque; possesses strong double refraction of light; its lustre is between vitreous and resinous; its cross fracture conchoidal; the crystals are all striated in length; its colors are yellowish or brownish green, orange-yellow, sometimes blue and black. It scratches white glass and felspar, but is scratched by topaz. Its streak-powder is white, and it has a specific gravity of 3·8 to 3·4. Before the blowpipe, it is fusible into a brownish glass. It consists of lime, alumina, silex, with some oxide of iron and manganese.

Idocrase is found in different geological positions in primitive and volcanic rocks, in the cavities of the serpentine in the Alps, in Piedmont, Mount Somma, Vesuvius, Etna; also, Norway, Sweden, Spain; in the United States, at Worcester, Massachusetts; Salisbury, Connecticut; Cumberland, Rhode Island.

Idocrase, of pure green and brown colors, and transparent, is used for rings and pins, and at Naples and Turin, it is principally cut for jewelry on a leaden wheel, and is polished on wood with pumice-stone. The forms it receives are the brilliant, table, and pavilion, and if perfectly pure, is mounted *à jour;* otherwise with a suitable foil. The price of idocrase is not very high, as it is but little known among jewellers.

Chrysolite and the green garnet are often substituted for idocrase; but the first has a greater specific gravity and is of a more vivid color; the latter is harder, and likewise of greater specific gravity.

The Italian idocrase, which is cut at Naples, is mostly called the Italian chrysolite.

HAÜYNE.

The name of this mineral was given in honor of the celebrated French mineralogist, the Abbé Haüy. It occurs in dodecahedral crystals, with brilliant faces; also, in grains and massive; it has a conchoidal fracture; is transparent and translucent; possesses a strong vitreous lustre; its structure is imperfectly foliated. Its colors are indigo, sky, and smalt blue; also, white, green, gray, and black. It scratches white glass and is scratched by quartz; white streak-powder; specific gravity is 2·47. Before the blowpipe it loses its color and fuses into a porous glass, and with borax into a diaphanous glass, which turns yellow on cooling; it forms a jelly with acids. It consists of lime, alumina, silex, protoxide of iron, sulphuric acid, and soda or potash.

It is found in slacked basalt, and ejections of Mount Vesuvius; on Bodenmaise, on the Laach Lake, in Italy, and on the island of Tiree, Scotland.

Haüyne is not much known yet, but has lately been used for rings, ear-rings, brooches, &c.; it is cut like idocrase, but the price will always be high on account of its scarcity.

LAPIS LAZULI.

The name of this mineral is derived from the Persian language, and means blue color, or, with the Latin prefix, blue stone. The ancients were well acquainted with it, and have employed it as a substitute for other gems. The

Greeks and Romans are said to have called it by the name of sapphire, denominating that with specks of iron pyrites the *sapphirus regilus ;* Pliny called it the *cyanus.* It was formerly used as a strengthening medicine.

Lapis lazuli very seldom occurs crystallized; its regular form is the oblique four-sided prism; it mostly occurs compact, and in grains and specks, with an uneven and conchoidal fracture; it is translucent on the edges; its lustre is nearly vitreous and shining; structure foliated; its color is fine azure-blue, with different shades, often interspersed with spots and veins of pyrites. It scratches glass, but is attacked by quartz and by the file; its specific gravity is 2·3; before the blowpipe and on charcoal it with difficulty runs into a white glass, but with borax it fuses with effervescence into a limpid glass. It consists of lime, magnesia, alumina, and silex, with soda, protoxide of iron, and sulphuric acid.

It is generally called in trade, the Armenian-stone.

It is found in gangues of the older formations, and in Bucharia; it exists in granite rocks, and is disseminated in all veins of thin capacity; on the Baikal Lake it is found in solid pieces; also, in Siberia, Thibet, China, Chili, and Great Bucharia.

Lapis lazuli is much used for jewelry, such as rings, pins, crosses, ear-rings, &c. The best pieces are generally cut out from larger lumps by means of copper saws and emery, then ground with emery on a lead wheel, and polished with rotten-stone on a tin wheel. The rocks which yield lapis lazuli, where it is contained in specks, are likewise cut for ornamental purposes, such as snuff-boxes, vases, candlesticks, cups, columns, cane-heads, &c.; also, for architectural ornaments and stone mosaic; the larger specimens, having specks regularly disseminated on a white ground of the rock, are those selected for cutting.

The most important use of this mineral is that of furnishing the celebrated and beautiful pigment called ultramarine-blue, used by painters in oil, and said never to fade. The lapis lazuli takes a very high polish, but becomes dull again after being used for some time. It is sometimes imitated by lazulite (azure-stone), or blue carbonate of copper, which, however, is not near so hard, and effervesces on testing with nitric acid. Those specimens having iron pyrites inclosed are difficult to polish well, on account of the unequal hardness of the two minerals.

Lapis lazuli has latterly been discovered in California, but the color of the mineral from this locality is very indifferent, and its price is therefore much inferior to that from Persia. In Paris, the price is estimated at 300 francs per kilogramme. There are many engravings in lapis lazuli, such, for instance, as the Emblem of Peace—a figure with a torch in one hand and a cornucopia in the other, and appearing to embrace military trophies, placed before her.

The Chevalier d'Azara, Spanish minister in France, possessed while there a very beautiful cameo of lapis lazuli, representing the head of Medusa, but without serpents. Maffei speaks of a Venus being carried by a she goat whipped by Love.

The French crown-jewels contained some fine and gigantic specimens of lapis lazuli: one in the form of a boat of large dimensions, valued at 200,000 francs; a sabre-handle given to Louis XVI., by Tippoo-Saib, valued at 6000 francs; a large vase, valued at 2600 francs.

In 1855, at the Paris Exhibition, were numerous objects and carvings, exhibited by Rudolphi, which fairly compared with the antique relics of this species, both in material and in taste of execution.

A marine shell carved from lapis lazuli was beautifully mounted by Morrel, and another *chef d'œuvre*, in lapis lazuli, by Duponchel. A small round table of mosaic and lapis lazuli, which was a beautiful work by Jarry.

A magnificent bagnivola of lapis lazuli, of very large size, and extremely pure and rich in color, was exhibited by Mr. Jones, in the London Exhibition, in 1851.

Lapis lazuli has been well imitated of late, and, but for the touch, with much difficulty to be distinguished from the genuine, it is manufactured from bone-ashes and oxide of cobalt.

The value of lapis lazuli, although depending upon its purity, intensity of color, and size, has nevertheless much diminished when compared with its former prices.

The Chinese, who have for a long time employed lapis lazuli in their porcelain painting, call the pure and sky-blue stone *zuisang*, and the dark-blue, with disseminated iron pyrites, the *tchingtchang*, preferring the latter to the former; they work the same for many ornaments, such as vases, snuff-boxes, buttons, and cups.

In the palace which Catharine II. built for her favorite, Orlof, at St. Petersburg, there are some apartments entirely lined with lapis lazuli, which forms a most magnificent decoration. I have several slabs, three inches long, and of fine azure-blue color, in my possession.

The production of ultramarine has been known since 1502, and was already employed, under the name of *azurum ultramarinum*, by Camillus Leonarus.

The process of preparing ultramarine was known as early as the fifteenth century. The color is now mostly prepared at Rome, in the following manner: those pieces which are free from pyrites specks, are first calcined and pulverized; the powder is then formed into a mass with a resinous cement (*pastello*), and fused at a strong heat; this is then worked with the hands in soft water, whereby the finest coloring particles are disengaged in the water, which will soon be impregnated with the blue color; a fresh portion of water is then taken, and the same operation is continued until the remains are colorless. The ultramarine, after a short time, settles to the bottom of the vessels, and is carefully separated and dried. If the lapis lazuli be of the best quality, the product will be from two to three per cent. That color which remains yet in the mass is of an inferior quality, and is called the ultramarine ashes; it is of a paler and more reddish color.

Good ultramarine has a silky touch, and its specific gravity is 2·36. It does not lose its color if exposed to heat, but is soon discolored by acids, and forms a jelly. In order to distinguish the pure ultramarine from numerous spurious and adulterating coloring materials, such as indigo, Prussian-blue, mineral-blue, &c., it is only necessary to test the article in question with some acid, when after a few minutes the real ultramarine is discolored, yielding a clear solution and a white residuum. The real ultramarine has always been at a very high price, on account of the small product obtained from the mineral. An ounce of the purest ultramarine is sold in France for two hundred to two hundred and fifty francs, which is not within the reach of all painters.

In the year 1828, the discovery was made by Professor Gmelin, in Tubingen, that sulphuret of soda was the proper material for imitating this precious and valuable pigment. By his experiments he succeeded in preparing this substance from silex, alumina, soda, and sulphur, producing a color in every respect corresponding with the true color of the lapis lazuli, and bearing the same relation to acids as the genuine ultramarine. This, for economy, has become a great object to painters and color-men, since a whole pound of it may be purchased in France for twenty francs. As it bids fair to meet with a great consumption, being even substituted for cobalt in bluing paper, thread, and other stuffs, several manufacturers have already been induced to engage largely in its preparation; and there is now a very extensive establishment in full operation by M. Guimet, three leagues from Lyons, who likewise claims the priority of its discovery: the royal porcelain manufactory at Meissen, in Saxony, also prepares it. The process for making the artificial ultramarine, as it was first described by Gmelin, is here given, as it was published in the *Annales de Chimie.* The whole process is divided into three parts:

1. The pure hydrate of silica is prepared by fusing fine pulverized quartz or pure sand with four times its own weight of salt of tartar, dissolving the fused mass in water and precipitating by muriatic acid; also the hydrate of alumina is prepared from alum in solution, precipitated by ammonia.

2. Dissolve the silex so obtained in a hot solution of caustic soda, and add to seventy parts of the pure silex seventy-two parts of alumina; then evaporate these substances until a moist powder remains.

3. In a covered Hessian crucible, a mixture of dried sal soda, one part to two parts of sulphur, is heated gradually, until it is fully fused, and to the fused mass add small quantities of the earthy precipitate, taking care not to throw in fresh quantities until all the vapors have ceased; after standing for an hour in the fire, remove the crucible, and allow it to cool. It now contains the ultramarine, mixed with an excess of sulphuret, which is to be removed by levigation; and if the sulphuret is still in excess, it is to be expelled by moderate heat. Should the color not be uniform, levigation is the only remedy

KYANITE, SAPPARE, DISTHENE.

The name of this mineral is derived from the Greek, signifying blue, and was given to it on account of its blue color. It has been known for many centuries, having been cut by a German lapidary, Cornellius, in the reign of James I., under the name of sappare, by which it is yet known among the French jewellers.

It occurs in masses composed of a confused aggregation of crystals, and in distinct crystals of four or eight sided prisms, much compressed, with two broad shining faces. The crystals are generally closely aggregated, and are crossing or standing on each other in a hemitropic form, so as to present a singular and curious aspect. Some of the crystals are curved, others are corrugated or wrinkled, as though they had been pressed endwise, or had not room to stretch themselves at full length; others are pressed into triangular shapes, &c. It has a foliated structure; uneven fracture; is transparent and translucent; possesses simple refraction of light; its lustre is vitreous and pearly; its colors are azure-blue, passing into light-blue or bluish-white and bluish-green. It scratches white glass, and is attacked by topaz or a good file; yields a white streak-powder; has a specific gravity of 3·63 to 3·67. It becomes electric by rubbing, and often exhibits positive and negative electricity in one and the same specimen; it is infusible before the blowpipe, but, with borax, fuses with difficulty into a transparent limpid glass: acids have no effect upon it.

It consists of alumina and silex, sometimes combined with oxide of iron and water.

The kyanite is found in micaceous, talcose, and argillaceous slate, at St. Gothard, in the Tyrol, and in Switzerland; in Styria, Carinthia, Bohemia, Spain, and Siberia; also, in the United States, of the purest azure-blue color: large specimens in Litchfield, Haddam, and near New Haven (Connecticut); Chesterfield, Conway, Granville, Deerfield, and Plainfield (Massachusetts); Grafton, Norwich, and Bellows Falls (Vermont); Oxford (New Hampshire); East Bradford, East Marlborough, and Chester county (Pennsylvania); likewise, of a delicate light-blue, variously shaded, in Foster (Rhode Island).

The kyanite has not yet been received as a favorite among the jewellers (perhaps from not being generally known by them), or else it would long since have been cut for various ornamental purposes, more particularly in in this country, where the localities are so numerous and the color so beautiful. When well cut, it may be substituted for the sapphire. I indulge the hope that some jewellers or lapidaries may take a hint from this remark. In France and Spain, it has for some years past been used for rings, brooches, and other jewelry. It is generally ground with emery on a lead wheel, and with pumice-stone polished on a wood plate, receiving the last polish with rotten-stone. The form it receives is cabochon or table cut. Usually, the best parts of good uniform colored specimens are picked out for cutting.

The price of this stone depends upon the hardness, color, and polish: perfect specimens command a good price. Very fine cut specimens are brought from the East Indies, and sold in France as sapphires.

TURQUOISE.

The name of this mineral is probably derived from the country whence it was generally brought into market, which is Turkey. In ancient times it was used as a remedy for several diseases, and was also worn as an amulet against disasters. It occurs in reniform masses and in specks; has a conchoidal fracture; is opaque; of a dull and waxy lustre; its colors are blue and green, from sky-blue to apple-green, sometimes yellowish; it scratches apatite, but not quartz nor white glass, and is easily attacked by the file; it has a white streak-powder; its specific gravity is 2·86 to 3·0; it is infusible before the blowpipe alone, but loses its blue color and becomes yellowish-brown; but it fuses with borax into a limpid glass. Muriatic acid has no effect upon it. Consists of alumina, phosphoric acid, water, oxide of copper, and protoxide of iron.

There are two kinds of turquoise used in trade, which differ materially in their composition, and are from different localities:

1. Turquoise from the old rock, or true turquoise, which is generally called *Oriental turquoise*, we receive from Persia, and is of a sky-blue and greenish color.

2. Turquoise from the new rock, the *occidental* or bone and tooth turquoise, which is either dark-blue, light-blue, or bluish-green; the surface of this mineral is sometimes traversed by veins which are lighter than the ground; it is of organic origin, consisting, probably of colored teeth of antediluvian animals; it owes its color, according to Bouillon Lagrange, to two per cent. of phosphate of iron, which is contained in it. It is easily distinguished from Oriental turquoise by its structure, internally foliated and striated, which is an indication of a bony composition; it does not take so high a polish, is discolored in distilled water, dissolves in acids, and is totally destroyed by aquafortis. Its localities are Siberia, Languedoc in France, and other places.

True or Oriental turquoise is found in small gangues of bog-ore and silicious schist, in boulders, &c. A mineral by the name of kalaite, occurring as a coating to silicious sinter, in Silesia and Saxony, was some years ago discovered. Turquoise is brought to market by the merchants of Bucharia, ready cut and polished; and in Moscow it is wrought over, being ground on a lead wheel with emery, and polished with rotten-stone or pumice-stone on a tin wheel; and its last and best polish is received from the jewellers, by rubbing with a linen rag and rouge. Since it is often traversed by fissures and cracks in the interior, it requires great caution in grinding. It is mostly cut in the form of cabochon; also, as thick or table stones, and is used for numerous purposes in jewelry, such as rings, earrings, brooches, and also for mounting around the most precious gems.

The price of turquoise has, for the last ten years, much decreased; that of an Oriental is generally four times higher than the occidental: one the size of a pea is worth about five dollars; a good turquoise, sky-blue and oval-cut, five lines long and four and a half lines broad, was sold in France for two hundred and forty-one francs; and a light-blue, greenish lustre, and oval-cut, five and a half lines long and five broad, was sold for five hundred francs; whereas an occidental turquoise, four lines long and three and a half broad, brought only one hundred and twenty-one francs. Turquoise is very well imitated artificially (so much so as to render it difficult to discover the difference between that and the real), by adding to a precipitated solution of copper and spirits of hartshorn, finely-powdered and calcined ivory-black, and leaving the precipitate to itself for about a week, at a moderate heat, and afterwards carefully drying the same, and exposing to a gentle heat. This artificial turquoise is softer than the real, and cuts with a knife in shavings, whereas the genuine yields a white powder. The real turquoise displays in the daytime a sky-blue, and at night a light and greenish color; is not attacked by acids, and resists the fire.

In the museum of the Imperial Academy at Moscow, is a turquoise more than three inches in length and one inch in breadth.

A jeweller at Moscow is said to have had in his possession a turquoise two inches long, in the form of a heart. This formerly belonged to Nadir Shah, who wore it as an amulet, for which he asked five thousand rubles.

A short time ago, I beheld, at a sale, one of the largest and most splendid turquoises, which was one inch in size, and of a blue color.

Major McDonald's collection of turquoises, from Arabia, exhibited at the London Exhibition, in 1851, was very beautiful; it consisted of two hundred specimens, cut and polished. They differed very little from the Persian turquoises. He discovered several localities in the country of Sonalby, sixteen days' journey northeast of Suez, but all were within a range of forty miles, and upon a mountain range, at from five thousand to six thousand feet of elevation. Some turquoises were found in *situ*, but most of them were collected from the ravines descending the mountain chain. The rock is a reddish sandstone, composed of quartz grains, belonging to the paleozoic rocks. Their hardness is equal to that of agate. The nodules of turquoise form groups, almost like currant seeds, in the sandstone. There may be observed in this collection, veins and small concretions from one tenth to one twentieth of an inch in thickness, which cut across the bed of sandstone like small threads; in color they vary from an intense blue to a bluish-white.

NATROLITE.

This mineral has been discovered of late years, and receives its name from the Latin *natron*, soda, given to it on account of that alkali being contained in it; it occurs reniform, botryoidal, and massive, such as mammillary, and in the alternate zones around the centre; it has a splintery fracture; is translucent on the edges; of a pearly lustre; its colors are white, yellowish-white, or reddish-brown, and they often alternate in different layers; it scarcely scratches glass, but is scratched by felspar; has a white streak-powder; its specific gravity is 2·16; it fuses before the blowpipe into a colorless spongy glass; it consists of soda, alumina, silex, and water, sometimes a little oxide of iron. Its localities are Switzerland, Bohemia, Saxony, Scotland, and Nova Scotia. Natrolite, on account of its susceptibility of a high polish, has been used for rings and other ornaments in jewelry, but has not yet been in much demand, and its value is also very inconsiderable.

FLUOR SPAR.

This mineral was well known to the ancients, but did not attract particular attention until the sixteenth century, when it was introduced as a flux. As early as 1670, the art of etching on glass by means of fluor spar was practised at Nuremberg.

Fluor spar occurs mostly in crystals of various forms, the principal of which is the octahedron with its varieties, the cube and the rhomboidal dodecahedron; also, massive and in specks; it has an uneven or splintery fracture; is transparent or translucent on the edges; possesses simple refraction of light; a vitreous lustre; its colors are green, yellow, gray, blue, and white; also purple and red, in all their various shades, from the violet to the rose-red.

It scratches lime, but not glass; yields to the knife; has a white streak-powder; its specific gravity is 3·14 to 3·17; it becomes electric by rubbing; before the blowpipe it fuses with ebullition into an opaque globule, but with borax, into a transparent glass; when pulverized and treated with heated sulphuric acid, it emits fluoric acid gas, which is employed in etching on glass; phosphoresces when thrown on hot iron; it consists of fluoric acid and lime.

From the variety and beauty of its colors, it is known, when cut, in trade, under the various names of false emerald, false amethyst, false ruby, and false topaz, according to the color it exhibits. It is mostly found in metalliferous veins, and very rarely in the newer formations. Its localities are in Baden, Bohemia, Saxony, St. Gothard, at Derbyshire and Devonshire, in England, and the United States, in the last of which countries it occurs of most beautiful colors in fine crystals; from a lately-discovered locality at Russy, in St. Lawrence county, State of New York, I have specimens of crystals two feet long and five wide. It is found in Illinois, seventeen miles from Shawneetown; Blue Ridge, Maryland; Smith county, Tennessee; at Franklin Furnace, and Hamburgh, New Jersey; Saratoga Springs, and at Alexandria, New York; Middletown and Huntingdon, Connecticut; Thetford and Southampton lead mines, Massachusetts, and on the White Mountains, New Hampshire.

Fluor spar is cut for ring-stones and shirt-buttons, and particularly in such forms as are intended to be substituted for other gems; in Derbyshire there have been large mills for grinding, cutting, and polishing the flour spar into vases, cups, obelisks, plates, candlesticks, &c., ever since 1765, and there are now more manufactories, principally at Derby. That fluor spar which may be called the nodular variety, and the colors of which run in bands or zones, is only found in a single mine near Castleton, Derbyshire, and is known by the technical name of Derbyshire-spar or Blue John; it is used for various ornaments, to be met with all over the world, in parlors or mineral collections. In order to heighten the various colors in the ornamental specimens, before they are polished, they are heated to a certain degree, when the dark spots, or tints, disappear, and the colored bands become more distinct, and assume a peculiar purple or amethystic hue.

Fluor spar is often intermixed with lead ore, called galena, which produces, when polished, a beautiful appearance. Ornaments of fluor spar still command a high price, which, however, depends a good deal on the perfect qualities of the various specimens, their color, size, &c.

A translucent variety of fluor spar, called chlorophane (found in Cornwall, England, in Siberia, and principally in the United States, at New Stratford, Connecticut), is of beautifully variegated colors, but principally blue, violet, and green; it is chiefly interesting on account of its phosphorescence; when put on hot iron in a dark room, it emits a most beautiful emerald-green light. One of the first localities of chlorophane discovered in this country, was at Sheekonk, Massachusetts, near the summer residence of the Hon. Tristam Burges, about one and a half miles from Providence. It is massive, opaque, and of a deep purple color. It phosphoresces readily on being projected upon a moderately-heated shovel, when it loses its color and becomes white. It also occurs of a crystalline structure in Wrentham, Massachusetts, near the Cumberland and Rhode Island line, in the vicinity of Diamond Hill. A beautiful vase of Derbyshire-spar, as also crystalline groups, may be seen in the collection of the New York Lyceum of Natural History.

MALACHITE.

The name of this mineral is from the Greek, alluding to its color; it was well known to the ancients; Theophrastus called it the pseudo-emerald; it was worn by many as an amulet.

It occurs tuberose, globular, reniform, mammillary, and stalactiform; also, in fibres; it has an uneven, conchoidal, and splintery fracture; it is opaque; of a dull and shining lustre; and has an emerald or verdigris green color, alternating sometimes in stripes of different shades of green. It scratches lime, but not glass; its streak-powder is of lighter color than the mineral; its specific gravity is 3·67; before the blowpipe, it decrepitates and turns black; with borax, it is reduced to a metallic grain; it effervesces with nitric acid; is dissolved, and forms a blue color with ammonia; it consists of oxide of copper, carbonic acid, and water.

Malachite is found in various rocks, primitive as well as secondary, in gangues and strata. The finest specimens are obtained in Siberia, Tyrol, France, Hungary, Norway, Sweden, England, Bohemia, and the United States, at a great number of localities, but either in small specimens, or as a coating of other copper ores, which will ever render it useless for ornamental purposes. The principal localities in this country are in New Jersey, Maryland, Connecticut, and at the various copper-mines; it is also found in the island of Cuba, from which place I have seen some good compact specimens.

Some very fine specimens of compact malachite from Siberia, were presented to the New York Lyceum of Natural History, by Charles Cramer, Esq., of St. Petersburg. I have also seen some excellent specimens of malachite in the collection of Dr. Martin Gay, at Boston; Dr. Chilton, of New York, &c.

Malachite, when cut, takes a high polish, which well adapts it for various ornaments, such as rings, pins, ear-rings, &c. Snuff-boxes, candlesticks, mosaics, &c., are likewise made from it. In general, the specimens are assorted, and the best pieces cut on a leaden wheel with emery, and polished with rotten-stone on a tin plate. Very large specimens are used for table plates and vases.

The value of the malachite is not high, being very abundant; yet much depends upon the size of the various specimens. At St. Petersburg, a very large slab, said to be in the collection formerly belonging to Dr. Guthrie, thirty-two inches long, seventeen inches broad, and two inches thick, was valued at twenty thousand francs. Many rooms in several European palaces are laid out with malachite; and the Mineralogical Museum, at Jena, possesses a large collection of malachite, which was presented by the Grand Duchess of Saxe Weimar, a Russian princess.

An apartment in the Grand Trianon, at Versailles, is furnished with pier and centre tables, mantel-pieces, ewers and basins, and enormous ornamental vases of malachite, the gift of the Emperor Alexander to Napoleon.

The malachite furniture exhibited by the Russian government at the London Exhibition, excited so much admiration and was sold at such high prices, that the author considers himself justified in copying a part of the report by the jury on inlaid work in malachite:

"Malachite is a peculiar mammillated or stalagmitic form of the green carbonate of copper, chiefly found in an available state for inlaid work, in a very few localities in Siberia, and lately in South Australia. It has long been employed in Russia in this manufacture. The mineral is remarkable for its fine emerald-green color (often presenting several distinct shades in the same specimen), its brilliant and silky lustre, and compact texture. It is softer than marble, very much heavier, and by no means so easily worked, owing to its brittleness and the concentric arrangement it generally presents. It can rarely be found in masses weighing more than ten to twenty pounds, and good specimens have a very high value, as the finer kinds are used exclusively for decorative purposes.

"The most important locality at present known for the finer kinds of Siberian malachite, is in the copper ground of Nijug Tagilsk, in the government of Ekaterinenburg, on the river Tura, a tributary of the Irtish, on the Siberian side of the Uralian mountains, in latitude 57½° N., longitude 56° E. In a mine at this place, belonging to Messrs. Demidoff, Sir Roderick Murchison has described an immense mass of malachite, which at the time of his visit, a few years back, had been recently discovered at the depth of two hundred and eighty feet, strings of green copper conducting to it; and these strings increasing in width and value, were found to terminate in a vast irregular botryoidal mass, estimated to contain not less than half a million of pounds of this valuable mineral. The larger blocks, when exposed to the air, break up into smaller fragments, rarely weighing more than from one to four pounds.

"It is by no means a modern application of this material, to employ it in inlaying or veneering for decorative purposes; and few palaces or large public museums in the principal capitals of Europe, are without specimens, marking the progress of its manufacture from time to time, and generally regarded, from their great rarity, cost, and beauty, as worthy of being made imperial and royal presents. It is, however, only lately that Messrs. Demidoff, the owners of the mine in which the mineral occurs, have established in St. Petersburg a manufactory, where, after numerous trials and the expenditure of much capital, labor, and ingenuity, it has been found possible to produce such works as those sent to the London Exhibition, and in testimony of the magnitude and importance of the objects exhibited, their extraordinary beauty and richness, the excellence of the production, and the application of the various new methods of manufacture, Messrs. Demidoff have been awarded the highest premiums. These are chiefly seen in the construction of the doors, and more especially in the ingenious and beautiful manner in which the pattern is adapted to the material, the detached pieces of mineral being fitted to each other so as to preserve the pattern; they may also be noticed in the nature of the cement, which being mixed with broken fragments of the malachite itself does not interfere with the plan, or in any way injure the effect of the whole.

"The working of malachite on a large scale is extremely tedious and laborious, and the mode of operation is too long to detail in this treatise.

"The quantity of malachite obtained from the mine and brought into market annually is very small, and the price of the raw material is considerable, it ranges from twelve to seventeen shillings sterling per pound, according to color rather than veining, the darker colors being cheapest; there are four shades quoted, denominated respectively, *foncée*, *ordinaire*, *claire*, and *pale*; but these are also subdivided, the two first into *ronde* and *longue*, the others into *ronde*, *longue*, and *tachetée*. A large proportion of the malachite in the specimens exhibited was of very good color, and the average value probably exceeded fifteen shillings sterling per pound.

"The objects exhibited consisted of a pair of folding-doors, several vases, a chimney-piece, a table, a set of chairs, and sundry smaller articles; of these, the doors and vases were at once the most important and the most highly finished, and it is understood that the former required the constant labor of thirty workmen employed by day and night during a whole year. They were most skilfully and and beautifully planned, and the workmanship was in all respects admirable."

There are fluted Corinthian columns of malachite in some churches in St. Petersburg, and many other large ornaments of large slabs of malachite in the palace of the King of Prussia, at Potsdam.

A large oblong table, inlaid with malachite, partly Russian and partly Australian, was also exhibited by a manufacturer of Paris, with specimens of azurite (blue carbonate of copper), but were all put in the shade by the Russian articles.

SATIN SPAR.

