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Published monthly by the
New York State Education Department

BULLETIN 363 DECEMBER 1905

New York State Museum

JOHN M. CLARKE Director

Bulletin 98

MINERALOGY 4

CONTRIBUTIONS FROM THE MINERALOGIC LABORATORY

BY

H. P. WHITLOCK

ALBANY

NEW YORK STATE EDUCATION DEPARTMENT

1905

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DEAR SIR: I transmit herewith for publication as a bulletin of the State Museum a paper entitled *Contributions from the Mineralogic Laboratory*, prepared by H. P. Whitlock, Mineralogist of this division.

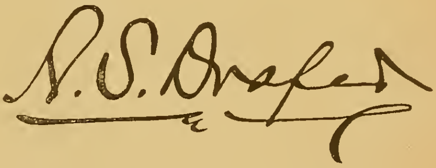
It is with some satisfaction that I communicate a paper, brief in itself and wholly concerned with pure science, which constitutes a really substantial addition to our knowledge of the mathematical and physical characters of New York minerals.

Very truly yours,

JOHN M. CLARKE

Director and State Geologist

Approved for publication June 14, 1905



Commissioner of Education

New York State Education Department

New York State Museum

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Bulletin 98

MINERALOGY 4

CONTRIBUTIONS FROM THE MINERALOGIC LABORATORY

BY

H. P. WHITLOCK

MINERALS FROM RONDOUT, ULSTER CO.

In the spring and fall of 1904, the New York State Museum came into possession, through purchase and by the gift of Mr P. E. Clark, ot a very complete and representative collection of minerals from the mines of the Newark Cement Co., at Rondout. As such a mass of mineralogic material from this interesting locality has probably never before been available for study, the writer has availed himself of this opportunity to contribute these brief notes in the hope that they may prove of value in furthering a detailed knowledge of the mineral occurrences of New York. The writer wishes to express his thanks to Mr Clark for the many courtesies extended to him in his work.

General description. The mineral material consists principally of the filling of seams or veins in the Rondout limestone which constitutes the cement rock of these deposits. Of these vein minerals calcite predominates and is characterized by a wide and interesting variation in crystal habit. Crystallized quartz and dolomite occur associated with the calcite together with pyrite and marcasite of a younger generation. All of these present characters of interest and will be described in detail.

Marcasite. Marcasite occurs implanted on the calcite and quartz of the vein filling and less frequently impregnating the calcite in minute detached crystals. The crystals vary from 5mm in width, parallel to the *b* axis, to microscopic individuals. In crystal habit they present the usual types, the combination shown in figure 1[a] representing the prevailing habit. The faces are in general marred and distorted by striations and vicinal planes to such an extent that exact goniometrical measurements were

[a]Figures 1 and 2 are shown with the *b* axis vertical.

rendered difficult, and where fairly sharp reflections were obtained from the corresponding faces of a number of crystals, the results showed a considerable variation, probably due to incipient groupings of a number of crystals in approximately parallel position. The brachi dome *r* (014) was noted in a number of cases but always trending toward a connection with (011) and (001) by series of vicinal planes giving curved surfaces [fig. 2]. Twinning parallel to (110) is quite common producing the usual stellate forms. In one case the repeated twinning shown in figure 2 was noted. Aggregates of the usual "cockscomb" aspect are common.

Pyrite. The pyrite which occurs at Rondout presents several features of interest both from a crystallographic and a genetic point of view. In addition to the small brilliant crystals (1 millimeter diameter) which in places thickly incrust the calcite of this locality, in a number of specimens a decided and unusual distorted habit was noticed in the pyrite crystals occurring associated with the dolomite, which latter appeared to be of a younger generation than the calcite. The distortion takes place perpendicular to the opposite faces of a cube (100) and varies in extent from an elongation of five times the cross section to thin acicular crystals somewhat resembling the acicular habit of millerite. Twinning occurs parallel to the dodecahedral (110) face [fig. 3], giving rise to L and T shaped crystals. Repeated twinning occurs in several cases. Scepter crystals resembling those common to quartz were observed in several instances, the relation between the acicular shaft and the crowning individual being that shown in figure 4. Pyrite dendrites of remarkable size and beauty occur in seams in the limestone. These bear a marked resemblance to the arborescent forms of native copper and may owe their origin to similar crystallographic development.

Quartz. Crystallized quartz is found at Rondout for the most part in detached crystals contained in the clay pockets of the Manlius limestone which forms the hanging wall of the cement beds. These exhibit in a great number of instances the phenomenon of a clearly marked inner crystal of smoky quartz surrounded by a secondary layer of colorless quartz. These phantoms of smoky quartz occasionally occur in series showing successive deposits of smoky and clear quartz. Small amounts of anthracite were noted in the associated limestone. In many of the crystals a marked tendency toward parallel grouping, very similar to the occurrence of quartz at New Baltimore[1], often results in cavernous crystals which closely resemble those from Stony Point, N. C.

[1] N. Y. State Mus. Bul. 58, pl. 1.

Penetration twins on twinning axis *c* are quite common resulting in the forms shown in figures 5 and 6. Measurements of a number of crystals yielded the following results:

ZONE (1010), (1011)

Forms	Measured angle on 1010	Calculated angle on 1010
m $(60\bar{6}5)$	33° 15′	33° 13′
j $(30\bar{3}2)$	27 44½	27 42
i $(50\bar{5}3)$	25 18½	25 17
Γ $(40\bar{4}1)$	11 11	11 8
v $(71\bar{8}1)$	8° 50′	8° 52′
ε $(12\bar{3}1)$	24 59	25 5
s $(11\bar{2}1)$	38 7	37 58

The presence of vicinal forms in the zone [1010.1011] interfered materially with the measurement of this zone.

Calcite. The vein calcite of Rondout occurs, for the most part, as a secondary deposit on dolomite and presents types of crystallization of marked variety and unique development. The associated pyrite which is here present in extremely minute crystals, occurs in many cases included in the larger calcite individuals arranged along the crystallogenetic lines of the latter mineral in distinct bands on the surface of, or as phantoms within, the crystals of the calcite. These structure lines as outlined by the pyrite inclusions are of notable interest in their relation to the development of the calcite. Somewhat similar inclusions have been noted in the calcite from Phoenixville Pa[1]. A careful study of some 200 specimens has led to the division of the observed combinations of crystal forms into nine types, of which the second and third may be regarded as variations of the same type with respect to crystal habit.

DISCUSSION OF TYPES

First type. The simple combination of the prism $(10\bar{1}0)$ with the rhombohedron $(01\bar{1}2)$ which is the prevailing type throughout the vein calcite of the Siluric limestones of the Hudson valley, is here present in crystals which occasionally reach a diameter of 3 cm. As elsewhere noted in this region, this type appears to mark a condition of regular and uninterrupted deposition as distinct from the disturbed and brecciated vein structure characteristic of some of the types to be subsequently discussed. The planes of the rhombohedron *e* $(01\bar{1}2)$ are dull whereas those of the prism are fairly brilliant and marked with natural etchings. Twins occur parallel to *c* (0001).

[1]Smith, J. L. Am. Jour. Sci. Ser. 2. 20:251.

Second type. The scalenohedron Λ $(15.4.\overline{19}.3)$ which is common in crystals from this locality is developed in long, slender forms, the brilliant faces of which give excellent reflections and are susceptible of exact measurements. The rhombohedron *e* $(01\bar{1}2)$ terminates this type [fig. 7]. Twins occur according to two laws, parallel to *c* (0001) and parallel to *e* $(01\bar{1}2)$. The pyrite inclusions observed in connection with crystals of this type take the form of phantoms outlining the faces of a steep scalenohedron, possibly Λ $(15.4.\overline{19}.3)$. The largest crystals of this type were 25 mm in length.

Third type. As in the preceding type the scalenohedron Λ $(15.4.\overline{19}.3)$ and the rhombohedron *e* $(01\bar{1}2)$ form the distinguishing habit of this type, but developed in rather more equal proportions, giving rise to crystals of rather blunter aspect. The basal scalenohedral edges are beveled by the prism *e* $(11\bar{2}0)$ and those between the scaleonohedron and rhombohedron by the small triangular faces of the rhombohedron *M* $(04\bar{4}1)$, this latter being only occasionally present. The basal plane *c* (0001) is also occasionally present in this type [fig. 8]. Twins are of frequent occurrence parallel to *c* (0001). The largest crystal noted measured 8 centimeters in length.

Fourth type. Crystals of this type, which were noted on but one specimen, are of prismatic habit showing *a* $(11\bar{2}0)$ terminated by the rhombohedron *e* $(01\bar{1}2)$ and modified by the positive scalenohedron Λ $(15.4.\overline{19}.3)$ and the negative scalenohedron n $(3.16.\overline{19}.2)$ [fig. 9]. Crystals are small but with bright faces giving fair reflections.

