HOLDENITE, A NEW ARSENATE OF MANGANESE AND ZINC, FROM FRANKLIN, NEW JERSEY

CHARLES PALACHE AND E. V. SHANNON[1].

The single specimen on which the mineral here described has been seen was found in the collection of A. F. Holden, fifteen years ago, mistakenly labelled leucophoenicite. Crystals were then measured by the senior author and practical certainty was reached that they represented a new arsenate of manganese. To determine its chemical nature, however, it would have been necessary to remove most of the material from the only specimen. In the many ensuing years, continued search for more examples of the mineral proved fruitless. The resolution was finally reached that the sole specimen must be sacrificed and this was done, all but two or three crystals being detached. The material so obtained has been analyzed by the junior author, the result confirming the conclusion that the mineral is a distinct species.

Holdenite is orthorhombic with the axial ratio:

$$a:b:c = .3802:1:.2755. \quad p_0 = .7230. \quad q_0 = .2755.$$

Seven crystals were measured giving concordant results in angular values from a complex form series as shown in Table 1. The crystals are tabular parallel to the face taken as the macropinacoid, the largest one on the specimen measuring 8 mm. in greatest diameter.

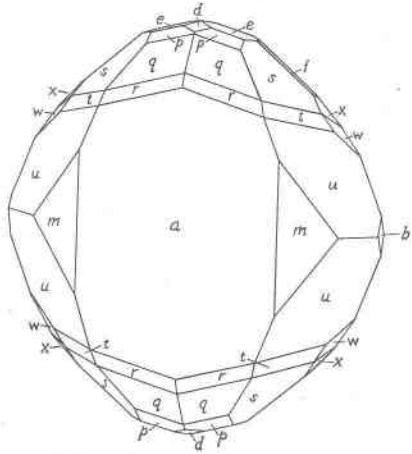

Figure 1. Crystal of Holdenite

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TABLE I. FORMS AND ANGLES OF HOLDENTE.

Symbol	Number of		Calculated Angles		Measured (average) Angles			
	faces	crysts	ϕ	ρ	ϕ	Limits	ρ	Limits
c (001) ρ	1	1	00°00′	00°00′	00°00′		00°00′	
a (100) ρ	7	1	90 00	90 00	90 00		90 00	
b (010) °	7	7	00 00	"	00 00		"	
m (110) ρ	20	7	69 08	"	69 12	+6′ −4	"	
l (120) ρ	2	2	52 41	"	52 46	+1	"	
n (130) ρ	4	4	41 10	"	41 12	+12 −4	"	
e (011)	7	6	00 00	15 24	00 00		05 41	+16 −10
f (031)	2	1	"	39 34	00 10	+10	39 33	+2 −2
d (102)	2	2	90 00	20 03	90 00		20 02	+1 −1
p (111)	23	7	69 08	37 44	69 11	+12 −9	37 47	+8 −4
q (211)	23	7	79 13	55 49	79 11	+9 −4	55 48	+12 −2
r (311)	9	6	82 46	65 26	82 44	+6 −14	65 24	+3 −1
s (131)	15	6	41 10	47 41	41 08	+7 −4	47 41	+7 −13
w (151)	3	1	27 41	57 16	27 28	+4 −5	57 18	+7 −8
t (251)	5	5	46 23	63 24	46 20	+5 −10	63 32	+15 −9
x (182)	2	1	18 10	49 14	18 12	+14 −14	48 55	+15 −16
u (7.16.2)	2	1	48 57	73 24	49 23	+12 −12	73 35	+5 −5

The crystals vary little in habit and most of the forms occur on all of them as shown in Table 1. The base, *c* was seen but once and *n* and *e* were found on but two crystals. The forms *f*, *w* and *x* were also found but once, all on the most complex crystal measured which is shown in the figure. There was, however, a form present on all the crystals with relatively large faces which varied widely in its angular position. This is the pyramid *u* to which has been assigned the symbol (7. 16. 2). As shown in the figure this form is in a zone with *t* and *s*; and the angles as found on this one crystal agree well with the calculated values. On other crystals, however, the value of ϕ varied from 47° 14′ to 54° 36′ and that of ρ from 72° 10′ to 76° 06′. The symbol (491) is simpler in form and also lies in the zone with *t* and *s*; but while the value of ϕ for it, 49° 23′, agrees exactly with the best measured angle, the ρ angle is two degrees too large and the preference was therefore given to the more complex symbol.

Holdenite has a poor cleavage parallel to the brachypinacoid. Its hardness is 4 and the specific gravity, determined by floating in Clerici solution, is 4.07. The color varies from clear pink to deep red and yellowish red. Biaxial (+). The plane of the optic axes is parallel to (010) with the acute bisectrix emerging normal to (100). $2V = 30° 20'$ (measured), 28° 58′ (calculated). Dispersion easily perceptible, $\rho > \nu$.

α || to *c*	$\alpha = 1.769$
β || to *b*	$\beta = 1.770$
γ || to *a*	$\gamma = 1.785$

We are indebted to Professor Larsen for the index values, determined by the immersion method.

About 0.42 gr. of fairly pure material was prepared by Mr. Berman for the analysis. It contained willemite and calcite as impurities.

1. Analysis of Holdenite by E. V. Shannon.
2. Molecular ratio of 1.
3. Molecular ratio after eliminating willemite and calcite.

	1.	2.	3.	
	Per cent			
SiO_2	2.01	.033		
As_2O_5	17.40	.076	.076	.076=1×.076
MnO	37.75	.532	.532	
FeO	1.80	.025	.025	
ZnO	28.08	.345	.279	.914=02×.076
CaO	3.80	.067	.042	
MgO	1.45	.036	.036	
H_2O	6.62	.367	.367	.367=5×.073
PbO	trace			
Mn_2O_3	trace			
Al_2O_3	trace			
	98.91			

The presence of calcite in the sample was proved optically and by effervescence of grains on solution in acid. The sample, however, was not sufficiently large to permit determination of CO_2. We assume the deficiency of the analysis, 1.09%, to be CO_2 and take enough of the CaO to satisfy this as $CaCO_3$. We regard the SiO_2 as due to willemite and take sufficient ZnO to satisfy this compound. On this basis there was 7.38% of willemite and 2.49% of calcite in the sample. Deducting these from the analysis we obtain the ratios of column 3 above which leads to the formula for holdenite

$$12R''O \cdot As_2O_5 \cdot 5H_2O.$$

Manganese and zinc are present in the proportion of approximately 2:1. The formula may then be expanded to the form

$$8MnO \cdot 4ZnO \cdot As_2O_5 \cdot 5H_2O$$

which requires the following composition:

As_2O_5	18.96
MnO	46.78
ZnO	26.83
H_2O	7.43
	100.00

Holdenite is thus a very basic arsenate of manganese and zinc. The only mineral at all resembling it in composition is the recently described mineral chlorophoenicite, also from Franklin, to which was assigned the formula $10R''O \cdot As_2O_5 \cdot 7H_2O$ with R'' chiefly manganese and zinc in the proportion of 3:2.

Holdenite is named in honor of A. F. Holden in whose splendid collection now at Harvard University the unique specimen of this mineral was discovered. This was a slab of massive franklinite ore with a slickensided surface 10 by 7 cm. in dimensions, clearly one wall of a narrow veinlet. The crystals of holdenite were attached for the most part directly to the vein wall or to a thin coating of manganiferous calcite. With it was associated barite, galena, pyrochroite and fibrous willemite, all in minute amount.