THE CRYSTALLOGRAPHY OF HERDERITE FROM TOPSHAM, MAINE

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ABSTRACT

Crystals of herderite, $CaBe(OH,F)PO_4$, from Topsham, Maine, a new locality, exhibit several novelties: prismatic development in the direction of the c-axis, twinning on (100), and the new forms $\alpha(\bar{1}04)$, $\beta?(\bar{1}15)$, $\gamma(121)$. Herderite from a new find at Greenwood, Maine, shows the normal columnar development of the clinodome zone and known forms with the addition of $\gamma(121)$. The crystallography of the species is revised and referred to new parameters, $a:b:c=0.6307:1:1.2822$; $\beta=90°6'$, obtained by trebling the c-axis of Penfield. The revised form list contains 33 accepted forms (2 new) and 11 uncertain forms (1 new). Three described forms are rejected. For the accepted forms a suitable angle-table is given.

In the summer of 1933 a pocket in the pegmatite of Fisher Quarry, Topsham, Maine, was opened under the active direction of Professor Charles Palache, and an interesting suite of minerals was uncovered. The field relations of this material, which is preserved in the Harvard Mineralogical Museum, were described in a general paper by Palache (1934). The minerals found are more or less typical of the complex acid pegmatites of Maine: cleavelandite, quartz, lepidolite, beryl, topaz, gahnite, tourmaline, garnet, columbite, sericite, apatite, torbernite, cookeite and, last to form, the rare phosphate herderite in considerable abundance.

The herderite occurs in well developed crystals up to nearly 5 cm. long and 3 cm. wide, attached to quartz, cleavelandite, lepidolite, topaz, and sericite. They range from white or greenish-white to colourless; some are stained brown. Among the smaller crystals a considerable number are transparent and fairly brilliant, but all those over half a centimeter long are mottled and translucent. A few crystals are soiled with dried kaolin; the majority, however. are clean and suitable for measurement.

A study of these crystals revealed the fact that herderite presents peculiar goniometric difficulties because of surprising variation in habit and similarity of angles in different zones. It was decided, therefore, to study the crystallography of the species in some detail, supplementing observations on the material from Topsham by measurements on crystals from a new find at Greenwood, Maine, already known through Penfield's work (1894) as a herderite locality. This study suggested a revised statement of the crystallography in which some of the described forms have been rejected and some set aside as uncertain; two new forms have been added to the list of accepted forms and an angle table has been prepared in a suitable form with reference to a new choice of parameters.

Herderite from Ehrenfriedersdorf, Saxony, was recognized as a new species by Haidinger (1828), and described as an othorhombic mineral. E. S. Dana (1884) described crystals from Stoneham, Maine, which he found to be orthorhombic, developed prismatically with the *a*-axis. Penfield (1894) first recognized the monoclinic symmetry of herderite from several localities in Maine, and the twinning, together with nearly rectangular axes, which leads to the orthorhombic appearance of the crystals. He chose an orientation and elements that agreed as closely as possible with the orthorhombic setting of Dana. Thus the clino-axis became the axis of prismatic development with the observed twinning plane as the base. In a short note, Henglein (1909) described a crystal from Epprechtstein, Bavaria, with several new forms, prismatically developed with the *c*-axis and twinned on the orthopinacoid. Dürrfeld (1909 A) discredited Henglein's description, and showed that in the conventional setting, Henglein's supposed new forms were already known on herderite. In subsequent studies, Dürrfeld (1909 B, 1910, 1911) described numerous crystals from Epprechtstein, on which he found several new forms; all the crystals showed the usual prismatic development in the direction of the clinoaxis, with twinning on the base. Ford (1911) added further crystallographic observations on material from Auburn, Maine, retaining Penfield's setting of the mineral.

Four crystals from Topsham were selected for measurement and description. They all proved to be prismatically developed with the vertical axis, two being monoclinic individuals, the other two twins on the orthopinacoid. Since this is the very type of development that was once announced and immediately discredited, it will be necessary to compare the measured angles with those of herderite in the conventional setting and in the position which results from the interchange of the *a*- and *c*-axes.

Two crystals from Greenwood were also measured. They proved to be monoclinic individuals developed equally in the directions of the *a*- and *c*-axes, and terminated in front by positive forms above and negative forms below.

