can be noticed. Many others more complicated will occur in the descriptive part of this article. Among holohedral combinations, the cube, octahedron, and rhombic dodecahedron are the predominant forms. In fig. 27 the cube has its angles replaced by the faces of the octahedron, which truncate the angles, and the sign of this combination is $\infty O \infty$, O. In fig. 28 this process may be regarded as having proceeded still farther, so that the faces of the octahedron nearly equal those of the cube, while in fig. 29 they now predominate; the sign, still of the same two elements, but in reverse order, is O, $\infty O \infty$ It will thus be seen that, through an increase in the amount of the abstraction of the faces of the cube, the figure gradually passes over into that of the octahedron. This may occur in all cases, and is termed the passage of the cube into the octahedron (or *vice versa*), or a "transition by decrement."

In fig. 31 the cube has its edges replaced by the faces of the rhombic dodecahedron, which truncate the edges, the sign being $\infty O \infty$, ∞O; while in fig. 32 there is the same combination, but with the faces of the cube subordinate, and hence the sign is ∞O, $\infty O \infty$. The former figure, it will be seen, has more the general aspect of the cube, the latter of the dodecahedron. Here the solid angles of the latter are truncated by the faces of the cube, and we have the passage of the cube into the dodecahedron by decrement. The same transition, through truncation or decrement, could be shown in all cases of combinations, and in both directions, the last stage of the passage into one or other form always consisting of the replacement of its solid or interfacial angles by faces of the departing figure, more or less minute. A few illustrations of this may be given, in the three most important forms.

The relationship of the tetrakishexahedron to the cube has above been stated to be, that its faces form six low quadrilateral pyramids, which rest upon or spring from the edges of the cube. (From this the form derives its trivial name of four-faced cube.) Hence these faces bevel the edges of the cube. The first stage of such bevelling (or the last stage of the truncation of the tetrakishexahedron by the faces of the cube—whichever way it may be regarded) is seen in fig. 55. As the cubic face is here dominant, the sign is $\infty O \infty$, $\infty O3$. Fig. 56 shows a somewhat similar stage

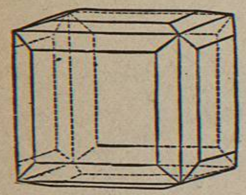
Fig. 55.

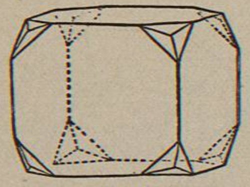
Fig. 56.

in the modification produced through the combination of the icositetrahedron with the cube. The trilateral pyramid which this form places upon the faces of the cube rests upon its solid angles, instead of, as in the last case, upon its edges; hence it is these solid angles which, in the process of decrement, it replaces by faces which form a low three-sided pyramid. The triakisoctahedron,

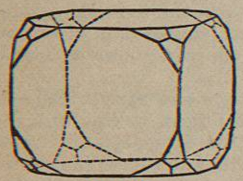
Fig. 57.

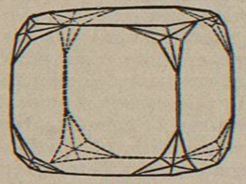
Fig. 58.

again, modifies the solid angles of the cube, as shown in fig. 57, by a low three-sided pyramid, positioned at right angles to that considered in the last combination. As the hexakisoctahedron is merely the two-faced form of that last considered, the pyramid which modifies the solid angles is, in its combination with the cube, six-sided, as in fig. 58.

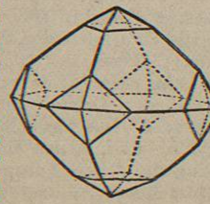
Fig. 59.

As the faces of the rhombic dodecahedron truncate the edges of the octahedron, fig. 34 represents the first stage of such truncation or combination; while fig. 35 may be taken as representing the last, the faces of the octahedron being there nearly totally removed.

Fig. 59 shows the first stage of the passage of the octahedron into the icositetrahedron, in the truncation of the solid angles of the former form by a four-sided pyramid formed by the (6×4) faces of the latter. The faces of the octahedron truncate the three-faced solid angles of the rhombic dodecahedron. Fig. 35 shows the first stage of this truncation, while fig. 34 shows an advanced amount. The faces of the icosi-

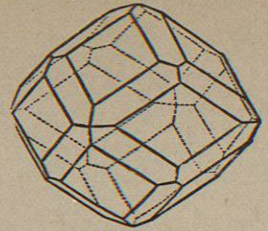
Fig. 60.

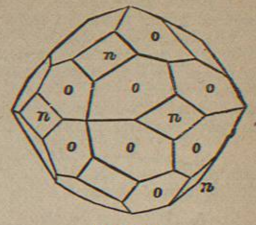

Fig. 61.

tetrahedron truncate the edges of the rhombic dodecahedron, as in fig. 60; while those of the latter truncate the unequal-angled tetragonal (or rhombic) angles of the former (fig. 61). The faces of the hexakisoctahedron bevel the edges of the rhombic dodecahedron.