This mineral occurs stalactiform, globular, reniform, and massive; it is of a fibrous texture (that is, of fine delicate fibres closely adhering together), a pearly lustre, and is translucent on the edges; the colors are snow-white, yellowish-white, or pale-red, colored by metallic oxides. It scratches gypsum, but not glass; specific gravity, 2·70; becomes electric by rubbing; before the blowpipe is infusible, and changes into quicklime, but borax reduces it to a clear glass. It effervesces and dissolves with nitric acid; and consists of lime and carbonic acid. Satin spar is called by mineralogists fibrous limestone, and is found in the coal formations, and in the cavities of several limestones. The finest specimens are found in Cumberland and Derbyshire, England; in Hungary; and in the United States, near Baltimore, in Pennsylvania, also at Westfield and Newburyport, Massachusetts, where splendid specimens five inches long are obtained, according to Professor Hitchcock. It takes a fine polish, and is distinguished by its extraordinary fine satin lustre, and is therefore used for various articles of jewelry, such as ear-rings, necklaces, beads, and also for inlaid work; large specimens are used for snuff-boxes.

Satin-spar beads have been in great favor as necklaces and ear-rings, and were sold a few years ago in England at very high prices. In modern times, the satin beads or pearls have been imitated to a great extent in France and Germany, in white and deep-yellow colors: glass beads, of a bluish-white tinge, and hollow, are made to imitate the reflection of the satin spar, by means of the scales of a small river-fish called the bleak, that are suspended in dissolved isinglass, and dropped into the bulbs, which are then turned in all directions in order to spread the solution equally over their interior surface; in this way the glass bulbs assume the natural color and brilliancy of satin spar; they are harder, however, and it is easy to detect them on that account.

Fine specimens may be seen at the New York Lyceum of Natural History, also in the collection of Dr. Gay, of Boston.

Satin gypsum, which bears the greatest resemblance to satin spar, and only differs in its chemical constituents (having sulphuric acid, instead of carbonic, as a component part), is much used for the same kind of ornamental purposes, and is more abundant over the world. I have seen very splendid specimens at South Boston, in the beautiful collection of minerals belonging to Francis Alger, Esq., who brought them from Nova Scotia, and who (as also Dr. C. T. Jackson) has given so valuable a description of all the mineral treasures of that province.

Satin gypsum is, however, much softer than satin spar, and is much easier scratched; for which reason it is not so generally employed.

ALABASTER.

This mineral is a compact gypsum, and occurs massive, with a compact fracture; it is translucent; has a glimmering lustre, and its colors are white, reddish, or yellowish.

The purest kinds of this mineral are used in Italy for vases, cups, candlesticks, and other ornaments. It is found at Castelino, in Tuscany, thirty-five miles from Leghorn, at two hundred feet below the surface of the earth.

The yellow variety, called by the Italians, *alabastro agatato*, is found at Sienna; another variety of a bluish color, obtained at Guercieto, is remarkably beautiful, being marked with variegated shades of purple, blue, and red. The above alabasters are carbonates of lime.

The principal manufactory of alabaster ornaments is at Valterra, thirty-six miles from Leghorn, where about five thousand persons live by this kind of labor. In making, they require great care, and must be preserved from dust, as the alabaster is difficult to clean. Talcum, commonly called French chalk, will remove dirt, but the best mode of restoring the color, is to bleach the alabaster on a grass-plat. Gum water is the only cement for uniting broken parts.

Plaster of Paris is likewise a compact gypsum, but contains a small portion of carbonic acid, which makes it effervesce when treated with acids. It was formerly exported only from Montmartre, near Paris, hence its name; it is much used in ornamenting rooms in stucco, in taking impressions of medals, in casting statues, busts, vases, time-piece stands, candelabras, obelisks, and for many other purposes.

The common plaster of Paris is ground after being calcined; and in this condition it has the property of forming a pliable mass with water, which soon hardens, and assumes the consistency of stone.

Oriental alabaster is not a sulphate but a true carbonate of lime, and on account of its peculiar tint and transparency, and as it appears that it was formed similar to stalagmite, it was called by the ancients, alabaster; the large vase of this Oriental alabaster which was so justly and so much admired by the thousands of spectators at the London Exhibition, was executed by Dallamada, of Rome. It was really a magnificent piece of workmanship, being from a large block and the whole work of one entire piece, the vase, the handles, which consisted of serpents, along with the tazza and the extremely fine polish, displayed the great ingenuity of the master.

A hollow altar of Oriental alabaster, provided with a lamp and intended to show the remarkable transparency of the material, and of excellent workmanship, along with a great many statues and groups of life-size figures, were exhibited both in the London and New York Exhibitions.

AMBER.

This gem was known to the inhabitants of remote ages; the Phœnicians sailed to the Baltic (the Glessany islands), for the sole purpose of obtaining amber, which they wrought into chains and other ornaments, that were sold to the Greeks, who called the same *electron*. In the Trojan war, as Homer reports, the women wore necklaces of amber. Its electric properties were likewise known, for Thales was so much surprised at that phenomenon, that he attributed it to a soul in the amber; and Pliny says that amber is revived by heat, the nature of electricity not being understood. It was also worn as an amulet, and used for medicine. The ancients could not agree as to its origin: Philemon, according to Pliny, classed it as a fossil; Tacitus, however, judging from the insects held in it, concluded it must be a vegetable juice, whence its name in Latin, *succinum*, or juice. Many naturalists have, until lately, considered amber as a mineral; but it has been satifactorily proved by Schweigger and Brewster, from its chemical characters, and polarizing light, to be a gum-resin, and that it is the juice of a tree, called the amber-tree, now extinct.

Amber occurs in nodules or roundish masses, from the size of grains to that of a man's head; and sometimes in specks; it has a conchoidal fracture; is transparent and translucent; possesses single refraction of light; a resinous lustre in a high degree: its colors are wine and wax yellow, greenish or yellowish white, or reddish-brown; sometimes the colors vary in layers. It scratches gypsum, but is attacked by carbonate of lime; its streak-powder is yellowish-white; it has a specific gravity of 1·08 to 1·10; it becomes electric by rubbing. Before the blowpipe it burns with a yellowish and bluish green flame, emitting at the same time a dense and agreeable smoke, and leaving a carbonaceous residuum; heated oil softens and makes it pliable; it does not melt as easily as other resins, requiring 517° Farenheit; it yields by dry distillation an acid which is called succinic acid, also an essential oil, known by the name of oil of amber, and in the retort remains a brown mass, called the resin of amber, which is used in the arts as amber varnish; any essential oil, or spirits of turpentine may be used for procuring the resin; fat oils dissolve amber perfectly; its elementary constituents are carbon, hydrogen, and oxygen, with some lime, alumina, and silex.

Amber is found either thrown up by the sea, or in the small rivers near it; sometimes in alluvial deposits of sand or gravel in the vicinity of the sea, or in bituminous formations, such as lignite, bituminous wood, or jet, where crystallized minerals are at the same time found, such as iron pyrites, &c.

Its geological distribution is in the green-sand formation, or, according to De la Beche, the stratified rocks, between the third and fourth large group.

Amber occurs in the greatest abundance on the Prussian coast, in a bed of bituminous coal, where it is washed out or cast ashore during the autumnal storms on the coast of

Pomerania and Prussia proper, between Konigsberg and Dantzic; it is also obtained there by sinking a shaft into the coal, and is mined in a systematic way. All along the line of the Baltic coast, at Courland, Livonia, Pomerania, and in Denmark, it is picked up. On the Sicilian coast, near Catania, sometimes very peculiarly tinged blue, it is also found. In Greenland, at Hasen island, it occurs in brown coal. Near Paris it occurs in clay. It is also found in China. One of the largest specimens ever met with on the Baltic was found in 1811, measuring fourteen inches in length by nine inches in breadth, and weighing twenty-one pounds.

I had in my own collection, in the year 1831, a splendid wax-yellow amber, from the Baltic, which measured about sixty cubic inches, and weighed nearly two pounds. It is also found on the Danish coast, and in Greenland, Sicily, Monrovia, Poland, France, and the West Indies. A sailor is said to have found a remarkable specimen, eighteen inches in length, in a singular manner; the discoverer accidentally seated himself on it, when he became so attracted to the amber, excited by his natural heat, that it was with some difficulty he could detach himself from it.

In the United States we find amber at Cape Sable, in Maryland, in a bed of lignite, in masses of four and five inches diameter; also, near Trenton, and at Camden, New Jersey, where a transparent specimen, several inches in diameter, was found. According to Professor Hitchcock, it is found at Martha's Vineyard, Gayhead, and at Nantucket. At the latter place, a light-colored specimen was found, of three or four inches diameter, which is in the collection of T. A. Green, Esq., of New Bedford.

The production of amber depends upon the position of the respective localities; whether it is found among sand and gravel, in mines called amber mines, or in the sea, on the shore, or in smaller rivers near the sea-coast; and the modes of collecting are threefold:

1. The amber mines, which are numerous in Prussia, are wrought like other mines, and explored to a depth of more than one hundred feet. Shafts are constructed for raising the product from the interior of the mines; the miners dig until they reach the amber vein, which is generally found after passing a stratum of sand and a bed of clay of twenty feet thickness, and another stratum of decomposing trees or lignite, which may be fifty feet through; they come then to the pits, which the characteristic color of the soil is the best indication to search for.

2. The second mode of collecting amber is practised, generally after a storm, by the fishermen, who either wade into the water, provided with leather dresses, to their necks, or use small boats, and find at the depth of three fathoms the floating amber.

3. It is mostly, however, collected in large quantities on the shore, after having been thrown up by severe storms.

The amber fishermen are, by practice, pretty well skilled in finding out the spots where the largest quantities may be obtained.

Amber from the mines does not essentially differ from that of the sea, excepting that the former is rather more brittle, and is often covered with an earthy crust.

The amber is assorted before it comes into the hands of the lapidary or merchant, and according to size and clearness of color, it receives different technical names. Thus, there are—

1. The *exquisite* specimens, which are perfectly pure, transparent, and compact, weighing from five to six ounces or more; these are employed in larger ornaments and specimens of the arts, and bring the highest price.

2. The *ton* stones, which weigh from a quarter of an

ounce to four ounces; the largest or purest pieces of which are used for jewelry, and the impure for incense or medicine.

3. The *nodules* are still smaller.

4. The *varnish* stones are still smaller than the former, but are very pure and hard, so as to be easily pulverized, and are used for varnishes, sealing-wax, &c.

5. The *sandstones* are very small, opaque, and perforated pieces.

6. The *lumps* are large but impure specimens, unfit for a lapidary's use; they are sold as specimens, or employed as incense, or for the manufacture of succinic acid.

7. *Refuse* are those pieces which fall off at the lapidary's bench.

The pure amber receives from the lapidary distinct names, according to the shades of color it possesses, such as egg, pale, and light yellow, and so into its brownish shades. The assorted amber is treated according to the various purposes it is intended for, and receives its requisite form by cleaving with an appropriate instrument, by which, also, the external crust is removed. It is generally believed that the worse the crust is in appearance, the more beautiful is the interior of the amber.

Amber, taking a very high polish, is employed for a great many purposes of jewelry, and for various ornaments, such as beads, necklaces, bracelets, ear-rings, buttons, rosaries, mouth-pieces for pipes, cane-heads, snuff-boxes, work-boxes, &c. It is generally wrought on the turner's lathe, by steel instruments, and is easily bored; it is polished on a leaden wheel, with pumice-stone, then with linen or a hat-body and rotten-stone, and lastly by rubbing it with the hand. Common specimens are polished with a linen rag, chalk, and water. Beads of amber must be drilled before receiving the facets. In cutting and working amber, care must be taken not to overheat it by friction, as it will then be liable to crack. Amber has occasionally been cut into cameos, busts, images, &c.

Impure amber pieces may be much improved by wrapping them in paper and allowing them to digest for forty hours in hot ashes, in a pot filled with sand; or by boiling them with gradually increased heat in linseed oil. Amber may also be colored red, blue, and violet, and dissolved in absolute alcohol; it may be cast into different ornaments. Broken amber may be mended by a cement of linseed oil, gum mastic, and litharge; or by moistening the ends of both pieces with potash, warming the same, and pressing the parts together.

The price of amber was, in former times, much higher than at present, but size, color, and transparency always govern the same. A pure exquisite specimen of one pound is sold for forty dollars; but most good specimens are sent to Armenia, the East, and Turkey, to which places manufactured amber goods to the amount of fifty to sixty thousand dollars are annually exported from one manufactory at Stolpe, in East Prussia.

Amber is often adulterated in various ways, and more especially with gum copal, which is palmed upon the ignorant for amber, and which does actually resemble it in many respects: for both are of the same color; both become negatively electric by friction; both have nearly the same specific gravity; and both give a pleasant odor in burning; hence when wrought as jewelry or ornaments, it is not easy to distinguish the one from the other. One mode of detection was pointed out by the Abbé Haüy: "If," says he, "a fragment of amber be attached to the point of a knife and inflamed, it will burn with some noise and a kind of ebullition, but without liquifying so as to flow, and if it should fall on any flat surface it rebounds a little; whereas copal, under similar circumstances, melts and falls in drops, which become flattened." My own experience has taught me the following distinguishing characteristics: first, the electrometer, a small instrument composed of a brass needle, suspended on a pin, is the most essential distinguishing guide,—for amber, on being rubbed, will excite the instrument about ten degrees more than copal; secondly, amber, on being brought before the fire, requires a moderately high temperature for melting it, and exhibits no kind of ebullition, whereas copal easily liquifies, burns with much smoke, and decrepitates more than amber.

Amber is likewise adulterated by gum arabic, gum thus, shellac, and glass pastes. The last can easily be distinguished by their hardness, and the others by their solubility in hot water.

Amber very frequently has inclosed within it insects, such as flies, beetles, &c., in a state of complete preservation. Such specimens are much sought for, and command a very high price; and on that account the adulterations are mostly practised, and in the following manner: either by boring a hole in the amber, introducing the beetle, filling it up with pulverized gum-mastic, and then letting it melt over a charcoal fire; or by melting the amber, throwing in the insects, and letting it cool. The former adulteration may easily be detected, since the mastic will never be able to combine closely with the amber, and shows more or less cracks and fissures; but the latter is scarcely to be detected, without a scientific investigation of the inclosed insects, which in the natural specimens do not exist in the present world, being called antediluvian, or extinct species of animals.

The most extensive use of this elegant material is for the manufacture of the mouth-piece, an essential constituent of the genuine Meerschaum and Turkish pipe. Amber mouth pieces have always been in great request in the East, where they command great prices; but in the United States a fashionable taste, similar to other countries, has sprung up of late, which bids fair to outvie the East. No young man of any pretensions to smoking cigars, can do so without his meerschaum and amber cigar-holder. The dearer he pays for this luxury, the more respected he considers himself. There is a current belief in Turkey, that amber is incapable of transmitting infection, and as it is a great mark of politeness to offer the pipe to a stranger, this supposed negative property of amber accounts, in some measure, for the estimation in which it is held.

There is evidence of the extreme antiquity of amber in the fact that the Phœnicians imported it from Prussia. Since that period it has been obtained there uninterruptedly, and no diminution in the quantity annually collected has been perceived. If we incline to the theory that amber is a species of wax or fat, having undergone a slow process of putrefaction, based on the fact that chemists are able to convert ceraceous or fatty substances into succinic acid, by inducing oxidation artificially, the belief must be entertained that a new formation of amber is constantly going on, which theory is strengthened by the different appearance of the varieties of amber, which seem to exhibit the successive stages of its development and decay. On the other hand, Tacitus, in his Germania, states that it is a resin, exuded by certain coniferæ, traces of which are frequently observed among the amber. Certain it is that, at one time, amber must have been liquid, from the simple fact that numerous small animals are found inclosed within it; these, for the most part, are insects belonging to an extinct species of arachnidæ. A specimen containing the leg of a toad was seen among an extensive collection at the London Exhibition, and it is said that in China, amber containing insects is of frequent occurrence. From the fact that amber and fossil wood have been found in alluvial deposits of sand and clay, and associated with ocean shale and iron pyrites, at a depth of sixty feet, it is the author's firm belief that the marine amber is a subsequent formation to the terrestrial amber. That Pliny already took it for a vegetable production, may be inferred from his expression: "quod arboris succum, prisci nostri credidere."

The different kinds of amber are distinguished by varieties of color and degrees of transparency. All shades of yellow, from the palest primrose to the deepest orange, or even brown, are its constant colors. In point of clearness, amber varies from vitreous transparency to perfect opacity; some are nearly as white as ivory, which is, however, a rare occurrence. If there are two layers together, the transparent and opaque varieties, it is used for cutting cameos. An inquiry naturally suggests itself as to which of these varieties of amber is the most valuable. It is self-evident that this must depend, as in the diamond, upon the size and the uniformity of the pieces. Besides, as all varieties excepting the white, which has its special uses, are equally applicable for manufacturing purposes, it follows that the value of any particular sort must depend in a great measure upon its variety. The straw-yellow, slightly translucent variety is the most rare, and is that which the Orientals prefer to all others, and which they purchase at extravagant prices. Every piece of that quality is exported to Turkey, in the raw or manufactured state.

Among the exquisite specimens of amber in the London Crystal Palace, were four most splendid imaums, or round amber mouth-pieces, richly ornamented with brilliants; the shortest two, which in smoking are pressed against the lips, were each worth three hundred pounds sterling, and were each of that peculiar color and degree of transparency which approaches nearest to the Turkish ideal of beauty. The two longer mouth-pieces were of a different form, and although not of so good a color, nor enriched with as many diamonds, were still valued at two hundred pounds sterling each.

A large specimen obtained from the amber pits in Prussia, weighing six pounds, and another marine amber and waterworn, weighing four and a half pounds, owned by Mr. Wolff Manheimer, of Konigsberg, Prussia, were likewise at the London Exhibition.

At the Royal Museum in Berlin, is a large mass of amber, weighing eighteen pounds.

In the kingdom of Ava, a mass nearly as large as a child's head was found some years ago, which was intersected in various directions by veins of crystallized carbonate of lime.

Amber is very fusible and liable to be broken. To join the broken pieces, and to unite them in such a manner as to look and wear as well as new, the author of this treatise recommends the use of soluble glass (either the silicate of soda, or silicate of potash), which is applied to the fissure or fractured part, after which the united parts are tied with with a twine and kept so for some days; it will then remain firm. Thick shellac varnish is also highly recommended: dissolve bleached shellac in ninety-five per cent. alcohol, to the consistency of syrup, touch the broken parts with the varnish, tie them with twine, and leave the article in a warm place for some days before using.

Amber powder made into a paste with thick shellac varnish and moulded, may easily be made into a variety of forms, and represent genuine amber.

The most extraordinary collection of specimens of amber may be seen in the cabinet at Dantzic. A specimen of amber of fifteen pounds weight is preserved in the cabinet at Berlin. The inhabitants of Colberg, in 1576, presented to the Emperor Rudolph II. a specimen weighing eleven pounds.

JET.

This mineral occurs massive; has a conchoidal fracture; is opaque; has a shining lustre; and is of a jet, or pitch-black color. It is pretty soft, and yields to the knife; its hardness is 1· to 2·5; specific gravity, 1·29 to 1·35; it burns with a greenish flame, and emits a strong bituminous smell. In trade it is also called black amber, or pitch coal. It is found in the brown-coal formation, the plastic clay, and the lias, with lignite and amber, in England, France, Silesia, Hesse, Italy, Spain, and Prussia.

Jet bears a high polish, and is wrought into necklaces, ear-rings, crosses, rosaries, snuff-boxes, buttons, bracelets, and particularly mourning jewelry. It is at first generally assorted to select the best pieces, most suitable for working; such as are free from iron pyrites, lignite, and have no cracks or fissures. It is then turned on a lathe, and likewise on horizontal sandstone wheels, which run unequally on their periphery, by which the various specimens may be cut and polished at the same time. During the operation the jet must be moistened with water, else it may crack from being overheated. It is polished with rotten-stone or crocus martis and oil, on linen or buckskin; and lastly by the palm of the hand.

The manufacturing of jet ornaments was formerly a considerable branch of industry in France, where, in 1786, the department de l'Aube occupied twelve hundred workmen; but at the present time it is not worn, and the black enamel is substituted for it.

Jet is a species of bituminous coal, which has several names, such as common coal, black coal, cherry coal, splint coal, cannel coal, jet, lignite, &c.; more properly, however, it is a variety of cannel coal, but it is much blacker, and has a more brilliant lustre. It occurs in detached pieces, in clay, on the coast near Whitby, in Yorkshire, and is the *gagates* of Dioscorides and Pliny, a name derived from the river Gagas, in Syria, near the mouth of which it was found.

Cannel coal, which comes nearest to jet, has a dark-grayish, black, or brownish-black color, a large conchoidal fracture, and receives a good polish; takes fire readily, and burns without melting, with a clear yellow flame. On this account it has been used as a substitute for candles, and hence receives its name. It is very abundant in Scotland, and in several parts of Ayrshire; is wrought into inkstands, snuff-boxes, and other similar articles. In England the bituminous coal trade is a large traffic; over one hundred thousand people are engaged in Newcastle, in digging. The principal coal mines of France are those of St. Etienne, Mons, Charleroi, and Liege. Germany has some coal; but Belgium, Norway, Denmark, and Russia seem to be entirely destitute of coal beds. Some few beds are found in the Apennines, in Italy. In Spain, coal occurs in Andalusia, Aragon, Estremadura, Catalonia, Castile, and the Asturias, but not in large quantities. The only coal bed in Portugal which is worked, is situated in the province of Beira. Coal is also abundant in China, Japan, the island of Madagascar, Africa, and New Holland. But nowhere are its deposits more extensive and numerous than in the United States. It occurs extensively throughout the Middle and Western States. The great coal formation in the United States is one of its principal and most striking geological features, and in its influence upon our industrial pursuits, it is unquestionably the most important of all. The coal measures are distributed over two principal areas, termed the great eastern and the great western coal fields, being separated from each other by a wide area of older formations. The eastern, or Alleghany coal field, may be traced from near the northern limit of Pennsylvania to the southwest, in a line parallel with the Alleghany chain, quite to the central part of the State of Alabama. The anthracite basins, which are of comparatively small extent, lie beyond, or to the east of the line here traced as the limits of the great eastern coal field.

From its northeasterly margin it is traced along a very irregular outline, as far as the Alleghany river, in Warren county, Pennsylvania, and from thence it follows a direction nearly parallel to the shore of Lake Erie, to Portage and Summit counties, in the State of Ohio. From thence it follows a line generally parallel to its eastern margin, though gradually converging to its southern extremity, in Alabama. This coal field has a length of more than seven hundred and fifty miles, and an extreme breadth of one hundred and eighty miles. The superficial area has been estimated by Richard C. Taylor to be sixty-five thousand square miles; and when we consider the aggregate thickness of the different beds of coal over this wide extent, the aggregate amount of fossil fuel appears indeed incomprehensible.

The great western coal field, or, as it has been usually termed, the Illinois coal field, occupies the larger part of the State of Illinois, and parts of Indiana and Kentucky. It is separated only by a narrow belt of the lower formations, along the Mississippi valley, from the coal fields of Iowa and Missouri, the extent of which has lately been shown to be much greater than had been supposed. Including the parts of this field on both sides of the Mississippi river, its greatest extent from southeast to northwest, or from the headwaters of Green river, in Kentucky, to its northern limit, on the Desmoines river, in Iowa, is more than five hundred miles; while its greatest breadth across the States of Indiana, Illinois, and Missouri, is more than four hundred miles, and from its northern termination in Iowa to its present known limits, on the Osage river, at the south, is more than three hundred miles. This western coal field, therefore, including the area thus occupied on both sides of the Mississippi river, has a much greater superficial extent than the eastern coal field, already described. Perhaps the entire area may be estimated at one and a half that of the Alleghany coal field, or nearly one hundred thousand square miles. Still farther to the south, in Arkansas, there is a coal field of considerable extent, which has not yet been fully explored; it is probably connected with the Missouri field.

There are coal fields in Michigan, Rhode Island, and Massachusetts, Eastern Virginia, North Carolina, near Fort Laramie, Puget's Sound, and Bellingham Bay.

The entire area occupied by coal measures in the United States, east of the Rocky Mountains, is about two hundred thousand square miles.

The quantity of bituminous and anthracite coal consumed in the United States, may be estimated at fifteen millions of tons annually.

The jet of Whitby, in Scotland, forms part of a thick bed of lignite found there in the upper lias marls; it differs in this respect from the jet worked in France and Spain, which is found in irregular veins in the lower marls of the cretaceous series.

Cannel coal is chiefly used in the manufacture of gas, but some of the harder and more compact kinds are occasionally cut into various ornamental objects, several of which were represented in the London Exhibition; the most interesting of these, as a finished work, well designed and well executed, was a garden seat, from the parrot coal, in the Fifeshire coal field, exhibited by His Royal Highness, Prince Albert; also a model of the Durham Monument, and a wine-cooler, both of which were wrought from the Newcastle coal field. A set of chessmen and a snuff-box, both made of cannel coal from China, were exhibited. In Roman Catholic countries, a large quantity of small ornaments, such as crosses, beads, rosaries, &c., are made of jet, and it is generally worn for mourning decorations.

In regard to the comparative extent of the coal fields of Great Britain and the United States, it may be stated that the former comprise five thousand four hundred square miles, while those of the United States contain one hundred and ninety-six thousand eight hundred and fifty square miles. The amount of workable coal in Great Britain is put down at 190,000,000,000 tons, while that of the United States is set down at 4,000,000,000,000 tons, or twenty-two times greater in amount than the mines of Great Britain; and it is well worthy the reflection of political economists, if we consider what has been achieved by the produce of the coal fields of Great Britain, what revenue must, at a future day, accrue to the inhabitants of the United States from their vast coal fields.

MEERSCHAUM.

This mineral is of somewhat rare occurrence. It is a hydrous silicate of magnesia; has an earthy fracture, opaque, dull, smooth surface; color, white, inclining to yellow, red, or gray; streak, shining; adheres to the tongue; has a hardness of 2·5, and a specific gravity of 1·2 to 1·6. If heated in a matrass, it yields water and turns black. Before the blowpipe, it melts on the edges; with a solution of cobalt becomes red, and is decomposed by hydrochloric acid.

It is found in nodules, at Kiltschiek, near Conian, in Natolia, in a large fissure, six feet wide, in calcareous earth; near Thebes, and in many other parts of Greece; Vallecas, near Madrid, and Cavañas, near Toledo; Pinheiro, in Portugal; Hrubschitz and Osbowern, in Moravia, and in Sweden; but by far the largest quantity is derived from the peninsula of Natolia, in Asia Minor. It is called meerschaum, or *écume de mer*, on account of the belief of the workmen engaged in digging the mineral, that it grows again in the fissures of the rock, and that it puffs itself up like froth. Good meerschaum is tolerably soft; resists the pressure of the hand, but is easily indented by the finger nail, and especially after having been wetted; it may be easily cut with a knife.

Although the fracture is earthy, and rarely conchoidal, still the state of aggregation of pure meerschaum is very variable, as is proved by the marked difference in the specific gravity. Some kinds sink in water, others float on its surface; and these qualities are, in the estimation of the pipe-maker, indicative of different values, for he rejects both the very heavy and the very light, and prefers those of medium density. The light varieties are generally very porous, and even contain large cavities, whilst the heavier kinds are suspected to be an artificial product. Formerly, the material was roughly fashioned, on the spot, into bowls, which were elegantly carved in Europe. The art was specially cultivated at Pesth and Vienna, where it formed an extensive and important branch of trade. These rough bowls still occur in commerce; but by far the greater part of the meerschaum is exported in the shape of irregular blocks, with obtuse angles and edges, requiring careful manipulation, with the aid of water, in order to remove irregularities and faulty portions. This preliminary treatment still leaves numerous blemishes. The meerschaum of commerce has defects of various kinds; besides various minerals scattered through its mass, it contains a hard sort of meerschaum, which the manufacturers call chalk, and which is the cause of much difficulty in the carving. Previous to the mechanical treatment of the meerschaum for making the bowl, it is subjected to a certain preparation. It is soaked in a liquified unguent, composed of wax, oil, and fat; the wax and the fat which the substance absorbs, cause the colors which meerschaum assumes after smoking. Under the influence of the heat produced by the burning tobacco, the wax and fat pass through all the stages of a true process of dry distillation; the substances thus formed become associated with the products of the distillation of the tobacco, and by their diffusion through the meerschaum, all those gradations of color which are so highly prized by the connoisseur, are produced.

Occasionally, though rarely, the bowls are artificially stained, by steeping them, before they are soaked in wax, in a solution of copperas, either alone or with dragon's blood. This process must manifestly very materially affect the shade of color produced in smoking.

The large quantity of meerschaum parings left in roughing out the bowls, would entail considerable loss, unless some process had been devised of rendering them available. A species of meerschaum bowl has long been known in commerce, under the name of *massa* bowls, which is made from the parings. They are triturated to a fine powder, boiled in water, and moulded into blocks, with or without the addition of clay. Each of these blocks suffices for one bowl; but before they can be used, they must be allowed to dry for some time, as they contract considerably. These bowls are distinguished from real meerschaum by their greater specific gravity; but there is no very certain test by which the real meerschaum can be distinguished from the composition, and many suppose that all the heavier descriptions are spurious, though there is no absolute proof of this being the case. A negative test may, however, be mentioned: the composition bowls never exhibit those little blemishes which result from the presence of foreign bodies in the natural meerschaum; therefore, if a blemish occur in a meerschaum bowl (which is frequently the case), the genuineness of the bowl is rendered more probable; but as these do not show until after the bowl has been used for some time, the test is not of much value.