TABLE 1. HERDERITE. TWO-CIRCLE MEASUREMENTS ON SIX CRYSTALS

Forms	Measured						Calculated		Calculated with *a*- and *c*-axes interchanged		
	Range		Mean		No. of Faces	No. of Crystals					
	ϕ	ρ	ϕ	ρ			ϕ	ρ	Forms	ϕ	ρ
c 001	90°01′–90°02′	0°17′– 0°27′	90°01′	0°21′	6	5	90°00′	0°06′	*a* 100	−90°00′	0°06′
b 010	0 00 – 0 04	–	0 02	90 00	8	4	0 00	90 00	*b* 010	0 00	90 00
a 100	–	–	90 01	90 00	1	1	90 00	90 00	*c* 001	90 00	90 00
l 120	38 47 –38 55	–	38 51	90 00	4	3	38 24½	90 00	*v* 011	37 57	90 00
m 110	57 43 –58 10	–	58 00	90 00	20	6	57 45½	90 00	*t* 012	57 20	90 00
u 013	0 13 – 1 01	23 07 –23 11	0 45	23 09	9	4	0 14	23 08½			
t 012	0 00 – 0 16	32 20 –32 38	0 09	32 32	13	6	0 09½	32 40	*m* 110	−0 09½	32 14½
v 011	0 04 – 0 29	51 37 –51 58	0 11	51 48	10	4	0 04½	52 03	*l* 120	−0 04	51 35½
s 021	0 04 – 0 14	68 40 –68 46	0 05	68 44	5	3	0 02½	68 42			
*α $\bar{1}04$	−89 31 –90 50	26 58 –27 07	−90 10	27 03	2	2	−90 00	26 52			
e 102	90 01 –90 02	45 40 –46 06	90 02	45 54	4	4	90 00	45 31	*e*: $\bar{1}02$	90 00	44 28½
e: $\bar{1}02$	−89 43 –90 01	44 39 –45 36	−89 52	45 07	2	2	−90 00	45 25½			
p 113	57 26 –58 11	38 15 –39 15	57 48	38 47	4	2	57 49½	38 45			
q 112	57 58 –58 33	50 15 –50 18	58 15	50 17	4	2	57 48½	50 16½			
q: $\bar{1}12$	−57 10 –57 40	49 33 –50 30	−57 30	50 01	3	2	−57 43	50 12			
n 111	57 54 –58 12	67 12 –67 42	58 03	67 26	14	6	57 47	67 25½	*z*: $\bar{1}24$	57 20	66 54½
n: $\bar{1}11$	−57 40 –57 46	66 44 –67 24	−57 44	67 06	3	2	−57 44½	67 74			
r: $\bar{1}23$	−38 04 –40 31	46 41 –47 41	−39 01	47 29	12	5	−38 20	47 27½			
*β $\bar{1}15$	–	–	−61 12	25 11	2	1	−57 39	25 36½			
h $\bar{2}14$	–	–	−72 40	50 30	1	1	−72 28	46 47			
*γ 121	38 31 –40 42	73 25 –74 16	39 41	73 53	13	5	38 26	73 01			

* New form.

The measurements of the six crystals are summarized in table 1, which gives the observed forms, the range of the measured two-circle angles, the resulting averages, and the calculated angles. To these are added the calculated angles of known forms which nearly coincide with different known forms when the *a*- and *c*-axes are interchanged. Although the crystals measured are, like all herderites, only moderately good, it will be seen that the mean measured angles are consistently closer to the calculated angles in proper position than to those resulting from misorientation. Furthermore, most of the forms found are already known in the position in which the crystals were measured, whereas in the alternative position many would give symbols corresponding to unknown forms. The proper orientation and consequently the remarkable development of the Topsham crystals is thus established geometrically. A determination of the optical orientation of one of the measured monoclinic individuals brought independent verification.

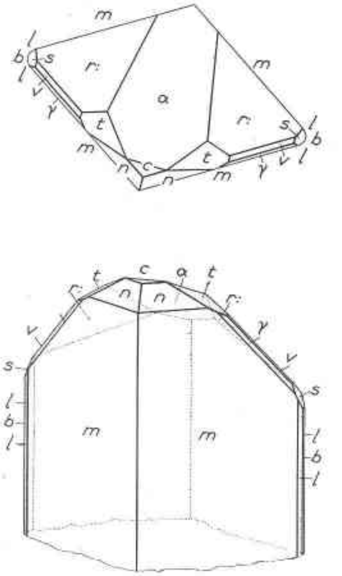

FIG. 1.