While such transitions may appear indefinite, yet certain minerals have either in themselves a habit, or have at certain localities a habit, of crystallizing so markedly *in a certain stage* of these transitions as to be absolutely capable of recognition thereby.

Combinations of hemihedral or, as they have been called, semitesseral forms are of three classes:—those with holohedral forms, those in which the faces fall obliquely on one another, and those with parallel faces. Fig. 62 shows the combination of a right-

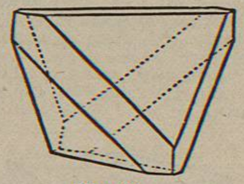
Fig. 62.

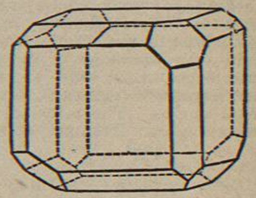
Fig. 63.

handed tetrahedron with the cube, which truncates its edges, the tetrahedron here being dominant. Fig. 63, again, shows a combination of the cubo-dodecahedron with a right-handed tetrahedron, the first or holohedral form being in this case markedly dominant.

Fig. 64 is an illustration of the second class, combinations of

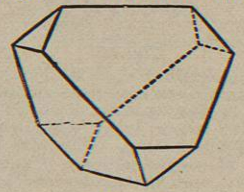
Fig. 64.

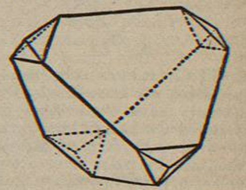
Fig. 65.

oblique-faced semitesseral forms with each other. In it a right-handed tetrahedron has its solid angles truncated by the faces of one which is left-handed; and so its sign is $\frac{O}{2}, -\frac{O}{2}$. Fig. 65 shows a combination of a right-handed tetrahedron with a left-

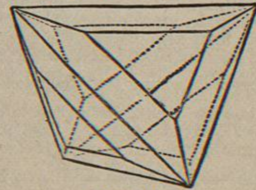
Fig. 66.

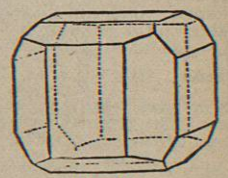
Fig. 67.

handed three-faced tetrahedron. Fig. 66 shows a combination of a right-handed hemihedron of the icositetrahedron with a right-handed tetrahedron.

Parallel-faced hemihedrons generally form combinations with holohedral forms; and the amount of relative dominance is of all degrees. Fig. 67 shows a combination, in equal amount, of the cube

with a vertical-faced pentagonal dodecahedron; while fig. 68 shows an increase in the amount of truncation effected by the latter. Fig. 69 shows the combination of the cube with the dyakidodecahedron,

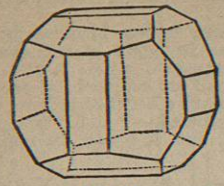
Fig. 68.

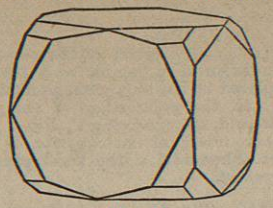
Fig. 69.

the former being dominant. In fig. 70 an octahedron, in dominance, is combined with the vertical-faced pentagonal dodecahedron; in

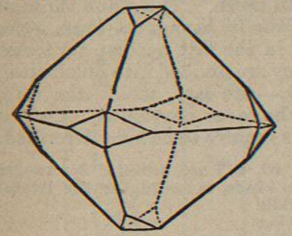
Fig. 70.

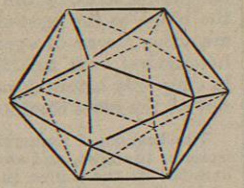
Fig. 71.

fig. 71 the faces of these forms are of nearly equal size, while in fig. 72 the octahedral faces are nearly removed. The solid angles of

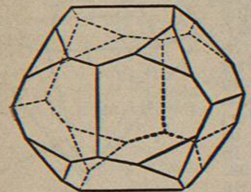
Fig. 72.

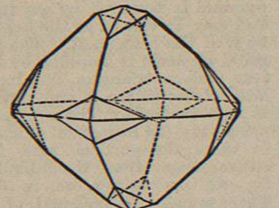
Fig. 73.

the octahedron are modified in fig. 73 by the faces of the dyakisdodecahedron. In fig. 68 a vertical-faced pentagonal dodecahedron is the prevailing form in combination with the cube; while in fig. 74 the faces of the octahedron are superadded. In fig. 75 its octahedral angles are modified by the faces of the icositetrahedron,

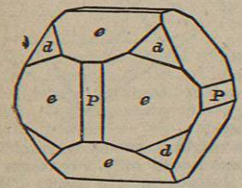

Fig. 74.