Very extensive and valuable collections of meerschaum pipes and mouth-pieces were exhibited in the London Crystal Palace, from Gotha, of both real and imitation meerschaum bowls. From Turin, Sardinia, were elaborately-carved meerschaum pipe-bowls, the sculpturing of which was very exquisite. From Austria a large collection of massa pipe-bowls and cigar-tubes, which were manufactured from meerschaum dust; the former of these articles was elegant, and the execution so good, that they were with difficulty distinguished from the real meerschaum.

The importation of meerschaum pipes and cigar-tubes into the United States has of late become very extensive, and it was estimated at two hundred thousand dollars the last year.

LAVA.

This mineral is a compound of several minerals, and is a volcanic production. It occurs massive, with vesicular or porous marks; has a splintery and conchoidal fracture; a lustre dull or glistening; is opaque, and of gray, brown, red, yellow, black, green, and white colors, of all their shades. It often contains crystals of felspar, leucite, hornblende, &c. In the arts, for ornamental purposes, the compact varieties, only, are cut and polished. In Naples, jewelry and ornaments in great quantities are manufactured and exported; such as pins, ear-rings, intaglios, snuff-boxes, vases, candelabras, &c. The different lavas are cut with sand and emery, and polished with pumice-stone. Lava is found in all volcanic countries, and particularly at Etna, Vesuvius, Hecla, in Mexico, the Lipari Islands, &c. Lava is often used as the base for mosaic works. The blue lava of Mount Vesuvius has the appearance of artificial blue-enamel, and is in much demand for jewelry and ornaments. I have inspected fine specimens of polished slabs at the rooms of the Boston Society of Natural History.

JADE.

This mineral is called, in mineralogical works, nephrite, hatchet-stone, punamu. It occurs massive; has a splintery fracture; a greasy lustre when polished; it is translucent; scratches glass, and is attacked by felspar; it is of mountain-grass and sea-green colors; is fusible into a greenish glass; it consists of silex, lime, alumina, magnesia, and iron. It was originally found in China; it occurs in Egypt, on the Amazon river, in an island in New Zealand, called Pavia Punamu, and in the United States (Smithfield, R. I., and Newbury, Mass.), of a sky-blue color, and a greenish and reddish-gray variety at Easton, Pa.

The name nephrite is derived from νεφρος, a kidney. It was supposed to be a cure for diseases of the kidneys.

It is used for snuff-boxes, cups, &c.; and in Turkey it is used for handles to sabres, daggers, and hatchets. Deities formed of it have frequently been excavated from ancient ruins. Such I saw, a few years ago, in a collection of Indian curiosities brought from Mexico.

SERPENTINE.

This mineral derives its name from its variegated color, which resembles the skin of a serpent. It is generally divided into two varieties: the common, or opaque serpentine; and the precious, noble, or translucent serpentine.

Serpentine occurs massive; the common is occasionally crystallized in rhomboidal crystals,—in Norway, New Jersey, and Pennsylvania; it has a splintery, uneven, and conchoidal fracture; is unctuous to the touch; yields to the knife; its colors are green in all its shades, but also reddish and grayish; hardness, 3·4; specific gravity, 2·5; is infusible before the blowpipe, but with borax dissolves into a transparent glass. It does not belong to the stratified rocks, but to the ophites of Brogniart, and is mostly associated with granite, gneiss; micaceous, chlorite, argillaceous schists, and limestone; it therefore belongs to the primitive formation.

Serpentine, for richness and variety of colors, exceeds all other rocks; and it abounds all over the globe, in large consolidated masses. The finest precious serpentines come from Fahleen and Gulsjo, in Sweden, the Isle of Man, the neighborhood of Portsay, in Aberdeenshire, Corsica, Siberia, and Saxony. Common serpentine occurs at Lizzard Point, in Cornwall. In the Alps we find the serpentine nine thousand feet high; in France, the mountains of Limousin; in Spain, Norway, Sweden, Scotland, the Shetland Isles, England, Italy, Bohemia, Saxony, Bavaria, and Switzerland; in the United States we find it all along the Atlantic coast, where the primary rocks are found, as at Hoboken (New Jersey), opposite to New York city, Warwick (New Jersey), as far as Maryland, at Bare Hills, through Pennsylvania, Rhode Island, Connecticut, Massachusetts, Vermont, &c. The serpentine beds of Massachusetts are inexhaustible. In Middlefield, Massachusetts, the bed is one quarter of a mile in breadth and six miles in length, which alone would be sufficient to supply the whole world with a valuable material for ornamental and architectural purposes. There are beds at Westfield, Blanford, Pelham, Zoar, Windsor, Marlborough, Cavendish, and other towns in Vermont. Most beautiful specimens are found in Newbury, near Newburyport; and latterly a new locality was discovered by Dr. Jackson, in Lynnfield, Massachusetts.

Serpentine incloses chromate of iron in the Shetland Islands, Maryland, &c.; and is on that account of the highest importance to the artist.

It is easily wrought on lathes into various articles; such as snuff-boxes, vases, inkstands, &c.; in a small place named Zoblitz, in Saxony, several hundred persons are constantly employed in the manufacture of boxes, trinkets, and chimney-pieces. The locality at Granada, in Spain, has supplied many churches and palaces of Madrid with large columns, and other ornaments. It is really surprising that the inhabitants of those districts where the precious serpentine is found, have not yet employed it as an article of trade, as the quality of the American serpentine is, if not superior to the English and Spanish, certainly not inferior to any hitherto found: and I trust that the day is not far distant when our parlors will be embellished with mantel-pieces, tables, and mantel-ornaments, made of it. Candlesticks, mugs, pitchers, knife-handles, fire-iron-stands, jamb-hooks, and many other domestic articles, might be formed of it, instead of silver-plated, steel, and cast-iron ware.

Serpentine is often associated with a number of other minerals: as, *a*, serpentine with talc; *b*, serpentine with diallage or schiller-spar; *c*, serpentine with amianthus; *d*, serpentine with asbestos; *e*, serpentine with garnets; *f*, serpentine with actinolite, &c. That variety which contains amianthus in a layer, is sometimes exceedingly beautiful; and when polished has the appearance of satin spar.

MARBLE.

This is a carbonate of lime, and a wide range of minerals belong to this class, containing substances which are subservient to architectural and ornamental purposes; the author intends, therefore, treating this subject more extensively and giving it a wider range than other common minerals, and to copy from the jury report of the London and New York Exhibitions.

The primary form of calcareous spar is an obtuse rhombohedron, with a great many secondary forms; has a hardness of 2·5 to 3·5; specific gravity, 2·5 to 2·7; it has a vitreous lustre, also earthy; white or grayish-white streak; color usually white, with a great variety of shades of gray, red, green, and yellow, also brown and black; it is transparent and opaque, the transparent varieties exhibit double refraction very distinctly; fracture usually conchoidal, but obtained with difficulty, when the specimen is crystalline. It is composed of lime and carbonic acid, the colored varieties often contain in addition, small portions of iron, silica, magnesia, alumina, and bitumen, and acids produce a brisk effervescence; before the blowpipe it is infusible,—it loses, however, its carbonic acid, gives out an intense light, and ultimately is reduced to pure lime, or quicklime.

Calcareous spar appears under a very great variety of forms and aspects; a great many species have, therefore, been created by mineralogists.

Iceland spar was first applied to a transparent crystallized variety from Iceland, where it was found in a cavity in trap, with stilbite, on the north shore of Eskifiord, on the east coast of Iceland; and the property of double refraction was first observed in this variety of carbonate of lime.

Oolite consists of minute spherical particles aggregated by calcareous cement, so as to produce a massive structure and nearly earthy appearance; it occurs in extensive beds, and is so called from its resemblance to the roe of fish, from *ωον*, the egg.

Pisolite, or pea-stone, differs from oolite in the larger size of its particles, which are composed of concentric laminæ.

Chalk is a massive opaque variety, usually white, and possessing a purely earthy aspect and absence of lustre, it is usually much softer than the other varieties of this species, and appears to consist in a great measure of an aggregation of fossils, chiefly infusorial.

Tufa, an alluvial deposit from calcareous springs; it has a very porous structure.

Agaric mineral, or rock milk, is a loose friable variety, deposited from waters containing carbonate of lime in solution, it is formed about lakes whose waters are impregnated with lime; also in fissures in limestone, and in limestone caverns.

Anthraconite, or stink-stone, swine-stone, which is found columnar, granular, and compact, of various shades, emits a fetid odor when struck with the hammer.

Stalactites are pendant masses of limestone, formed in limestone caverns by the percolation of water, holding lime in solution, through their rocky roofs; the evaporation of the water causes the deposition of the lime, and thus, in time, columns are often formed extending from the roof to the floor of a cavern; the water which drops to the floor from the roof also evaporates and causes the formation of a layer of limestone over the floor; this variety has been called *stalagmite.*

Argentine possesses a silvery-white lustre and contains a little silica.

Fontainebleau limestone is an aggregate of secondary rhombohedrons, containing, mechanically mingled, large portions of sand; this species in some of its forms is very generally diffused.

Marble includes all the imperfectly crystalline and earthy varieties which admit of a high polish; it is also called granular limestone, or statuary marble, which forms sometimes entire mountains; but more frequently occurs in beds in gneiss, porphyry, and mica slate. The world has been supplied for centuries past with statuary marble from the Carrara beds on the gulf of Genoa, from the islands of Paras, Naxos, and Tenos; Pentillicus and Hymettus, near Athens, in Greece, and Schlandens, in Tyrol.

Calcareous spar is the principal source of our polished marbles, the material for sculpture, quicklime, for artificial stone, flux for smelting ores, &c. A peculiarly fine-grained compact variety is employed in lithography, which is mostly imported from Bavaria, under the name of lithographic stone..

Italy is pre-eminently the country where the manufacture of marble has been found most congenial to the artistic feeling of the mass of the people, and there, or in its vicinity, at the present day, a large part of the best marbles used in central Europe are obtained and worked. Of late years, however, France, Spain, Portugal, and parts of Germany and Belgium, have employed for their own use and in their own style, many useful and valuable marbles with which they abound, and in England manufactories have arisen, at first and chiefly in Derbyshire, but also in Devonshire and Cornwall, in which much has been done to raise the character of marble decoration, by employing the excellent material which abounds in those places, and by introducing various useful objects of house-decoration at a price which, though somewhat too high for the mass of consumers, is far below that of foreign goods of the same kind in that country. Ireland, also, in which several fine marbles occur, has given proof of some activity in this manufacture, for which, indeed, nature has afforded many facilities to carry out to full advantage.

Many marbles from Greece, Italy, and the coast of Asia Minor, were used by the ancients, but the quarries are now exhausted or concealed by rubbish. Among them may be mentioned the true *Parian* of Greek sculptors, and some other fine white marbles; the *nero antico*, now a very rare black marble, considered purer and better than the known kinds; the *rosso antico*, a deep blood-red marble with veins and spots; the *verde antico*, a green and very beautiful porphyritic breccia; the *giallo antico*, not unlike the modern Sienna marble, of very rich yellow tint, with some others. Most of these are only known in sculptured specimens; but many, if not all the colors are closely approximated by recent marbles.

The French marbles, those illustrating the Pyrenees and Vosges, were not less interesting. Messrs. Dervillé exhibited one hundred slabs of marble, each sixteen inches in height, comprising twenty varieties, and among them the marble called "girotte" (spotted with red and brown), and the white marble of St. Béat, all remarkable for the rarity of their colors and the beauty of their polish. The Campan marbles also possess a peculiar geological interest in the number of goniatites which they inclose and which are often mixed confusedly with the paste; an arrangement which evidences the great change which these limestones have undergone at some period, and which proves their metamorphism, like the limestones of the State of New York.

The chief marble manufacture of England is in a part of Derbyshire remarkable for its picturesque beauty, extending along the valley of the Derwent and its principal tributary, the Wye, from below Buxton to Derby.

The machinery for sawing and polishing was first established at Derbyshire at the village of Ashford, near Bakewell, in the year 1748, water being the motive power; in 1810, similar machinery was erected in Bakewell, and for many years past, also, in Derby.

The most important marbles of Derbyshire are the black, the rosewood, the encrinital, the russet or bird's eye, and a mottled dark and light gray kind, occasionally containing numerous small corals. Of some of these there are several varieties. Others might be added to the list of those found in the northern part of the county, one of which is a beautiful red, resembling the *rosso antico*, but it is obtained only in small blocks or lumps.

At Welton, in Staffordshire, near the borders of Derbyshire, are marbles differing much from the above, but they have not been brought into any considerable use, and are generally subject to flaws. The black marble is of very fine color and texture, but large slabs free from small veins of calcareous spar are rare; the best quality occurs in beds of from three to eight inches in thickness, some beds are thicker. This marble is, perhaps, superior to the similar kinds found in other parts of Europe and is greatly valued for inlaying; it is tough and contains a good deal of carbon, which imparts the color.

Black marble is extensively used for ornamental objects, such as vases, pedestals, chimney-pieces, &c., for which it is admirably adapted.

Rosewood marble is extremely hard and of close texture;

the beds are of considerable thickness, but the most beautiful part of the marble is only about six inches thick; the name is derived from the marking of the marble being somewhat similar to that of rosewood.

Encrinital marble is the one in most extensive use, and contains very numerous fossils, consisting almost exclusively of the broken fragments of encrinital stems, often entangled in coral; it may be obtained in blocks of large superfices and of a thickness of two to two and a half feet.

Russet, or bird's eye, takes its name from its color and appearance; the shades varying from light-gray to brown. It contains numerous minute fossils, also encrinital, and is found in beds from six to eighteen inches in thickness.

Dark and light mottled gray marble, called Newburgh marble, and the overlying bed, which is coralline, can be obtained from one to two feet thick.

The manufacture of Devonshire marble is much more modern, and the material is generally less manageable. Almost all the beautiful marbles of that county, especially those near Plymouth, are fossiliferous, brittle, and very apt to contain veins and cracks. The marbles of Devonshire belong to an older geological period than those of Derbyshire, the latter being exclusively of the carboniferous limestone series, underlying the coal measures and millstone grit; while the former are of the devonian or middle paleozoic epoch.

Among the most notable marbles in the London Exhibition, may be mentioned the following articles:

Three chimney-pieces of Carrara marble, with many sculptured figures, from Milan, in Italy; columns and pedestals of the madrepore marble, from a quarry in Devonshire; some pedestals of green marble, from Connemara, in Ireland; a table belonging to the East India Company was exhibited, the top of which consists of a slice of a column from Nineveh; several slabs of the Lumachella marble, and a marble called *verde di prato*, were exhibited from Tuscany, which were extremely beautiful. A bust of Grattan, of Irish marble of a beautiful yellow color, attracted much attention.

It may not be out of place to mention here the extensive display of marble statuary, which was also at the London Exhibition,—only a few will be enumerated for want of space:

1. Marble statue representing Gratitude.
2. Group representing Eve with Cain and Abel asleep in her arms.
3. Marble statue of Susannah.
4. Iconic statue in marble.
5. Marble statue of Eve after the Fall.
6. Marble statue representing the Greek Slave.
7. Marble group representing Cephalus and Procris.
8. Marble figure representing a Boy frightened by a Lizard.
9. Reclining figure, in marble, representing Ishmael.
10. Marble statue of a Boy catching a Butterfly; also, a marble figure representing Arethusa.
11. Marble statue representing Giotto.
12. Marble statue of the sculptor Flaxman, and two statues of the first Lord Eldon, and his brother, Lord Stowell.
13. Marble group of a Girl with a Lamb, representing Innocence.
14. Marble statue representing a Startled Nymph.
15. Marble figure of a Bacchante.
16. Marble statue of Dying Gladiator.
17. Marble group representing an episode in the history of the war between the Amazons and the Argonauts.
18. Marble statue of Psyche.

19. Marble statue representing a Girl carrying a Nest of Cupids.

20. Marble statue representing Eurydice.

21. Marble group,—"The Orphans."

22. A reclining marble figure of Bacchus.

23. Model in marble of a Friar presenting the Crucifix to two Children.

24. Marble bust of the poet, Vincenzo Monti.

25. Figure in marble representing Mary Magdalen.

26. Marble group,—Sleeping Child and Dog.

Italian marble furnished the material from which most of the above sculptures were wrought.

The United States limestones, for building purposes, and marble for statuary, are found in great abundance, and many of them fairly compare with the Italian and English marbles. The white granular limestones are mined in many places; they all belong to the newer metamorphic rocks, where they occupy a wide range, from Vermont, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, and Maryland, to Missouri; but the best statuary marble has as yet only been found in the eastern part of Vermont: 100,000 cubic feet of good marble, suitable for building stone, mantel-pieces, &c., have been mined annually in Vermont.

The character of the white marble varies from finely granular to coarsely crystalline, and from a compact, close-grained mass to a friable crystalline rock; they all derive their existence from the metamorphism of lower silurian limestones. The whole range of these newer metamorphic rocks, from Northern Vermont as far as Maryland, yield abundance of the granular limestone; along the western slope of the Green Mountain range, the principal localities are Brandon, Dorset, Pittsford, Rutland, Middlebury, Pairhaven, and Sudbury, in Vermont; the principal quarries in Massachusetts are at West Stockbridge, Egremont, Great Barrington, Lanesborough, New Ashford, Sheffield, and New Marlborough. In New York, marble is quarried in large quantities at Hastings and Sing Sing, and Dover, in Dutchess county, and the range of granular limestones extends through Columbia, Dutchess, and Putnam counties; and in Connecticut the same granular limestones occur in abundance; also in New Jersey, a few miles west of Philadelphia, and near Hagerstown, in Maryland. The marble quarries in Rhode Island, Eastern Massachusetts, and Maine, furnish very fine marble, belonging to the metamorphic limestones of a more recent date, but it is not as durable as those of an older age; it is more friable, and has more fissures.

Bird's-eye or encrinital marble forms an extensive bed in the State of New York; it is a compact crinoidal limestone, containing fragments of stems and joints of crinoids of a bright pink, and other organic remains of a dark color, which, on the gray ground, give a beautiful variety. A similar limestone, susceptible of receiving a polish, occurs in the lower bed of the Niagara limestone, at Lockport and at Becraft's Mountain, near Hudson, where the organic remains are nearly similar to the first. Also the Onondaga limestone affords a similar marble, and taking a fine polish, with a much greater variety of organic remains than either of those just described. All these limestones compose very thick beds, and are all suitable for ornamental purposes; they are a very excellent and durable building-stone, and are extensively used for the massive and beautiful locks and piers on the Erie canal, at Lockport, and as building-stone in Buffalo, Lockport, and Rochester, and the city hall and court house in Chicago have been built from it; they belong to the group of limestones called the Niagara group.

On a recent visit to Buffalo, the author's special attention was directed to the wide range of marble, beginning at Harlem Bridge, New York island, where the fine white granular marble begins; crossing thence to Hastings, twenty miles farther up the Hudson river, of a still finer, and also coarser white marble; farther on, the Dutchess county white marble; and gradually coming into the black marble region at Schenectady. At Little Falls, high cliffs of that species of limestone, with magnificent scenery, excited his admiration on passing in the railroad cars. A short visit to the State Cabinet of Geology in Albany gratified him in the extreme; and every person desirous of being informed of the vast resources of limestone of the State of New York, cannot spend a more pleasant or instructive day than to examine the well-arranged museum of the geological formation of the State of New York, and of the minerals of this State and neighborhood.

A short description of this class of limestones may give the reader some idea of the intrinsic value of the results of the scientific research, accomplished through the liberally extended munificence of the several legislatures of the State, by such men as Hall, Emmons, Conrad, Mather, and Vannuxem. The visitor will perceive, on the entrance into the large hall of the Geological Cabinet, a large slab of the chalky limestone, with the thousand ammonites and orthoceratites imbedded; he next beholds the bird's-eye limestone, some specimens having also thousands of sharks' teeth on the surface; he next sees the Black river and Trenton limestone, both rough, and also fine polished specimens, inclosing the orthoceratite in its polished state, as if cut in two parts, and it makes a very beautiful appearance; the Mohawk valley and Hudson river group, with all the imbedded fossils, next attracts his attention; the Utica slate and its large trilobites, from one to twelve inches in length, along with the Niagara limestone group, displaying likewise the gigantic trilobite family, is not less attractive than the enormous slab of the black limestone, called the corniferous limestone, with the Marcellus shale, near Manlius, in Onondaga county. This slab contains several ammonites of one foot in length; it is called now the *goniatilis expansus orthoceratas marcellinius.* This specimen must weigh at least one hundred pounds, and is three feet in length; and it is certainly a very magnificent specimen.

The large rhombic limestone, from St. Lawrence county, with the dogtooth spar, from Lockport, form interesting specimens in the mineralogical department of the State Cabinet.

The splendid quartz crystals, from Herkimer county and Lake George, as also the fluor spar of Jefferson county, and the beautiful green crystals of apatite, from St. Lawrence county, with the sulphate of strontia specimens, from the latter, Onondaga, and Schoharie counties,—all claim their respective merits; the labrador spar and hypersthene, from Essex county, the gypsum, sulphate of baryta, the beautiful rose quartz, from Fort Henry, the red sapphire crystals, from Orange county, and the amethysts, intermixed in layers with the serpentine, from Putnam county, form very fine ornamental minerals.

Among the most interesting minerals of this State may be mentioned the rensselaerite, from Fort Edward; a great many specimens of this interesting mineral, both rough and polished, may be seen in the State Cabinet. It forms irregular masses in that limestone region, has an unctuous feel of stalactite, but is of superior hardness; resembles more the satin spar in its crystalline form; it resembles pyroxene, but differs much from it in its hardness and specific gravity; its hardness is 3·5 to 4·, and specific gravity 2·87; its color is white, yellowish-white; has uneven fracture. This mineral was named in honor of the late patroon, Gen. Stephen Van Rensselaer, of Albany. This mineral abounds in St. Lawrence county, and will, no doubt, at no distant day, be wrought into many beautiful ornaments; the polished specimens in the State Cabinet are very fine.

The Potomac and breccia marble is a rock of the newer red sandstone series; it forms a beautiful rock, and the columns of the hall of the House of Representatives, at Washington, are cut from this somewhat hard material.

The serpentine marble, or *verd-antique*, occurs in numerous localities along the belt of formations which extends from northern Vermont, through the western part of Massachusetts, Connecticut, a small portion of southern New York, New Jersey, Pennsylvania, and Maryland; this formation is metamorphic of a part of the Hudson river group. A very beautiful verd-antique marble occurs at Cavendish, Lowell, and Troy, in Vermont; in Cheshire, Massachusetts, and in Milford, Connecticut. There are two kinds of verd-antique marble—the true verd-antique, and the serpentine marble; the first occurs in Vermont and Milford, Connecticut, and the latter, called the common, near New Haven, Connecticut.

The white coarse-grained marble, from Texas, Baltimore county, Maryland, is quarried very extensively, and used in Washington City for the capitol extension, treasury, and post-office department.

In Missouri occur large beds of white and reddish-white marble, in Jefferson county and near St. Louis; the Genevieve marble, which is an oolitic limestone, has a very extensive formation, and is used in St. Louis and New Orleans as building-stone; some marble quarries are full of organic remains, and some are so hard and durable that they are used for hearths, having extraordinary power to resist the action of heat.

Breccia Marble, of Lancaster county, Pennsylvania.—This is a recent discovery of a variegated marble, a pure carbonate of lime, and differs materially from other marbles of the United States and foreign countries; and an independent name has been given to it by its discoverer, viz.: the *leocadia breccia*, which forms a solid, unstratified bed of compact marble. It is admirably adapted for ornamenting churches, banks, hotels, and other public buildings, as also for private houses for mantels, tables, wainscoting, balustrades, &c. It is very easily wrought, and has, therefore, the advantage of many other marbles of the United States. This new locality bids fair to drive the foreign and more costly marbles out of the market; as for brilliancy of color and its variegated character, and for strength and durability, it has not its equal, either in the United States or any foreign country. It is sincerely to be hoped that so valuable a bed of limestone may not be left slumbering for another century, but that the discoverer, Mr. James W. Hale, may reap the benefit of its speedy development and general application.

The New York Exhibition of 1853 was well supplied with statuary from the whole world, but particularly from Italy. The Italian works consisted mostly of copies from the antique. The copy of the Flora of the Capitol; Bartolini's Faith; Harpocrates, and Cupid in a mischievous mood; Canova's Hebe, and Thorwaldsen's statuary,—were all of great merit. Power's statues of Eve and Proserpine have been, in addition to the Greek Slave and Fisher-boy, already noticed among the great curiosities of the London Exhibition. We will enumerate the other statues in marble which were much admired at the New York Exhibition, viz.:

1. A Bacchante, and Psyche, from the sculptor, Galt, of Norfolk, Va.

2. Bust of Daniel Webster; the Husbandman's Orphan, a nude figure of a boy leaning on a spade; and the Sleeping Child,—all in marble, by Pietti, New York.

3. The Minstrel's Curse, by Miller, New York.

4. Christ in the Sepulchre, by Creswell, Brooklyn.

5. Bust of Dr. John Green, of South Carolina, and one of Charles Allen, of Massachusetts, by Kinney, of Worcester, Massachusetts.

6. Head of a Female, by Ives, Connecticut.

7. Bust of Daniel Webster, by King, Boston.

8. A veiled Cupid, by Moon, New York.

9. Head of Jupiter, and statuettes, by Ferris & Taber, New York.

10. Cupid, and Charity, a female figure seated, with an infant in her arms, life size, by Baudel, London.

11. Busts of Daniel O'Connell and Father Mathew, from Hagan, Dublin.

12. Bust of Jenny Lind, by Durham, London.

13. Bust of Palmerston, by Sharp, London.

14. Ruth and Naomi, by Kirk, Dublin.

15. Bust of Louis Napoleon, emperor of France, by Deumier, Paris.

16. Statue of Racine, by D'Angier, Paris.

17. Lesbia, by L'Evêque, Paris.

18. Damalis, by Etex, Paris.

19. A veiled head; a sleeping Cupid; Psyche reposing, and bust of Prayer, by De Bokeleer, Antwerp.

20. Statue of Venus and Cupid, by Fraikin, Brussels.

21. Two Children Sleeping, as a group, by Geess, Brussels.

22. Hebe, from Canova, by Lazzerini, Rome.

23. A Danaide, head of an Amazon, and bust of Queen Victoria, by Bariata, Rome.

24. Iris, by Cartei, Florence.

25. Hagar and Ishmael in the Desert, by Catelli, Florence.

26. Lord Palmerston, by Fabrucci, Florence.

27. Harpocrates, the God of Silence, full length; and Cupid in a mischievous mood, by Santarelli, Florence.

28. Statue of Truth, a tipsy Bacchus, and Virgin of the of the Eucharist, a bas-relief; by Cambi, Florence.

29. The Betrothed, and the Son of William Tell, by Romanelli, Florence.

30. The Genius of Sacred Music, and Laura, by Consani, Florence.

31. The Sleep of Innocence, by Dupri, Florence.

32. John the Baptist sleeping, by Magi, Florence.

33. Death of Ferruccio, by Giampaoli, Lucca.

34. Rebecca, Faithful Love, the Child's First Grief, bust of Cleopatra, and bust of Heloise, by Vaspi, Florence.

35. The Mendicant, by Strazza, Rome.

36. Shepherdess and Bird, the Guardian Angel, and Psyche sorrowing, by Bimaimi, Rome.

37. Cupid leaning on a wine-skin, by Strechi, Rome.

38. Cupid with the arms of Mars, the Sacrifice of a God, and three Female Dancers, by Jerichau, Rome.

39. Columbus, Staffetti, Carrara.

40. A Bacchante, a nymph wreathing herself with flowers, the Genius of Summer, the Genius of Spring, Herminia writing the name of Tancred, and Poetry, by Pelliccia, Carrara.

41. Cupid, Psyche, and Venus of the Louvre, by Fabricotti, Carrara.

42. The Flora of the Capitol, Bartolini's Faith, the Dying Gladiator, bust of the Saviour, St. John the Baptist, bust of Rousseau, by Baratta, Carrara.

43. Pope Pius IX., by Tenerasie, Carrara.

44. Bust of Washington, by Bagazzi, Carrara.

45. Copy of the Warwick Vase, Flora of the Capitol, the Pet Bird, Apollo Belvidere, Copernicus, Diana of the Louvre, Dante, Jupiter, Shakspeare, Madonna, and Faith, by Marchetti, Carrara.