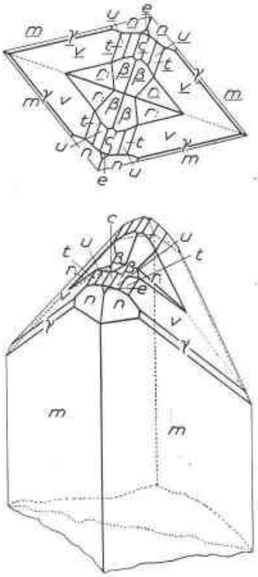

FIG. 2.

FIG. 1. Herderite. Individual crystal from Topsham, Maine, with pronounced monoclinic development. Forms: *c*(001), *b*(010), *l*(120), *m*(110), *t*(012), *v*(011), *s*(021), α(1̄04) new, *n*(111), *r*: (1̄23), γ(121) new.

FIG. 2. Herderite. Twin on (100) from Topsham, Maine. Forms: *c*(001), *m*(110), *u*(013), *t*(012), *v*(011), *e*(102), *n*(111), β?(1̄15) new, *r*: (1̄23), γ(121) new.

Figures 1, 2, and 3, illustrate the principal features of the new material. Figure 1 represents a monoclinic individual from Topsham, exhibiting the novel prismatic habit. The crystal is bounded mainly by *m*(110), and the terminal forms $\alpha(\bar{1}04)$ and *r*:$(\bar{1}23)$. The prism *m*(110) is the common prism of herderite. The negative orthodome $\alpha(\bar{1}04)$ is a new form, and appears on this crystal and on another similar one as a large dull but plane face with measured angles agreeing well with the calculated values. The negative pyramid *r*:$(\bar{1}23)$, a common form on herderite, is likewise dull and gives weak reflexions. The edges between the terminal forms and the prisms are truncated by small faces of the known forms: *c*(001), *t*(012), *v*(011), *s*(021), *n*(111), and $\gamma(121)$, which is a new form. The acute edges of the prism *m* are truncated by narrow faces of *b*(010) and *l*(120). The new pyramid $\gamma(121)$ was observed on all the Topsham crystals and also on one of the crystals from Greenwood. On the Topsham crystals it occurred characteristically as two narrow faces in the zone [*m v r*:].

Figure 2 also illustrates a Topsham crystal developed prismatically like the one described above and twinned on the orthopinacoid. The prism zone is bounded by *m*(110) only, while the termination is formed mainly by the faces of the clinodome *v*(011) in nearly parallel position on the two individuals. Indication of twinning is given by a deep re-entrant following the plane of (100) and dividing the termination symmetrically. The re-entrant is formed by badly etched and curved faces of *r*:$(\bar{1}23)$ and $\beta(\bar{1}15)$, a new form the symbol of which is regarded as doubtful since the surface gave very poor reflexions. Smaller faces of *c*(001), *u*(013), *t*(012), *n*(111), and the new form $\gamma(121)$ are also found on the terminations.

Penfield (1894) showed that the twinning of herderite can be referred to either *c*(001) or *a*(100) as the twinning plane, and figured a twin with hypothetical traces of both planes. All of the actual twins with visible re-entrants described by him indicated twinning on *c*(001). Such twinning should give parallelism in the two clinodome zones, whereas twinning on *a* should result in coincidence in the prism zones. Careful observations on the Topsham crystals showed that both the prism zones and the clinodome zones deviate slightly from exact parallelism. It therefore seems best to regard the composition plane (100) as the twin plane; the twinning thus becomes an example of the alternative and hitherto unobserved expression of Penfield's twin law.