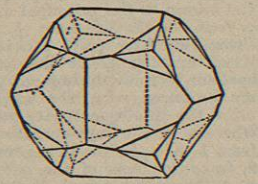
Fig. 75.

and in fig. 76 by those of the octahedron in addition. In fig. 77 they are modified by the faces of the dyakisdodecahedron.

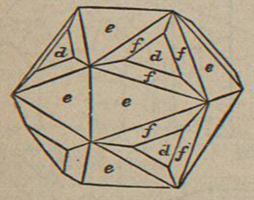

Fig. 76.

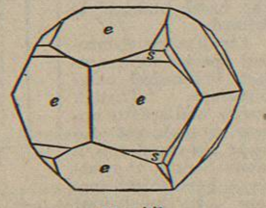

Fig. 77.

In each of the five systems which follow there is this difference from the cubic system that one axis is always unequal to (longer or shorter than) the others. This is placed erect, and named the chief axis; its ends are poles, and the edges connected with them polar edges. The other axes are named subordinate or lateral axes, and the plane that passes through them is the base. A plane through the chief and a lateral axis is a normal chief section. In these systems also occur the three forms of "pyramids," "prisms," and "pinacoids." (1) The pyramids have their faces triangles. Pyramids in crystallography are each composed of two geometric pyramids placed base to base, and named "closed forms," as the crystals are shut in by definite faces on every side. (2) The prisms are bounded by plane faces parallel to one axis. They are thus of unlimited extent in the direction of that axis, and therefore named "open forms," but in solid crystals are shut in by faces of other forms. (3) The pinacoids, or tables, have two faces intersecting one axis and parallel to the others, and thus are also open forms, or unlimited in the direction of these axes. Forms (2) and (3), when conjoined, mutually shut in each other, or produce closed forms.

II. *Pyramidal or Tetragonal System.*—This system has three axes at right angles, two of them equal, and the chief axis longer or shorter. The name tetragonal is derived from the form of the base, which is usually quadrangular.

There are eight tetragonal forms, of which five are closed. (1) Tetragonal pyramids (figs. 78, 79) are enclosed by eight isosceles triangles, with four middle edges all in one plane, and eight polar edges. There are three kinds of this form,

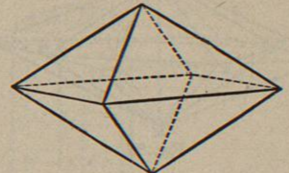
Fig. 78.

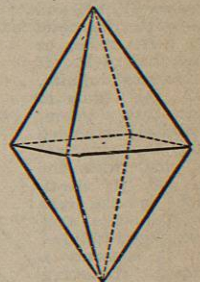
Fig. 79.

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 last being hemihedral forms. These pyramids are also distinguished as obtuse (fig. 78) or acute (fig. 79), according as the vertical angle is greater or less than in the regular octahedron. (2) Ditetragonal pyramids (fig. 80) are bounded by sixteen scalene triangles, whose base-lines are all in one

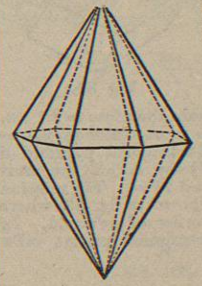
Fig. 80.

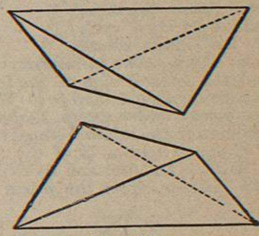
Fig. 81.

plane. This form rarely occurs except in combinations. (3) Tetragonal sphenoids (fig. 81), bounded by four isosceles triangles, are the hemihedral forms of the first variety of tetragonal pyramids. (4) The tetragonal scalenohedron (fig. 82), bounded by eight scalene triangles, whose bases rise and fall in a zigzag line, is the hemihedral form of the ditetragonal pyramid. Nos. (3) and (4) are rare. (5) The tetragonal trapezohedron is not found in minerals as a simple form. The three open forms are—(1) tetragonal prisms, bounded by four planes parallel to the principal axis, which may be either longer (fig. 83) or shorter (fig. 84) than the lateral axes; (2) ditetragonal prisms, bounded by eight similar planes; and (3) the basal pinacoid, consisting merely of two parallel faces bounding the prisms at the ends, above and below.