46. Marcus Tullius Cicero, and Paris, by Fontana, Carrara.

47. The Shepherdess and Lamb; a Struggle for the Heart, by Orlandi, Carrara.

48. Ceres, Venus, Child with a Bird, Psyche, Poetry, and Vincenzo Gioberti, by Bruneri, Turin.

49. The Virgin mourning over the dead body of Christ, by Angero, Turin.

50. The Virgin and Angel of Annunciation, by Galeazzi, Turin.

51. Hebe offering Nectar to the Eagle, by Kachszman, Milan.

52. Boy riding on a Crawfish, a Tortoise, Leda with the Swan, Innocence, and veiled head, by Croff, Milan.

53. Atala and Chactas, colossal bust of the Redeemer, by Fraccardi, Milan.

54. Infant Saviour, Child on the Waves, by Galei, Milan.

55. The Deserted, veiled head, Cupid forcing the Roses, nest of Cupids, cage of Cupids, and basket of Cupids, by Motelli, Milan.

56. Sleeping Venus, by Rados, Milan.

57. Resignation, by Tandardini, Milan.

58. The Fisher-boy, by Cacchi, Milan.

59. The Soldier's Son, by Jorini, Milan.

60. Head of the Saviour, and colossal bust of Vincenzo Monti, by Langiorgio, Milan.

61. Virgin grieving, by Nezeo, Milan.

62. Eve after the Fall, by Ragani, Milan.

And many more, less notable. All of these sculptures were in Italian marble.

Stalactite and Stalagmite.

It occurs in large tuberous, undulated masses, botryoidal, mammillary, or concretional, either in icicles or circles; has a fibrous fracture; is translucent; of a pearly lustre; color generally yellowish-white and white; its composition is calcareous spar; it originates in caverns, through which water, holding this in solution, filters, and on its ultimate evaporation leaves the carbonate of lime in various forms, which sometimes resemble altars, pillars, animals, &c.

Those pillars or icicles which are pendant from the roof, and those rising from the base, are sometimes divided into stalactite for the former, stalagmite for the latter. But the cause of their existence is the same, and there ought not to be any distinction in their name.

Ornaments of stalactite in the shape of vases, &c., are often seen in fancy stores. The greatest localities of this mineral are, the Grotto of Antiparos, and Bauman's Cave, in the Hartz, which I visited in 1827, and which displays gigantic stalactites; also in Derbyshire. In the United States, are very celebrated caves which yield this article.

These have been described by my friend, Charles Cramer, Esq., late Russian Vice Consul at New York, now of the Isle of Wight, an enthusiastic mineralogist, of St. Petersburg, in a pamphlet published by the Imperial Mineralogical Society of St. Petersburg, in the German language; and as this interesting little work is not accessible to all, I will here translate the list of all the caves enumerated by him as North American. We would observe that these are not all situated in limestone regions, neither do they all furnish stalactites.

Canada.—Grotto in the Niagara; a cave in Lanark, Upper Canada; a smaller cave at the same place.

New Hampshire.—The Devil's cave.

Vermont.—Caves in Bennington; caves in Dorset.

Massachusetts.—Natural bridge and cave at Nahant; natural bridge over the Hudson brook; cave near Sunderland; cave in Berkshire; two caves near New Marlborough; cave near West Stockbridge; cave in Lanesboro; cave in Adams; Purgatory, near Sutton.

Connecticut.—West Rock cave, New Haven.

Rhode Island.—Purgatory, near Newport; Spouting cave, near Newport.

New York.—Cave near Watertown; cave at Niagara; Ball's cave; Knox's cave; Monito, at Wigwam, or Devil's Abode; Esopus cave.

Pennsylvania.—Devil's Hole, in Bucks county; cave on the Swatera river.

Maryland.—Hughes' cave; cave at Harwell.

Virginia.—Weyer's cave; Wreast's cave; Madison's cave; Zane's cave; Blowing cave, near Panther Dale; Greenbriar's cave; cave on the Kanhawa river; Chapin's cave; Johnson's cave; Allen's cave; Ruffner's cave; Roger's cave; Reid's cave; Natural Tunnel in Scott county; Natural Bridge in Rockbridge county.

Ohio.—Mason's cave; Nature's Building, or Cave in the Rock.

Indiana.—Epsom Salt cave; cave near Corydon.

Kentucky.—Boone's cave; Russell's cave; White cave; Mammoth cave; cave on Crooked creek.

Tennessee.—Big-bone cave; Arched cave.

South Carolina.—Great Flat Rock cave; Lover's Leap.

Georgia.—Nicojack cave.

Missouri.—Ashley's cave.

Mississippi.—Abode of the Great Spirit on the North West Coast; cave on Copper river.

Mexico.—Dantoe cave; Chamacasapa cave; San Felipe cave.

Cuba.—Cave near Matanzas.

Hayti.—Cave near St. Domingo.

Peru.—Cave in the Andes.

New Andalusia.—Canipe cave.

Mr. Cramer mentions the size of the stalagmites in the antechamber of Weyer's cave, as being twelve feet high; those in Solomon's Temple, of the same, twenty-five feet high, which are nearly transparent; and its Hermit's Chandelier, four feet high, and twelve feet in circumference; the colossal stalagmite in Washington Hall, which is said to represent the Father of his Country wrapped in his cloak; Pompey's column, thirty feet high; also Babylon's Tower, thirty feet in circumference.

Egyptian Marble.

This is generally milk-white, or grayish-white and bluish, and also black and red, which is called the *rosso antico;* it is of a close granular structure, and was a great favorite with the ancient architects.

Italian Marbles.

With these may be counted the Parian marble; the Pentelian marble; the Venetian or Lombardy marble, which is quite translucent; the Luni and Carrara marble; and the Laconian marble, or *verd-antique.* They have all yielded materials for the most ancient Greek and Italian sculptors. The Venus de Medici, the Diana Hunting, and Venus leaving the Bath, are of Parian marble; a Bacchus in repose, a Jason, a Paris, and many Grecian monuments, are from Pentelian marble, which comes from the vicinity of Athens.

American Marble.

(Additional from the former edition of this treatise.)

The varieties of marble, which substance is inexhaustible in the United States, are very numerous; and I am proud to assert, that for architectural and ornamental purposes, they will successfully compete with those of any foreign country. The colors are various, from the snow-white to the black with gold and grass-green veins. A small district in New England, of about fifty miles in extent, concentrates, I may say, the marbles which may be collected in Europe through a space of two thousand square miles; for we find in the county of Berkshire, and that of New Haven, the representatives of marbles from Italy and Ireland; and the discoveries which are constantly being made of additional marble localities are a source of great satisfaction. Thirty years ago, the City Hall, of New York city, was built of marble from West Stockbridge, Massachusetts, which was transported at great expense, a distance of over four hundred miles; whereas, afterwards, the same quality of marble was discovered on New York island, but a few miles distant. According to Professor Dewey, the county of Berkshire alone turned out forty thousand dollars' worth of marble several years ago. I will here enumerate a few of the most interesting marbles:

a. The Philadelphia marble, which is snow or grayish white, and sometimes variegated with blue veins, which takes a very high polish.

b. The Potomac marble, which is properly called a breccia, being composed of rounded and angular fragments from the size of a pea to that of an ostrich's egg. Its colors are red, white, gray, and blackish-brown, intermixed; it takes a very fine polish, and forms a most beautiful ornamental stone. It comes from the banks of the

Potomac, in Maryland. As specimens of this, we would refer to the columns in the House of Representatives at Washington, which are twenty feet high, and two feet in diameter.

c. The Verd-Antique, of New Haven, Connecticut. This marble is intermixed with serpentine veins, and makes a most beautiful appearance. There are inexhaustible quarries of it at New Haven and Milford; it bids fair to rival every other ornamental stone in the world. Four chimney-pieces of this mineral were purchased for the Capitol at Washington; and I lately examined a splendid centre table, wholly cut from this marble, that was exhibited at the tenth annual fair of the American Institute. It is to be hoped that some company may undertake to introduce this marble more extensively into notice, for it does not yet appear to be sufficiently known among our wealthy citizens: the enterprise would be well rewarded. Large slabs may be seen at the New York Lyceum of Natural History, and in the cabinet of Yale College, New Haven. I possess a very fine, large slab, polished. Portsmouth, Vermont, likewise furnishes splendid verd-antique, specimens of which may be seen at the American Institute, in New York.

d. Berkshire county, in Massachusetts, may justly be called the marble pillar of the United States; and, as Professor Hitchcock remarks, the inhabitants of that county cannot but regard their inexhaustible deposits of marble as a rich treasure to themselves, and an invaluable legacy to their posterity. The towns, West Stockbridge, Lanesborough, New Ashford, Sheffield, New Marlborough, and Adams, in that county, keep thousands of hands constantly working in their quarries. In 1827, two thousand seven hundred tons of marble were exported from that town; and in 1828, a block of from fifty to sixty feet square, and eight thick, was raised by one charge of gunpowder.

e. White, fine, granular marble, bearing the closest resemblance to the celebrated Carrara marble, is obtained from Smithfield, Rhode Island; Stoneham, Massachusetts, and near Hastings, on the Hudson river.

Shell Marble.

This mineral is a secondary marble, and is called also conchitic marble, on account of its containing petrified shells, which, when polished, communicate to their matrix, the marble, a most beautifully variegated appearance.

a. The Lumachella marble is a kind which is very scarce; it has a gray or brown ground, interspersed with shells of a circular form and golden color, and when held towards the reflection of light, displays red, blue, and green tints, like those of the precious opal or iridescent labrador.

It is sometimes seen in the form of pins and other jewelry, but stands, on account of its scarcity, very high in price; the only locality is in Carinthia; one formerly in Devonshire, England, being exhausted. Some splendid specimens from Carinthia, are in the collection of Baron de Lederer, Austrian consul for this city; and a very fine specimen of the lumachella, at the Boston Society of Natural History, was marked with the locality of Neufchatel.

b. Panno di morto, or funeral pall, is a deep black marble, with white shells, like snails; it is only seen at Rome, and is very scarce.

c. Bristol marble, from England, is a black marble, interspersed with white shells.

d. Italian shell marbles from Florence, Lucca, and Pisa, are red, containing white shells (ammonites).

e. French shell marbles are very numerous; those from Narbonne are black with white belemnites; that from Caen is a brown marble with madreporites; and those from

Languedoc are of a fiery red color, mixed with white and gray univalve shells; of this Napoleon's eight columns for his triumphal arch in the Carousel, at Paris, were cut.

f. The United States have a great many shell-marble quarries; but they are all black and gray. Those of Trenton Falls, Little Falls; near Seneca lake; Northumberland county, Pennsylvania; Bernardston, Massachusetts, and Hudson, New York, contain either trilobites or encrinites; some take a very fine polish.

PISOLITE AND OOLITE.

These minerals are likewise composed of carbonate of lime; they occur massive, and in distinct concretional layers, either in the form of peas or other round grains or pebbles, and are of white, yellowish-white, brownish, or reddish color; when cut and polished, they make a fine ornamental stone, and present a very effective appearance. The former is found in alluvial deposits of the hot water mineral springs of Carlsbad, in Bohemia, and the baths of St. Philip, in Tuscany; the latter forms large beds in England and France. The city of Bath, in England, is mostly built of this limestone.

ROCK OF GIBRALTAR.

This is likewise a carbonate of lime; occurs massive, mostly striped; is yellowish-white, yellow, and brownish; is only found in that rock from whence it takes its name, and has been heretofore a great favorite for jewelry and other ornaments. At this day we see in shops and private houses, pins, brooches, ear-rings, seals, cane-heads, snuff-boxes, letter-holders, vases, urns, candelabras, obelisks, &c., formed of it. It takes a high polish.

APATITE.

This mineral was named by Werner, on account of its color being so deceptive (*απαταω*, to deceive), as it resembles the color of some other precious stones; it occurs in six-sided prisms, massive and globular; has a conchoidal fracture; a vitreous lustre; color usually sea-green, bluish-green, or violet-blue, sometimes white, occasionally yellow, gray, and red; is transparent and opaque; it resembles the beryl and emerald, but is distinguishable by color and hardness; hardness, 4·5 to 5; specific gravity, 3 to 3·235. A bluish opalescence is observed in the direction of the vertical axis in some specimens, especially in the white variety; fracture conchoidal and uneven; brittle. Some varieties are phosphorescent when heated, others become electric by friction. It is infusible alone before the blowpipe, except at the edges; dissolves slowly in nitric acid, and without effervescence.

Apatite usually occurs in primitive rocks; is often found in veins of primitive limestone traversing granite,—it also occurs in serpentine and in ancient volcanic rocks.

It contains about ninety per cent. subsesquiphosphate of lime, and the rest is chloride and fluoride of calcium. On account of its phosphoric acid, the compact varieties of apatite have become an important article of trade for agricultural purposes.

The principal localities are in Saxony, at Ehrenfridersdorff, in the Hartz mountains, where the author collected, in his youthful years, some magnificent crystals; also in Bohemia, at Schlackenwald; in Cumberland and Devonshire, England; at St. Gothard, in Switzerland; and a greenish-blue variety, called moroxite, is found in Norway, at Arendal.

Asparagus stone, which is of a yellow color and translucent, is found at Estremadura, in Spain, of which many fine specimens may be seen at the Academy of Natural Sciences of Philadelphia,—in Maclure's collection; also in Zillerthal, Tyrol, where it is imbedded in talc. The phosphorite, or massive varieties, from Spain and Bohemia, has been found in large beds. In the United States it occurs in a vein of limestone intersecting the granite at Gouverneur, St. Lawrence county, New York, and crystals of ten to twelve inches long and one and a half to two inches in diameter, of fine sea-green color, were formerly found in abundance.

Yale College has some fine specimens of this crystallized variety, from Baron Lederer's cabinet. Professor Shepherd, Mr. Francis Algar, and Dr. Charles T. Jackson, in Boston, possess many fine and large crystals. Mr. Kranz, in Bonn, was fortunate to procure, through his collector, some gigantic crystals of this beautiful mineral. There are some other localities of the crystallized variety in the United States, such as Amity, New York, where it occurs of a green color in white limestone, presenting the primary form, and accompanied with pyroxene and scapolite. Crystallized and massive specimens of a bluish-green color occur at Boston, Massachusetts, associated with sphene and petalite. Reddish-brown crystals, of one inch in length, have been obtained from a granite vein in Greenfield, New York. The massive variety of phosphate of lime from Crown Point, New York, has furnished several thousand tons for export to England as a fertilizing agent, and the concretional variety of phosphate of lime from Dover and Franklin, in New Jersey, has likewise yielded considerable quantities for a manure. These two latter varieties have been treated with sulphuric acid (oil of vitriol), in order to obtain a superphosphate of lime, which is now considered the most useful vehicle to enrich the soil, and to produce the most prolific crops. Liebig and Johnstone, the two great agricultural chemists, have demonstrated beyond any controversy that the resuscitation of worn-out soils depends materially upon the addition of phosphate of lime; and hence the application of bone-dust, which is a phosphate of lime, and guano, which contains the latter ingredient with the ammoniacal salts in combination, of which at the present day 100,000 tons are annually consumed by the farmer, along with the artificially prepared superphosphate of lime, are well known, but do not belong here.

LEPIDOLITE.

This mineral derives its name from the Greek language, from its scaly structure; it occurs massive, presenting an aggregate of minute, shining, flexible scales or hexagonal plates; it has a splintery fracture; a glistening and pearly lustre; is translucent on the edges; its colors are lilac, rose-red, pearl-gray, greenish-yellow, and blue; it is scratched by glass, and yields to the knife; has a specific gravity of 2·81; is fusible with ease into a transparent globule. It is found in granite and primitive lime, in Monrovia, France, island of Elba, Corsica, Sweden, and in the United States, in Maine, New Hampshire, Vermont, and Massachusetts. It is cut in Europe for various ornaments, such as plates, vases, snuff-boxes, &c., and will, I trust, at some future day, be more extensively used in jewelry; for there are some variegated specimens of a peach-blossom color, and very fine granular structure, which are extremely beautiful.

MICA.

This mineral occurs crystallized, in six-sided tables and oblique rhombic prisms, and massive; also, disseminated;

it has a perfectly foliated structure; a glittering and metallic lustre; is transparent and translucent; very fusible and elastic; its colors are white, green, black, brown, peach-red, yellowish, and bluish; it has a specific gravity of 2·7. It is found in primitive rocks, and forms an ingredient in granite, gneiss, mica slate, and other rocks, where it more or less predominates; its localities are, therefore, universal, but in Siberia it forms large beds, and is quarried for special purposes, such as a substitute for glass windows; and although the United States afford ample localities of it, yet a few years ago quantities were imported here for the doors of Nott's stoves.

The *plumose mica* is a beautiful variety, and derives its name from its resemblance to a quill or plume, the lamellar or fine delicate crystals diverging in such a manner as to present this appearance. It is of a pearl-gray color. It is found in the United States, at Williamsbury, Mass., Hartford, Conn., and many other places. The *green mica* is of a beautiful grass-green color, and is found in Brunswick, Maine. The *rose-red mica* is a very beautiful mineral, and is found in numerous places, in this country; principally at Goshen, Chesterfield, Mass.; Acworth, N. H.; Bellows Falls, Vt., &c. Mica may, when of good colors, be used for jewelry and other ornaments, as well as the lepidolite.

PYRITES.

This mineral is called sulphuret of iron, iron pyrites, and markasite. It occurs crystallized in many forms; such as the cube, octahedron, and dodecahedron; also massive, disseminated, capillary, and cellular; it has a conchoidal fracture; a brilliant metallic lustre; its colors are bronze, yellow, brass-yellow, and steel-gray. This mineral takes a very high polish, and from its fine lustre looks extremely well when cut in the form of a brilliant or rose. It was formerly much used in jewelry for ear-rings, rings, pins, and necklaces. It was, in former times, considered a great preservative of health. It is now but seldom seen, except in mineralogical cabinets.

ROSE MANGANESE.

This mineral is called in mineralogical works the silicious oxide of manganese, and also the carbonate of manganese. It occurs massive; has a foliated structure; a conchoidal fracture; a shining lustre; it scratches glass; its colors are rose-red, reddish, and yellowish.

It is found in Siberia, Sweden, Hungary, England; and in the United States, at Middlebury, Vt., and at Cummington and Plainfield, Mass., where, according to Professor Hitchcock, the silicious oxide, or according to Dr. Thompson, the bisilicate of manganese is found in great abundance. Since it takes a very high polish, and is much wrought at Ekaterinenburg, in Siberia, into many ornaments, it is confidently to be hoped that it may also find its amateurs in this country, as it is very easy to cut and polish, and the material is so plenty.

PORPHYRY.

This mineral forms rocks in a geological sense, but is properly a compact felspar. It has various colors and shades, and contains imbedded crystals of felspar and quartz. The name porphyry signifies purple, from *πορφυρα*, such having been the usual color of the ancient porphyries; the same rock exhibits, however, almost every variety of color; it is the hardest of all rocks, and when polished, is probably the most enduring. It is much used in Europe for ornamental and architectural purposes; also for slabs, mortars, and other articles.

In the United States, porphyry has never been used for any purpose; but Professor Hitchcock remarks, in his Geological Report of the State of Massachusetts, that it would be strange if an increase of wealth and refinement should not create some demand for so elegant and enduring a rock as porphyry. In the same excellent work the author divides porphyry into four varieties, as occurring in Massachusetts, in the neighborhood of Boston:

1st. Compact felspar, with several predominating colors; the one with yellow, resembling the Turkey stone; one with red, from brownish to blood-red, closely resembling jasper; one with a rose-red color, resembling the rose petrosilex of Europe.

2d. Antique porphyry; closely resembling that European porphyry which was employed by the ancients in monuments and ornamental furniture and forms, and is, when polished, a beautiful ornament. It presents numerous varieties and shades of color: one of the most elegant is the light-green; then a deep-green; red of various shades; reddish-brown; black, or nearly so; gray, and purple; and the imbedded crystals are usually of a light color, sometimes white, brown, and greenish.

3d. Porphyry with two or more minerals imbedded, and having a base of common felspar. This mineral is between sienite and porphyry, resembling the trachytic porphyry, and is generally unfit for ornamental purposes; the quartz which it contains is hyaline and smoky.

4th. The brecciated porphyry, which is composed of angular fragments of porphyry and compact felspar, reunited by a paste of the same material; the fragments are also of various colors, usually, however, gray and red; the rock is very hard, and when polished, furnishes specimens of great delicacy for ornamental purposes.

Porphyry is much used in England for paving stones, in the entrance halls of large public buildings or private mansions, and the Cornwall porphyry is particularly celebrated for its various tints of colors. The author distinctly recollects four slabs: one was a black slab; another, red; a third, green; and a fourth, a large slab, containing twenty-four specimens of various variegated rocks of porphyry. Also, the elvan-stone, from the quarries of New Quay, in Cornwall, which is a beautiful porphyry. The large slab, weighing about eight hundred pounds, was of very fine red color; it was without flaw or defect.

In Prussia porphyry is abundant, and there were some fine specimens in the London Exhibition, such as a table, a small column and tazza; the latter was a round slab of red color and fine texture, and the tazza vase and pedestal were of the same material.

From Sweden and Norway a sienitic porphyry, of grayish-red color, was also in the London Exhibition.

The porphyry vase in the Berlin Museum, which, according to the author's recollection, is about eight feet high and six feet in diameter, is well deserving a place in this treatise, as it is unique of its kind in the world.

SIENITE.

This rock is composed essentially of felspar and hornblende, and sometimes contains quartz or mica, or both. When polished, it forms the most splendid ornamental stone of all rocks; it is very hard; and its color and the mode of distribution of the various ingredients, make it very agreeable to the eye. It much resembles granite, and is often almost identical with it; but by close inspection it may be distinguished from the want or addition of the component ingredients.

Professor Hitchcock describes six varieties of sienite:

1st. That sienite which is composed of felspar and hornblende, when the first is white, greenish, and yellowish, and the latter invariably black.

2d. Felspar, quartz, and hornblende; the first is foliated, and commonly of grayish, bluish, or yellowish color; the second from quite light to dark color and hyaline; and the latter is black. Under this variety the quarries at Quincy and Cape Ann have been arranged by the author (which are generally called granite), on account of the absence of mica. The Quincy granite, or rather sienite, is that celebrated architectural material used in the cities of Boston and New York, for those huge and magnificent edifices, public as well as private, erected within the last six years; and it may be supposed that five thousand buildings in the city of New York have been constructed with this splendid article.

3d. Felspar, hornblende, quartz, and mica. This rock, likewise, has a beautiful appearance, but is, as yet, less wrought than the other varieties. The felspar and hornblende are predominant. The quartz is in small grains, and the mica is black.

4th. Porphyritic sienite; its base is quartz and felspar, and the hornblende is almost entirely absent; it has a porphyritic aspect; the felspar predominates. It is the most ornamental stone when polished.

5th. Conglomerated sienite; it is a quarternary compound of felspar, hornblende, quartz, and mica, but all in rounded or conglomerated masses, having the aspect of a pudding-stone; the nodules are from half an inch to six inches in size, and may be easily broken out of the mass, and the hornblende predominates mostly in them. It is unfit for architectural purposes.

6th. Augite sienite; in this rock the hornblende is present and mica absent. It is composed of black hornblende, greenish augite, and yellowish felspar; all, except the felspar, presenting a crystalline structure; it is also composed only of augite and felspar.

The name of the rock sienite was originally derived from Syene, in Upper Egypt, from whence the first specimen was procured; it was examined and identified by Werner; many of the Egyptian monuments, such as Cleopatra's Needle, and Pompey's Pillar, were obtained from there.

There are valuable quarries of sienite in abundance in the State of New York. It is a durable and beautiful stone, and may be quarried in large blocks, but on account of its great hardness requires much labor to dress it.

Along the North River there are many localities: Anthony's Nose, or Anthony s Face, which is a mountain in the northwest corner of Putnam county, opposite Fort Montgomery. It is called so in consequence of the profile bearing a rude resemblance to the human face, that may be seen in one position, when passing it; but on account of its steepness, being five hundred feet in height, it is more generally called Breakneck Mountain. Here is the granitic sienite. It is composed of a darkish-gray colored felspar, with a little black hornblende.

In Peekskill bay, on the Hudson river, and the adjoining hills for five miles in length, very valuable quarries of this fine rock may be quarried.

The sienite rock of the Highlands is very extensive; such as the Target rock on Constitution Island, opposite West Point, and all along the slopes of the mountains in the Highlands, there are boulders and blocks of this valuable and useful rock.

Fort Putnam, near West Point, and the base of Butter Hill, four miles north of West Point, are composed of sienite.

When it was ascertained that the famous rock from Syene, in Upper Egypt (so much employed in ancient monuments), and from which the name of sienite was derived, was nothing but granite with black mica, and also, that Mount Sinai, in Arabia, was composed of genuine sienite, a French geologist proposed to substitute *sinaite* for sienite, but the name, although a good one, has never been adopted.

The Quincy and Cape Ann sienite, which is sent from Massachusetts to all parts of the United States, and forms such a beautiful architectural material, is composed of felspar, quartz, and hornblende.

GRANITE.

This rock is composed of quartz, felspar, and mica, and forms the crust of our globe. It occurs over the whole earth, and the eastern part of the United States is abundantly furnished with this valuable mineral. As a building material it has been most extensively used for the last ten years; but the great fire in New York, which, in December, 1835, consumed seven hundred buildings, among which about two hundred were of granite, has given a sufficient proof that granite is, in this changeable climate, unfit for a building material, but that it may be usefully employed for ornamental and architectural purposes, where it is not constantly exposed to the atmosphere and weather, which make it so liable to decomposition.

Nevertheless, granite continues to be generally employed in the erection of public buildings, warehouses, bridges, &c., and begins to form an important pecuniary object to the merchant and mechanic; and on this account I cannot forbear to treat more fully on its general characters, and I must confess that the rich granite treasures of Connecticut, Rhode Island, and Massachusetts, which I had occasion to examine a short time since, on a journey into those regions, deserve fully all the encomiums bestowed upon them in Hitchcock's Report on the Geology of Massachusetts, and in Shepherd's Report on the Geological Survey of Connecticut. So abundant and large are the granite rocks in the eastern part of the United States,* that some single localities are sufficient to supply many countries with this lucrative article.

Professor Hitchcock divides the granite of Massachusetts into four varieties, viz:

1. Common granite, which, according to him, embraces nine tenths of the granite in Massachusetts: the ingredients are a distinct crystalline structure, of mixed and discriminating colors.

2. Pseudomorphous granite is that variety in which the mica separates distinctly the other ingredients, which are closely mixed.

3. Porphyritic granite: it contains, besides the usual composition of quartz, felspar, and mica, distinct imbedded crystals of felspar.

4. Graphic granite: this variety consists of quartz and felspar only; the cross-fracture presents the appearance of written characters.

Professor Shepherd divides the ornamental granite of the State of Connecticut into eight different types, viz.:

1. Gray granite.

2. White granite. This variety I have examined myself in Plymouth, Connecticut, and so beautiful was its color and close granular texture, that I took it at a distance for a sandstone, or white marble.

3. Flesh-colored granite.

4. Red granite.

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* Professor Hitchcock remarks that there is not a town in Massachusetts in which more or less granite does not occur, either as situ or as boulders.

5. Epidotic granite.
6. Porphyritic granite.
7. Chloritic granite.
8. Sienitic granite.

In Rhode Island a fine white granite has, according to Dr. Webb, of Providence, been employed for the erection of the arcade of that city, from a quarry in Johnstone, five miles from Providence.

The manner in which granite is usually split out at the quarries, is this: a number of holes, of a quadrangular form, a little more than an inch wide and two or three inches deep, are drilled into the rock at intervals of a few inches, in the direction in which it is wished to separate the mass. Iron wedges, having cases of sheet iron, are then driven, at the same time and with equal force, into these cavities; and so prodigious is the power thus exerted, that masses of ten, twenty, thirty, and even fifty and sixty feet long, and sometimes half as many wide, are separated. These may be subdivided in any direction desired; and it is common to see masses thus split till their sides are less than a foot wide, and their length from ten to twenty feet.

The price of the granite from these quarries, according to Professor Hitchcock, is from forty to forty-five cents per superficial foot, and for hammering and fine dressing it, about thirty cents the superficial foot, such as in the style of the Tremont House in Boston; common work from twenty to thirty-five cents; posts for stone fronts cost thirty-four cents per foot. The enterprising citizens of the city of New York have erected gigantic monuments of granite, for future generations to admire.

New York abounds in granite, both east and west of the Hudson river, Staten Island, Westchester and Putnam counties. In the city of New York, a large bed of fine granite extends from Thirty-first street on the west side, and from Twenty-fourth street in the middle, to Sixtieth street on the north. The Croton Aqueduct is mostly built of granite quarried in Tenth avenue near Forty-eighth street.

Granite abounds in Rockland and Orange counties; it occurs in beds, veins, and irregular masses, forming hills, and often the tops of mountains.

The fine-grained varieties of granite are best for economical uses. When granite contains distinct crystals of felspar, it is called porphyritic; when the ingredients are blended into a finely granular mass, with imbedded crystals of quartz and mica, it is called by French writers, *eurite.* A granular mixture of quartz and felspar is called pegmatite.