Fifth type. Crystals of the fifth type though by no means common were noted in a number of instances. They are characterized by the equal development of the rhombohedrons *e* $(01\bar{1}2)$and *η* $(04\bar{4}1)$, the modifying form being the prevailing scalenohedron Λ $(15.4.\overline{19}.3)$. The rhombohedrons of this type are notably striated parallel to their intersection edges [fig. 10].

Sixth type. Crystals referable to this type are quite common, being noted in as many as eight specimens. They are of rhombohedral habit, the preponderance of the rhombohedron T $(0.12.\overline{12}.1)$ (*new*) giving to them an aspect almost prismatic. The rhombohedron *l* $(04\bar{4}5)$ which with *e* $(01\bar{1}2)$ terminates the type is of variable development from a face equal to *e* $(01\bar{1}2)$ in habit to a mere line [fig. 11]. Vicinal planes are frequent in crystals of this type and are often present to such an extent as to modify the basal edges to curved lines and give to the crystal the aspect shown in figure 12.

Seventh type. Crystals of the seventh type are rhomhohedral in aspect and present scalenohedrons of the zone $[01\bar{1}2.10\bar{1}1.11\bar{2}0]$ as shown in figure 13. Of these the faces composing the middle band belong to the form *v* $(61\bar{7}5)$ while those which, with the rhombohedron *e* $(01\bar{1}2)$, form the termination are built up faces, probably belonging to *D* $(8.1.\bar{9}.10)$ though the presence of vicinal planes and striations render the measurements obtained from these faces vague and the form uncertain. The rhombohedron *r* $(10\bar{1}1)$ and the prism *a* $(11\bar{2}0)$ also occur. The presence of pyrite inclusions arranged on the phantom faces of the rhombohedron *a* $(10\bar{1}1)$ suggest that crystals of this type were produced by a "building up" process from secondary calcareous solutions upon primative, rhombohedral crystals. Small amounts of galena and sphalerite were found associated with this phase of the Rondout calcite.

Eighth type. Crystals of this type are notably larger than those heretofore described and are characterized by rather dull faces. The combination shown in figure 14 which represents this phase consists of the positive scalenohedrons λ $(31\bar{4}2)$ Y $(53\bar{8}2)$ and Θ $(10.3.\bar{13}.2)$ terminated with the rhombohedron $(01\bar{1}2)$. Of these the scalenohedron λ $(31\bar{4}2)$ is represented by dull and roughened faces and the scalenohedron γ $(53\bar{8}2)$ is frequently absent from crystals of this type. Pyrite inclusions are present on, or just below, the surface of *e* $(01\bar{1}2)$, as distinct bands bisecting the symmetry along the edges of *r* $(10\bar{1}1)$ and often terminating in brushes [fig. 15]; in some cases noted these bands were connected by lateral extensions along the basal edges of *r* $(10\bar{1}1)$. Phantoms of opaque white calcite which are shown on the cleavage and take the form of the rhombohedron *r* $(10\bar{1}1)$ suggest the secondary derivation of this type from a simpler primitive crystal.

Ninth type. The rhombohedron *r* $(10\bar{1}1)$ which gives to crystals of this type a distinct rhombohedral habit, is represented by large dull faces. The rhombohedron *e* $(01\bar{1}2)$ which modifies the terminal edges, and the prism *a* $(11\bar{2}0)$ which modifies the basal edges of *r* $(10\bar{1}1)$ are present as narrow bright faces. The scalenohedron Λ $(15.4.\bar{19}.3)$ is occasionally present as a modification represented by small faces of medium brilliancy [fig. 16].

TWINNING

Twin crystals are quite frequent among the calcite forms from Rondout, the common type being that formed with the twinning plane parallel to *c* (0001). Several instances were noted of crystals of the second type twinned parallel to *e* $(01\bar{1}2)$. Figure 17 shows a crystal of the first type twinned parallel to *c* (0001) in which the natural etchings present on the prismatic planes, emphasize the twinning habit. Figures 18 and 19 show twin crystals of the second type twinned according to both laws mentioned above. Figure 20 shows a twin crystal of the third type.

SUMMARY OF OCCURRING FORMS

Forms		First type	Second type	Third type	Fourth type	Fifth type	Sixth type	Seventh type	Eighth type	Ninth type
0001	*c*			×						
$10\bar{1}0$	*m*	×								
$11\bar{2}0$	*a*			×	×			×		×
$10\bar{1}1$	*r*							×		×
$01\bar{1}2$	*e*	×	×	×	×	×	×	×	×	×
$04\bar{4}5$	*l*						×			
$04\bar{4}1$	*η*					×				
$0.12.\overline{12}.1$	*T*						×			
$8.1.\bar{9}.10$	*D*							× ?		
$61\bar{7}5$	*ν*							×		
$31\bar{4}2$	*λ*								×	
$5.3.\bar{8}.2$	ϒ								×	
$10.3.\overline{13}.2$	*θ*		×	×	×	×				×
$15.4.\overline{19}.3$	*A*				×					
$3.16.\overline{19}.2$	𝔫								×	

SUMMARY OF MEASURED AND CALCULATED ANGLES[a]

Forms		0001 Λ ohhl		X hkil Λ hikl		ϒ hkil Λ ikhl		Z hkil Λ khil	
		measured	calculated	measured	calculated	measured	calculated	measured	calculated
$01\bar{1}2$	*e*	45° 3′	45° 3′						
$04\bar{4}5$	*l*	38° 6′	38° 16¾′						
$04\bar{4}1$	*η*	75° 43′	75° 47′						
$0.12.\overline{12}.1$	*T*[b]	85° 15	85° 10½						
$8.1.\bar{9}.10$	*D*					7° 30′	7° 29½′		
$6\,1\bar{7}5$	*ν*					12° 4′	12° 0′	85° 54′	85° 59′
$3\,1\bar{4}2$	*λ*					24° 13′	24° 10′	66° 39′	66° 15½′
$10.3.\overline{13}.2$	*θ*					25° 19′	25° 5′	39° 15½′	39° 13′
$15.4.\overline{19}.3$	*A*			95° 3′	95° 2′	22° 43′	22° 41′	41° 44′	41° 54′
$3.16.\overline{19}.2$	𝔫					16° 46′	16° 52′	44° 56′	44° 57½′

[a]The scalenohedron ($5\bar{3}82$) was identified by means of measurements taken with a contact oniometer. [b]New.

CALCITE FROM UNION SPRINGS, CAYUGA CO.

In the summer of 1899 Dr John M. Clarke, then State Paleontologist, found at Union Springs some extremely interesting crystals of calcite. Several specimens of these were sent to Yale University and were described by Messrs Penfield and Ford[1]. The writer has found by a careful study of the bulk of the material collected by Dr Clarke (some 70 specimens) some points of additional interest not shown in the comparatively small amount of material available for the above article.

The calcite crystals under consideration occur in vein material in the Onondaga limestone associated with saddle-shaped aggregates of dolomite and more rarely with crystallized quartz. They represent two generations, separated by a period in which dolomite was deposited, of which the older consists of brilliant individuals of extremely varied habit which are for the most part small, varying from 3 to 10 millimeters in length. One type of these crystals of the first generation is represented in figure 1, of the article by Penfield and Ford, above cited.

The crystals of the second or younger generation are generally larger in size than those of older deposition and are largely of scalenohedral type, showing a marked tendency to twinning according to several laws. They are frequently of a dull surface and black or dark gray in color as the result of bituminous inclusions. It is these latter which have been described at length by Penfield and Ford.

The small brilliant crystals of the first generation contain frequent inclusions of pyrite chalcopyrite and marcasite in microscopic individuals, the latter mineral in beautiful doubly terminated twin crystals, specially prevalent in forms of the rhombohedral type. Frequent zones of deposition of these inclusions occur which renders their aspect almost that of a phantom within the crystal.

Pyramidal type. The second order pyramid, γ $(8.8.\overline{16}.3)$ is a peculiarly dominant form in crystals from this locality, particularly so with crystals of the first generation. In the type shown in figure 21 which occurs in the lining of a thin seam, the form occurs developed to the exclusion of all modifications except those of the terminal rhombohedrons *r* $(10\bar{1}1)$ and *e* $(01\bar{1}2)$. These crystals are exceedingly small, the largest not exceeding 4 millimeters in length and quite brilliant, giving very satisfactory reflections when measured.

The pyramidal type as shown in figure 21 is, in some cases, modified by narrow faces in the prismatic zone, the type gradually merging into the combination shown in figure 23 which may be regarded as a transitional type between the pyramidal [fig. 21] and

[1] Penfield, S. L. & Ford, W. C. Some Interesting Developments of Calcite Crystals. Am. Jour. Sci. 1900. 10:237–41.

the scalenohedral [fig. 25] types. In this series the combination shown in figure 24 forms an additional link in the sequence of development from the pyramidal to the scalenohedral types.