The various series of tetragonal crystals are distinguished from each other only by their relative dimensions. To determine these,

Primitive pyramid. one of the series must be chosen as the primary 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, whilst the proportion of the principal axis a to the

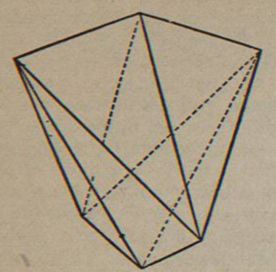

Fig. 82.

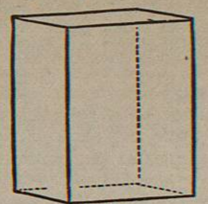

Fig. 83.

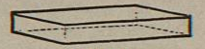

Fig. 84.

lateral axes, supposed equal to 1, gives its linear dimensions. The parameters, therefore, of each face of the fundamental form are $1 : 1 : a$.

Now if m be any (rational) number, either less or greater than unity, 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 order, but more or less acute or obtuse than P, are formed.

Derived pyramids. The general sign of these pyramids is mP and the most common varieties $\frac{1}{2}P$, $2P$, and $3P$,—with the chief axis half, twice, or thrice that of P. If m becomes infinite,

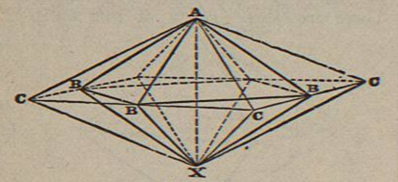

Fig. 85.

Prism. 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. 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

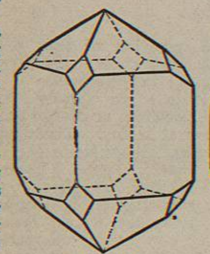

Fig. 86.

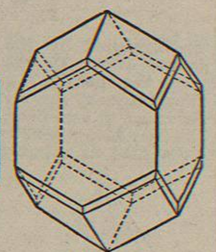

Fig 87.

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 order 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 order is shown in fig. 85, where ABBBC is the first and ACCCX the second order of pyramid. In like manner, from the prism ∞P, the ditetragonal prisms ∞Pn

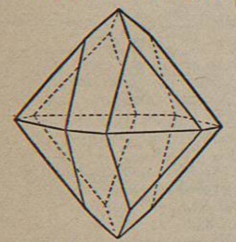

Fig. 88.

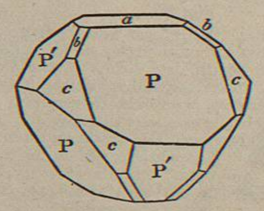

Fig. 89.

are derived, and, finally, when $n=\infty$ the tetragonal prism of the second order, whose sign is $\infty P\infty$.

The combinations of the tetragonal system are either holohedral or hemihedral; but the latter are rare. Prisms and pinacoids must always be terminated on the open sides by other forms. Thus in fig. 86 a square prism of the first order is terminated by the primary pyramid, and has its lateral angles again replaced by another more acute pyramid of the second order, so that its sign is ∞P, P, $2P\infty$.

In fig. 87 a prism of the second order is first bounded by the fundamental pyramid, and then has its edges of combination replaced by a ditetragonal pyramid; its sign is $\infty P\infty$, P, $3P3$. In fig. 88 the polar edges of the pyramid are replaced by another pyramid, its sign being P, $P\infty$. In fig. 89 a hemihedric form, very characteristic of chalcopyrite, is represented,—P and P′ being the two sphenoids, a the basal pinacoid, and b, c two ditetragonal pyramids.

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 these. The plane through the lateral axes, or the base, from its hexagonal form, gives the name to the system. As in the last system, its forms are either closed or open. They are divided into holohedral, hemihedral, and tetartohedral,—the last, which are rare, having only a fourth part of the faces developed. Only a few of the more common forms require to be here described.

Pyramids. The hexagonal pyramids (figs. 90, 91) 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 last being hemihedral forms. They are also classed as acute or obtuse, but without any 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; in these the vertical axis may be either longer than the lateral, as in fig. 92, or shorter, as in fig. 93. There are also dihexagonal, of twelve sides.

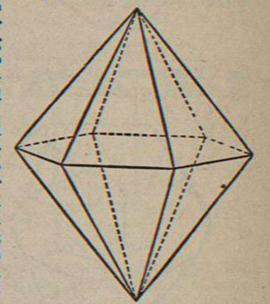

Fig. 90.

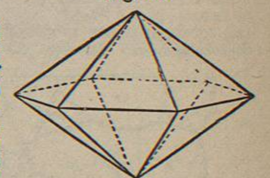

Fig. 91.

A particular pyramid P is chosen as the fundamental form of this system, 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 mPn, 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 order, whose sign is $mP2$. When $m=\infty$, various prisms arise from similar changes in the value of n; and when $m=0$ the basal pinacoid is formed.

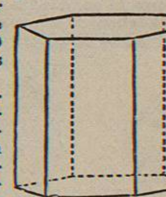

Fig. 92.