Figure 3 shows a typical crystal from the new occurrence at Greenwood. As in most of the published figures of herderite, the form of the crystal is determined mainly by the clinodome zone. The forms observed on two crystals of this type are *c*(001), *a*(100), *b*(010), *l*(120), *m*(110), *u*(103), *t*(012), *e*(102), $e{:}(\bar{1}02)$, *p*(113), *q*(112), $q{:}(\bar{1}12)$, *n*(111), $n{:}(\bar{1}11)$, $r{:}(\bar{1}23)$, $h(\bar{2}14)$, $\gamma(121)$. The negative forms are all more or less etched and rounded, a common characteristic of herderite and further confirmation of the non-equivalence of the positive and negative forms, even though the angles are nearly alike.

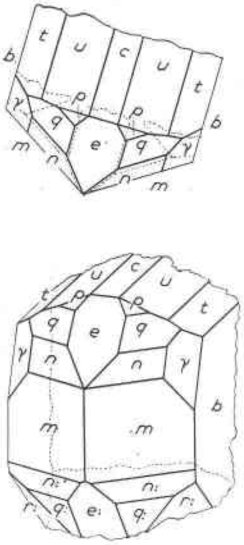

Fig. 3. Herderite. Individual crystal from Greenwood, Maine, with orthorhombic appearance. Forms: *c*(001), *b*(010), *m*(110), *u*(013), *t*(012), *e*(102), $e{:}(\bar{1}02)$, *p*(113), *q*(112), $q{:}(\bar{1}12)$, *n*(111), $n{:}(\bar{1}11)$, $r{:}(\bar{1}23)$, $\gamma(121)$ new.

The Greenwood crystals gave good angles in close agreement with the angles calculated from Penfield's elements; the angles measured on the Topsham specimens agree less closely. From the best measurements on the latter an axial ratio, which compares with earlier values as follows, was obtained:

a :*b*: *c*	β	
0.6237:1:0.4255	90°15′	(Yatsevitch, 1935)
0.6246:1:0.4258	.....	(Dürrfeld, 1909)
0.6308:1:0.4274	90°06′	(Penfield, 1894)
0.6206:1:0.4236	90°	(Dana, 1884)

Since the measurements made in this study are less comprehensive than those of Penfield, the calculated angles are based on Penfield's measurements referred to new parameters as explained below.

In the monoclinic system a setting in which the clinoaxis is the axis of columnar development is ungainly and inconvenient. However, since columnar development may follow either the *a*-axis or the *c*-axis in herderite, nothing will be gained by a rotation of axes. In the adopted setting, therefore, the axial directions of the previous workers are retained, so that the figures present the same aspect as those already published. A consideration of the symbols of the known forms of herderite in relation to the importance of the corresponding forms suggested a new choice of the unit pyramid that results in trebling the *c*-axis of Penfield. Goldschmidt (1897) already simplified the symbols of herderite by taking a *c*-axis equal to three-halves of Penfield's. Our choice of the unit pyramid, namely *n*(111), the only pyramid found at every known herderite locality, results in further simplification as can be seen by comparing the lists of symbols for corresponding forms in the three settings in table 2. Furthermore, the gnomonic projection of the estab-

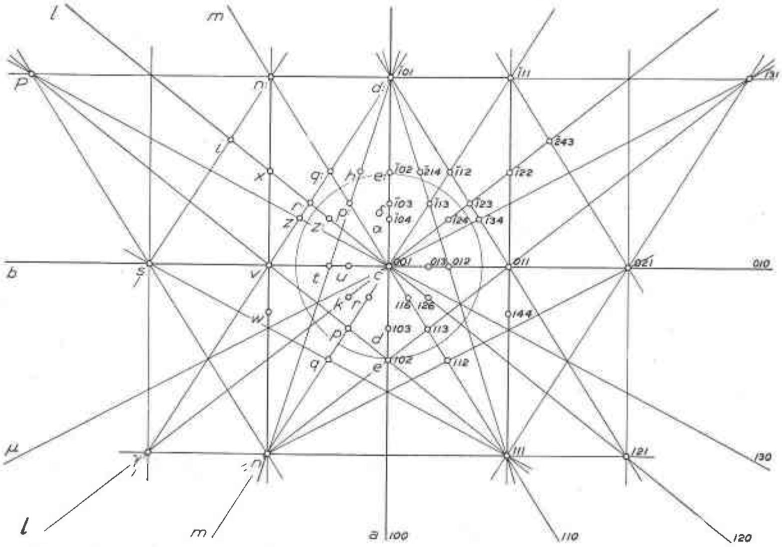

FIG. 4. Herderite. Gnomonic projection of the accepted forms showing the pseudo-orthorhombic character of the species and the importance of the poles of *n*(111), the preferred parametral plane, in the zonal network.

lished forms of herderite (figure 4), shows the importance of $n(111)$ as a zonal node and normal distribution of poles in radial zones.