Regarding the genetic relationships of the members of this interesting series, the writer can do little more than speculate. It is, however, quite apparent, from its position, which is always that of close proximity to the walls of the seam, that the pyramidal type occupies the lowest place in the crystal development, representing the oldest generation of calcite. It is equally certain that the scalenohedral type is predominant in crystals of the second generation which might possibly have been, in a measure, derived from the re-solution of the first generation of calcite. Between these limits we find a variety of expressions of crystal habit which, when considered with reference to the main facts above noted, leads us to seek for the solution of the crystallogenetic problem along several lines. It is the opinion of the writer that, in the case of the Union Springs locality at least, development in crystal habit is not dependent solely on chemical or physical differences in the crystallizing solutions, but is further complicated by the presence of external forces.

Occurring forms and combinations

As previously noted, the second order pyramid γ $(8.8.\overline{16}.3)$ is of characteristic occurrence in the Union Springs calcites, specially in those of the first generation. It is present as a series of brilliant faces giving good reflections and only in the case of the prismatic crystals shown in figure 22 does it show any tendency toward merging into vicinal planes. In the above exception there appear traces of a steeper pyramid which could not, however, be identified from the material at hand. Figure 22 shows a prismatic habit which is clearly a phase of the second generation. The crystals of this habit are considerably larger than those generally noted from this locality, individuals 30 millimeters in length being not uncommon. Inclusions of marcasite in microscopic crystals are so plentiful as to render the calcite, which would otherwise be transparent, quite translucent. These inclusions are distributed along planes parallel to the rhombohedron r $(1\bar{1}01)$. The planes of a $(11\bar{2}0)$ and γ $(8.8.\overline{16}.3)$ are both sharp and brilliant as are also, to a lesser degree, those of π $(3.16.\overline{19}.2)$. As has already been shown[1] the rare scalenohedron π $(3.16.\overline{19}.2)$ also occurs on crystals of prismatic habit at Rondout. The planes of e $(0\bar{1}12)$ are dull and

[1] See page 8.

those of m $(10\bar{1}0)$ brilliant but somewhat rounded and covered with vicinal prominences.

In the combination shown in figure 23 which is represented by small, bright transparent crystals of the first generation, the prismatic zone is developed as a narrow band encircling the crystal, both a $(11\bar{2}0)$ and m $(10\bar{1}0)$ being present. The second order pyramid γ $(8.8.\overline{16}.3)$ which is here present as a characteristic form is beveled on alternate edges by the positive rhombohedron $M(40\bar{4}1)$ lying in the zone $[8.8.\overline{16}.3.\ 16.8.\bar{8}.3]$. A new scalenohedron X $(81.41.\overline{122}.40)$ very near the common v $(21\bar{3}1)$, is present as a prominent form. This combination is quite similar to that figured by Penfield and Ford[1]; it is common on a number of specimens and, as previously noted, appears genetically to form a connecting link between the pyramidal type of the first generation and the scalenohedral type of the second.

Figure 24 shows a combination which mainly differs from the preceding in that the scalenohedron v_1 $(7.4.\overline{11}.3)$ takes the place of X as a predominating form, the latter form being present only as a subsidiary modification and frequently passing into the commoner form, v $(21\bar{3}1)$. This combination is distinctly scalenohedral in habit and occurs mingled with secondary crystals of the form shown in figure 25 which latter frequently shows the suppression of the pyramid γ. The type shown in figure 26 is found in crystals of the second generation which occur deposited on a thin layer of first generation calcite of rhombohedral habit [*see* figure 28]. These differ from all which have been previously described in two essential characteristics: they are opaque and milky white in color and show a complete absence of all marcasite or pyrite inclusions. In crystallization this type is also unique showing the scalenohedron U $(10.4.\overline{14}.3)$ in the zone $[40\bar{4}1.8.8.\overline{16}.3]$ as a highly developed form. A negative rhombohedron η $(0\bar{4}41)$ is present as a narrow face beveling the alternate pyramidal edges. M, X, r and γ are all present as bright, well defined faces.

The rhombohedron r $(10\bar{1}1)$ which is present as a modification on the combinations shown in figures 21, 23, 24, 26 is developed to the extent of a crystal habit in the case of the types shown in figures 27 and 28 which represent crystals of the first generation. Of these figure 27 may be regarded as a rhombohedral phase of figure 23 showing an additional scalenohedron C $(61\bar{7}8)$ in the zone $[0\bar{1}12.10\bar{1}1.11\bar{2}0]$. The crystals, which contain the marcasite in-

[1]Penfield, S. L. & Ford, W. E. Some Interesting Developments of Calcite Crystals. Am. Jour. Sci. 1900, 10: 237, fig. 1.

clusions characteristic of the younger calcite in this locality, often show elongation parallel to the rhombohedral zone assuming a somewhat prismatic aspect. They apparently fill a gap in the genetic series between the pyramid scalenohedral habit [fig. 23] and the distinctly rhombohedral habit shown in figure 28.

Crystals of this last type [fig. 28] occur in a loosely compacted mass deposited on a layer of crypto-crystalline carbonate of lime occupying the space between the crystallized calcite and the limestone wall of the cavity or vug to the depth of about 5 millimeters. The calcite crystals are piled upon this crystalline layer to the depth of from 10 to 15 millimeters, the largest individuals lying in the top layers. The order and manner of deposition suggest the possible derivation from a solution which originally completely filled the space and deposited its dissolved carbonate of lime first from a rapidly then from a slowly cooling medium. The crystals of this type which are remarkably clear, brilliant and well developed, range in size from 5 to 20 millimeters in diameter. All the faces give excellent reflections. The middle edges of the rhombohedron *r* $(10\bar{1}1)$ are beveled by the scalenohedron *X* $(81.41.\overline{122}.40)$ which throughout this occurrence replaces the common form *v* $(21\bar{3}1)$ which it approaches very closely. It was only after repeated measurement of a number of crystals, both of this and of the foregoing types that the form was considered as established. The prism *a* $(11\bar{2}0)$ is present as a small face in this zone. In the zone of the pyramidal faces $[16.8.\bar{8}.3.8.8.\overline{16}.3]$ occur the forms *M* $(40\bar{4}1)$ and *S'* $(19.10.\overline{29}.6)$ both lying well within the zone and agreeing as to measured angles well within the limits of accuracy.

The twin crystals of the second generation have been so amply described by Messrs Penfield and Ford that there is little to add. The twin crystal shown in figure 29 occurs on several specimens in milky individuals of about 20 millimeters diameter, which suggest in their rather peculiar development the familiar types occurring at Rossie, St Lawrence co[1].

Figure 30 shows the prevailing type of scalenohedral twin, the habit being that of the scalenohedron v. $(7.4.\overline{11}.3)$ and the twinning plane parallel to the rhombohedron *e* $(01\bar{1}2)$. The reentrant angle or "gash" is chiefly formed by the planes of γ $(8.8.\overline{16}.3)$ and *m* $(10\bar{1}0)$.

[1]Nason, F. L. Some New York Minerals and their Localities. N. Y. State Mus. Bul. 4. 1888.

SUMMARY OF MEASURED AND CALCULATED ANGLES

		0001∧h.h.2h.l		h.h.2hl∧ 2h.h.h.l		X hkil∧hikl		Y hkil∧ikhl		Z hkil∧khil		
		Measured	Calculated	Measured	Calculated	Measured	Calculated	Measured	Calculated	Measured	Calculated	
8.8.16.3	γ	77° 48′	77° 37′	58° 25′	58° 28′							*a*
6178	*C*					59° 44′	59° 46′	9° 37′	9° 31′			
2131	*v*					75° 17′	75° 14′	35° 36′	35° 36′	47° 7′	47° 1 ½′	*a*
81.41.122.40	*X*							35° 52′	36° 00′	46° 21′	46° 20′	*b*
7.4.11.3	*v′*							40° 1′	40° 4′	39° 2′	39° 11′	*a*
19.10.29.6	*S′*							38° 10′	38° 33′	33° 17′	33° 28′	*a*
3.16.19.2	n							17° 4′	16° 52′	44° 32′	44° 57½′	

*a*Found also on calcite from Rhisnes. *b*New.

The prevalence of the rare pyramid γ (8.8.16.3) throughout the varied types of calcite crystals occurring at Union Springs has led the writer to compare these latter with the types presenting this form, which have been noted at other localities. The pyramid γ (8.8.16.3) is found in the calcite at Rhisnes, about 4500 meters northeast of Namurs in Belgium[1], at Andreasberg in the Hartz[2] and in the Bad Lands of South Dakota[3]. Regarding the crystals from Rhisnes, Cesàro has noted not only the pyramid γ (8.8.16.3) above mentioned, but also the forms *M* (4041), *η* (0441), *v* (2131) and S' (19.10.29.6) as well as the occurrences of the prismatic zone [1120.-1010]. Several of his types are identical in form and habit with figures 21 and 23 as well as a twin crystal similar to figure 30. Cesàro finds evidence that many of the crystals from Rhisnes of the first generation have been formed around a parent crystal having γ (8.8.16.3) as the dominant form.