In England, Cornwall is particularly celebrated for its granite; the obelisk from the Lamorran quarries, twenty-two feet high, which was exhibited at the London Exhibition, was twenty-one tons in weight, and of a coarse grain, and another, from Cornseco granite, weighing thirty-one tons, and eighteen feet high, were beautiful specimens of this useful rock. They were each wrought from a single block of granite, and were remarkable for extreme fineness and closeness of grain, and the delicacy of finish which was thereby obtained.

The granite column of Cheesewing granite, the property of the Prince of Wales, near Liskeard, in Cornwall, was likewise a magnificent piece. It was thirty feet high.

The bust and pedestal of blue Peterhead granite was also an interesting specimen of its kind.

Swedish granite has been known for many centuries; it is obtained from extensive quarries on the island of Maleuva, on the west coast of Sweden. It bears a high polish

PEARLS.

Pearls are concretions, consisting of carbonate of lime, having a roundish, tubercular, or angular form; a white, gray, blue, or green color; a shining lustre, and the hardness of lime; specific gravity, 2·68. They are found in several bivalve shells—the meleagrina margaritifera, haliotis gigas, and haliotis iris, and a large species of turbo, which shells are known in commerce as flat shells, ear shells, green snail shells, buffalo shells, and Bombay shells; many unios, alamadontas, &c. Mother of pearl is the internal or nacreous layer of such shells. These precious substances are the result of an excretion in superimposed concentric laminæ of a peculiarly fine and dense nacreous substance, which consists of membrane and carbonate of lime. The finest quality is produced by the bivalve of the Indian seas, called *par excellence* the pearl oyster (*meleagrina margaritifera*). In the United States the alasmadonta arcuata, corresponding with the mytilus margaritiferus of Barnes, the unio ochraceus, unio complanatus, and many other species, contain the pearls, and according to the nacre of the shells the color of the pearl is corresponding.

The origin of pearls is by some considered to be unfructified eggs; by others, a morbid concretion or calculus, produced by the endeavor of the animal in the shell to fill up holes therein; by others again, as mere concretions of the juice of which the shell has been formed, and with which the animal annually augments it. It is very plausible, however, that the animal of the shell is attacked often by enemies, such as the boring shells (turritella), &c.; that grains of sand, or any other pointed substance, which, on such occasions, come within the shell, stick fast and augment with the growth of the shell; it is also known that pearls may be produced artificially, by pressing a sharp body on, or by boring a hole in, the shell. The Chinese are in the habit of laying a string with five or six small pearls separated by knots, inside of the shells, when the fish are exposing themselves to the sun, and taking them out after some years, whereby they obtain very fine and large pearls, and but a little open on the side where they were adherent to the shell. The pearl fishers say that when the shell is smooth and perfect, they never expect to find any pearls, but always do so when it has begun to be deformed and distorted. It was therefore concluded, that as the fish grew old, the vessels containing the juice for forming the shell and keeping it in vigor, became weak and ruptured, and from this juice accumulating in the fish, the pearl was formed, and the shell brought to decay, as supposed by M. Reaumur. It would be, according to this idea, a sure guide to know from the form of the shell, whether the pearl is large or small; and thus by the smaller ones being thrown back into the sea, a constant crop of large pearls might be obtained. The mother-of-pearl fish is found in the East and West Indies, and other seas in warm latitudes, and in the rivers of north and middle Europe. In some parts of the globe, they are found in clusters, containing a great number; the places where found are called pearl-banks. The most famous are near the coast of Ceylon, that of Japan, and in the Persian Gulf, near the island of Bahreim; also near the coast of Java, Sumatra, &c. The finest and most costly pearls are called the Oriental, and are from the above places; they are all white or yellowish; those from the Persian Gulf, on account of their perfect whiteness, are preferred to those from Ceylon. Pearls are collected in rivers with the hand, but in seas it is the business of divers, brought up to this most dangerous occupation from early youth. In the East Indies there are two seasons for pearl fishing; the first in March and April, the second in August and September; and the more rain, the more productive are the pearl fisheries. In the beginning of the season there are sometimes two hundred and fifty barks on the banks; the larger barks have two divers, the smaller, one. The divers descend from their barks with a rope round their body, and a stone of twenty or thirty pounds attached to one of their feet, so that they may sink speedily from eight to twelve fathoms, where they meet the shells fastened to the rocks; the nostrils and ears are stuffed up with cotton, and to the arm a sponge dipped in oil is fastened, which the diver now and then brings to his mouth, in order to draw breath without swallowing water. He also carries down with him a large net, tied to his neck by a long cord, the other end of which is fastened to the side of the vessel, to hold the shells, and the cord is to draw him up when the net is full, or when he wants air; he has likewise a knife or an iron rake, for detaching the the shells from the rocks. Thus equipped, he precipitates himself to the desired depth, where he can very distinctly see all that is passing around, yet cannot escape in time the sudden approach of sharks, to whom he too often becomes a prey. When the diver has been in water some minutes, and has his net filled, or is unable to stay any longer, he loosens quickly the stone at his foot, shakes the line, and he is drawn up by his companions. The diving-bell is now frequently used; more so than in former years.

In the Persian Gulf the divers rub their bodies with oil, and fasten a stone of about fifty pounds to their feet.

The shells obtained are piled up in heaps, and left exposed to the rain and sun until the body of the animal putrefies, and they open of themselves. Those containing any pearls have from eight to twelve. After being picked out, washed, and dried, they are passed through nine sieves of different sizes.

At the Pearl Islands, near the Isthmus of Panama, the pearl fisheries have, within a few years past, become a lucrative business to many of the inhabitants. The divers use more simple methods than those we have mentioned, for collecting the pearl oysters: they traverse the bay in canoes that hold eight men, all of whom dive naked into the water, from eight to ten fathoms deep, where they remain about two minutes, during which time they collect all they can with their hands, and dexterously rise to deposit them in their canoe, repeating the operation for several hours.

In Sweden, the pearl oyster is caught with a pair of long tongs. The fishermen are in small boats, painted white on the bottom, which reflects the light to a great depth, and as soon as they perceive them passing underneath they seize the oyster.

Pearls are esteemed according to their size, form, color, and lustre; the largest, of the size of a small walnut, are called paragons, which are very rare; those the size of a cherry, are found more frequently, but still are rare; they are the diadem or head pearls. They receive names, also, according to their form, whether quite round, semi-circular, and drum-form, or that of an ear-drop, pear, onion, or as they are otherwise irregularly shaped. The small pearls are called ounce pearls, on account of being sold by weight, and the very smallest, seed pearls. Those of a brilliant white color, or white water, are most sought for in Europe; those of a yellowish color in some parts of Asia; and some of a lead color, or those of a jet black, are preferred among some nations. They all turn more or less yellow with age, and to restore the white color, they are either baked in bread, rubbed with boiled salted rice, or kept for a short time in the gastric juice of fresh-killed chickens.

Pearls are sold by weight—troy weight; but the pennyweight of twenty-four grains is counted as thirty; so that an ounce has six hundred grains, pearl weight, and four troy grains are equal to five pearl grains. The price has, within the last forty years, much diminished, for two reasons:

1st. Diamonds, and particularly brilliants, have become more plentiful, and have since been worn, not by the higher classes alone, but also by the middling.

2d. Within the last twenty years, artificial pearls have been manufactured in high perfection, and are worn to a great extent.

It is my opinion, however, that the price of pearls will take a fresh rise among the nobility and richer classes, diamonds being now so generally worn; as persons, thinking to invest safely, without any future loss, their surplus capital, purchase brilliants that formerly were possessed exclusively by the rich.

Pearl fisheries were first carried on in remote times in the Persian Gulf, and the most celebrated, formerly, were near the island Bahreim. Five hundred thousand ducats was then the yearly produce. About one million dollars' worth, at the present time, are exported. The island Kharack now produces the most considerable quantity. The principal market is at Muscat; from thence they are brought to Surat. The mode of procuring them pursued in those countries, is in canoes, holding fifteen men, six of whom are divers: the shells caught during the day are delivered to a surveyor, when they are opened on a white cloth, and whoever finds a pearl of some value, puts it in his mouth, to give it, as they say, a "better water." The greatest harvests are generally after many rains, and the largest pearls are mostly found in the deepest water. At Ceylon the pearl fisheries are now considerable, particularly in the bay of Condatchy. The shells are there left to reach the age of seven or eight years, and in the fourth year they have small pearls, sometimes a hundred and fifty. They fish yearly, in the month of May, during four weeks. In the year 1804, eight hundred canoes, each with two divers, were engaged. Before the year 1800, the pearl banks were leased, to an Indian merchant, for three hundred thousand pagods; and before the arrival of the Europeans in India, the same bank was used every twenty or twenty-four years; when under the Portuguese, every ten, and under the Dutch, every six years. In 1800, the produce was from one hundred to one hundred and fifty thousand pounds sterling.

Japan has some pearl banks, which are, however, not much sought; the same may be said of the Nipthoa lake, in Chinese Tartary. America sent, in the sixteenth century, pearls to the amount of eight hundred thousand dollars to Europe. The shells were mostly collected from Cape Paria to Cape Velo; round the islands Margarita, Cubagua, Coche Punta, Aragy, and at the mouth of Rio la Hacha, from which latter locality, and the Bay of Panama, Europe is now mostly supplied. The former localities have long since been relinquished, on account of their small produce; too many shells having been removed at one time, thereby retarding the growth of pearls. Panama has sent, within a few years past, about one hundred thousand dollars' worth of fine pearls to Europe, the trade being carried on by Messrs. Plisé, of Panama. The coast of Florida is said to have been very lucrative to the Indians, as a pearl fishery, which, however, does not prove so now, since the settlement of civilized people.

England used to be supplied from the river Conway, in Wales; and Scotland supplied the London market, between the years 1761 and 1764, to the amount of ten thousand pounds sterling; but the supply has failed. Pearls are found in the Elster river, in the kingdom of Saxony, from its source at the borders of Bohemia to Elsterberg, where the fishery has been carried on since 1621, with some advantage to the sovereign; some pearls found there were valued at fifty Prussian dollars each. In the river Watawa, in Bohemia, and in the Moldau river, from Kruman to Frauenburg, pearls are found of great beauty; so much so as to equal in price the Oriental pearls. Also, at Rosenberg, pearls are sometimes found superior to the Oriental in lustre; and at Oelsnitz, a considerable pearl fishery is carried on. Most of the rivers in Sweden, Lapland, Finland, Poland, Norway, Jutland, Silesia, and other places, contain pearls, but they are not collected.

It is a fact that the pearl is equally hard throughout all its concretional layers, for by putting the pearl in a weak acid, the outside layer becomes gelatinous, and the succeeding layers are found to be equally hard and uniform. It is almost impossible, therefore, that the story told of Cleopatra having swallowed a pearl after being dissolved in vinegar, should be true; besides, if the pearl had been dissolved as quickly as reported, it would not have made a very disagreeable beverage. Pearls were known, and were very much esteemed by the Greeks and Romans, and when they became acquainted with the Indies, by commercial intercourse and conquest, they preferred the pearls of the East to those that were obtained from the rivers of Europe, or even from the Mediterranean.

With the ancients the wearing of this species of curiosity became a passion and even a folly. Necklaces, bracelets, and ear-rings were then worn in profusion; dresses, head and foot ornaments were manufactured with pearls. Millions of sesterces (a Roman coin of two hundred francs value), were expended and lavished for the best and most extraordinary pearls. The two pearls of Cleopatra cost nearly two millions of francs; Julius Cæsar presented to Servilia, the sister of the celebrated Cato, of Utica, a pearl which he purchased for one million two hundred thousand francs.

Lollia Paulina, the wife of Caligula, wore ornaments to the value of eight millions of francs. The ladies went so far as to ornament their buskins with pearls. Nero lavished pearls upon his lewd women. In modern times Buckingham distributed in the halls of the Empress Ann, of Austria, and of King Louis XIII., pearls to the value of three hundred thousand francs.

The baroques, which are excrescences in the mother of pearl, are sometimes very large, and display some extraordinary figures and inconceivable freaks of nature. They are held in high estimation, and are mostly worn in Spain and Poland.

Caire, the celebrated French jeweller, possesses many baroques; one representing a bearded dog; another, representing the order of the fleece. He had a mother of pearl containing a large excrescence, representing a Chinese with crossed legs.

The prices of pearls, from one carat upwards, were formerly determined like those of diamonds, viz: if the carat be fixed at five dollars, and a pearl weighs four carats, take the square, or sixteen, which multiplied by five is equal to eighty; so that a pearl of four carats was estimated at eighty dollars.

At present the following are the prices of pearls:

1	grain is	worth,	in France,	4	francs	per carat.
2	"	"	"	10	"	"
3	"	"	"	25	"	"
4	" (1 carat)		"	50	"	"

The baroque pearls are sold at from three hundred to one thousand francs per ounce.

The seed pearls, when quite round, are worth about one hundred and twenty francs per ounce.

In France, perforated pearls are valued at twice the prices given above. The piercing of the pearl is well understood in the Indies. The value of a pearl is always enhanced by size, perfection, and color; those that have a yellowish-white, or silver-white, or very pale gold-yellow shade, or a rose or lilac color, are the most esteemed pearls.

The French pearl fisheries produce at least from three to four millions of francs.

The French Crown possesses pearls of immense value:

One round virgin pearl, of a magnificent orient, weighing, $27\frac{5}{16}$ carats, is valued at two hundred thousand francs. Two pear-shaped pearls, well formed, of a beautiful orient, and weighing together $57\frac{11}{16}$ carats, are valued at three hundred thousand francs; two ear-drops, weighing $99\frac{6}{16}$ carats, are valued at sixty-four thousand francs.

About seventy-two more large pearls, of great beauty and exquisite form, pear-shaped and round, valued in the aggregate sum of three hundred and fifty thousand francs.

At the Paris Exhibition, in 1855, an enormous pearl, of pear-shape, brought from Berlin, by Napoleon I., was exhibited.

The Princess Royal of England, at her marriage to Prince Frederic William, of Prussia, wore a necklace of the finest pearls, which cost, at the least calculation, five hundred thousand francs.

The Emperor Rudolph possessed a pearl weighing one hundred and twenty grains.

King Philip II., of Spain, possessed a pear-shaped pearl of the size of a pigeon's egg, weighing one hundred and thirty-four grains. It came from Panama, and was valued at fifty thousand ducats. It was called the Peregrina.

In 1620, King Philip IV., of Spain, purchased a pear-shaped pearl from Gougitas, of Calais, which weighed four hundred and eighty grains. An anecdote is told of the King, who asked the merchant how he could risk his whole fortune in so small a piece as that pearl; whereupon the merchant replied, that he knew there was one king of Spain in the world who could afford to purchase it. It now belongs to the Princess Youssopoff.

A costly collection of pearls from the Indies, Ceylon, and Singapore, and innumerable pieces of ornamental jewelry set with most costly pearls, was exhibited at the London Exhibition by Messrs. Garrard, Hunt, Roskell, and other jewellers.

A large pearl, from Vermont, United States, weighing eleven carats, and very round, but not of bright color, is in the possession of Mr. S. H. Palmer.

Messrs. Blogg & Martin, of London, inform me, under date of April 25, 1859, that they have in their possession a magnificent pearl necklace, consisting of thirty-seven perfect pearls, of forty grains each; they sent a description of it, and also of two beautiful pearl-drops, which they value at two thousand pounds sterling. The necklace and drops, which must be unique specimens, deserve more than a mere notice, but the description came too late for insertion.

United States Pearls.

New Jersey merits the credit of producing fine pearls; a great many thousand pearls have been obtained from the mussels, which compare fairly with those of the India pearl-shell; size, color, nacre, and orient are displayed in many of the New Jersey pearls in a high degree, and are now passing in Europe for the genuine Oriental or Panama pearls. In 1857, a shoemaker named David Howell, living

Fig. 12 *a*.

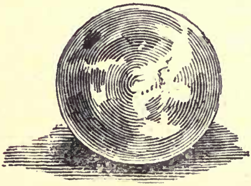

Fig. 13.

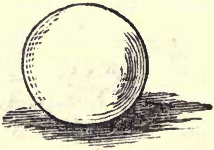

Fig. 14.

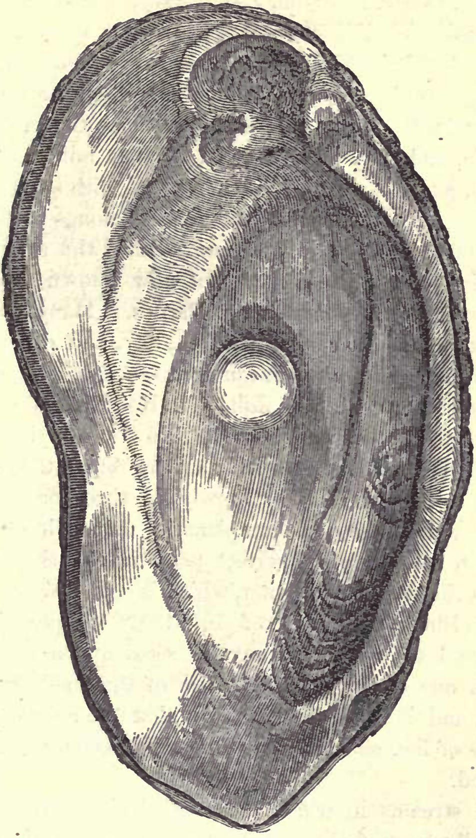

Fig. 12 *b*.

Fig. 15.

Fig. 16.

near the town of Paterson, New Jersey, went to a neighboring brook, called Notch brook, in order to collect some mussels for his breakfast, and, on opening them, discovered a great many loose pearls falling out, which he took to a jeweller in Paterson, who stated to him that they were valuable, and they both began to collect millions of these mussels, and their efforts were crowned with success. The preceding representation of the mussel belongs to the great family of unio, which was formerly called the avicula margaritifera, mya margaritifera, but now known as an alasmadonta arcuata—named by Barnes. Many unios (of which there are, according to Lea, Say, and other American conchologists, over six hundred species), contain pearls more or less; and Mr. John H. Redfield, the efficient corresponding secretary of the New York Lyceum of Natural History, informs me that he found the pearls in the same locality in New Jersey, in three or four other unios, such as the unio complanatus, unio ochraceus, unio radiatus, &c. A very perfect pearl in the shell may be seen in the annexed drawing, which is copied from "Frank Leslie's Illustrated News" of May, 1857; the pearl is rather dark, and the shell, as may be seen, appears worn off. This is one of the characteristics of the shells containing pearls, and it appears to indicate that the animal is in the decline of life, and that the mussel is becoming gradually decayed.

The streams in which these pearl shells are found are generally very shallow, not more than one or two feet deep, and the shells may be picked up with the hands; many thousand shells are opened, containing deposits of the pearly matter, most of which contains shapeless and colorless pearls, which are so small that they are of no value; many, however, contain very perfect pearls; the crown-pearl, weighing ninety-one grains, in the possession of Messrs. Tiffany & Co., was purchased from Mr. Howell for $1500. This pearl resembles a crown, having three smaller pearls resting upon the large pearl; another representation of a pearl weighing nearly four hundred grains, here represented, was destroyed by cooking the mussel in order to open it better, and the color of the nacre has been spoiled; it would, probably, have been the largest pearl of modern times, and of immense value.

The alasmadonta of the present day was formerly called mya, from the Greek *μύω*, to compress, it is called in English, the gaper, on account of the bivalve gaping at one end, its hinge having a solid, thick, patulous tooth, seldom two, and not inserted in the opposite valve; the same genus was originally called mytilus; they inhabit both the ocean and fresh water; they perforate the sand or mud at the bottom. Many species are caught for food, and others for the pearls; some few of the same genus perforate and live in limestone, like the pholadites.

The pearl-bearing mya, now alasmadonta, is frequently found in the large rivers of northern latitudes. The British Islands, especially Ireland, were formerly famous for their fisheries, and a few pearls of great value have at times been obtained from these sources, although the British specimens are not held in high estimation, with the exception of a few procured from the river Shannon, in the year 1821.

The river Irt, in Cumberland, the Conway, in Wales, and the Tay, in Scotland, were once noted for their pearl fisheries. Suetonius reports that Cæsar was induced to undertake his British expedition for the sake of the pearls; and according to Pliny and Tacitus, he brought home a buckler made with British pearls, which he dedicated to, and hung up in the temple of the idol Venus genetrix.

The gapers are mostly used for food, both in Britain and on the Continent; around Southampton, in England, these mussels are known by the whimsical name of "old maids," and the inhabitants of the northern islands call them smuslin, and consider it a fine supper-dish, which is by no means unpalatable.*

I am informed by Mr. Plisé, who brought a considerable quantity of pearls from Panama, that he receives four dollars per grain in England, for those of good size and quality.

Pope Leo bought a pearl for eighty thousand crowns. Tavernier describes one belonging to the King of Persia, which is said to have cost one million six hundred thousand livres. Portugal has a pearl in her treasury of the size of a pear. Two Greeks, residing in Moscow, are in possession of a pearl weighing twenty-seven and seven eighths carats.

For restoring Oriental pearls to their original lustre, which they lose in the course of time, the following process is resorted to in Ceylon: the pearls are allowed to be swallowed by chickens, which are then killed, and the pearls are an hour afterwards taken out of the stomach, when they are as white and as lustry as if just taken from the shell.

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* The poet Cowper thus expatiates on the mussel:

"Condemn'd to dwell
Forever in his native cell;
Ordain'd to move where others please,
Not for his own content or ease;
But toss'd and buffeted about,
Now in the water and now out;
Yet in his grotto-work inclosed
He nothing feels in that rough coat,
Save when the knife is at his throat;
Wherever driven by wind or tide,
Exempt from every ill beside."

Artificial Pearls.

Artificial pearls or beads are of various kinds; most generally they consist of solid masses of glass, with a hole drilled in them; or they are blown hollow, and then filled out with metallic lustry grains, wax, or with the fine scales of the bleak fish, which have a silvery and pearly lustre.

The art of imitating pearls is attributed to a manufacturer of beads, of the name of Janin or Jalquin, who lived at Paris in 1680; he was led to the discovery by seeing, one day, the scales of the bleak fish swimming in a trough, where the fish detached them by rubbing against each other, and he at once conceived the idea of applying these scales for imitating the orient of the pearls, by mixing them with a mucilage and filling the interior of hollow glass bulbs, and he gave this natural and wonderful production the name of Extract of Orient—a very singular name, but still significant of the meaning of its employment. It is well known that this little white fish, the bleak, is found in abundance in the rivers Seine and Marne, in France, and in many small rivers in Sweden, Germany, and Italy. The bleak fish fructifies around water-mills, where they are caught by nets.

For the purpose of extracting the color of the scales of the fish, they are rubbed pretty hard in the fresh water collected in a stone basin, which settles down in the bottom of this vessel; the sediment is then pressed out through a linen rag, and they are then replaced again in fresh water and left there to settle for several days, when the water is drawn off and the precipitate is carefully collected; this is called the extract or essence, and it requires from seventeen to eighteen thousand fishes to obtain five hundred grammes (a little over one pound).

The scales being animal matter are, therefore, liable to decomposition, and for their preservation numerous chemical agents have been employed by the different manufacturers, all of whom, who have succeeded, keep it a secret; it is, however, known that liquid ammonia is added to the paste of the scales.

The operation of the manufacture is very difficult, but an experienced workman can manufacture six thousand pearls in a day.

The chemists have experimented for some years to imitate the extract of orient,—as it requires such a large quantity of fishes to obtain any amount of the scales,—and according to Mr. Barbot, the following preparation has produced a favorable result: which is by distilling one part of oxide of bismuth and two parts of corrosive sublimate; the product is a species of butter, which on redistilling yields metallic quicksilver and a very fine powder; this is the substance used for orientalizing or coating the artificial pearls with the true gloss of an Oriental pearl.

The same scales are likewise used to coat beads of gypsum, or alabaster, which are soaked in oil and then covered with wax to give them a pearly appearance. The Roman beads are made in this manner: the scales are dissolved either in liquid ammonia, or vinegar, and the solution or liquid is used for covering those artificial beads. The Turkish rose-beads are made of an odoriferous paste, and are turned afterwards like those of coral, amber, agate, or other hard substances. The knitting beads are sold in meshes of one hundred and fifty, or twenty strings, of fifty beads each, of various colors; and the large glass-beads in meshes of twelve strings. There are numerous manufactories in Germany and Italy of the various kinds of beads, which are used to a very great extent both in Africa and North and South America. Germany exports yearly from its different manufacturing places, such as

Heidelberg, Nuremberg, Sonnenberg, Meistersdorf, in Bohemia, and Mayence, more than a million dollars' worth. In Venice are large establishments for the finest cut beads.

Nuremberg manufactures, besides glass beads, considerable quantities of amber beads. In Gablontz, in Bohemia, more than six thousand persons are engaged in the manufacture of beads, that are made of pure glass, or of a composition. From the glass-houses, which are very numerous in Bohemia, the rods of different sizes are delivered to the glass mills for cutting, which is performed by water power or by hand. In 1828 there were in that neighborhood one hundred and fifty-two mills in operation; a number of glass-blowers were likewise engaged, who possessed great dexterity in blowing the small beads with the assistance of a small blow-table. In the manufactory of George Benedict Barbaria, at Venice, six hundred varieties of beads are constantly making; and that of Messrs. Gaspari and Moravia manufactures, besides the beads, every article of jewelry from the same material.

The rose beads of Steffansky and Tausig, are made of bread crumbs, which are beaten up with rose water in a wooden mortar, until they become a uniform mass, to which is added some otto of roses and drop-lake, when it is made into beads with dissolved gum tragacanth; for the black rose-beads, Frankford black is substituted in the place of the drop-lake.

Lamaire, of France, manufactures beads equal in lustre and beauty to real pearls. He adds to

1000 ounces of glass beads,
3 " scales of the bleak-fish,
½ " fine parchment glue,
1 " white wax,
1 " pulverized alabaster,

with which he gives them an external coating.

Rouyer manufactures his beads, also in France, from opal, which he covers with four or five layers of dissolved isinglass, and then with a mixture of a fat oil, spirits of turpentine, and copal, so as to prevent their becoming moist. In order to render them of the peculiar lustre of the Oriental pearls, they are covered with a colored enamel. The opal is fused into rods by a lamp, over which is laid a brass wire to support it; the wire is held in one hand and the opal in the other, and the wire is then kept turning until the bead has the desired size and roundness; if a colored enamel is to be applied, the beads are made but half the required size, which being done, they are once more covered with the opal, then the solution of isinglass is used, and lastly the varnish. Beads made in this manner are with difficulty distinguished from the Oriental pearls.

The best method of making artificial pearls, is certainly by means of pulverized real pearls. Either the smallest, or the deformed large specimens, may be reduced to a fine powder, and then soaked in vinegar or lemon-juice, and the paste made up with gum tragacanth; they may then be cut out with a pill machine, or a silver mould, of any desired size, and when a little dry, inclosed in a loaf and baked in an oven: by tin amalgam, or by the silver of the scales of young fish, the proper lustre may be given.

The artificial pearls, by Constant Valès & E. Truchy, of Paris, which were on exhibition in the London Crystal Palace, were extremely beautiful, and were with the greatest difficulty distinguished from the natural pearls.

Messrs. Bouillette, Hyvelei & Co., of Paris, exhibited, besides many beautiful pearls, a great variety of artificial stones, all of their own manufacture, and very tastefully set; among them was a stomacher in diamonds, pearls, and emeralds.

The shad-fish, as well as the white-fish of our lakes, must yield an extract of orient, of as good a quality as the bleak-fish of the Seine, and it is to be hoped that some enterprising mechanic may take an opportunity of preparing the white matter adhering to the scales of the fish just mentioned, either for export, or for the purpose of imitating pearls, which may be done as well in this country as anywhere else.

The usual price of false pearls is two dollars and fifty cents a string,—one hundred to the string; but some are lower, and some higher, according to color.

CORALS.

Corals are zoophytes, whose calcareous habitations resemble vegetable branches. They live in the sea, adhering to rocks, stones, or vegetables, and shoot to the surface of the water in tubiform stems with branches, generally coated with a gelatinous or leathery skin that incloses a cartilaginous marrow, composed of many cells, inhabited by the animals,—who propagate in sprouts from eggs so fast, that small reef-rocks are formed, which in the course of time become islands.

The red coral, or precious coral (*iris nobilis*), belongs to that family of zoophytes which live mostly in the cavities of rocks in the sea; the stem is always of a beautiful red color, rarely white; quite compact, striated on the outside, of entire calcareous composition; it grows one foot high and an inch thick. The stem is covered with a leathery crust, containing open warts of eight teeth, in which the animals, or polypi, with their eight arms, are situated; the arms are whimpered, and the animal grows very slowly.

The red coral is fished up with nets of strong ropes, fastened on large wooden cross-beams, which are thrown down on the places where the corals are known to be fastened, and an expert diver contrives to entangle the nets in the reefs, which are then drawn up by force. The corals so brought up are cleaned, assorted, and sold to the manufacturers.

Messrs. Payenne & Laminal have invented a very ingenious machine for collecting the coral from the banks of the ocean, without breaking the fine branches and without injuring the banks which are formed for the growth of the coral.