The elements and symbols in the three settings are related by the following equations:

$a:b:c$ (G.M.Y.) = $a:b:2c$ (Goldschmidt) = $a:b:3c$ (Penfield)
hkl " $=hk2l$ " $=hk3l$ "

A complete form list of herderite was compiled as a result of an examination of the published work, and is presented in table 2. In the list eleven forms are regarded as uncertain for the reasons given below. Three forms with highly complex symbols are omitted. The following are those considered uncertain:

$f(\bar{2}09)$; described as $f(203)$ by Dürrfeld (1909) with sign uncertain. Later (1910 B) given as $f(\bar{2}03)$. A minute face in poor zonal relation. Possibly the same as the new form from Topsham, $\alpha(\bar{1}04)$.
$E(803)$; $\epsilon(\bar{8}03)$; described without measurements as new forms $E(801)$ and $\epsilon(\bar{8}01)$ by Dürrfeld (1910 A).
$\beta(\bar{1}15)$; described in this paper. "Badly etched and curved."
$g(114)$; g:$(\bar{1}14)$; described as $g(334)$ by Dürrfeld (1909) with sign uncertain. Later (1910 B) given as $g(\bar{3}34)$. In poor zonal relation. Possibly the same as the new and uncertain form from Topsham, $\beta(\bar{1}15)$.
$o(443)$; given as an orthorhombic form $o(441)$ by Haidinger (1828) and never observed again.
$y(133)$; $y(\bar{1}33)$; described as an orthorhombic form $y(131)$ by Dana (1884) from Stoneham, Maine, but not found again. In good zonal relation, but sign unknown.
$G(\bar{3}49)$; described as $g(\bar{3}43)$ by Ford (1911). "Striated and curved"; in poor zonal relation.
$H(135)$; described as $h(395)$ by Dürrfeld (1910 B). "Ein Produkt der Aetzung." In good zonal relation.

The following forms are neglected:
(20.37.0) = l(20.37.0), Dürrfeld (1909). "Uneben und matt."
(881) = p_{24}(24.24.1), Dürrfeld (1909). Vicinal to (110).
(11.22.24) = (11.22.8), Dürrfeld (1909). "Uneben und matt. Wahrscheinlich $x(362)$."

The optical constants of the Topsham material were determined on the measured single crystal illustrated in figure 1, and on grains by the immersion method. The values obtained agree closely with those given by Penfield (1894), and are given below:

$$\left.\begin{array}{l} X \text{ (obtuse bisectrix)} = 1.591 \\ Y(=b) = 1.611 \\ Z \text{(acute bisectrix)} = 1.619 \end{array}\right\} \pm 0.003 \qquad \begin{array}{l} 2V = 75° \pm 5°;\ r > v. \\ \\ Z:c\text{-axis} = 3\tfrac{1}{2}°. \end{array}$$