He announces a theory of genesis of these crystals as follows:

The examination of these crystals has led us to the conclusion that they have been formed encircling a pre-existing second order pyramid and were deposited by the action of three successive mediums: the first producing pyramidal types, the second forming around the first a combination the faces of which are truncations of the lateral edges of γ, the third depositing around the second stage a crystal having for fundamental form scalenohedrons of the zone [1011.1120].

This sequence of generation appears to agree perfectly with that already given on page 12 with reference to the Union Springs calcites. The truncation of the lateral edges being produced in the latter instance by the rhombohedron *M* (4041) as shown in

[1] Cesaro, G. Les Formes Cristallines de la Calcite de Rhisnes. Ann. de la Soc. Geol. de Belgique 1889. 16:163.

[2] vom Rath, G. Pogg. Annalen 1867. 138:521.

[3] Penfield, S. L. & Ford, W. E. Siliceous Calcites from the Bad Lands, Washington County, S. D. Am. Jour. Sci. 1900. 9:352.

figure 23. Certainly the occurrence of such similarity in crystal habit involving one or more rare forms can not be set down as a mere coincidence and when, as will be presently pointed out, the geological conditions show a corresponding similarity at the two localities, we are led to connect the two phenomena.

At Andreasberg the pyramid Y was first noted by vom Rath in 1867. Sansoni[1] in 1884 failed to find this pyramid, but as pointed out by Cesàro, the doubtful scalenohedron $(7.8.\overline{15}.4)$ given by Sansoni approaches very near the pyramid $(8.8.\overline{16}.3)$ in intercepts and is probably the same. The latter compares the forms of the Rhisnes calcites with those found by Sansoni at Andreasberg and points out several interesting similarities.

Both Rhisnes and Andreasberg lie in the horizon of the Devonic and Upper Carbonic rocks and present the phase of subordinate beds of limestone overlaid by graywacke, clay slate, silicious slate and quartzite. In the vicinity of Andreasberg, these strata are frequently broken through by granite masses[2]. These conditions show a marked analogy to those existing at Union Springs, where the limestone beds are overlaid by the shale and silicious slate of the Marcellus and Hamilton groups and show evidences of considerable local disturbance. The limestone on which the Union Springs pyramidal calcite crystals are deposited is unique in that the silicious residue obtained from its solution consists of minute but perfectly formed quartz crystals. As pointed out by Penfield and Ford[3] pyramidal crystals of calcite, of the form $(8.8.\overline{16}.3)$ and containing nearly 50% quartz sand, have been found in the Bad Lands of South Dakota. It would, therefore, appear that in at least two localities producing this rare pyramid as a crystal habit, the occurrence is marked by the presence of silica under rather unusual circumstances. When we add to this fact the equally significant one that the formations at Union Springs and at the Belgium and Hartz localities show in each instance disturbed limestone beds overlaid by strata rich in silica we would seem to have reason for connecting the pyramidal habit of calcite with a crystallizing solution carrying silica in quantities approaching saturation.

CALCITE FROM HOWES CAVE

Calcite occurs at Howes Cave, Schoharie county, N. Y. in brilliant transparent crystals filling or partly filling the veins in the Rondout limestone. The specimens which form the basis for the

[1] Sansoni. Att. Acc. Linc. Mem. 3. 1884. 19:450.
[2] Phillips, J. A. & Louis, Henry. A Treatise on Ore Deposits. 1896. p. 384.
[3] Penfield, S. L. & Ford, W. E. Silicious Calcites from the Bad Lands, Washington County S. D. Am. Jour. Sci. 1900. 9:352

following notes were collected by the writer, through the courtesy of the Helderberg Cement Co., from the mine which furnishes natural cement rock to this company. The crystals which vary in size from 40 millimeters in diameter to microscopic individuals are of uniform habit and are invariably characterized by a marked twinning parallel to *e* $(01\bar{1}2)$. They are frequently associated with tufted aggregates of acicular aragonite which appears, in one instance at least, to have been derived from the re-solution of the calcite. In the instance noted a geodic mass almost completely filled with crystallized calcite yielded on fracture several fine tufts of aragonite deposited on calcite crystals of the prevailing habit which latter were found to be deeply pitted with natural etchings. Calcite crystals of a second type were found in the Helderberg limestone, overlying the Rondout, lining the fossil remains of Rhynchonella wilsoni with which portions of this formation are thickly studded. These latter differ somewhat from the type of the principal occurrence and will be discussed as a supplementary type.

The crystals of the principal type shown in figure 31 exhibit a complex combination of forms occurring in several clearly defined zones; the relation of these is shown in the spherical projection [fig. 33].

Rhombohedrons. The rhombohedron *r* $(10\bar{1}1)$ is frequently present alternating with the low scalenohedron *q* $(51\bar{6}7)$ which latter, although clearly defined, is without question a built up form more or less vicinal in character. The planes of *r* are smooth but rather dull. The rhombohedrons *M* $(40\bar{4}1)$ and *τ* $(70\bar{7}1)$ occur as narrow but extremely brilliant faces, giving excellent reflections and beveling the edges of *U* $(10.4.\overline{14}.3)$ and *V* $(62\bar{8}1)$ respectively. In the zone with these is also found the negative rhombohedron Φ $(0.14.\overline{14}.1)$ occurring as small triangular faces of fine brilliancy.

The rhombohedron *e* $(01\bar{1}2)$ is universally present as brilliant faces which make excellent points of reference in this zone.

Scalenohedrons. As previously noted the scalenohedron *q* $(51\bar{6}7)$ is present in many instances as a built up form with deeply striated faces giving poor reflections. The basal edges of *q* are modified by the common scalenohedron *v* $(21\bar{3}1)$ the obtuse polar edges of which are terminated by the scalenohedrons *U* $(10.4.\overline{14}.3)$ and *V* $(62\bar{8}1)$. Owing to the fact that the indexes of these latter forms are quite near those of *v* and to one another their intersection edges are not distinctly marked, the successions of forms tending to produce a slight rounding of the crystal toward the rhombohedral zone. Excellent reflections were, however, obtained from all of these scalenohedrons and the closeness in agreement of the observed angles with theoretical values, taken, together with the fact that the rhombohedrons *M* and *τ*, which truncate the polar edges of *U* and *V* respectively, lie well in the zones of these faces, establish their identity beyond peradventure. The negative scalenohedron *N* ($4.16.\bar{20}.3$) which is invariably present is characterized by small, sharp and brilliant faces.

Twinning. A very marked tendency toward twinning parallel to the plane *e* ($01\bar{1}2$) results in the production of thin flat extensions of one individual of the pair and the formation of a deep reentering angle as shown in figure 32. So common is this form of twinning that it is rarely absent from crystals of this occurrence to which it gives a distinct character. Twinning according to this law is common in calcite crystals and examples of it may be found in almost every important occurrence. The abnormal extension of one member of the twin above noted is, however, unique and seems to indicate a metagenic rather than a paragenic mode of twinning.

The calcite crystals found in the fossil remains of Rhynchonella wilsoni show combinations of the supplementary type illustrated in figures 34 and 35. The crystals though small are remarkably brilliant and give excellent reflections in all zones. Of the observed forms *M* ($40\bar{4}1$), *e* ($01\bar{1}2$), *r* ($10\bar{1}1$) and *v* ($21\bar{3}1$) are common to the crystals previously described from the underlying beds of the Rondout limestone. The scalenohedrons are all of the zone [$0\bar{1}12.10\bar{1}1$]. The scalenohedron *E* ($41\bar{5}6$), here replaces *q* of the principal type. This form appears as a series of well developed planes having none of the vicinal characters which mark the development of *q* of the principal type. The scalenohedron *λ* ($31\bar{4}2$) occurs as a series of narrow faces between *v* and *r*. Traces of the characteristic twinning which mark the crystals of the principal type are here noted; the twinning tendency is, however, very weak and only finds expression in an occasional shallow reentering "gash."

SUMMARY OF MEASURED AND CALCULATED ANGLES

		0001 ∧ h0hl		X hk$\bar{i}$l ∧ hi$\bar{k}$l		Y hk$\bar{i}$l ∧ ik$\bar{h}$l		Z hk$\bar{i}$l ∧ kh$\bar{i}\bar{l}$	
		Measured	Calculated	Measured	Calculated	Measured	Calculated	Measured	Calculated
70$\bar{7}$1	*τ*	82° 3′	81° 45½′						
40$\bar{4}$1	*M*	75° 46′	75° 47′						
10$\bar{1}$1	*r*	44° 44′	44° 37′						
0.14.$\overline{14}$.1	*Φ*	85° 54′	85° 51½′						
01$\bar{1}$2	*e*	26° 14½′	26° 15′						
21$\bar{3}$1	*v*			75° 27′	75° 22′	35° 28′	35° 36′	46° 56′	47° 1½′
31$\bar{4}$2	*λ*							66° 17′	66° 15½′
41$\bar{5}$6	*E*			54° 9′	54° 7′	13° 12′	13° 3½′		
10.4.$\overline{14}$.3	*U*					31° 11′	31° 16′	38° 50′	38° 49′
6.2.$\bar{8}$.1	*V*					27° 26′	27° 31′	35° 43′	35° 52′
4.16.$\overline{20}$.3	*N*					21° 29′	21° 30′	42° 20′	42° 27′

DATOLITE FROM WESTFIELD MASS.