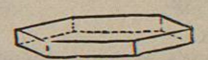

Fig. 93.

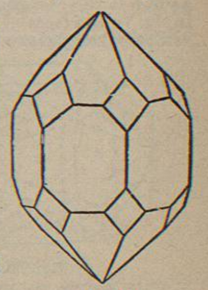

Fig. 94.

Few hexagonal mineral species form perfect holohedral combinations. Though quartz and apatite appear as such, yet properly the former is a tetartohedral, the latter a hemihedral species. In holohedral species the predominant faces are usually those of the hexagonal

Prisms prisms ∞P (fig. 92) and $\infty P2$, or of the pinacoid $0P$ (fig. 93); whilst the pyramids P and 2P2 are the most common subordinate forms. Fig. 94 represents the prism, bounded on the extremities by two pyramids,—one, P, forming the apex, the other, 2P2, the rhombic faces on the angles, or ∞P, P, 2P2. Fig. 95 is a similar form, the upper part of the pyramid being replaced by the pinacoid. In some crystals the lateral edges of the prism are replaced by the

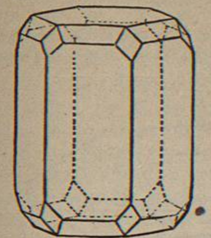

Fig. 95.

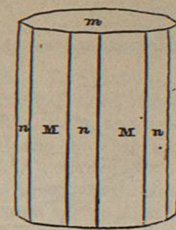

Fig. 96.

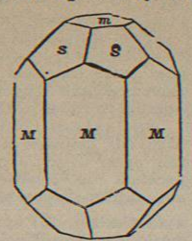

Fig. 97.

second prism $\infty P2$ (fig. 96), producing an equiangular twelve-sided prism, which always represents the combination ∞P, $\infty P2$, and cannot occur as a simple form. Figs. 97. 98 are combinations in this

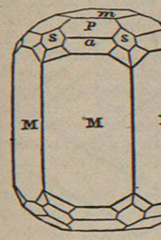

Fig. 98.

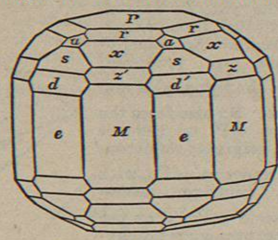

Fig. 99.

system seen in beryl. An example of a more complicated combination is seen in fig. 99, of a crystal of apatite, whose sign with the corresponding letters is $\infty P(M)$, $\infty P2(e)$, $0P(P)$, $\frac{1}{2}P(r)$, $P(x)$, $2P(z)$, $P2(a)$, $2P2(s)$, $4P2(d)$.

Rhombohedral forms. Hexagonal minerals frequently crystallize in those series of hemihedral forms that are named "rhombohedral," from the prevalence in them of rhombohedrons. These (figs. 100, 101) are bounded by

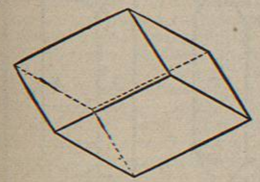

Fig. 100.

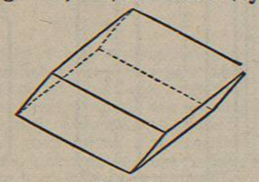

Fig. 101.

six rhombi, whose lateral edges do not lie in one plane, but rise and fall in a zigzag 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 than 90°, acute; fig. 102 represents the first, fig. 103 the second. Hexagonal scalenohedrons (fig. 104) are bounded by twelve scalene triangles, whose lateral

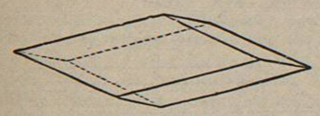

Fig. 102.

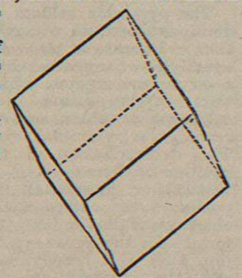

Fig. 103.

edges do not lie in one plane. The principal axis joins the two hexagonal angles, and the secondary axis the middle points of two opposite lateral edges.

The rhombohedron is derived from the first order of hexagonal pyramid by the hemihedral 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 complementary figure by $-mR$. When the prism or pinacoid arises as its limiting form, 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 hemihedral form of the dihexagonal pyramid, but is more easily understood as derived from the inscribed rhombohedron mR. If the halves of the principal axis of this be multiplied by a definite number n, and then planes be drawn from the extremities of this enlarged axis to the lateral edges of the rhombohedron, as in fig. 105, the scalenohedron is constructed. It is now designated by mRn (the n on the right here referring to the chief axis), and the dihexagonal prism in this series by ∞Rn (formerly mR^n and ∞R^n).