TABLE 2. HERDERITE. DISTRIBUTION AND CORRELATION OF FORMS

Symbols Dana (1884) Penfield (1894)	Stoneham[1]	Paris[2]	Hebron[2]	Auburn[3]	Greenwood [4,5]	Topsham[5]	Epprechtstein[6] Ehrenfriedersdorf	Symbols Goldschmidt (1897, 1918)	Letters & Symbols Yatsevitch
001	*c*	*c*	*c*	*c*	*c*	*c*	*c*	001	*c* 001
010	*b*	*b*	—	*b*	*b*	*b*	—	010	*b* 010
100	—	*a*	—	—	*a*	—	*a*	100	*a* 100
130	*μ*	—	—	—	—	—	—	130	*μ* 130
120	*l*	—	—	—	*l*	*l*	*l*	120	*l* 120
110	*m*	*m*	*m*	*m*	*m*	*m*	*m*	110	*m* 110
011	*u*	—	—	—	*u*	*u*	—	023	*u* 013
032	*t*	*t*	—	*t*	*t*	*t*	*t*	011	*t* 012
031	*v*	*v*	—	*v*	—	*v*	*v*	021	*v* 011
061	*s*	*s*	—	—	—	*s*	—	041	*s* 021
$\bar{2}03$	—	—	—	—	—	—	*f*	$\bar{4}09$	*f* $\bar{2}09$?
$\bar{3}04$	—	—	—	—	—	*α*	—	$\bar{1}02$	**α* $\bar{1}04$
101	*d*	—	—	—	—	—	—	203	*d* 103
$\bar{1}01$	—	—	—	—	—	—	*δ*	$\bar{2}03$	*δ* $\bar{1}03$
302	*e*	*e*	—	*e*	*e*	*e*	*e*	101	*e* 102
$\bar{3}02$	*e*:	—	—	—	*e*:	—	—	$\bar{1}01$	*e*: $\bar{1}02$
$\bar{3}01$	—	—	—	*d*:	—	—	—	$\bar{2}01$	*d*: $\bar{1}01$
801	—	—	—	—	—	—	*E*	16.0.3	*E* 803?
$\bar{8}01$	—	—	—	—	—	—	*ϵ*	$\overline{16}.0.3$	*ϵ* $\bar{8}03$?
112	—	*r*	—	*r*	—	—	—	113	*r* 116
$\bar{3}35$	—	—	—	—	—	*β*	—	$\bar{2}25$	**β* $\bar{1}15$?
334	—	—	—	—	—	—	*g*	112	*g* 114?
$\bar{3}34$	—	—	—	—	—	—	*g*	$\bar{1}12$	*g*: $\bar{1}14$?
111	*p*	—	—	—	*p*	—	*p*	223	*p* 113
$\bar{1}11$	—	—	—	—	—	—	*p*:	$\bar{2}23$	*p*: $\bar{1}13$
332	*q*	*q*	*q*	*q*	*q*	—	*q*	111	*q* 112
$\bar{3}32$	*q*:	—	—	—	*q*:	—	*q*:	$\bar{1}11$	*q*: $\bar{1}12$
331	*n*	*n*	*n*	*n*	*n*	*n*	*n*	221	*n* 111
$\bar{3}31$	*n*:	*n*:	—	*n*:	*n*:	—	*n*:	$\bar{2}21$	*n*: $\bar{1}11$
441	—	—	—	—	—	—	*o*	883	*o* 443?

TABLE 2—(*Continued*)

Symbols Dana (1884) Penfield (1894)	Stoneham[1]	Paris[2]	Hebron[2]	Auburn[3]	Greenwood[4,5]	Topsham[5]	Epprechtstein[6] Ehrenfriedersdorf	Symbols Goldschmidt (1897, 1918)	Letters & Symbols Yatsevitch
122	—	*k*	—	—	—	—	—	123	*k* 126
392	—	—	—	—	—	—	*h*	265	H 135?
3.12.4	—	*w*	—	—	—	—	—	142	*w* 144
$\bar{3}64$	—	—	—	—	*z*:	—	—	$\bar{1}22$	*z*: $\bar{1}24$
$\bar{3}94$	—	*z*	—	—	—	—	—	$\bar{1}32$	*z* $\bar{1}34$
$\bar{1}21$	—	—	—	*r*:	*r*:	*r*:	*r*:	$\bar{2}43$	*r*: $\bar{1}23$
$\bar{3}43$	—	—	—	*g*	—	—	—	$\bar{6}89$	*G* $\bar{3}49$?
131	*y*	—	—	—	—	—	—	263	*y* 133?
$\bar{1}31$	*y*	—	—	—	—	—	—	$\bar{2}63$	*y*: $\bar{1}33$?
$\bar{6}34$	—	—	—	*h*	*h*	—	—	$\bar{2}12$	*h* $\bar{2}14$
$\bar{3}62$	*x*	—	—	—	—	—	*x*	$\bar{1}21$	*x* $\bar{1}22$
$\bar{2}41$	—	—	—	—	—	—	*i*	$\bar{4}83$	*i* $\bar{2}43$
361	—	—	—	—	*γ*	*γ*	—	241	**γ* 121
$\bar{3}91$	—	—	—	—	—	—	*p*:	$\bar{2}61$	*P* $\bar{1}31$

* New form. German form letters taken from the literature are consistently replaced by the corresponding English letters followed by a colon.