In February 1905 the State Museum acquired by exchange from Mr R. F. Jones a number of specimens of datolite from Lane's trap quarry near Westfield Mass. As the quality of this occurrence far exceeds that of the datolite hitherto described from this region, in size, beauty and complexity of crystallization, the writer has added the following notes to the foregoing descriptions of New York minerals in the hope that the unusual interest attached to these crystals will prove sufficient excuse for such an extralimital digression.

The datolite occurs in veins in a diabase which shows evidence of considerable folding and decomposition, particularly along the walls of the vein where it is entirely replaced by prochlorite. The crystals which in some instances measure 10 cm. on the *b* axis are deposited on a thin layer of calcite. They are cut through by deep parallel furrows due to the former presence of mica which has been dissolved away leaving the cast, partly filled with calcite of a later generation; fragments of this mica, highly altered, were found in place. In color the crystals are whiter than those from the New Jersey trap region which they strongly resemble in crystal habit. The presence of second generation calcite of the form *f* (02$\bar{2}$1), which also occurs associated with the datolite from West Paterson, gives added significance to this similarity. The faces are almost universally sharp and brilliant and fall well within several clearly marked zones, greatly facilitating the ease and accuracy of their identification.[1]

Cleavage was noted parallel to a, quite perfect, and parallel to c, somewhat less so; the measured angles gave $m \wedge a$ (cleavage) = 32° 18½′, and $g \wedge c$ (cleavage) = 19° 18′, the calculated value for these angles being 32° 23½′ and 19° 22′ respectively.

Figures 37 and 38 represent the prevailing crystal habit, the disposition of the planes in zones being shown in the spherical projection, figure 36. The intersection of zones in the plus half of the projection is specially interesting. Three new hemipyramids were observed in zone [001.140] as narrow faces beveling the edges between the clino dome *g* (012) and three prominent hemipyramids ϵ $(\bar{1}12)$, λ $(\bar{1}13)$ and μ $(\bar{1}14)$ in the zone [001.110]. These gave the indexes $\bar{1}48$, $\bar{1}49$ and $\bar{1}.4.10$ respectively and were assigned the letters ϵ', λ' and μ'. A plane in the zone [001.120] which is quite prominent in these crystals gave the indexes $\bar{1}22$ and is noted in the text and projections as *M*. An enlarged projection of a portion of one of the typical crystals drawn in reversed position to show the disposition of these rare planes is given in figure 39.

Pinacoids. The three pinacoids *a* ,(100); *b*, (010) and *c* (001) are commonly present, the two former as brilliant faces and the latter as a somewhat dull series. The clinopinacoid *b* which is present as a very narrow face serves as an excellent plane of reference in orienting the crystal.

Prisms. The faces in the prismatic zone are characterized by considerable brilliancy. The prisms *m* (110) and *o* (120) are commonly present; *r* (230) was noted in two instances on quite small crystals.

Domes. In the zone of the hemiorthodomes *x* (102) is prominent giving to the combination a habit very similar to the Bergen Hill and West Paterson occurrences; *v* (103) is often absent. The presence of one or more hemidomes between *a* and *x* was noted in several instances, but the faces were so minute and ill defined that it was impossible to obtain any definite measurements from them.

The zone of the clinodomes is, on the other hand, very well developed, showing *m* (011), *g* (012), *t* (013) and Ω (018), the latter sometimes present.

[1] In measuring the dull faces, notably 012 and 018 in the zone of the clinodomes and 103 in the zone of the orthodomes, the method of placing a drop of alcohol on the dull face was successfully used to obtain a clear reflection of the goniometer signal. The face was brought into approximate position and moistened by a drop of alcohol applied by means of a dropping tube. The curved surface of the drop at first gives the effect of a series of multiple images; these, however, as the drop reduces in thickness by evaporation, gradually merge to a center and at the instant preceding complete evaporation combine in a clear and bright image of the signal. The writer finds this expedient more satisfactory than the usual method of a cemented cover glass and suggests it for crystals not soluble in alcohol.

Pyramids. The hemipyramids of the zone [001.110] form a regular series universally present as well defined planes; of these *n* (111), ν ($\bar{1}$11) and ε ($\bar{1}$12) are particularly well developed. The hemipyramids λ ($\bar{1}$13), μ ($\bar{1}$14) and κ ($\bar{1}$15) are represented by relatively narrow faces often showing natural etchings. In the zone [001.120] the planes of the hemipyramids *Q* (122), β (121), *M* (122), *i* (123) and α (124) are represented by small narrow faces beveling the edges between the planes of the clinodome zone and those of the zone [001.110]. They were for the most part identified by zone equasions. The rare faces ($\bar{1}$48), ($\bar{1}$49) and ($\bar{1}$.4.10) have been already noted in the zone [001.140]. This series of planes gave fair reflections and were measured on five crystals, the results agreeing with theory within the limits of accuracy.

Twinning was observed on one crystal 8 centimeters in length on the *b* axis. This crystal which is shown in figure 40 is a penetration twin parallel to *a* (100); having *c* for the twinning axis. The larger individual is of the snowy white color, which is common to the occurrence and which suggests the color of cryolite; the smaller individual which is shown protruding from this last is light greenish in color, transparent and resembles the typical Bergen Hill datolite.

A list of the occurring forms with the measured and calculated angles is given below.

SUMMARY OF OCCURRING FORMS, MEASURED AND CALCULATED ANGLES

Zone [a. c]

			Measured	Calculated
a	100	*ax*	45° 0′	45° 0
x	102	*cx*	44 53	44 51
v	103	*cv*	33 46	33 35
c	001			

Zone [c.b]

			Measured	Calculated
b	010	bm_x	38° 15′	38° 18½′
*m*x	011	$m_x m'_x$	103 16	103 23
g	012	*gg′*	64 37	64 39½
t	013	$m_x g$	19 22	19 22
Ω	018	*gt*	9 26	9 27½
		tΩ	13 43	13 53

Zone [a.m]

			Measured	Calculated
m	110	*am*	32° 25⅓′	32° 23½′
o	120	*ao*	51 50	51 45½
r	230	*or*	8 12	8 10

Zone [m.n.ε]

n	111	*nm*	22° 54′	22° 56′
ν	$\bar{1}11$	*mν*	22 56	22 57
ε	$\bar{1}12$	*νε*	17 18⅓	17 21
λ	$\bar{1}13$	*ελ*	11 30½	11 33
μ	$\bar{1}14$	*λμ*	7 36	7 40
κ	$\bar{1}15$	*μκ*	5 13	5 17

[Zone [β.o.α]

Q	122	*oQ*	31° 47′	31° 48′
β	121	*oβ*	17 13	17 13½
α	$\bar{1}24$	*mα*	28 19	
i	123			
M	$\bar{1}22$			

Zone [r.π]

π	$\bar{2}31$	*rπ*	10° 29′	10° 15′

Zone [g.ε]

		gε	39° 59′	40° 10′
ε′	$\bar{1}48$	*gε′*	11 46	11 54
		gα	22 45	22 51

Zone [g.λ]

λ′	$\bar{1}49$	*gλ*	32° 59′	32° 45′
		gλ′	11 26	11 19½

Zone [g.μ]

μ	$\bar{1}.4.10$	*g.μ*	29° 11′	29° 13′
		gμ′	11 28	11 21

EXPLANATION OF PLATES

PLATE 1

1 Marcasite from Rondout showing prevailing habit of crystals. Forms: *c* (001), *m* (110), *e* (101), *l* (011), *S* (111).

2 Marcasite from Rondout, showing repeated twinning. Forms: *c* (001), *m* (110), *e* (101), *l* (011). Figures 1 and 2 are shown with *b* axis vertical.

3 Pyrite from Rondout, showing cube twinned parallel to (110), producing L-shaped form.

4 Pyrite from Rondout, showing scepter crystal.

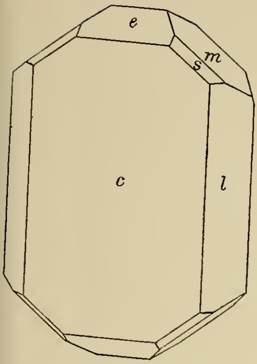
5,6 Quartz from Rondout, showing penetration twins on twinning axis *c*. Forms: *m* (10$\bar{1}$0), *r* (10$\bar{1}$1), 𝔪 (60$\bar{6}$5), *i* (50$\bar{5}$3), *z* (01$\bar{1}$1), *s* (11$\bar{2}$1), *v* (71$\bar{8}$1), ϵ (1231).