It is a fact admitted by naturalists and fishermen, that the growth and accumulation of the zoophytes take place continually in the same waters; and that as great and prolific a traffic may be created by coral catching as by the fisheries in France. Lord Ellis proved, in 1754, that the coral polype possesses an ovarium filled with small eggs, prepared for hatching; all these eggs are attached together by a species of cordon, and resemble worms; tentacles are shooting out from them, which move in the same manner as the grown polypes.

In 1856, Mr. Focillon presented a report to the Acclimitation Society at Paris, on the methodical exploration of the ancient and natural banks, and on the construction of artificial coral banks in such a manner as to secure the most favorable position for the production and operation of an easy and sure coral harvest. Facts have already been elicited, that the new coral succeeds so well at a depth of seven to eight metres (twenty-four feet), under the influence of the rays of the sun, that it develops quickly, and becomes large and of good color at the end of eight or nine years; while a coral at a depth of thirty to fifty metres (one hundred and fifty feet), requires from thirty-five to forty years to shoot out, and it is not then of as good a color as the former. This discovery ought to stimulate the African coast (Algeria), particularly the inhabitants on the shores of Bona, Oran, and other places, who ought to be beforehand in the application; also on the Marseilles coast, which is already full of coral reefs.

Coral was formerly cut in facets, and was in great favor under the consulate and empire of France, for almost every species of luxury; combs, ear-rings, necklaces, beads, crosses, &c., were manufactured and sold at high prices; but the fashion and price soon fell. Ten or fifteen years afterwards an endeavor was made to bring coral in vogue again, by offering coral engraved as cameo, and made into other ornaments,—such as brooches, bracelets, ear-rings, and pins, which were then sold pretty high; but on account of an insufficient supply of the article and bad workmanship, it fell back to its original lethargy, and for many years it was considered worthless and altogether out of fashion.

During the last two years, coral has resuscitated very much, and got into good grace with the ladies.

The Parisians have, however, changed their taste for the former favorite,—the *red* coral; the *rose-colored*, cut in a round form, so as to nearly resemble a rose pearl, being preferred, which is acknowledged to be extremely rare. The price of these rose-colored corals has of late risen so high, that a fabulous sum is paid for them; and a coral which was worth but fifty francs in 1810, is now sold for three hundred francs and upwards. At present the fashion for corals is at its height, and ornaments of every conceivable variety may be seen in the shops of jewellers in this country, imported from France and Italy.

At the last Paris Exhibition there was a coral chess-board, with all its figures representing an army of Crusaders and of Saracens, which was admirably executed, and valued at 10,000 francs. Coral branches, if without a fracture, bring a great price.

France manufactures and exports coral ornaments to the value of six millions of francs, and the demand for them is much greater; the establishments of Barbaroux and Garaudy & Fils, in Marseilles, where the coral is principally manufactured into ornaments, give proof that France will retain the supremacy in this species of luxury.

In the Paris Exhibition of 1855, many curious sculptured and chiselled objects were shown by Arsène Gourdin, of Paris.

In the London Exhibition, fine corals were shown from the Cape of Good Hope, from Reffaelli & Son, in Tuscany; from Algiers was also a collection. Tucker & Co., of Bermuda, exhibited a fine collection of both corals and madrepores, including the black flexible coral (gorgonia). Among the ancient rare coral engravings is the head of the philosopher, Chrysippe, in high relief: it was in the Orleans collection. A coral cameo of the 14th or 15th century, representing a Sphinx with three Cupids, well executed, is mentioned by Caire.

The red corals are distinguished by the names of the countries where found.

1. The Barbarian, which are the thickest and purest.
2. The Corsican, which are the darkest, but not so thick, and less pure.
3. The Neapolitan, and those from Ponza, which are clear and pretty thick.
4. The Sardinian, which are thick and clear.
5. The Catalonian, which are nearly as dark as the Corsican, but mostly thin.
6. The Trapanian corals, from Trapani, in Sicily, which are somewhat preferred at Leghorn.

The darkest corals are most liable to be worm-eaten.

The polished corals are generally sold in bundles, which consist of a certain quantity of strings, of a certain weight.

They are strung in Leghorn, either of various or equal thicknesses, which latter are then of various sizes, and the bundles receive their names accordingly; *grossezze*, *mezzanie*, *filotti*, *capiresti*, &c. The thickest corals are put up in one string, resembling a tail, and are called *codini;* the smallest are called *smezzati.*

At Genoa, the various large corals are called *mezzanie;* the uniform large, *filze;* and the uniform small, *migliari.*

They are distinguished according to color at Leghorn; the darkest red are called *arcispiuma*, which are the dearest; and then *primo*, *secundo*, *terzo*, *quarto*, *coloro* or *sangue*, *chiari*, *moro*, *nero*, &c.

According to form they are called round (*tondi*), and cylindrical-round (*boticelli*). The former are sent to all parts of the world, but the latter are only sent to Poland. The large *boticelli* are put up in meshes of twelve pounds, containing thirty-six strings; and the middling size of the *boticelli* are in meshes of six pounds, containing sixty strings; those *boticelli* which are still larger, are called *olivatti*, and are only sent to Africa; those which are globular, and not drilled, are called *pallini altorni*, and sent principally to China, where the favorite color is the rose-red.

The sound corals are called *netti*, and the worm-eaten, *camolatti*, which latter are mostly sent to the East Indies.

The tops of the branches are called *dog-teeth*, or *dents canines*, and the thick ends of the branches are called *maometti;* both kinds are perforated lengthwise, and are used in Barbary as ornaments for horses. The fine large coral stems which form suitable specimens for cabinets of natural history, in Marseilles, are called *chouettes.*

There are one hundred varieties of shades of red coral distinguished at Marseilles.

Corals are principally used for ornaments, in the East Indies, China, and Africa, where they are preferred to the diamond. Almost every East India lady wears a bracelet or necklace of corals.

The white coral has its origin from the eight-star coral (*madrepora occulta*); and the black coral from the black-horned coral (*gorgonia antipothes*). The medusa head (*caput medusœ*), called the sea polen, belongs likewise to the coral family, and consists of sixty-two thousand six hundred and sixty-six articulated members.

Corals are fished for on the coast of Barbary, between Tunis and Algiers; in the latter state Bona is the principal station; the French have one also at Basteon de France.

The monopoly was purchased by France, in the seventeenth century, at eighteen thousand dollars annually; and by England, since 1806, for fifty thousand dollars.

At Bona there is a summer fishery, from the first of April to the first of October, which occupied, in 1821, thirty French, seventy Sardinian, thirty-nine Tuscanian, eighty-three Neapolitan, nineteen Sicilian barks; altogether, two hundred barks of two thousand and twenty-three tons capacity, with two thousand two hundred and seventy-four men; they fished up forty-four thousand two hundred pounds of coral, valued at two million four hundred thousand francs. The winter fishery of the same year occupied three French barks, each with nine men, and they obtained six hundred and eighty pounds of coral.

The principal manufactories of corals are now at Leghorn, where this branch of business has been carried on for two hundred years past, by the Jews. There were formerly twenty establishments, but the number has lately been much diminished.

They are sent principally to China, the East Indies, and Arabia, partly by the way of London, and partly by Moscow, Aleppo, and Alexandria; many corals are likewise sent to Poland.

Genoa has a few manufactories, in which the Sardinian corals are mostly wrought. At Marseilles there has been a large manufactory ever since 1780, and at present it is the only establishment of the kind in France.

The East Indies consume, according to the statement of Le Goux de Haix, nearly four million francs' worth.

Corals are worn in the East as ornaments in the turban, and the Arabs bury the coral with their dead.

A large coral, from the manufactory at Marseilles, was sold in China, to a mandarin, for twenty thousand dollars.

Purpurin is the name of artificial coral. A large quantity of this false and base imitation of coral has been imported into this country. It is used for setting in cheap jewelry; brooches, bracelets, ear-rings, and pins may be seen everywhere in this city, all carved in figures and animals, resembling the true coral, but on testing it with a knife, the baseness is easily detected. It is composed of marble powder, made into a paste by a very siccative oil or varnish, or soluble glass (silicate of potash), and a little isinglass, and colored by Chinese vermilion. The paste is then moulded into the various objects required, and when dry such parts as require it are perfected with the chisel.

SHELL CAMEOS.

The shells employed for cameo-cutting, are the cassis rufa, and several species of cyprea, called cowries. They are dense, thick, and consist of three layers of differently colored shell material. In the cassis rufa, each layer is composed of many very thin plates, or laminæ, which are perpendicular to the plane of the main layer; each lamina consists of a series of elongated prismatic cells, adherent by their long sides; the laminæ of the outer and inner layers are parallel to the lines of growth, while those of the middle layer are at right angles to them. In cowries there is an additional layer, which is a duplicature of the nacreous layer, formed when the animal has attained its full growth.

At the London Exhibition there was a very fine collection of shell cameos, from Rome, owned by the engraver Seculine.

Certain natives of India prepare shell cameos with rude but efficient instruments for cutting them, and the Indian department in the Exhibition showed numerous specimens.

MOSAIC AND PIETRA DURA.

Roman, Venetian, Florentine, and other Mosaics.—The art of mosaic (*opus musivum* of the Romans), was originally applied only to the combination of small dice-shaped stones (precious and common), or tesseræ of the ancients, in patterns. It has long been an important source of labor to the inhabitants of several parts of Italy, such as Venice; and under various modifications is now carried on in the principal cities of Europe. The manufacture has long ceased to be confined to combinations of tesseræ, and is now understood to include all kinds of inlaid and veneered work, in whatever material,—fragments of pseudo-precious stones (agate, chalcedony, malachite, lapis lazuli), marbles of the most variegated colors, porphyry, lava, granite, fluor-spar, and also the various colored glasses (imitation gems), avanturine, and enamels, which, when put together (sometimes in microscopical fragments), and formed into a landscape, figures, or other design, are now called mosaics. The richer the colors and shadings, so as to produce fine pictures, the more striking the mosaics fall on the eye of the spectator. The Roman mosaics, in which prisms or threads of glass, of various sizes and shapes, compose the whole picture; the Venetian mosaics, where the glass is a tessera or square shape, of some size, inlaid often in a cement base.

The manufacture of true Roman mosaics has always been confined to the city whence its name is taken, and no country has entered into competition with Rome. They are composed of glass, sometimes called smalt, and sometimes paste; are made of all kinds of colors and every different hue. For large pictures they take the form of small cakes; for small works they are produced in threads, varying in thickness from that of a piece of string to the finest cotton thread: large quantities of these, of all tints and colors, are prepared. A plate or slab of copper, marble, or slate is then provided, of the size and thickness required for the intended work. This slab is hollowed out so as to resemble the bottom of a box or a tray, to a depth proportioned to the work; this may vary from an inch to the eighth, or even the sixteenth of an inch, if the work is to be small. This hollow is then filled with plaster of Paris, well smoothed, on which the outline of the proposed design is very accurately traced, and an inked pen is passed over the outline to preserve it. Very few tools are required by the workmen, but for the large works, where comparatively large pieces are to be inserted, small shape-cutting hammers are made use of for splitting the cakes and reducing them to their proper size and form; pincers also, of different forms, are used for placing them equally. In very small works, instead of hammers, sharp-pointed pincers are made use of, like those with which diamonds are taken up, and sometimes a small tool like a scarpello. The heat of an oil lamp is required, to enable the workman to draw out the strips of glass to the desired fineness, even to that of a hair. When this is all ready, the first operation is to dig or scoop out, with a scarpello of a proper size, a small piece of plaster of Paris from the bottom of the box or tray, without injuring the outline; this is filled up with a kind of mastic or putty, like that which is used for panes of glass in the sashes of a window; and the required piece of smalt or glass is then pressed into the composition. In this way, step by step, and from day to day, repeating the operation of scooping out a small piece of plaster of Paris, and never losing sight of the outlines, they gradually fill up the whole tray. In works of considerable dimensions, the workmen place the tray before them as painters place the canvas on which they are painting, and have the original always close to them. For smaller works they sit at a table, as if writing, and keep the work flat on the same. The designs used in these mosaics are for the most part copied from the pictures of some artist of eminence, the designers themselves being also a separate body, working for the *mosaicisti*, who mechanically fill up the spaces as above described. When the operation is completed, it is passed over a stone made perfectly smooth and cleaned of every kind of dirt; it happens, however, that interstices, however minute, will be left more or less between the several small pieces of smalt inserted into the mastic; these are to be carefully filled up with heated wax, applied with hot iron instruments from a pallet on which it has been prepared for the purpose, and much of the good effect and finish of the work will depend on the ability and care of the workmen by whom this operation is performed.

A most remarkable specimen of this beautiful art was shown at the London Exhibition, by the Cavaliere Barberi; it was a large round table, and represented celebrated views in Italy; it was of singular delicacy and beauty of workmanship,—the style of the design, the exquisite shading of the colors, the brilliant though softened effect of the group of views, the atmosphere and sky of each mingling into the same ethereal tint, which relieved the eye and allowed it to rest with pleasure on the separate views: it was certainly a masterpiece. The author never left the Crystal Palace without passing by the table, which always excited fresh admiration.

There were two other mosaics, much larger than the former, and different in style, that were remarkably fine specimens of workmanship: one was a copy of a celebrated picture, by Guercino,—a St. John the Baptist; and the other a portrait of Pope Boniface the Second.

A circular table, a square slab, and a picture representing a view of Pæstum, were likewise among the Roman mosaics in the London Exhibition.

Dr. Chilton, of New York, has a beautiful Roman mosaic of the Pantheon, about three inches long.

In the New York Exhibition, in 1853, the large picture of Pope Pio IX., in medallion size, was much admired.

In the Paris Exhibition, in 1855, many large works of Roman mosaics were exhibited; one in particular, belonging to the Duke of Tuscany, required the constant work of fourteen years, and cost 700,000 francs. A large table in the rotunda of the panorama, of rich and elegant Roman mosaic, cost 400,000 francs.

The famous picture of the *Campo-vacino*, in Rome, by Galand, cost the artist ten years' labor.

Pietra dura, also called *Florentine mosaic*, consists in the manufacture of hard stone inlaid in a slab of marble; they are, for the most part, of the quartz species, such as agates, jasper, chalcedony, carnelian, &c.; also, lapis lazuli, malachite, and all such hard and colored minerals which, by their depth of color and brilliancy of lustre largely contribute to produce a picture of a flower or a landscape, and all come under the name *pietra dura* of the Florentine school.

In this kind of work, a slab of marble (generally black), of the required dimensions, and about one eighth to three sixteenths of an inch thick, is prepared, and the patterns to be inlaid are carefully cut out with a saw and file. The hard stones are worked into the required pattern by the ordinary methods of gem-cutting, and are accurately fitted into the spaces thus prepared, in a polished and finished state; for if the whole were to be polished at once, some of the substances being softer than others, would be worn away too rapidly. The work, also, is liable to be spoiled by the accidental placing of one stone lower than another, and mistakes of this kind will often lead to the ruin of the whole. After the surface is thus prepared it is veneered on a thicker slab and is then fit for use. In point of difficulty of execution, durability, and taste, this process of inlaying in hard stones or gems may rank as the most important purely decorative work within the whole range of mineral manufactures.

In order to illustrate the peculiar mode of inserting the different pieces of agate, jasper, &c., in these beautiful works of art, and to show also to those not familiar with them the elegant and simple forms produced, we give the following diagram, showing a fac-simile of a portion of the inlaid-work in one of the tables which were exhibited in the London World's Exhibition, in 1851.

In this diagram the dark line represents the outline of the flowers, leaves, &c., and the dotted part, the lines where the different pieces forming a single object are joined together. The extreme delicacy and accuracy of the joints can only be fully appreciated by the examination of the original specimens.

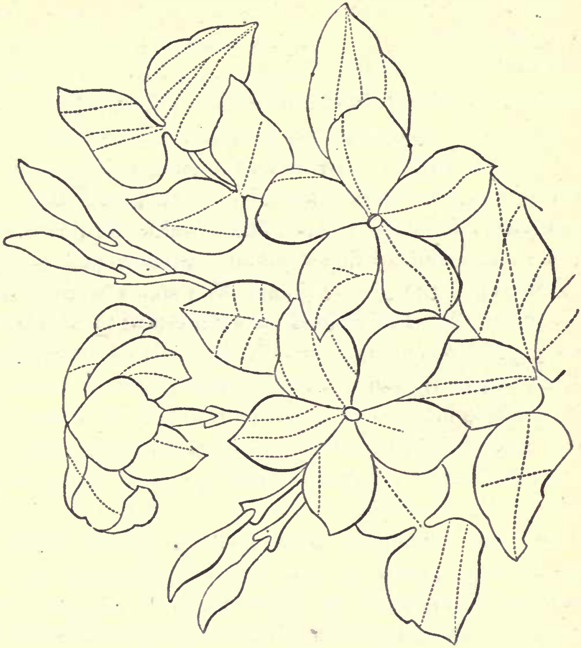


Fig. 11.

True Florentine mosaic, of fine design and good taste, was in profusion from Tuscany and St. Petersburg.

A jewel-case belonging to the Empress of Russia, was particularly worthy of notice: it was constructed of wood, having the four sides and top covered with groups of fruit cut in *pietra dura*, in a style which may be called cameo-mosaic in rather high relief; the stones were so selected as to afford perfect fac-similes, in color, size, and even in internal structure, of the fruit they represented, which were currants, pears, and plums, and the whole work was exquisitely finished.

The King of Sweden sent to the London Exhibition, an inlaid oblong table of granite, porphyry, and jasper, of beautiful workmanship; the materials were the hard stones of Sweden, which being nearly of equal hardness, admitted of being polished after the work was finished.

An Indian chess-table with an inlaid border, and a number of small objects from India, the ground being a white marble of a peculiar saccharoidal texture, attracted great attention. The pattern was a fine scroll-work, remarkable for the extraordinary delicacy and exactness of the stems of flowers and the perfect joints—the stems were of flint. This and another Indian inlaid-work are said to be of great antiquity. No comparison can be instituted between these Indian and European works, the mechanical execution of the former being at least equal to the best of those which have rendered Florence so justly celebrated, while the taste and design exhibited in them are greatly superior to *inlaid work in marble.*

The great expense of inlaying hard pebbles, which can only be cut as gems, and the excellent effect that may be produced by imitations in which marble of various kinds, shells, cement, and glass, replace the jasper and agate of Florentine mosaic, have caused the introduction into England, and elsewhere, of a manufacture which may be called inlaid marble work. In Derbyshire this branch of manufacture has become very important. There are two principal methods of producing marble mosaic; that followed in Derbyshire, where a recess is chiselled out of a solid block of marble, serving as the ground; and that pursued in Devonshire, where the whole surface is in fact *veneered;* numerous marbles of various colors and forms being merely cemented together on a base, which may consist of slate, or any kind of marble; the whole surface being afterwards polished together. In Malta the former process is followed, while in Russia the malachite inlaid work is performed, as just described. The Duke of Devonshire loaned his fine collection of Florentine mosaics to the manufacturers, from which they copied the butterflies, leaves, and sprigs of jessamine, for which these mosaics are so celebrated. These works being used as guides, the art of inlaying was brought into successful operation, and materials foreign to the vicinity, as malachite from Russia, Continental marbles, Avanturine and other glasses, from Venice, with some cements, have been introduced into them. The manufacturers at Matlock, Ashford, Bakewell, Buxton, Derby, and Castleton are all doing a thriving business.

A table with a wreath of flowers of extremely complicated pattern, and admirably finished, with a vast number of detached marbles, of Derbyshire work, owned by Mr. Vallance, attracted general attention at the London Exhibition. Although not to be compared with the Florentine work, there were, nevertheless, much skill and labor bestowed upon it.

A number of other tables of inlaid work, of the cinquecento style, were likewise well executed. The exhibition of Derbyshire inlaid work was very large.

A mosaic chess-table from the Isle of Man; from Lisbon, interesting specimens of mosaic, composed of sixty specimens of Portuguese marbles; and from the Cape of Good Hope, a peculiar kind of inlaid marble work, were at the London Exhibition, and all more or less interesting.

Clay and Porcelain Mosaics.

The encaustic and mosaic tiles used by the ancients for ornamenting houses, for pavements and walls, have of late years been extremely well imitated, both in England and the United States.

The encaustic or inlaid tiles are made by pressing clay in the plastic state into an embossed plaster mould, the pattern or design on the mould being raised. When the tile is withdrawn from the mould, the outline of the pattern is indented, and the indented parts are filled in with colored liquid clays, according to the colors it is desirable to produce. The surface is then scraped quite flat, until the pattern appears well defined. The tile is then heated, or as it is termed, fired, which brings out the colors to the proper tint.

The Venetian tiles and mosaics are produced by the compression of powdered clays into metal dies, of any geometrical form that may be devised, the clays having been previously stained with metallic colors. Each tile or *tessera* is, of course, of the same color throughout. When fired, they are arranged on a smooth platform, with the faces downward, according to the design intended, after which liquid Roman or Portland cement is poured upon them, and they are thus formed into slabs of any size required.

The Alhambra or Spanish tiles are made by pressing plastic clays into an embossed mould, which forms grooves or indentations; these tiles are then fired, and come out of the oven with the pattern formed. The indentations are then filled in with enamels of various colors and fired again, which produces a brilliant effect, and renders the tiles suitable either for floors or the interior walls of buildings.

A mosaic pavement, composed of *tesseræ* of vitrified clay, of several colors and shapes, all produced by machinery with great rapidity, and without the necessity of chipping any of the *tesseræ*, and at the same time making an endless variety of patterns, is produced in England, in the following manner: The clay being prepared in the usual way, by washing and sifting, and stained with various metallic oxides (oxide cobalt, blue smalts, manganese, zaffre, red lead, crocus martis, aurum musivum, oxide chrome, copper scales, &c., the principal ingredients used), is formed into thin ribbons, about three eighths of an inch thick and from three to four feet long, by a machine; out of these ribbons the *tesseræ* are cut by a patented machine, with great rapidity, and when dry are baked in saggers in the usual way.

Pavement slabs are made by laying these *tesseræ* face downwards on a perfectly flat slate, the pattern, of course, being reversed, and covering their backs with a layer of Portland cement, and two layers of rough thin tiles, carefully embedded in the cement. In this way strong slabs are formed, of from an inch and three quarters to two inches thick, which are almost perfectly impervious to moisture or rising damp.

The capitol extension, in the City of Washington, United States, is embellished with encaustic tiles; and both the pavement in the halls of the house of representatives and senate chamber, and the avenues leading to them, and the encased walls, are laid out with bright-colored tiles, in the most gorgeous manner.

Mosaic Tiles made with Soluble Glass.

The many useful applications of soluble glass (which may be the silicate of soda, or the silicate of potash, or both alkalies combined with the silica), form a new era in the production of an artificial stone, which, if properly adapted, must ultimately supersede all other artificial stones or cements of any kind. If grains of sand, pebbles, lime, marble, or even granite, clay, and fluor-spar, are mixed with soluble glass into a paste of the consistency of putty, and this paste is then moulded into any required form, after slowly air-drying and burning the articles thus manufactured in a kiln at a bright-red heat, which may be maintained for any length of time, by which process the alkali contained in the soluble glass is set free, the silica combines with the lime, and more particularly with the fluor-spar (fluoride of calcium), so durable a cement is formed thereby, that it will not admit of the smallest absorption of moisture, and consequently is absolutely unattackable by frost. By applying the chloride of calcium in solution to the cement, the supposed objection that the salts of soda, or alkali, are efflorescing by degrees, is hereby obviated, for the chloride of calcium at once absorbs the alkali.

Soluble glass may be colored by various metallic oxides, so as to produce, when heated, very sharp colors, similar to enamels, and may also be employed for a coating over other paints, such as fresco, &c.

As a cement for joining together heterogeneous and homogeneous substances, it is unsurpassed, and when applied, renders the substances so coated both water and fire proof.

If soluble glass is intended for a varnish, the proper specific gravity is 1·165, but for a paint it may be reduced to that of water.

In France, soluble glass is much used in coating common building-stones, for the purpose of rendering them damp-proof. Marble buildings and damp cellars may be made impervious to dampness by varnishing the surface with soluble glass; although the proper mode is to exhaust the air from the stone or brick, and then impregnate it with soluble glass by pressure. A patent was lately taken out in England, for preserving building, pier, and wharf stones, by first coating them with a wash of chloride of calcium, and afterwards by the application of the concentrated solution of soluble glass,—repeating the operation several times. Soluble glass was introduced into the United States, by the author of this work, in the year 1831, under the authority of the government, for the purpose of protecting the cannon and balls, exposed to the weather in the Brooklyn Navy Yard, against rust; for this purpose, when treated with the various coloring pigments,—such as oxide of manganese, umber, terra di sienna, ochre, Venetian red, ultramarine, &c.,—it is admirably adapted.


Diamond
Oriental Topaz
Or. Amethyst
Or. Ruby
Or. Chrysoberyl
Sapphire
Chrysoberyl
Spinell
Topaz
Emerald
Aquamarine
Zircon
Hyacinth
Garnet
Cinnamom stone
Tourmaline
Rock Crystal
Blood stone
Amethyst
Rose quartz
Cats eye
Prase
Avanturin
Jasper
Agate
Chalcedony
Onyx
Sardonyx
Chysoprase
Peridote
Chrysolite
Opal
Amazon stone
Lapis Lazuli
Turquoise
Malachite
Amber
Rose Mangan
Obsidian
Lava
Jet
Lepidolite
Serpentine
Idocrase
Labrador
Marble
Porphyry
Granite

EXPLANATION OF PLATES.

PLATE II.

THE MOST REMARKABLE ROUGH DIAMONDS.

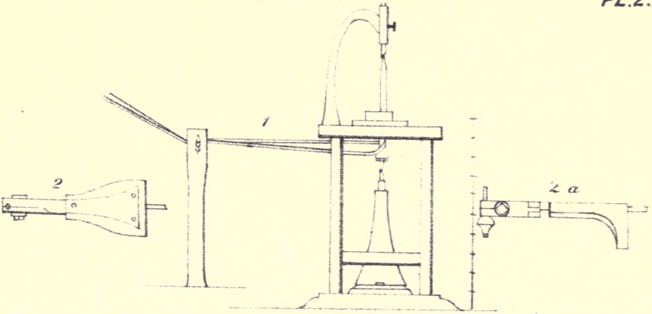
No. 1.—The Nizam, from India; it weighs 340 carats, is valued at five millions of francs, and belongs to the King of Golconda.

No. 2.—The great rough Diamond, as described by Tavernier, from India, weighing 282½ carats.

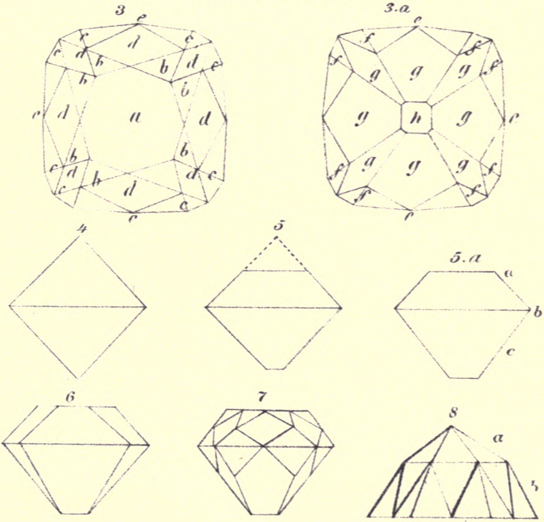
No. 3.—The great South Star, from Brazil, weight when rough 254½ carats, was found in the mines of Begagem, in the province of Minas Geraes, in Brazil. It is as clear as water, slightly tinged with yellow; it is valued at two and a half millions of francs; it is thirty millimetres in height, forty in length, and twenty-seven in breadth. Its shape is a twelve-faced rhomboid, presenting altogether twenty-four triangles.

DIAMOND LATHE.

PL. 2.



THE PRINCIPLES OF CUTTING.



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PL.3

THE LARGE ROUGH DIAMONDS.

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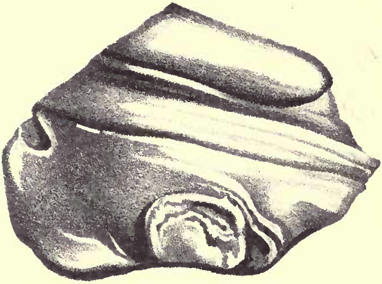

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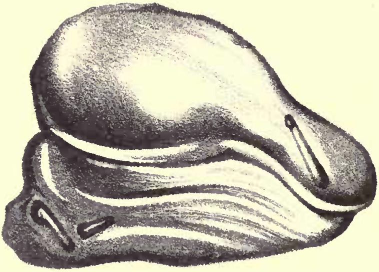

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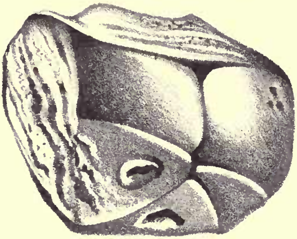

PLATE III.