[1] Dana (1884), Penfield (1894).

[2] Penfield (1894).

[3] Penfield (1894), Ford (1911).

[4] Penfield (1894, Yatsevitch (1935).

[5] Yatsevitch.

[6] Haidinger (1828), Dürrfeld (1909–1910).

In conclusion, an angle table for herderite is presented in a form which combines the requirements of both single-circle and two-circle goniometry. The angles ϕ_2, ρ_2, are two-circle angles referred to the *b*-axis as pole, while the angles A, B, C are *hkl*:(100), *hkl*:(010), *hkl*:(001) respectively. This method of presentation was described in a recent paper by Peacock (1934).

TABLE 3. HERDERITE—CaBe(OH, F)PO_4

Monoclinic: $a:b:c=0.6307:1:1.2822; \beta=90°06'$.
$p_0:q_0:r_0=2.0330:1.2822:1; \mu=89°54'$.
$r_2:p_2:q_2=1.5598:1.5855:1$.
$p_0'=2.0331, q_0'=1.2822; x_0'=0.0017$.

Forms	ϕ	ρ	ϕ_2	$\rho_2=B$	C	A
c 001	90°00′	0°06′	89°54′	90°00′	0°00′	89°54′
b 010	0 00	90 00	—	0 00	90 00	90 00
a 100	90 00	90 00	0 00	90 00	89 54	0 00
μ 130	27 51½	90 00	0 00	27 51½	89 57	62 08½
l 120	38 24½	90 00	0 00	38 24½	89 56½	51 35½
m 110	57 45½	90 00	0 00	57 45½	89 55	32 14½
u 013	0 14	23 08½	89 54	66 51½	23 02½	89 54½
t 012	0 09½	32 40	89 54	57 20	32 40	89 55
v 011	0 04½	52 03	89 54	37 57	52 03	89 56½
s 021	0 02½	68 42	89 54	21 18	68 42	89 58½
*α $\bar{1}04$	−90 00	26 52	116 52	90 00	26 58	116 52
d 103	90 00	34 11½	55 48½	90 00	34 05½	55 48½
δ $\bar{1}03$	−90 00	34 03½	124 03½	90 00	34 09½	124 03½
e 102	90 00	45 31	44 29	90 00	45 25	44 29
e: $\bar{1}02$	−90 00	45 25½	135 25½	90 00	45 31½	135 25½
d: $\bar{1}01$	−90 00	63 47½	153 47½	90 00	63 53½	153 47½
r 116	57 53½	21 54½	71 11½	78 34	21 49½	71 34½
p 113	57 49½	38 45	55 48½	70 32	38 40	58 00½
p: $\bar{1}13$	−57 41½	38 39	124 03½	70 30	38 44	121 52
q 112	57 48½	50 16½	44 29	65 48½	50 11	49 24
q: $\bar{1}12$	−57 43	50 12	135 25½	65 46½	50 17	130 30½
n 111	57 47	67 25½	26 10½	60 30½	67 20½	38 37½
n: $\bar{1}11$	−57 44½	67 24	153 47½	60 28½	67 29	141 19½
k 126	38 33	28 39½	71 11½	67 58½	28 35½	72 36½
w 144	21 41½	54 04	62 58½	41 12	54 02	72 35½
z: $\bar{1}24$	−38 18½	39 15	116 52	60 14	39 15	113 05½
z $\bar{1}34$	−27 46½	47 23	116 52	49 22½	47 26	110 03½
r: $\bar{1}23$	−38 20	47 27½	124 03½	54 41½	47 31½	117 11½
h $\bar{2}14$	−72 28	46 47	135 25½	77 19	46 52½	134 01
x $\bar{1}22$	−38 21½	58 33	135 25½	48 01	58 32	121 58

TABLE 3—(*Continued*)

Forms	ϕ	ρ	ϕ_2	$\rho_2=B$	C	A
i $\bar{2}43$	−38 22½	65 22	143 32½	44 33	65 25½	124 21
*γ 121	38 26	73 01	26 10½	41 29	72 57	53 31½
P $\bar{1}31$	−27 50½	77 03	153 47½	30 29	77 06	117 04½

* New form.

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