7 Calcite from Rondout showing crystals of the second type. Forms: Λ (15.4.$\overline{19}$.3), *e* (01$\bar{1}$2).

8 Calcite from Rondout showing crystal of the third type. Forms: *c* (0001), *a* (11$\bar{2}$0), *e* (01$\bar{1}$2) Λ (15.4.$\overline{19}$.3).

Plate I

1



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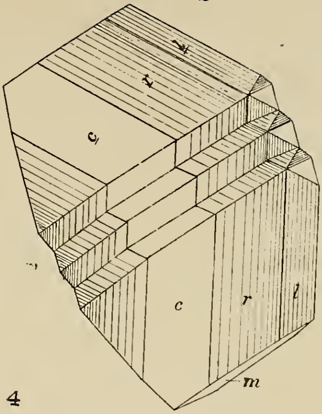

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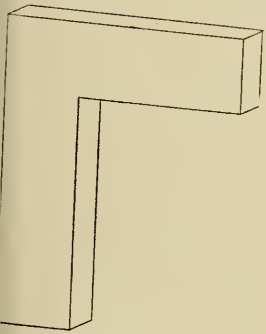

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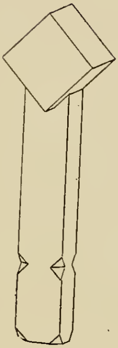

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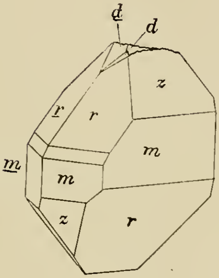

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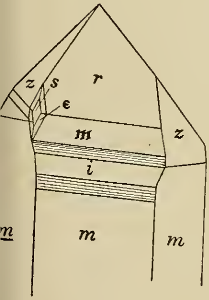

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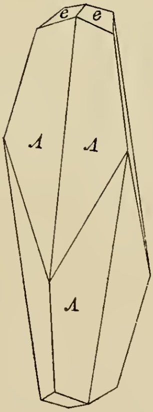

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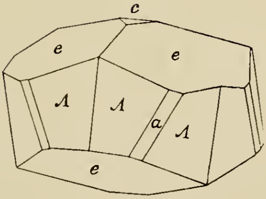


PLATE 2

9 Calcite from Rondout, showing crystal of the fourth type (prismatic habit). Forms: *a* $(11\bar{2}0)$, *e* $(01\bar{1}2)$, Λ $(15.4.\overline{19}.3)$, *n* $(3.16.\overline{19}.2)$.

10 Calcite from Rondout, showing crystal of the fifth type. Forms: *e* $(01\bar{1}2)$, *η* $(04\bar{4}1)$, Λ $(15.4.\overline{19}.3)$.

11 Calcite from Rondout showing crystal of the sixth type. Forms: *e* $(01\bar{1}2)$, *l* $(04\bar{4}5)$, *T* $(0.12.\overline{12}.1)$, the latter form is new to the species.

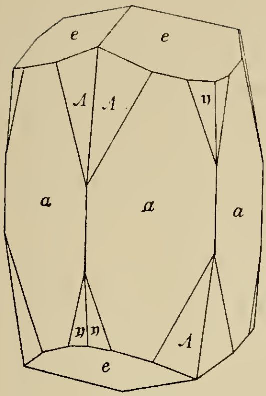
12 Calcite from Rondout, showing variation of the sixth type. The presence of vicinal planes in the zone of the negative rhombohedrons produce highly curved faces.

13 Calcite from Rondout, showing crystal of the seventh type. Forms: *r* $(10\bar{1}1)$, *e* $(01\bar{1}2)$, *ν* $(61\bar{7}5)$, *D* $(8.1.\bar{9}.10)$ (?).

14 Calcite from Rondout, showing crystal of the eighth type. Forms: *e* $(01\bar{1}2)$, λ $(31\bar{4}2)$, Υ $(53\bar{8}2)$, *θ* $(10.3.\overline{13}.2)$.

Plate 2

9



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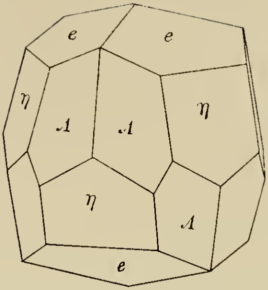

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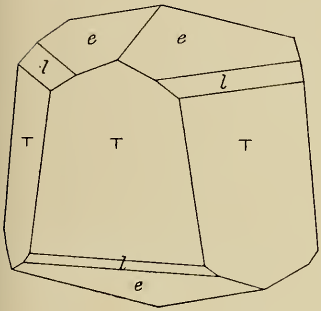

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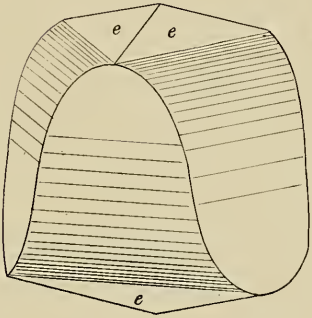

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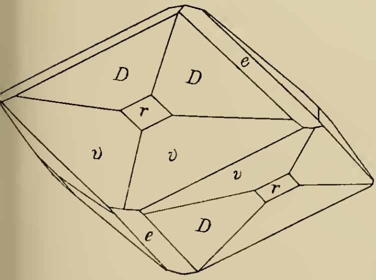

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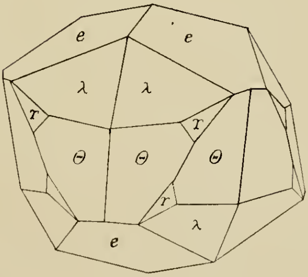


PLATE 3

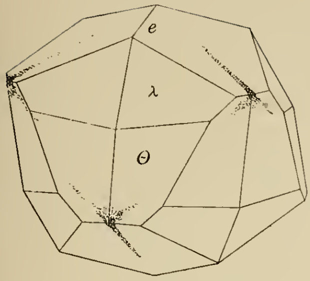
15 Calcite from Rondout, showing the development of pyrite inclusions on crystals of the eighth type.

16 Calcite from Rondout, showing crystal of the ninth type (rhombohedral habit). Forms: *a* $(11\bar{2}0)$, *r* $(10\bar{1}1)$, *e* $(01\bar{1}2)$, Λ $(15.4.\overline{19}.3)$.

17–20 Calcite from Rondout showing twin crystals. Figure 19 is drawn with the twinning plane *e* $(01\bar{1}2)$ vertical.

Plate 3

15



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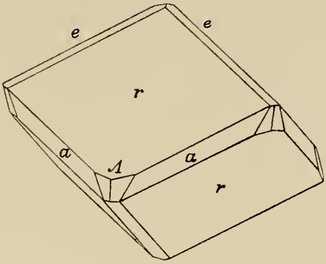

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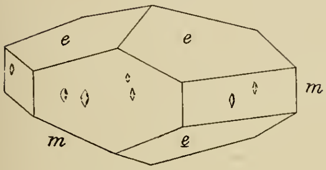

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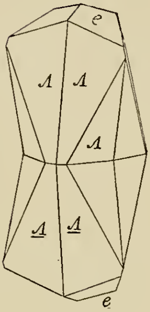

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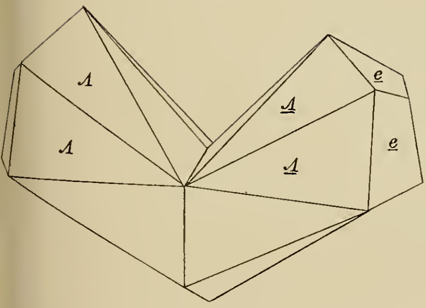

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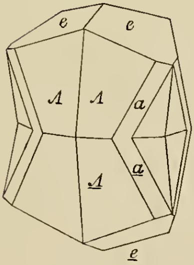


PLATE 4

21 Calcite from Union Springs, showing crystals of the pyramidal type characteristic of the first generation. Forms: γ (8.8.$\overline{16}$.3), *r* (10$\bar{1}$1), *e* (01$\bar{1}$2).

22 Calcite from Union Springs, showing crystal of prismatic habit marking one phase of the second generation. Forms: *m* (10$\bar{1}$0), *a* (11$\bar{2}$0), γ (8.8.$\overline{16}$.3), **n** (3.16.$\overline{19}$.2).

23 Calcite from Union Springs, showing crystal of transitional habit between pyramidal forms of the first generation [fig. 21] and scalenohedral forms of the second [fig. 25]. Forms: *m* 10$\bar{1}$0), *a* (11$\bar{2}$0), γ (8.8.$\overline{16}$.3), *r* (10$\bar{1}$1), *M* (40$\bar{4}$1), *X* (81.41.$\overline{122}$.40); the latter scalenohedron is new to the species.