The combinations of rhombohedral forms are very numerous, several hundreds having been described in calc-spar alone. Among the most common is the prism in combination with a rhombohedron, as seen in the twin crystal of calc-spar (fig. 106), with the sign ∞R, $-\frac{1}{2}R$, the lower half being the same form with the upper, but turned round 180°. In fig. 107 the rhombohedron mR has its polar

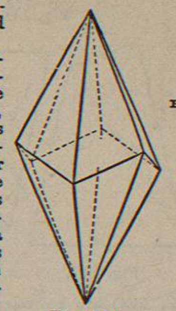

Fig. 104.

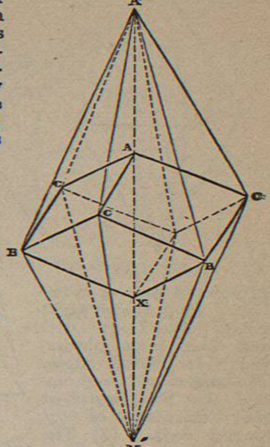

Fig. 105.

Fig. 106.

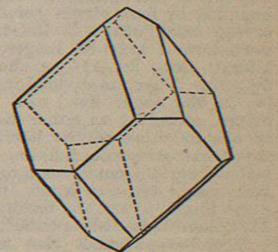

Fig. 107.

edges replaced by another rhombohedron $-\frac{1}{2}mR$, and in fig. 108 its lateral edges bevelled by the scalenohedron mRn. A more complex combination of five forms is represented in the crystal of calc-spar fig. 109, its sign, with the letters on the faces, being $R^5(y)$,

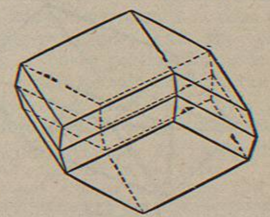

Fig. 108.

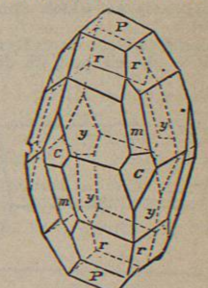

Fig. 109.

$R^3(r)$, $R(P)$, $4R(m)$, $\infty R(c)$. Tetartohedral combinations are seen most distinctly in rock-crystal.

IV. *Right Prismatic or Rhombic System.*—This system is characterized by three unequal axes, all at right angles to each other. Any one of these may be assumed as the chief axis, when the others are named subordinate. The plane passing through the secondary axes, or the base, forms a rhombus, and from this one of its names is derived. As prismatic forms are most frequent (the prism standing vertically on the rhombic base), it is best defined as the right prismatic. This system comprises only a few varieties of forms that are essentially distinct, and its relations are consequently very simple.

There are two closed forms. (1) The rhombic pyramids (figs. 110, 111), bounded by eight scalene triangles, whose lateral edges lie in one

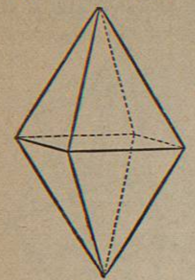
Fig. 110.

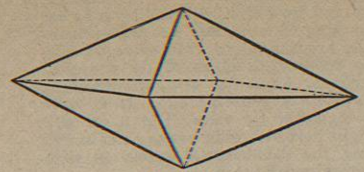
Fig. 111.

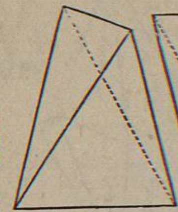
Fig. 112.

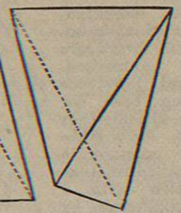
Fig. 113.

plane, and form a rhombus. They have eight polar edges (four acute and four more obtuse) and four lateral edges. The angles are six rhombic, the most acute at the extremities of the longest axis. (2) The rhombic sphenoids (figs. 112, 113) are bounded by four scalene triangles, with their lateral edges not in one plane, and are hemihedral forms of the rhombic pyramid. They are of very infrequent occurrence.

Sphenoids.

Prisms. The open forms, again, are rhombic prisms bounded by four planes parallel to one of the axes, which is indefinitely extended, and may be longer than the lateral, as in fig. 114, or shorter as in fig. 115. They are divided into upright (as in the above figs.) and horizontal prisms, according as either the principal or one or other of the lateral axes is supposed to become infinite. For the latter form the name doma or dome has

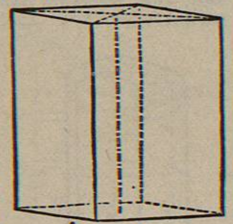
Fig. 114.

Domes. been used; and two kinds, the macrodome (fig. 116) and the brachydome (fig. 117), have been distinguished.