REMARKABLE ROUGH DIAMONDS.

No. 4.—The great Spheroidal, six-sided, with forty-eight facets.
" 5.—The spheroidal Diamond, with twenty-four facets.
" 6.—A dodecahedral-pentagonal rough Diamond.
" 7.—A dodecahedral-rhomboidal rough Diamond.
" 8.—An Octahedron, with twenty-four facets.
" 9.—An Octahedron, the primary form.

PLATE IV.

Remarkable rough Diamonds.

No. 10.—A rough Brazilian Diamond.
" 12.—A regular Tetrahedron.
" 12.—A round, concretional, rough Diamond, called Boort.
" 13.—A rough Brazilian Diamond.
" 14.—A rough cubical Diamond.
" 15.—A rough Brazilian Diamond.
" 16.—A truncated octahedron Diamond.
" 17.—A rough Diamond, described by Tavernier.
" 18.—A triangular crystal of Brazilian Diamond.
" 19.—An Octahedron, with modified secondary form.

PL.4

ROUGH DIAMONDS

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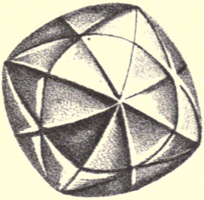

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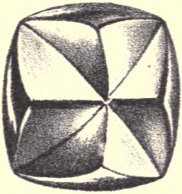

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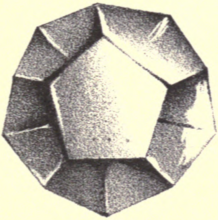

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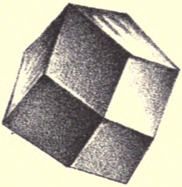

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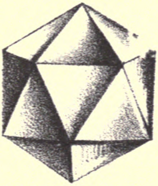

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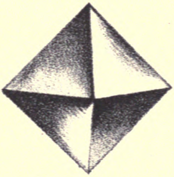

PL. 5.

ROUGH DIAMONDS

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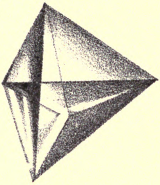

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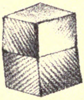

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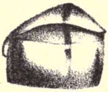

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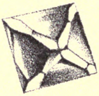

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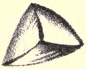

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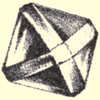

PLATE V.

No. 1.—The improved Diamond Lathe (exhibited in the Paris Exhibition, 1855, by Phillippe).

No. 2 and 2 *a*.—The pincers, front and side view.

THE PRINCIPLE OF CUTTING.

No. 3.—*a*. The table of a brilliant. *b*. The triangular faces. *c*. The angles terminating into planes. *d*. Lozenges—4 large and 4 small. *e*. The planes on the edge of the stone.

No. 3 *a*.—*f*. The angles parallel with the planes. *g*. Pavilion or facets corresponding to Lozenges.* *h*. The collet of the brilliant.

No. 4.—A rough Diamond, cleansed.

" 5.—Cut of the crown.

" 5 *a*.—The three different cuts. *a*. The table. *b*. The girdle. *c*. The collet.

No. 6.—A Brilliant not recut.

" 7.—A Brilliant recut.

" 8.—Rose Diamond. *a*. The crown. *b*. The facets.

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* **Lozenge is the geometrical form of a rhomb.**

PLATE VI.

The most celebrated cut Diamonds.

No. 1.—The Grand Mogul; it weighs 279 carats, and is valued at twelve millions of francs.

No. 2.—The Orlow, the great Russian Diamond, weighs 195 carats, and is the size of a pigeon's egg: cost two millions of francs and a pension of one hundred thousand francs.*

No. 3.—The table Diamond of Tavernier, weighing 242½ carats.

" 4.—The Polar Star, weighing 40 carats.

" 5.—The Shah, belonging to the Russian crown, weighing 95 carats.

*** It is on the top of the Russian sceptre, and has the form of a knob of a cane; the under surface is a plane.**

PL.6.

THE MOST CELEBRATED CUT DIAMONDS.

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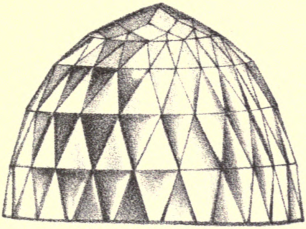

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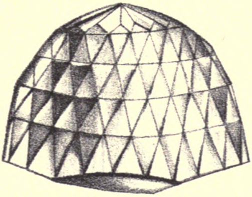

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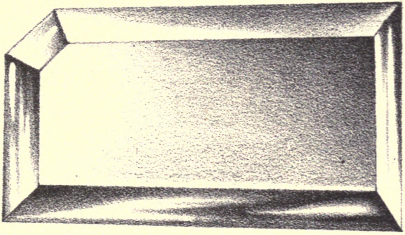

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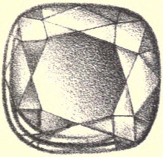

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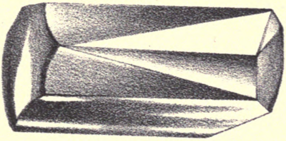

PL.7.

THE MOST CELEBRATED CUT DIAMONDS

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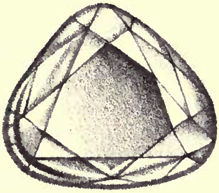

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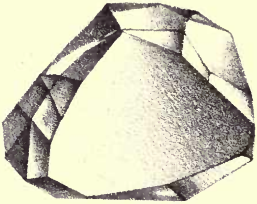

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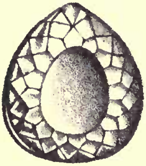

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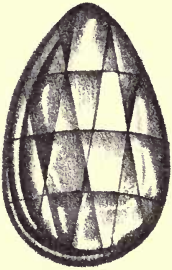

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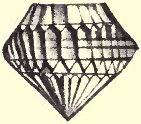

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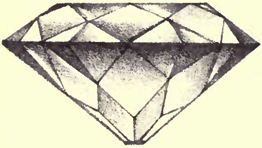

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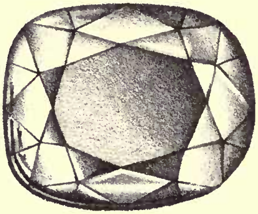

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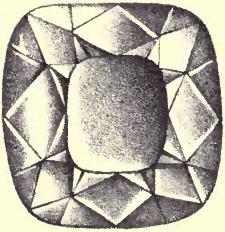

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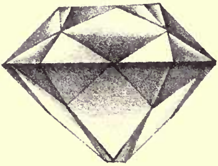

PLATE VII.

THE CELEBRATED CUT DIAMONDS.

No. 6.—The Nassack, weighs 78⅝ carats; was sold, in 1839, fo seven thousand six hundred pounds sterling, to the Marquis o Westminster.

No. 7.—The great India half-cut Diamond, weighing 112¾ carats.

No. 8.—A brillianted Rose in pear-shape, from India, weighing 16 carats.

No. 9.—Another Rose in pear-shape, weighing 94½ carats.

No. 10.—A recut India Brilliant, weighing 29 carats.

No. 11 and 11 *a.*—The South Star of Halphen, weighing 124 carats.

No. 12 and 12 *a.*—The Regent, or Pitt; it weighs 136 carats, belongs to the French crown, is valued at five millions of francs, and is certainly the best-proportioned Diamond in the world; it is perfectly pure and transparent, and sparkles with a magnificent play of color.

PLATE VIII.

THE CELEBRATED CUT DIAMONDS.

No. 13.—The Piggot, belonging to England, weighs 82 carats.

No. 14.—The Pacha of Egypt's Diamond, weighs 49 carats.

No. 15.—The Koh-i-noor, as it came from India; and 15 *a*, its present form, from a side view.

No. 16.—An India pear-shaped Brilliant, weighing $31\frac{3}{8}$ carats.

No. 17.—A Half-Brilliant, faceted, weighing $14\frac{7}{8}$ carats.

No. 18.—Large Rose Diamond, of 280 carats.

No. 19.—An irregular Rose Diamond, in pear form, weighing 20 carats.

No. 20.—An India Brilliant, described by Tavernier, weighing 52 carats.

No. 21 and 21 *a*.—Large table Diamonds, step-cut.

THE MOST CELEBRATED CUT DIAMONDS.

PL. 8.

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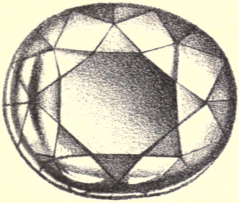

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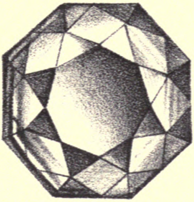

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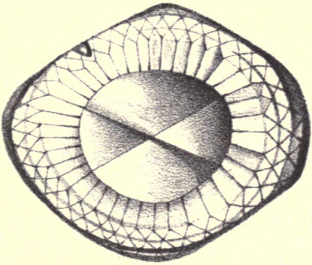

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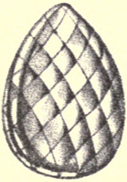

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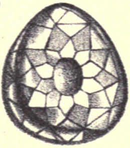

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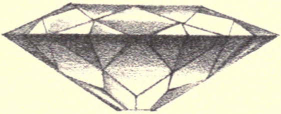

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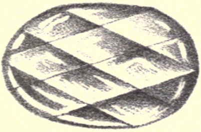

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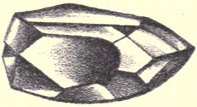

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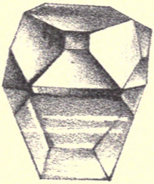

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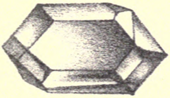

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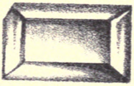

PL. 9.

THE MOST CELEBRATED CUT DIAMONDS.

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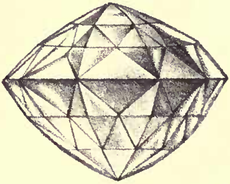

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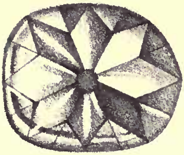

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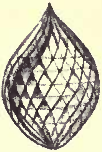

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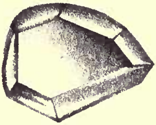

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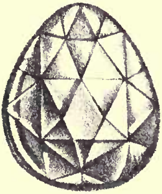

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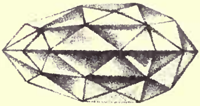

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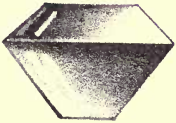

PLATE IX.

THE CELEBRATED CUT DIAMONDS.

No. 22.—The great Austrian Brilliant, belonging to the Grand Duke of Tuscany, weighing 139½ carats; valued at seven millions of dollars.

No. 23.—The Eugenie Diamond, belonging to the Empress of France, weighing 51 carats.

No. 24.—The Hope Diamond, a beautiful blue Diamond, weighing 44½ carats.

No. 25.—A Brillolet of 16¾ carats.

No. 26.—A knob-shape of 10 carats.

No. 27.—A table-shape of 10 carats.

No. 28.—A flat Diamond of 20 carats.

No. 29.—A flat Diamond of 14 carats.

No. 30 and 30 *a*.—The celebrated Sancy, belonging to the French crown-jewels, weighing 33¾ carats, of pear-shape; is valued at one million francs.

No. 31.—A large cleaved Diamond, of 64 carats, from India.

PLATE X.

No. 1.—Rock-Crystal Group, from Arkansas, U. S.

Size and weight of Diamonds, both round and square, from that of half a carat to 18½ carats.

PL.X.

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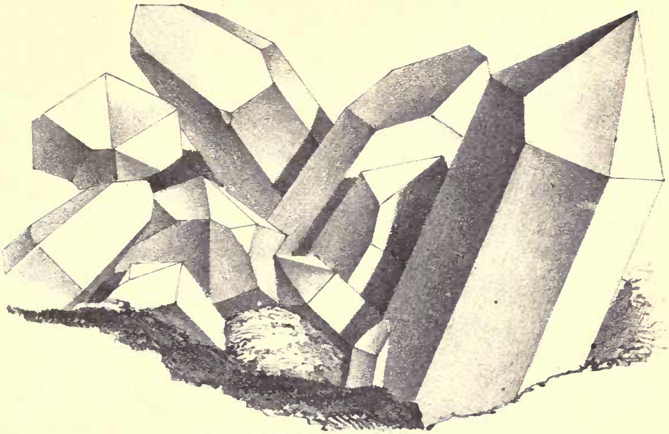
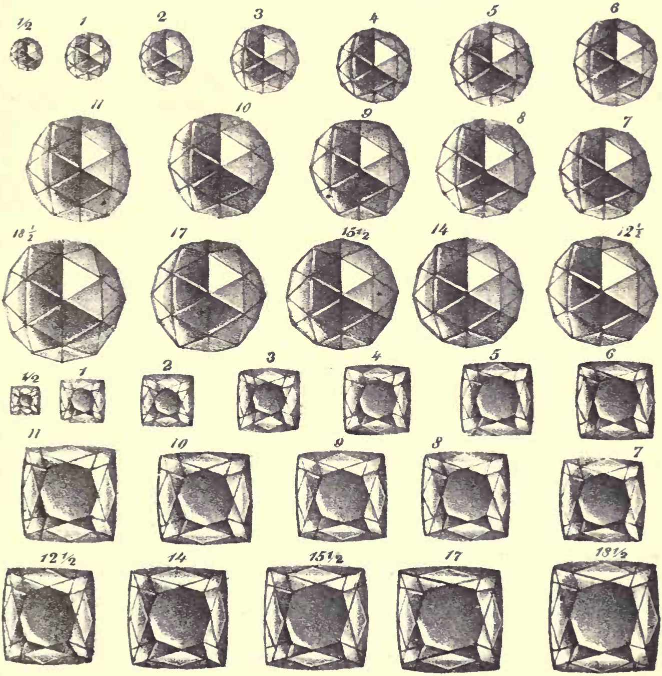


SIZE & WEIGHTS of DIAMONDS in CARATS.



PL.XI.

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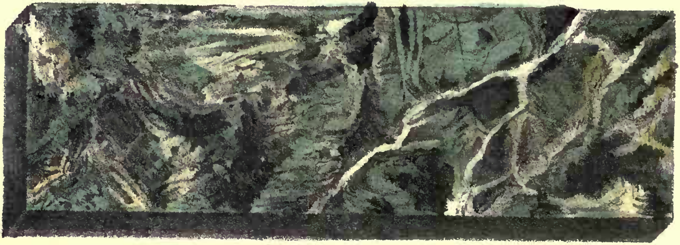

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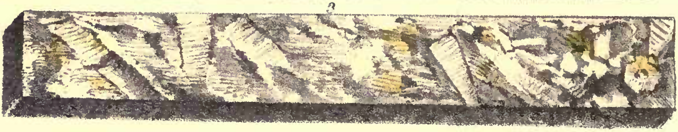

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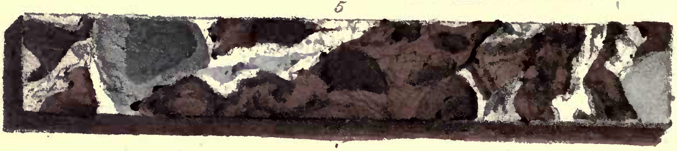

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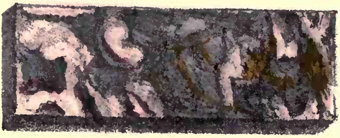

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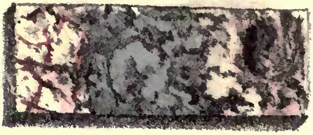

PLATE XI.

American Fancy Marbles.

No. 1.—California Marble.
" 2.—Verde Antique, from Vermont.
" 3.—Shell Marble, from New York.
" 4.—Tennessee Marble.
" 5.—Hale's Breccia Marble, from Lancaster, Pa.
" 6.—Potomac Marble.
" 7.—Variegated Marble, from the State of New York.

PLATE XII.

No. 1.—Black Marble, with petrified volutes (*Pyramidella turbinella*).

No. 2.—Red, green, and white brecciated Marble, from Sicily.

No. 3.—Red mottled Marble, tertiary fresh-water Limestone, from Swabian Alps, cut parallel to the planes of the layers.

No. 4.—Pale, yellow, and violet Marble, from the Jura, in Würtemberg.

No. 5.—Reddish-yellow and bluish-red mottled Marble, from Würtemberg.

No. 6.—Marble, tertiary, cut perpendicularly to the planes of the layers, from the Alps.

No. 7.—Pale-yellow Marble, and violet Flakes, from Würtemberg.

PL.XII.

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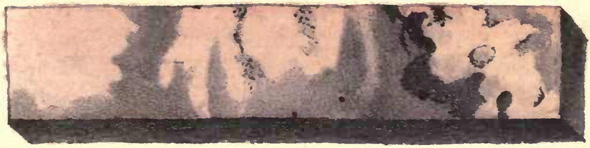

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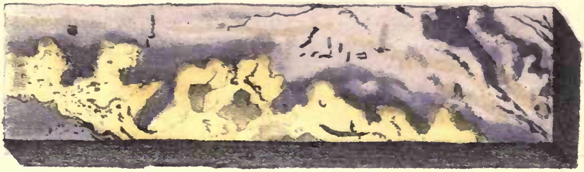

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PL.XIII.

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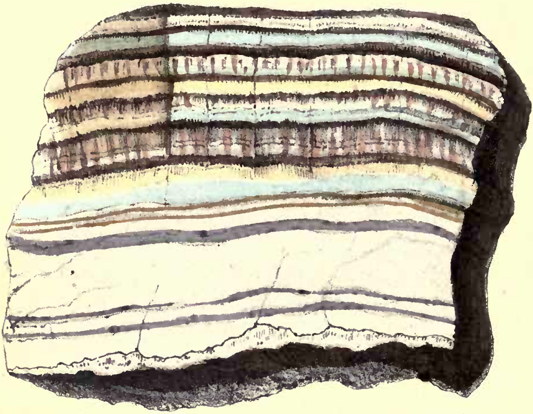

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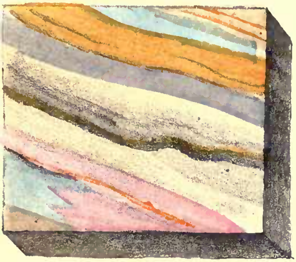

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PLATE XIII.

No. 1.—Tertiary brecciated Marble, from the Pyrenees.

No. 2.—Red Granite, consisting of red felspar, grey quartz, and black mica, from Upper Egypt; used by the ancient Egyptians in their monuments.

No. 3.—Fibrous Calcite, or so-called Thermal Tufa, Sprudelstein, from Carlsbad.

No. 4.—Compact Brown-spar, from Gibralter.

No. 5.—Agate Marble, from Algiers.

PLATE XIV.

No. 1.—Kyanite, light-blue and oblique rhombic prism, with truncation, from St. Gothard.

No. 2.—Amphibole or dark-green Hornblende, Actinolite, an oblique rhombic prism, from Tyrol.

No. 3.—Precious Serpentine, in right rectangular prisms, from Norway.

No. 4.—Lumachelli or Fire Marble, containing fossil shells; the variegated colors are owing to nautilus or ammonite, from Corinthia.

No. 5.—Ruin Marble, cut perpendicularly to the planes of the layers, from Tuscany.

No. 6.—Pea-stone, calcareous Stalactite, from the hot springs of Carlsbad.

No. 7.—Dark-brown ribbon Agate, Arabian Onyx, from the East Indies.

No. 8.—Pale-yellow Marble, from Florence.

No. 9.—Variegated Marble, containing Corals, from the transition rocks of Nassau.

No. 10.—Red brecciated Marble, from Italy.

No. 11.—Black Porphyry, from Sweden.

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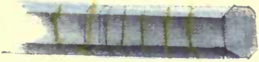

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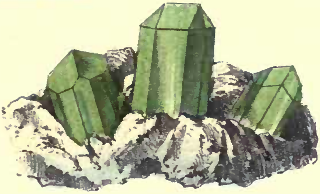

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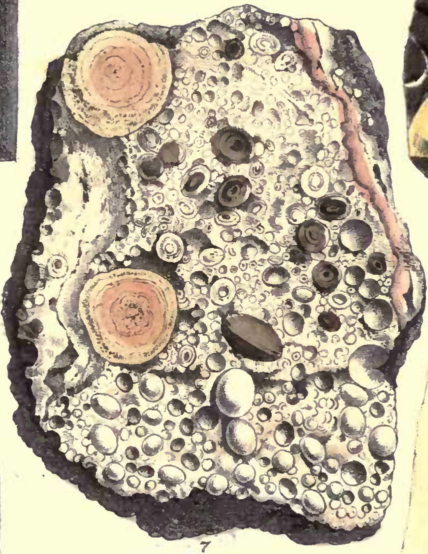

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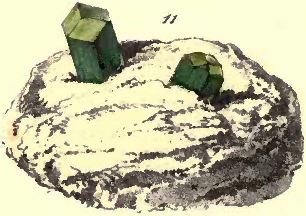

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PLATE XV.

No. 1.—Egyptian Jasper.

No. 2.—Ribbon Jasper, striated with red and green, from Siberia.

No. 3.—Pudding-stone or Quartz Conglomerate, from Scotland.

No. 4.—Horny-colored Agate, from the East Indies.

No. 5.—Chrysolite, from the East Indies.

No. 6.—Noble Garnet, Pyrope, from Bohemia.

No. 7.—Dark-yellow Topaz, burnt, and called Balais, from Brazil.

No. 8.—Granite, from Milan.

No. 9.—Wood Opal, a petrified pine, from Hungary.

No. 10.—Black ribbon Agate, from the East Indies.

No. 11.—Green Tourmaline (Brazilian Emerald) in Dolomite, from St. Gothard.

No. 12.—Moss Agate or Mocca-stone, from the East Indies.

No. 13.—Dark Topaz, from Brazil.

PLATE XVI.

No. 1.—Black and white mottled Marble, from the mountain limestone of Ardennes.

No. 2.—Red antique Porphyry, from Upper Egypt.

No. 3.—Blue Copper, Azurite, from Germany.

No. 4.—Malachite, Green Copper, from Siberia.

No. 5.—Natrolite on Clinkstone, from Bavaria.

No. 6.—Clear-yellow Amber, inclosing several flies, from the coast of the Baltic, near Dantzic.

PL. XVI.

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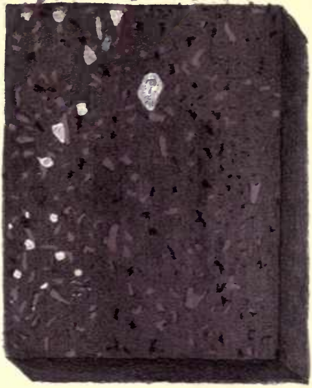

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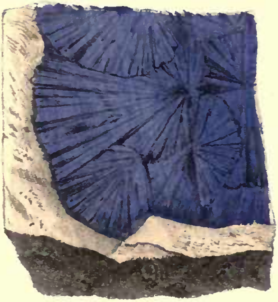

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PL.XVII.

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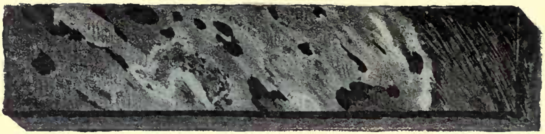

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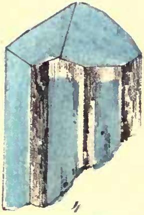

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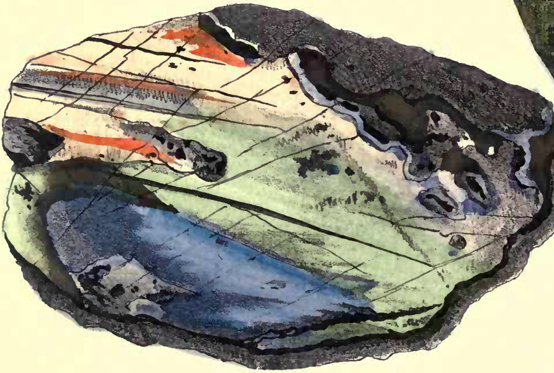

PLATE XVII.

No. 1.—Dark-green Serpentine, from the Apennines.

No. 2.—Amazon-stone or apple-green Felspar, an oblique rhombic prism, from the Ural Mountains.

No. 3.—Fortification Agate, from Oberstein.

No. 4.—Green Porphyry Felspar, from Greece.

No. 5.—Serpentine, Ophicalite, or Verde de Corsica duro, from Corsica.

No. 6.—Labrador Felspar, from Labrador.

APPENDIX.

CHRONOLOGICAL LIST

OF

WORKS ON GEMS AND MINERALS

SINCE THE FIFTEENTH CENTURY.

BECHAI, (Bèn Aschar,) Biur al Hattorah, (Exposition of the Law of Moses,) a Commentary on Exodus xxviii. 17–20. A. M. 5207, (A. D. 1447.*)

Plinii secundi, (Caii,) Naturalis Historia. Fol. *Venice*, 1469.

Aristotle, Lapidarius, de novo e Græco translatus. Lucas Brandis. 4to. *Regia Mersbourg*, 1473.

Serapion, (John,) De Medicamentis tam simplicibus quam compositis. *Mediolanum*, 1473.

Alberti, (Magni,) Philosophorum maximi de Mineralibus. Libri V. *Patavii*, 1476.

Avicenna, (Abou-Ali-Alhussein-Ben-Adloulah,) Canones Medicinæ, Latt. reddit. *Venice*, 1483.

Cæsalpinus, (Andreas,) De Metallicis Libri tres. 4to. *Rom.* 1496.

Leonardus, (Camillus, M. D.,) Speculum Lapidum. 4to. *Venet.* 1502.

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* This work contains an ample account of the properties of precious stones. The edition of 1447 is the earliest, but it has since been many times reprinted.

Aben Ezra, (Rabbi,) Commentarium in Decalogum. 8vo. *Hebr. Basel*, 1527.

Rue, (Franç, de la,) De Gemmis. 8vo. *Parisii*, 1547; 8vo. *Lugd.* 1622; 12mo. *Franc.* 1626; 12mo. *Gron.* 1626.

Agricola, (G.,) De Re Metallica, Libri XI.; et de Natura fossilium, Libri X. Fol. *Basiliæ*, 1546.

Ruens, (F.,) De Gemmis aliquot, iis præsertim quarum Divus Joannes Apostolus in sua Apocalypsi notavit. 8vo. *Paris*, 1547.

Libravii (Andr.,) Singularium libr. IV. quorum I. et III. de metallis lapidibus, et fossilibus. 8vo. *Francof.* 1549; also in 1601.

Encelius, (Christoph,) De Re Metallica, hoc est, de origine, varietate et natura corporum metallicorum, Lapidum, Gemmarum atque aliarum quæ ex fodinis eruuntur Libri III. 8vo. *Francf.* 1551.

Theophrasti, (Eresii,) Opera omnia, Græce, cura Camotii edidit F. Turisanus. 8vo. *Venetiis*, apud Aldi filios, 1552.

Langius, (Johannes,) Epistolæ Medicinales. Fol. *Lugd.* 1557.

Agricola, (George,) De Ortu et Causis Subterraneorum. De Natura eorum quæ effluunt ex Terra. Fol. *Bas.* 1558.

Mandeville, (John,) Le Grand Lapidaire, où sont declarez les noms de Pierres orientales, avec les Vertus et Propriétés d'icelles, et iles et pays où elles croissent. 12mo. *Paris*, 1561.

Porta, (Giov. Baptista,) Magiæ Naturalis Libri IV. *Antwerp*, 1561.

Fallopius, (G.,) De Medicatis Aquis atque de Fossilibus, tractatus ab Andrea Marcolino collectus. 4to. *Venitia*, 1564.

Dolce, (Ludovico,) Libri tre, nei quali si tratta delle diverse sorti delle Gemme che produce la Natura. 8vo. *Ven.* 1564.

Rulandus, (Martinus,) Medicina Practica. 12mo. *Arg.* 1564.

Gesneri, (C.,) De omni rerum fossilium genere, gemmis lapidibus, metallis, &c. 8vo. *Tiguri*, 1565.

Leonardus, (Camillus,) Trattato delle Gemme che produce la Natura; traduzione di M. Ludovico Dobe. 8vo. 1565.

Gesner, (Conrad,) Liber de Rerum fossilium, Lapidum, et Gemmarum, maxime figuris, etc. 8vo. *Tig.* 1565.

Epiphanius, De duodecim Gemmis in Veste Aäronis. Gr. Lat. cum corollario Gesneri. 8vo. *Tig.* 1565.

Fabricius, (G.,) De metallicis rebus et nominibus obs. var. erud quibus ea potissimum explicantur quæ G. Agricola præteriit. 8vo. *Tiguri*, 1566.

Lemnius, (Levinus,) Occulta Naturæ Miracula. 8vo. *Antwerp*, 1567.

Mizaldus, (Anton.,) Memorabilium Utilium et Jucundorum Centuria IX. 8vo. *Lutetia*, 1567.

Cellini, (Benvenuto,) Del Arte del Gioiellare. 4to. *Fior.* 1568.