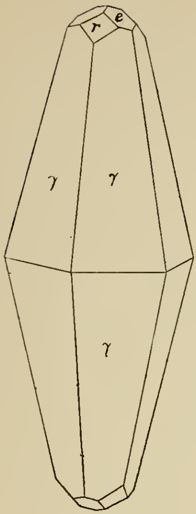
24 Calcite from Union Springs, showing crystal of scalenohedral habit characteristic of the second generation, but with subsidiary development of the predominating forms of figure 23. Forms: *m* (10$\bar{1}$0), γ (8.8.$\overline{16}$.3), *r* (10$\bar{1}$1), *m* (40$\bar{4}$1), *X* (81.41.$\overline{122}$.40), *v*, (7.4.$\overline{11}$.3).

25 Calcite from Union Springs showing crystal of distinctly scalenohedral habit. This combination is typical of the second generation. Forms: *m* (10$\bar{1}$0), *a* (11$\bar{2}$0), *M* (40$\bar{4}$1), *v*, (7.4.$\overline{11}$.3).

26 Calcite from Union Springs showing milky white crystal of second generation occurring with first generation crystals of rhombohedral habit [fig. 28.] Forms: *m* (1010), γ (8.8.16.3), *r* (10$\bar{1}$1). *M* (40$\bar{4}$1), η (0$\bar{4}$41), *X* (81.41.$\overline{122}$.40), *U* (10.4.$\overline{14}$.3).

Plate 4

21



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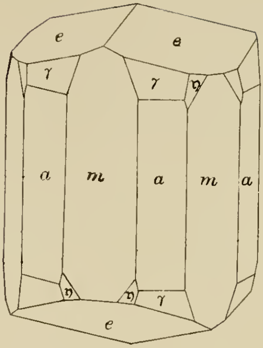

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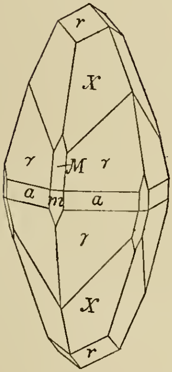

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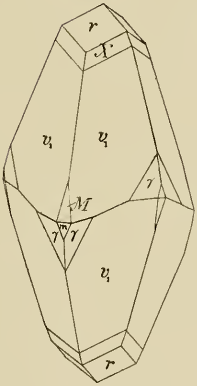

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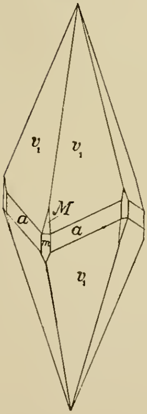

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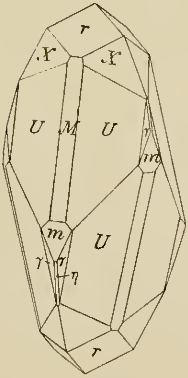


PLATE 5

27 Calcite from Union Springs, showing crystal of the first generation, transitional in habit between the pyramid-scalenohedral type [Fig. 23], and the rhombohedral type [fig. 28]. Forms: m $(10\bar{1}0)$, a $(11\bar{2}0)$, γ $(8.8.\overline{16}.3)$, r $(10\bar{1}1)$, M $(40\bar{4}1)$, e $(01\bar{1}2)$, C $(61\bar{7}8)$, X $(81.41.\overline{122}.40)$.

28 Calcite from Union Springs, showing crystal of the first generation of rhombohedral habit. Forms: a $(11\bar{2}0)$, γ $(8.8.\overline{16}.3)$, r $(10\bar{1}1)$, M $(40\bar{4}1)$, e $(01\bar{1}2)$, X $(81.41.\overline{122}.40)$, S' $(19.10.\overline{29}.6)$.

29 Calcite from Union Springs, showing milky crystal of the second generation twinned parallel to c. Forms: a $(11\bar{2}0)$, r $(10\bar{1}1)$, M $(40\bar{4}1)$.

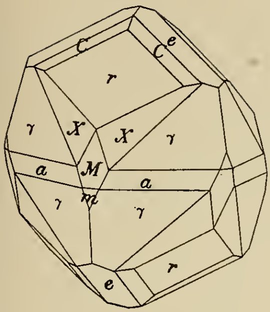
30 Calcite from Union Springs, showing the prevailing type of scalenohedral twin of the second generation. This combination is drawn with the twinning plane e $(01\bar{1}2)$ vertical. Forms: m $(10\bar{1}0)$, γ $(8.8.\overline{16}.3)$, v_1 $(7.4.\overline{11}.3)$.

31 Calcite from Howes Cave, showing principal type of crystal. Forms: M $(40\bar{4}1)$, τ $(70\bar{7}1)$, Φ $(0.14.\overline{14}.1)$, e $(01\bar{1}2)$, q $(51\bar{6}7)$, v $(21\bar{3}1)$, U $(10.4.\overline{14}.3)$, V $(62\bar{8}1)$, N $(4.16.\overline{20}.3)$.

32 Calcite from Howes Cave, showing a characteristic penetration twin.

Plate 5

27



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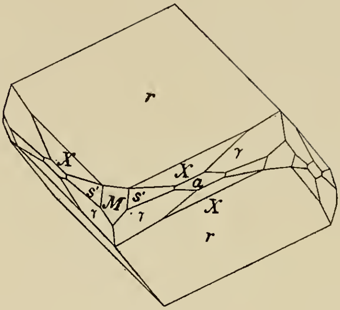

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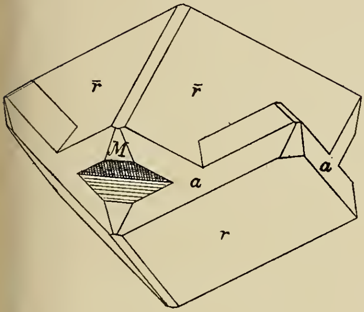

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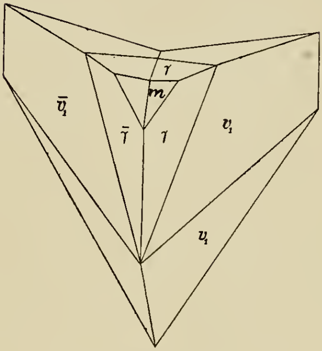

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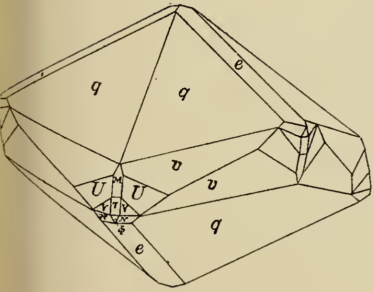

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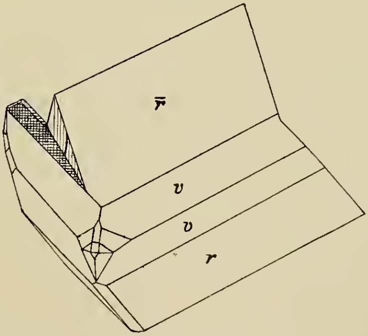


PLATE 6

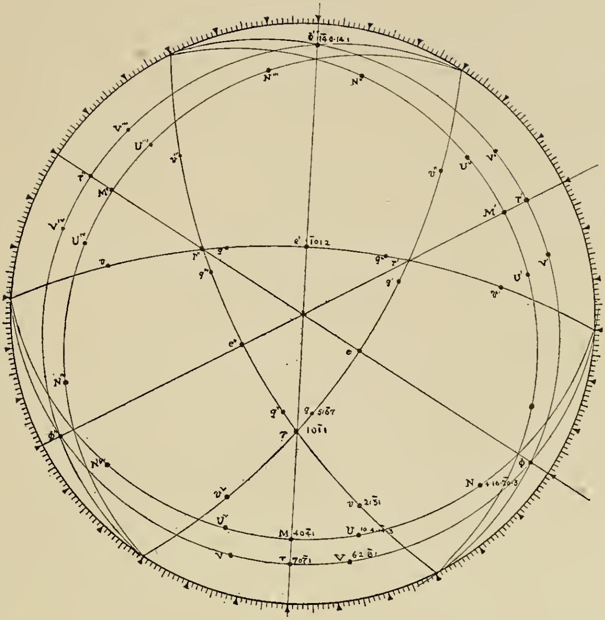
33 Calcite from Howes Cave. Spherical projection showing zonal relations of forms of principal type.

34 Calcite from Howes Cave showing supplementary type found in fossil remains of *Rhynchonella wilsoni*. Forms r ($10\bar{1}1$), M ($40\bar{4}1$), E ($41\bar{5}6$), λ ($31\bar{4}2$), v ($21\bar{3}1$).