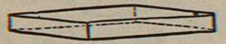
Fig. 115.

Pinacoids. Rhombic pinacoids also arise when one axis becomes $=0$ and the two others are indefinitely extended; and so we have macropinacoids (fig. 118) and brachypinacoids (fig. 119),—the qualifying term thus designating the axis to which the faces of the dome or pinacoid are parallel.

In deriving these forms from a primary, a particular rhombic pyramid P is chosen and its dimensions determined either from the

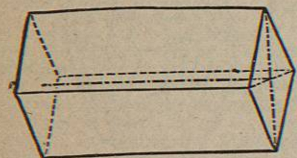
Fig. 116.

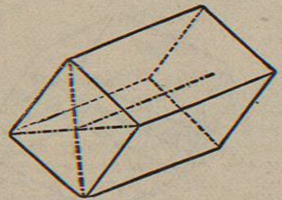
Fig. 117.

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 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. They consequently mark only the position of the faces in respect to the axes of the fundamental crystal, and frequently of necessity without reference to the relative magnitude of the derived axes.

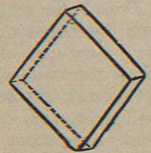
Fig. 118.


Fig. 119.

By multiplying the principal axis by any rational number m, greater or less than 1, a series of pyramids arise, whose general sign is mP, and their limits are the prism and pinacoid; the whole series being contained in this formula, $0P \ldots\ldots mP \ldots\ldots P \ldots\ldots mP \ldots\ldots \infty P$,—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 $m\bar{P}n$, the mark over the P pointing out the axis enlarged. When $n=\infty$, a macrodome results, with the sign $m\bar{P}\infty$. If the shorter axis is multiplied, then brachypyramids and brachydomes are produced, with the signs $m\breve{P}n$ and $m\breve{P}\infty$. So also from the prism ∞P, on the one side, originate numerous macroprisms $\infty\bar{P}n$, with the limiting macropinacoid $\infty\bar{P}\infty$; on the other, numerous brachyprisms $\infty\breve{P}n$, with the limit form $\infty\breve{P}\infty$, or the brachypinacoid. In figs. 120, 121 the two domes are shown in their relation to the primitive pyramid:

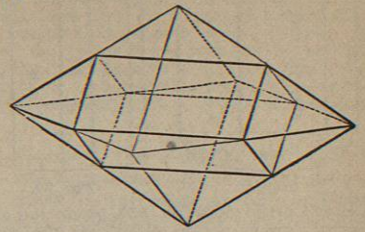
Fig. 120

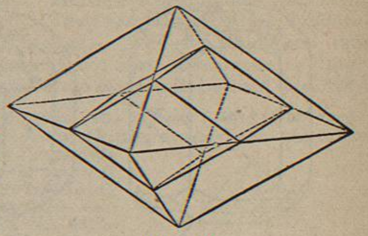
Fig. 121.

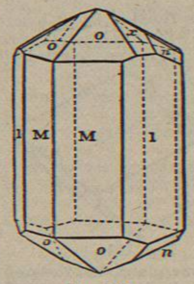

Fig 122.

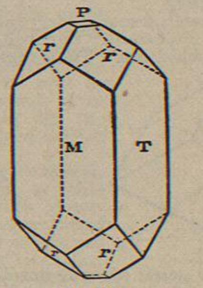

Fig. 123.

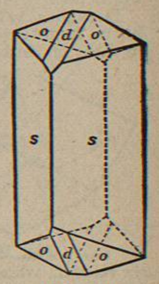

Fig. 124.

The pyramids seldom occur independent, or even as the predominant forms in a combination; sulphur, however, is an exception. Prisms or pinacoids usually give the general character to the crystal, which then appears either in a columnar or tabular or even 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. 122) 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. 123 of stilbite is another example, the macropinacoid $\infty\breve{P}\infty$ 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. 124 of a lievrite crystal, where the brachyprism and pyramid combine

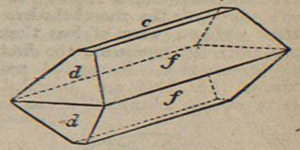

Fig. 125.

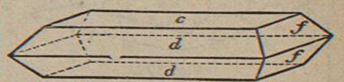

Fig. 126.

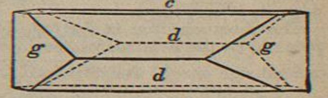

Fig. 127.

with the macrodome, or $\infty\breve{P}2$, P, $\bar{P}\infty$. The above figures are very common forms of barytes,—figs. 125 and 126 being both composed of the pinacoid 0P, a brachydome, and a macrodome, with sign $0P(c)$, $\breve{P}\infty\,(f)$, $\tfrac{1}{2}\bar{P}\infty\,(d)$. The variation in aspect arises from the predominance of different faces; and fig. 127 consists of the macrodome $\tfrac{1}{2}P\infty$, the prism $\infty P(g)$, and the pinacoid 0P.