Alberti, (Magni,) De Mineralibus et rebus metallicis. Libri V. 8vo. 1541, 1569.

Mizaldus, (Anton.,) Secrets de la Lune. 8vo. *Paris,* 1571.

Athenæus, Deiphnosophistæ, (Banquet des Philosophes,) traduit par Dalechamp. *Paris,* 1573.

Marbodæus, (Gallus,) De Gemmarum Lapidumque pretiosorum formis atque viribus opusculum. 8vo. *Colon.* 1593; 12mo. *Bas.* 1555; 12mo. *Lubec,* 1575.

Belleau, (René,) Les Amours et nouveaux Échanges des Pierres pré cieuses. 4to. *Paris,* 1576.

Evax, (a King of the Arabs,) a MS. is attributed to him on the properties and effects of precious stones, published by Henry Rantzovius, under the title "De Gemmis scriptum olim a poeta quodam non infeliciter carmine redditum et nunc primum in lucem editum." 4to. *Leipsic,* 1585.

Bacci, (Andrea,) Le XII. Pietre preziose. 4to. *Roma,* 1587.

Cæsalpin, (A.,) De re metallica. 4to. *Romæ,* 1596.

Porta, (Giov. Baptista,) A Method of Knowing the Inward Virtues of Kings by Inspection. Fol. *Neapoli,* 1601.

Arnobio, (Cleandre,) Il Tesoro delle Gioie, trattato maraviglioso. *Venet.* 1602.

Bacci, (Andrea,) De Gemmis et Lapidibus pretiosis, tractatus ex Ital. Lingua Lat. red. 8vo. *Francof.* 1605.

Fernel, (John Francis,) Pharmacia, cum Guliel. Plantii et Franc. Saguyerii Scholiis. 12mo. *Hanov.* 1605.

Morales, (Gasp. de,) Libro de las Virtudes y Propriedades maravillosas de las Piedras preziosas. 8vo. *Madrid,* 1605.

Porta, (Giov. Baptista,) De Distillationibus. 4to. *Rome,* 1608.

Avicennæ Opera. Romæ, 1593. *Venetiis,* 1608.

Ferrante Imperator: De fossilibus opusculum. 4to. *Napoli,* 1610.

Portaleone, (Abraham,) Shilte Haggeborim. (The Shields of the Mighty.) Heb. *Mantua,* (A. M. 5372,) 1612.

Clutius, (Augerius,) Calsvee, sive Dissertatio Lapidis Nephritici, seu Jaspidis viridis, naturam, proprietates, et operationes exhibens Belgice. 8vo. Amsterdam, 1621, et Lat. per Gul. Lauremberg, fil. 8vo. *Rostochii,* 1627.

Bacci, (Andrea,) De Gemmis ac Lapidibus pretiosis in S. Scriptura. 4to. *Rome,* 1577; 8vo. *Franc.* 1628.

Jonstonus, (Johannes,) Thaumatographia Naturalis. 12mo. *Amst.* 1632.

Clave, (Estienne,) Paradoxes, ou Traittez Philosophiques des Pierres et Pierreries, contre l'opinion vulgaire. 8vo. *Paris,* 1635.

Cæsius, (Bernardus,) De Mineralibus. Fol. *Lugduni,* 1636.

Toll, (Adrianus,) Gemmarum et Lapidum Historia. 8vo. *Lugduni,* 1636.

Boot, (Anselmus Boëtius de,) Gemmarum et Lapidum Historia. 4to. Hanover, 1690. Recensuit et commentariis illustravit Adr. Toll. 8vo. *Lugd. Batav.* 1636.

Boot, (Ans. Boëce de,) Le Parfaict Joaillier, ou Histoire des Pierreries, de nouveau enrichi de belles Annotations par André Toll, trad. du Lat. par J. Bachou. 8vo. *Lyon,* 1644.

Toll, (Adrianus,) Le Parfaict Joaillier, ou Histoire des Pierreries, où sont amplement descrites leur naissance, juste prix, etc. 8vo. *Lyon,* 1644.

Laet, (Jo. de,) De Gemmis et Lapidibus, Lib. II. Gr. et Lat. *Paris,* 1647.

Ecchellensis, (Abraham,) Versio Durrhamani de Medicis Virtutibus animalium, plantarum et Gemmarum. 8vo. *Paris,* 1647.

Habdarrahmanus, (Asiutensis Ægyptius,) De Proprietatibus ac Virtutibus medicis Animalium, Plantarum ac Gemmarum, ex Arab. Lat. redd. ab Abrahamo Ecchellensi. 8vo. *Paris,* 1647.

Laet, (John de,) De Gemmis et Lapidibus Libri II., quibus præmittitur Theophrasti Liber; de Lapidibus Gr. Lat., cum Annotationibus. 8vo. *Ludg. Bat.* 1647.

Boetius, (de Boot,) Gemmarum et Lapidum historia, quam olim edidit Ans. B. de Boot, postea Adrianus Tollins recensuit. Tertia Edit. longe purgatissima. Cui accedunt Jo. de Laet, de gemmis et lapidibus Libri II., et Theophrasti liber de Lapidibus. 8vo. *Lugduni Batavorum,* 1647.

Paracelsus, (Philippus Aurelius Theophrastus,) Nine Books on the Nature of Things; into English by J. F. 4to. *London,* 1650.

Nichols, (Thomas,) Arcula Gemmea; or, the Nature, Virtue and Valour of Precious Stones, with Cautions for those who deal in them. 4to. *Cambridge,* 1652.

Nichols, (Thomas,) A Lapidary, or History of Pretious Stones; with Cautions for the undeceiving of all those that deal with Pretious Stones. 4to. *Cambridge,* 1652.

Hermes Trismegistus, Tabula Smaragdina vindicata. 12mo. 1657.

Nichols, (Thomas,) Gemmarius Fidelis, or the Faithful Lapidary; experimentally describing the richest Treasures of Nature, in an Historical Narrative of the several Natures, Virtues and Qualities

of all Precious Stones, with a Discovery of all such as are Adulterate and Counterfeit. 4to. *London*, 1659.

Lowell, (Robert,) Panzoologicomineralogia, or a History of Animals and Minerals. 12mo. *Oxford*, 1661.

Johnson, (J.,) Notitia regni mineralis, sive Catalogus subterraneorum cum præcipuis differentiis. 12mo. *Lipsiæ*, 1661.

Berquen, (Robert de,) Les Merveilles des Indes Orientales et Occidentales, ou nouveau Traité des Pierres précieuses et des Perles. 4to. *Paris*, 1661.

Jonstonus, (J.,) Notitia Regni Vegetabilis et Mineralis. 12mo. *Lips.* 1661.

Boyle, (Hon. Robert,) Experiments and Considerations upon Colour, with Considerations on a Diamond that Shines in the Dark. 8vo. *London*, 1663.

Kircheri, (Athanasii,) Mundus subterraneus in Libros XII., digestus. With plates and portraits of Kircher and Pope Alexander. Fol. *Amsterdam*, 1665.

Histoire des Joyaux et des principales Richesses de l'Orient et de l'Occident. 12mo. *Genève*, 1665.

M. L. M. D. S. D., Dénombrement, Faculté et Origine des Pierres précieuses. Post 8vo. *Paris*, 1667.

Schmid, (Joachimus,) De Margaritis. 4to. *Wittebergæ*, 1667.

Rhosnel, Le Mercure Indien. *Paris*, 1668.

Piererus, (G. P.,) Lazulus, Dissertatio chymico-medica. 4to. *Argentorati*, 1688.

Aldrovandi, (Ulyssis,) Opera Omnia. 3 vols. fol. with several thousand wood cuts. *Bononiæ*, 1599–1668.

Tesoro delle Gioie, Trattato Curioso. 12mo. *Venetia*, 1670.

History of Jewels. 12mo. *London*, 1671.

Steno, (Nicolaus,) Prodromus to a Dissertation concerning Solids naturally contained within Solids. *London*, 1671.

Boyle, (Hon. Robert,) An Essay about the Origin and Virtues of Gems, with some Conjectures about the Consistence of the Matter of Precious Stones, etc. *London*, 8vo. 1672, and 12mo. 1673.

Sandius, (Christopher,) On the Origin of Pearls. *Phil. Trans.* 1674.

Tavernier, Voyages en Turquie, en Perse et aux Indes. 4to. *Paris*, 1676.

Kircher, (Athanasius,) Mundus Subterraneus in XII. Libros digestus. Fol. *Amstellodami*, 1678.

Blumenberg, Dissertatio Medica de Succino. 4to. *Jena*, 1682.

Kirani, Kiranedes, et ad eas Rhyakini Koronides, sive Mysteria Physico-Medica. 12mo. *London,* 1685.

König, (Emanuel,) Regnum Minerale, physice, medice, anatomice, alchymice, analogice, theoretice et practice investigatum. 4to. *Basil,* 1687.

Orpheus, (1260 B. C.,) Hymni et de Lapidibus, Gr. Lat., curante A. C. Eschenbachio; accedunt H. Stephani notæ. 8vo. *Traj. ad Rh.* 1689.

Panthot, (Jean B.,) Traité des Dragons et des Escarboucles. Small 12mo. *Lyon,* 1691.

Hiaerne, (Urban,) Kort Anledning til äskillige Malm och Bergarters, Mineraliers, etc.; eftersporjande och angifvande. *Stockholm,* 1694.

Hiller, (Matth.,) Tractatus de Gemmis XII. in Pectorali Pontificis Hebræorum. 4to. *Tübingen,* 1698.

Slevogtii, (J. H.,) De Lapide Bezoar. 4to. *Jenæ,* 1698.

Venette, (Nicolas,) Traité des Pierres. 12mo. *Amst.* 1701.

Strachan, Observations on Coral, large Oysters, Rubies, etc. *Abr.* ii. 711. *Phil. Trans.* 1701.

Gulielmini, De Salibus dissertatio physica, medico-mechanica. *Venetiis,* 1705.

Curiose Speculationen. *Leipzig,* 1707.

Description of the Diamond. *Phil. Trans. Abr.* ii. 405. 1708.

Chambon, Traité des Metaux et des Minéraux. 12mo. *Paris,* 1714.

Leisnerus, (Gott. Christ.,) De Coralliorum Natura, Præparatis et Usibus. *Wittembergæ,* 1720.

Cappeller, (Maur. Ant.,) Prodomus Crystallographiæ, de Crystallis improprie sic dictis Commentarium. 4to. *Lucernæ,* 1723.

Henckel, (J. Fr.,) Pyritologia. 8vo. *Lipsiæ,* 1725.

Woodward, (Dr. J.,) Fossils of all kinds digested into a method suitable to their mutual relation and affinity. With plates. *London,* 1728.

Woodward, (Dr. J.,) An attempt towards the Natural History of the Fossils of England, in the collection of J. Woodward. 8vo. *London,* 1729.

Mémoires de Règne de Catherine, Impératrice de Russie. *Amsterdam,* 1729.

Bourget, Lettres sur la Formation des Sels et Cristaux. 12mo. *Amst.* 1729.

Bromel, (Magn. von,) Inledning til nödig Kundskap om Bergarter, Mineralier, Metaller, samt Fossilier. 8vo. *Stockholm,* 1730.

Gimma, (D. Giacinto,) Della Storia naturale delle Gemme, delle Pietre e di tutti Minerali, ovvero della Fisica sotteranea. 4to. *Napoli,* 1730.

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TABLE OF THE DISTINGUISHING

Name and Color.	Lustre.	Specific Gravity.	Hardness.	No. in Scale of Hardness.	Composition.	System of Crystallization.
DIAMOND. White, pink, yellow, red, blue, green, black, orange, brown, opalescent. BOART. CARBONATE, (compact massive variety.)	Adamantine; reflects prismatic colors. None.	3·4 to 3·6	Scratches all other precious stones.	10	Pure Carbon.	Monometric or cubical.
SAPPHIRE. Sometimes Asteroid. White, blue, violet. RUBY, pink, red, violet-red. TOPAZ, *Oriental*, yellow. AMETHYST, *Oriental*, purple, violet. EMERALD, *Oriental*, green, generally pale.	Vitreous; very lively.	3·9 to 4·2	Scratched by diamond; scratches all others.	9	Alumina, . . 98·5 Oxide of Iron, . . 1·0 Lime, . . . 0·5	Hexagonal or rhombohedral.
CHRYSOBERYL, or ORIENTAL CHRYSOLITE. Bright pale - green, greenish-yellow, reddish-brown. ALEXANDRITE, when exhibiting a reddish, transmittent light. CYMOPHANE, or CHRYSOBERYL CAT'S EYE, when showing an opalescence like a cat's eye.	Vitreous; sometimes pearly.	3· to 3·8	Scratched by sapphire, etc.; scratches quartz readily.	8·5	Alumina, . . 80·2 Glucina, . . 19·8 (Trace of Per-oxide of Iron, of Oxide of Lead and Copper, depending on color and locality.)	Trimetric or rhombic, prismatic.
SPINEL. Dark-red, white, blue, green. PLEONASTE or CEYLANITE, black. RUBICELLE, orange. BALAS RUBY, rose-red.	Vitreous	3·8	Scratched by sapphire; scratches quartz readily.	8	Alumina, . 69·01 Magnesia, . 26·21 Protoxide of Iron, . 0·71 Silica, . . 2·02 Oxide of Chrome, . 1·10	Monometric or cubical.
TOPAZ. White, greenish, yellow, orange, cinnamon, bluish, pink.	Vitreous.	3·5 to 3·6	Scratched by sapphire; scratches quartz easily.	8	Silica, . . 34·01 Alumina, . 58·38 Fluorine, . 15·06 Traces of metallic oxides.	Trimetric or rhombic.

CHARACTERISTICS OF GEMS.

Form of Crystal.	Refraction.	Refractive Index.	Dispersive Power.	Electric Properties.	Fusibility.	Diaphaneity.
Cube, Octahedron, Rhombic dodecahedron, Tetrahedron, Hexa-octahedron.	Single.	White, 2·455 Brown, 2·487	0·38	Acquires positive electricity by friction; non-conductor of electricity.	Infusible; volatilized by long-continued heat.	Transparent and translucent; Carbonate opaque.
Hexagonal prism; often pointed at each end.	Double, in a small degree.	1·765	0·026	Acquires electricity by friction, and retains it several hours.	....	Transparent.
In flat hexagonal crystals; generally in rolled pebbles.	Double.	1·760	0·033	Acquires electricity by friction, and retains it several hours.	Infusible, alone.	Transparent and semi-transparent.
Octahedron, Rhombic dodecahedral octahedron, Tri-octahedron.	Single.	1·755 to 1·810	0·040	....	Infusible, alone.	Transparent, translucent.
Right-rhombic prism, Octahedral rhombic prism.	Double, in a slight degree.	1·635	0·025	Acquires electricity by friction and heat.	Infusible.	Transparent, translucent.

TABLE OF THE DISTINGUISHING

Name and Color.	Lustre.	Specific Gravity.	Hardness.	No. in Scale of Hardness.	Composition.	System of Crystallization.
EMERALD. Fine green. BERYL, or AQUAMARINE, pale sea-green, blue, white, yellow, rarely pink.	Vitreous.	2·67 to 2·75	Scratched by spinel; scratching quartz, (specimens vary.)	7·5 to 8·	Silica, . . 68·50 Alumina, . 15·75 Glucina, . 12·50 Oxide of Iron, . . 1·00 Lime, . . 0·25	Hexagonal or rhombohedral.
HYACINTH, or JACINTH, brownish-yellow, brownish-red, cinnamon. JARGOON, various shades of green, yellow, white, brown.	Vitreous, (almost adamantine.)	4·07 to 4·70	Scratches quartz slightly.	7·5	Silica, . . 33·0 Zirconia, . 66.8 Peroxide of Iron, . . 0·10	Diometric or square prismatic; pyramidal.
GARNET. Rarely Asteroid. { ALMANDINE, violet-red. CARBUNCLE, red. brownish. CINNAMON-STONE, white, yellow, orange. PYROPE, vermilion or Bohemian garnet.	Vitreous, inclining to resinous.	3·5 to 4·3	Scratches quartz slightly.	6·5 to 7·5	Silica. . . 38·25 Alumina. . 19·35 Red Oxide of Iron, . 7·33 Lime, . . 31·75 Magnesia, . 2·40 Protoxide of Manganese, . 0·50	Monometric or cubical.
TOURMALINE. Green, red, brown, yellow, blue, black, sometimes white.	Vitreous.	2·99 to 3·3	Scratches quartz slightly.	7· to 7·5	Fluorine, . 2·28 Silica, . . 38·85 Boracic Acid, 8·25 Alumina, . 31·32 Red Oxide of Iron, . 1·27 Magnesia, . 13·89 Lime, . . 1·60 Soda, . . . 1·28 Potash, . . 0·26	Hexagonal or rhombohedral.
QUARTZ, or ROCK CRYSTAL, white. AMETHYST, violet. CAIRNGORM, yellow. brown. CHRYSOPRASE, fine apple-green. CAT'S EYE, having *chatoyant* reflection. PLASMA, deep olive-green. JASPER, yellow, red, green, black, brown.	Vitreous.	2·65	Scratches glass.	7	Silica. . . 99·37 Alumina. . Amethyst, . Silica, . . 97·50 Alumina, . 0·25 Red Oxide of Iron, . 0·50 Oxide of Manganese, . 0·25	Hexagonal or rhombohedral.

CHARACTERISTICS OF GEMS.—(*Continued.*)

Form of Crystal.	Refraction.	Refractive Index.	Dispersive Power.	Electric Properties.	Fusibility.	Diaphaneity.
Hexagonal prism.	Double, (very feeble.)	1·585	0·026	Acquires positive electricity by friction.	Slightly fusible before the blowpipe.	Transparent.
Long square prism, Short square prism, Long square octahedron. The prisms often doubly terminated with square pyramids.	Double, in a very high degree, especially in the Jargoon of Ceylon.	1·990	0·044	Do. do.	Infusible before the blowpipe.	Transparent to opaque.
Rhombic dodecahedron. Rhombic dodecahedral cube, Trapezohedron, Hexa-octahedron.	Simple.	1·759	0·033	Do. do.	Fusible before the blowpipe.	Transparent, opaque.
Obtuse rhombohedron, Hexagonal prisms.	Double.	1·625	0·028	Acquires positive and negative electricity by friction and heat.	Fusible.	From transparent to opaque.
Hexagonal prism, Bipyramidal, dodecahedral.	Double.	1·549	0·026	Acquires positive electricity by friction.	Infusible.	Transparent and translucent. (Many varieties, nearly opaque.)

TABLE OF THE DISTINGUISHING

Name and Color.	Lustre.	Specific Gravity.	Hardness.	No. in Scale of Hardness.	Composition.	System of Crystallization.
BLOODSTONE, dark-green, with red spots. CARNELION, red, white, yellow. AGATE, various colors. ONYX, having black, brown and white layers. SARDONYX, having red or brownish and white layers. MOCHA-STONE, having infiltrated Oxides of Iron or Manganese, producing dendritic appearances.						
CHRYSOLITE. PERIDOT, olive-green. OLIVINE.	Vitreous.	3·3 to 3·44	Scratched by quartz.	6· to 7·	Silica, . . 39·73 Magnesia, . 50·13 Protoxide of Iron, . 9·19 Oxide of Nickel, . 0·32 Oxide of Manganese, . 0·09 Alumina, . 0·22	Trimetric or rhombic.
TURQUOISE. Blue, green, white.	Vitreous.	2·62 to 3·	Scratches glass feebly.	6	Phos. Acid, . 27·34 Alumina, . 47·45 Oxide of Copper, . 2·05 Oxide of Iron, . . 1·10 Oxide of Manganese, . 0·50 Phosphate of Lime, . 3·41 Water, . . 18·18	None.
OPAL. Colorless, red, white, green, gray, black, yellow. (Iridescent.)	Vitreous, inclining to resinous.	2·0 to 2·3	Scratches glass slightly.	5·5 to 6·5	Silica, . . 91·32 Water, . . 8·68 Traces of mineral coloring-matter.	None.
PEARL. White, yellow, pink, black, violet, brown, gray.	Pearly.	2·5 to 2·7	Various.	2·5 to 3·5	Carbonate of Lime, organic matter.	None.

CHARACTERISTICS OF GEMS.—(*Continued.*)

Form of Crystal.	Refraction.	Refractive Index.	Dispersive Power.	Electric Properties.	Fusibility.	Diaphaneity.
Generally in rolled grains and pebbles.	Double.	1·660	1·033	Acquires electricity by friction.	Infusible.	Transparent and translucent.
None.	....	....	....	None.	Infusible.	Opaque. Translucent at edges.
None.	....	....	....	....	Infusible.	Semi-transparent.
None.	None.	None.	None.	None.	Calcines by moderate heat.	Opaque; sometimes semi-transparent.

The value of stones above five carats is not attempted to be given, as it is impossible to fix it with any accuracy. It depends entirely on the demand for any particular size and the supply in the market; it remains a matter of negotiation between the buyer and seller.

When a Diamond has a very decided color, such as blue, red, green, &c., it is called a fancy stone, and will bring a most exorbitant price. A stone of five grains, of a brilliant emerald-green color, for which, if white, not more than £28 stg. could be obtained, has been known to sell for £320 stg. The terms first water, second water, &c., mean only first and second quality. Diamonds, when perfect, should be *clear* as a *drop of the purest water*, and they are described as second or third water when more or less clear, until decidedly yellow or brown, when they are termed *colored*. The value of stones of the first quality of a less weight than two grains, (half a carat,) is, according to Mr. Emanuel, £10 stg. per carat; the second quality, £8 stg.; the third, £7 stg. per carat.

The plates representing the sizes of the Diamonds, given in this Treatise, are drawn from nature; still it is quite difficult to get at the actual weight, for the Diamond cutters of the present day turn their attention more to the production of the greatest weight from a given quantity of rough Diamond, than to the production of perfectly proportioned stones, for which reason we often meet with stones weighing three carats, whose proper weight, if reasonably spread, should be two, which renders them less valuable and not nearly so brilliant as one of two carats properly cut; any over or under weight only detracts from its beauty. A well proportioned spread Diamond finds more amateurs than a heavy one. At present the following prices may be quoted for Diamonds in gold currency, viz.:

*2 grains, (half a carat,)		from.........	$68 to $75,	gold.
3 "		"	80 to 90	"
1 carat,		"	110 to 140	"
1½ "	(6 grains,)	"	200 the stone,	"
2 "	(8 ")	"	400 "	"
3 "	(12 ")	"	1,200 to 1,400	"
4 "	(16 ")	"	1,600 to 2,000	"
6 "	(20 ")	"	3,000 to 4,000	"

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* 4 grains are equal to 1 carat.
151½ carats " " 1 ounce troy weight.

Mr. Emanuel's price list quotes for 1865, in pounds sterling and shillings:

A Brilliant,	weighing	½	of a	carat,	....	£ stg.	5 10*s.* 5*d.*
"	"	¾	"	"	....	"	9 10
"	"	1	"	"	....	"	18
"	"	1¼	"	"	....	"	28
"	"	1½	"	"	....	"	38
"	"	1¾	"	"	....	"	48
"	"	2	"	"	....	"	65
"	"	2¼	"	"	....	"	70
"	"	2½	"	"	....	"	88
"	"	2¾	"	"	....	"	100
"	"	3	"	"	....	"	125
"	"	3¼	"	"	....	"	135
"	"	3½	"	"	....	"	150
"	"	3¾	"	"	....	"	175
"	"	4	"	"	....	"	220
"	"	4¼	"	"	....	"	230
"	"	4½	"	"	....	"	250
"	"	4¾	"	"	....	"	280
"	"	5	"	"	....	"	320

The Rose Diamond, which is not much in use in Europe, but more in South America, has not a very fixed value. The small Rose Diamonds, if under 40 to the carat, are worth about five shillings each; above that size, and up to one carat, bring from £9 stg. to £11 stg. the carat.

Ruby and Emerald.—Both these gems, when really fine, free from any defect, in color or size, are worth as much as Diamonds of the same weight.

A fair *Ruby* is worth from $30 to $40 per carat. A fine and pure Ruby, well spread and proportioned, is worth, according to Mr. Emanuel—

Of 1	carat,	....	£ stg.	14 to 20
1½	"	....	"	25 to 35
2	"	....	"	70 to 80
3	"	....	"	200 to 250
4	"	....	"	400 to 450

And those below the weight of one carat range from £2 to £8 stg. per carat; while stones of greater weight than four carats are of such exceptional occurrence as to command fancy prices. Again, a Ruby of four carats, but of a pale color, may not be worth £12 stg.

The *Emerald* is so rarely found perfect that the saying, "An Emerald without a flaw," has passed into a proverb. A good Emerald is at the present day worth more than a Ruby, on account of the pleasing effect it has both by day and candle-light, and is a very favorite gem; stands high in value; but the Emeralds found latterly and brought into market are far inferior to those formerly found. A good Emerald is worth in this country $40 to $50 per carat. In England the price ranges from 5*s.* to £15 stg. per carat; but one of deep, rich grass-green color, clear and free from flaws, may bring from £20 to £40 stg. per carat.

Sapphire.—A fine, perfect, evenly colored spread Sapphire, weighing one carat, of a deep rich blue color, by night as well as by day, is worth £20 stg.; it does not, however, increase so much in value in proportion to its size.

The Spinel or Balais-Ruby, if of good quality, is sold from 10*s.* to £8 stg. per carat. The value is extremely uncertain and variable; it depends entirely on caprice and fashion.

The *Topaz.*—The commercial nature of the Topaz as a jewel is entirely fictitious. A very fine stone can now be bought for a few shillings sterling, while it would have brought a great deal more when in fashion. Pink Topaz brings from £2 stg. to £20 stg. per ounce, the price depending on the depth of the pink color.

Beryl or Aquamarine.—The commercial value of this stone is trifling, and is used mostly for imitation jewelry. *Zircon, Hyacinth* or *Jacinth,* are also called *Jargoon.* These stones are identically the same, but differ in color; the red varieties are sometimes sold for inferior Rubies. The *Jargoon* is frequently cut in the form of a Rose Diamond, which is flat at the bottom and pointed at the top. The price is purely arbitrary.

The *Garnet, Essonite, Pyrope and Almandine.*—The color of the Syrian Garnet, being of deep crimson, is at present much in vogue, and commands a fair price, say from $1 to $2 per carat.

The Bohemian Garnets are worth from $15 to $25 per ounce.

Amethyst.—A fine deep-colored stone, of the size of a twenty-five cent piece, is worth from $80 to $100 per ounce; smaller sizes and inferior qualities are sold for 50 cents to $10 apiece.

Peridote, Chrysolite.—The value of both stones is but small; fair specimens of good size may be bought at from 25c. to $5 per carat.

Turquoise.—The Persian is much used in jewelry; small, clear stones bring from sixpence to 20*s.* stg. each, while a fine Ring stone will realize from £10 stg. to £40 stg. Large Turquoise, of good quality and fine color, are extremely rare, and realize extravagant prices.

Opal.—The value of the precious Opal depends entirely on the brilliancy and play of its colors; large, fine gems, of extraordinary beauty, have brought fabulous prices. They are not sold by the carat, but by the piece.

Coral.—The red Coral, which formerly was the most valuable, is now worth far less than the color which was formerly worthless. The pale, delicate pink, similar to that of the inside of the pale rose leaf, is sought after, but very scarce; a Coral of this tint is very valuable. £48 stg. per ounce has lately been paid in London. A large bead or drop will readily realize from £30 stg. to £40 stg.; small pieces, however, may be had for $4 to $6 per ounce.

Pearls.—The value for perfectly pure round Pearls, of a smooth and lustrous skin, perfectly free from specks or discoloration of any sort, of small size, is from......................$1 to $2 a grain.

4 grain	Pearls,..................	2 to 3	"
6 "	"	5 to 6	"
10 "	"	8 to 10	"

The following is Mr. Emanuel's table of prices of Pearls, viz.:

A Pearl of	1	grain	is worth	from	2*s.*	to 2*s.* 6*d.*
"	2	"	"	"	6*s.* 6*d.*	to 7*s.* 6*d.*
"	3	"	"	"	12*s.*	to 16*s.*
"	4	"	"	"	22*s.*	to 28*s.*
"	5	"	"	"	35*s.*	to 48*s.*
"	6	"	"	"	55*s.*	to 65*s.*
"	8	"	"	"	90*s.*	to 110*s.*
"	10	"	"	"	£ 8 stg.	to £ 9 stg.
"	12	"	"	"	£12 "	to £ 15 "
"	14	"	"	"	£15 "	to £ 18 "
"	16	"	"	"	£20 "	to £ 30 "
"	18	"	"	"	£30 "	to £ 40 "
"	20	"	"	"	£40 "	to £ 50 "
"	24	"	"	"	£60 "	to £ 70 "
"	30	"	"	"	£80 "	to £100 "

Round Pearls above the latter weight are of such rare occurrence and command such exceptional prices, that it would be useless to attempt any scale of valuation.