35 Calcite from Howes Cave. Basal projection of figure 34.

Plate 6

33



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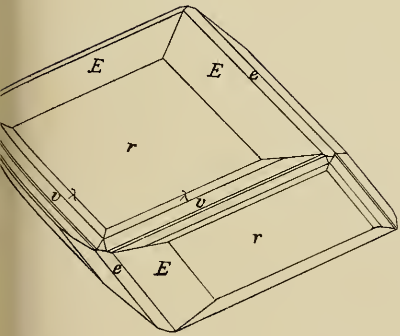

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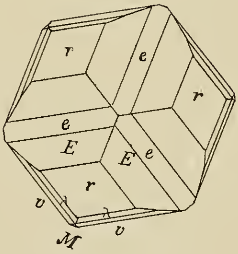


PLATE 7

36 Datolite from Westfield Mass. Stereographic projection showing zonal relations of occurring forms.

37 Datolite from Westfield Mass., showing typical crystal habit. Forms: *a* (100), *x* (102), *v* (103), *c* (001), *b* (010), m_x (011), *g* (012), *t* (013), Ω (018), *m* (110), *o* (120), *n* (111), ν ($\bar{1}$11), ϵ ($\bar{1}$12), λ ($\bar{1}$13), μ ($\bar{1}$14), κ ($\bar{1}$15), *Q* (122), β (121); α ($\bar{1}$24), *i* ($\bar{1}$23), *M* ($\bar{1}$22), ϵ′ ($\bar{1}$48), λ′ ($\bar{1}$49), μ′ ($\bar{1}$.4.10); the last three are new to the species.

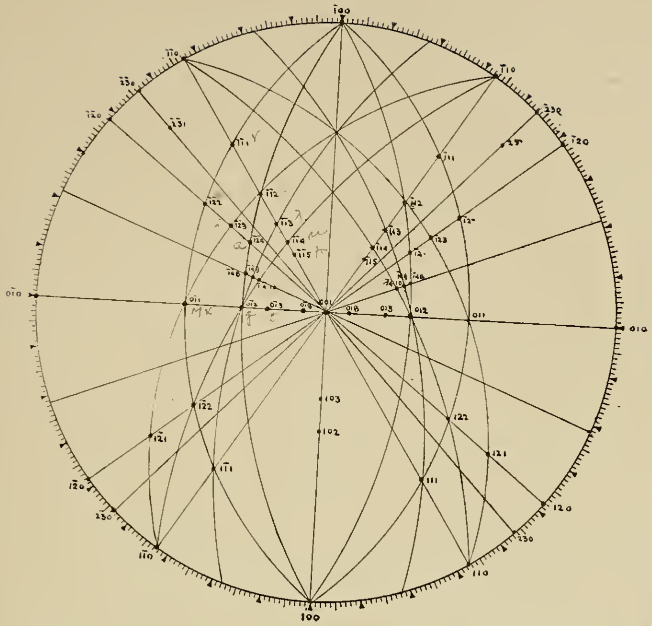
38 Datolite from Westfield Mass. Basal projection of figure 37.

39 Datolite from Westfield Mass., enlarged projection of a portion of figure 37, viewed in reversed position to show the position of the new planes.

40 Datolite from Westfield Mass. Penetration twin parallel to *a* (100); having *c* for the twinning axis. The faces *g* and *a* are composition planes.

Plate 7

36



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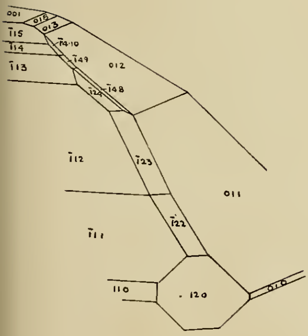

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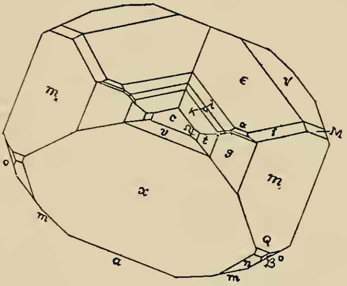

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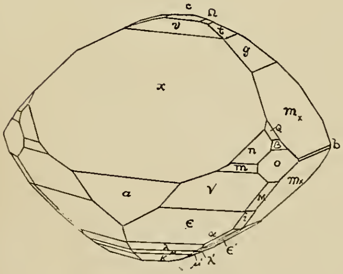

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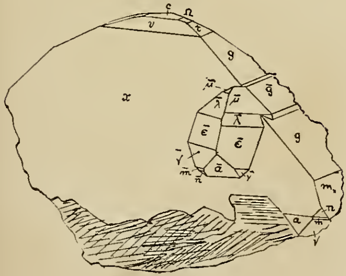

New York State Education Department

New York State Museum

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These reports are made up of the reports of the director, geologist, paleontologist, botanist and entomologist, and museum bulletins and memoirs, issued as advance sections of the reports.

Director's annual reports 1904–date.

These reports cover the reports of the State Geologist and of the State Paleontologist. Bound also with the Museum reports of which they form a part.
Report for 1904. 138 p. *20c.*

Geologist's annual reports 1881–date. Rep'ts 1, 3–13, 17–date, O; 2, 14–16, Q.

In 1898 the paleontologic work of the State was made distinct from the geologic and was reported separately from 1899–1903. The two departments were reunited in 1904, and reported in the Director's report.
The annual reports of the early natural history survey, 1837–41, are out of print.
Reports 1–4, 1881–84, were published only in separate form. Of the 5th report 4 pages were reprinted in the 39th museum report, and a supplement to the 6th report was included in the 40th museum report. The 7th and subsequent reports are included in the 41st and following museum reports, except that certain lithographic plates in the 11th report (1891) and 13th (1893) are omitted from the 45th and 47th museum reports.
Separate volumes of the following only are available.

Report	*Price*	*Report*	*Price*	*Report*	*Price*
12 (1892)	$.50	17	$.75	21	$.40
14	.75	18	.75	22	.40
15, 2v.	2	19	.40	23	.45
16	1	20	.50	[*See* Director's annual reports]	

Paleontologist's annual reports 1899–date.

See first note under Geologist's annual reports.
Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Those for 1901–3 were issued as bulletins. In 1904 combined with the Director's report.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882–date.

Reports 3–20 bound also with museum reports 40–46, 48–58 of which they form a part. Since 1898 these reports have been issued as bulletins. Reports 3–4, 17 are out of print, other reports with prices are:

Report	*Price*	*Report*	*Price*	*Report*	*Price*
1	$.50	9	$.25	15 (En 9)	$.15
2	.30	10	.35	16 (" 10)	.25
5	.25	11	.25	17 (" 14)	.30
6	.15	12	.25	18 (" 17)	.20
7	.20	13	.10	19 (" 21)	.15
8	.25	14 (En 5)	.20	20 (" 24)	.40

Reports 2, 8–12 may also be obtained bound separately in cloth at 25c in addition to the price given above.

Botanist's annual reports 1867–date.

Bound also with museum reports 21–date of which they form a part; the first botanist's report appeared in the 21st museum report and is numbered 21. Reports 21–24, 29, 31–41 were not published separately.
Separate reports for 1871–74, 1876, 1888–96 and 1898 (Botany 3) are out of print. Report for 1897 may be had for 40c; 1899 for 20c; 1900 for 50c. Since 1901 these reports have been issued as bulletins [*see* Bo 5–8].
Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have also been published in volumes 1 and 3 of the 48th (1894) museum report and in volume 1 of the 49th (1895), 51st (1897), 52d (1898), 54th (1900), 55th (1901), 56th (1902), 57th (1903) and 58th (1904) reports. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and, combined with others more recently prepared, constitute Museum memoir 4.

Museum bulletins 1887–date. O. *To advance subscribers, $2 a year or 50c a year for those of any one division:* (1) *geology, economic geology, mineralogy,* (2) *general zoology, archeology and miscellaneous,* (3) *paleontology,* (4) *botany,* (5) *entomology.*

Bulletins are also found with the annual reports of the museum as follows:

Bulletin	*Report*	*Bulletin*	*Report*	*Bulletin*	*Report*	*Bulletin*	*Report*
G 1	48, v.1	Pa 2, 3	54, v.3	En 11	54, v.3	Ar 3	52, v.1
2	51, v.1	4	" v.4	12, 13	" v.4	4	54, v.1
3	52, v.1	5, 6	55, v.1	14	55, v.1	5	" v.3
4	54, v.4	7–9	56, v.2	15–18	56, v.3	6	55, v.1
5	56, v.1	10	57, v.1	19	57, v.1, pt 2	7	56, v.4
6	57, v.1	Z 3	53, v.1	20	" v.1 "	8	57, v.2
Eg 5, 6	48, v.1	4	54, v.1	21	" v.1 "	9	" v.2
7	50, v.1	5–7	" v.3	22	" v.1 "	Ms 1, 2	56, v.4
8	53, v.1	8	55, v.1	Bo 3	52, v.1		
9	54, v.2	9	56, v.3	4	53, v.1	*Memoir*	
10	" v.3	10	57, v.1	5	55, v.1	2	49, v.3
11	56, v.1	En 3	48, v.1	6	56, v.4	3, 4	53, v.2
M 2	" v.1	4–6	52, v.1	7	57, v.2	5, 6	57, v.3
3	57, v.1	7–9	53, v.1	Ar 1	50, v.1	7	" v.4
Pa 1	54, v.1	10	54, v.2	2	51, v.1		

The figures in parenthesis in the following list indicate the bulletin's number as a New York State Museum bulletin.

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