V. *The Oblique Prismatic 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 form with the base two right angles and one oblique angle C.

Hemi-pyramidal character The forms of this system approach very near to those of the right prismatic series, but the inclination of the axis, 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.

Prisms. 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 monoclinic pyramids (fig. 128) 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.

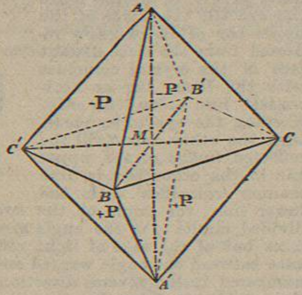

Fig. 128.

+ and − pyramids. The two pairs in the acute angle between the orthodiagonal and basal sections are designated the positive hemipyramid, whilst 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 rhombus; the clinodomes have a similar form and section; whilst the horizontal prisms or domes have unequal faces, and their section is a rhomboid.

The mode of derivation of these forms closely resembles that of the rhombic series. A complete double pyramid is assumed as the fundamental form, and designated $\pm P$, 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 the inclination of the orthodiagonal section to the base, are known.

The fundamental series of forms is $0P \ldots\ldots \pm mP \ldots\ldots \pm P \ldots\ldots \pm mP \ldots\ldots \infty P$, 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 $\pm mP^{o}n$ is produced, with the orthodomes $mP^{o}\infty$ as limiting forms. The clinodiagonal produces a similar series of clinopyramids $\pm mP^{c}n$, with the limiting clinodome $mP^{c}\infty$ always completely formed, and therefore without the signs $\pm$ attached. From ∞P arise orthoprisms $\infty P^{o}n$ and the orthopinacoid $\infty P^{o}\infty$, and clinoprisms $\infty P^{c}n$ and the clinopinacoid $\infty P^{c}\infty$. In these signs the o or c attached to the P indicates that the orthodiagonal (o) or clinodiagonal (c) axis has been multiplied. Formerly the latter forms were enclosed in brackets, thus $(mP\infty) = mP\infty$.

The combinations of this system may be easily understood from their resemblance to those of the right prismatic, the chief difficulty being in the occurrence of *partial* forms, which, however, closely resemble the hemihedral forms of the previous systems. A few examples only need therefore be given.

Fig. 129 represents a very common form of gypsum crystals, $\infty P^{c}\infty$, (P), $\infty P(f)$, $P(l)$. The most common form of augite is represented in fig. 130, with the sign $\infty P(M)$, $\infty P^{o}\infty\,(r)$, $\infty P^{c}\infty\,(l)$, $P(s)$.

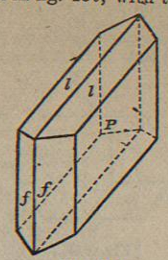

Fig. 129.

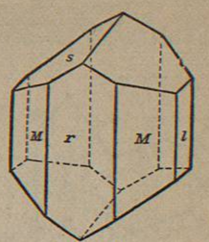

Fig. 130.

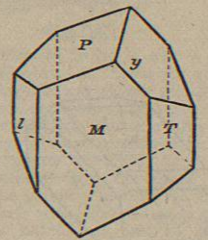

Fig. 131.

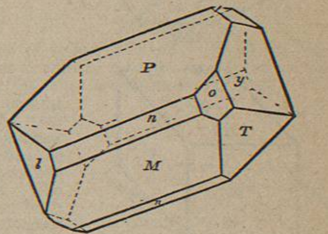

Fig. 132.

Fig. 131 is a crystal of common felspar or orthoclase, composed of the clinopinacoid $\infty P^{c}\infty\,(M)$, the prism $\infty P(T)$, the basal pinacoid $0P(P)$, and the hemidomes $2P^{o}\infty\,(y)$; to which, in fig. 132 of the same mineral, the hemipyramid $P(o)$ and the clinodome $2P^{c}\infty\,(n)$ are added.

VI. *Anorthic or Triclinic System.*—This is the least regular system, and departs the most widely, indeed almost absolutely, 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 systems, 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 of 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 triclinic crystals very unsymmetrical in appearance. **Anorthic system.**

Triclinic pyramids (fig. 133) 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 are 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 right prismatic system, with the modifications already mentioned.

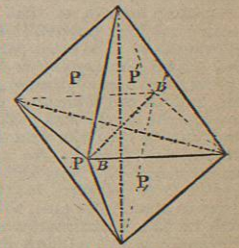

Fig 133.

Some combinations of this system, as the series exhibited by most of the felspars, approach very near to the oblique prismatic system; whilst others, as cyanose and axinite, show great incom-