

## CRYSTALLOGRAPHIC NOTES

1. PHOSPHOPHYLLITE; 2. HEMATITE; 3. WILLEMITE;  
4. HEDYPHANE

CHARLES PALACHE AND HARRY BERMAN

## 1. PHOSPHOPHYLLITE FROM HAGENDORF, BAVARIA.

CRYSTALLOGRAPHY. The mineral phosphophyllite was described by Laubmann and Steinmetz<sup>1</sup> in 1920. It is a complex hydrous phosphate and sulphate of iron, magnesium and potassium showing no clear chemical relationship to the previously known groups of such compounds.<sup>2</sup>

Good crystals of this mineral were found in the Holden Collection on specimens from the type locality, Hagendorf, Bavaria. Through their study attention was drawn to the somewhat unusual form series described in the original paper. The observations obtained from two-circle measurements of several crystals are here presented together with a new orientation which seems to yield more satisfactory indices for the forms present.

Phosphophyllite is monoclinic with prominent tabular development parallel to a form taken by Laubmann and Steinmetz as  $a(100)$  and with perfect cleavage and twinning parallel to a form taken as  $c(001)$ . With this position there are no prism forms and it was therefore simpler to measure the crystals on the two-circle instrument with the clinopinacoid (not present) as pole and the orthodome zone as prism zone. When these measurements were plotted in gnomonic projection, discussion showed that a different choice of axes was preferable.

<sup>1</sup> *Zeit. f. Kryst.*, 55, p. 566, 1920.

<sup>2</sup> During the publication of this paper a second article on phosphophyllite has appeared by Steinmetz in *Zeit. für Kryst.*, 64, 405, 1926. A new analysis establishes its composition according to the following simpler formula:  $3\text{RO}\cdot\text{P}_2\text{O}_5\cdot 4\text{H}_2\text{O}$  in which RO consists of  $(\text{FeO}+\text{MnO}):(\text{ZnO})$  in the proportion 1:1.75.

One new form is recorded as  $p(125)$  which in the new position would correspond to the form  $p(\bar{3}11)$ .

New optical data are also given which agree closely with those given below in this paper except for  $\beta$  which is 1.606 instead of Larsen's value of 1.614. This low value of  $\beta$  is inconsistent with the observed axial angle given by Steinmetz in his previous article. That angle,  $2E=70^\circ-80^\circ$ , would give by calculation the index 1.614 as given by Larsen.

The best results were obtained by taking the base of Laubmann and Steinmetz as orthopinacoid and their negative orthodome as base. The symbols for the forms in the two positions are shown in table 1.

TABLE I

	Symbol (L. and S.)	Symbol (P. and B.)		Symbol (L. and S.)	Symbol (P. and B.)
<i>c</i>	(001)	(100)	$\tau$	(I03)	(101)
$\rho$	(I01)	(001)	<i>a</i>	(100)	(I02)
<i>q</i>	(011)	(110)	<i>s</i>	(102)	(302)
<i>k</i>	(012)	(210)	$\omega$	(I23)	(111)
<i>g</i>	(021)	(120)	$\lambda$	(I25)	(211)
$\pi$	(I21)	(011)	<i>o</i>	(123)	(211)

The symbols in this position become simpler and the dominant forms on the crystal *a*,  $\pi$ ,  $\omega$  and *q* all become, except the first, fundamental forms. Figure 1 shows the crystal measured in the new position. The axial ratios in the two positions are as follows:

	Position of L. and S.	Position of this paper
<i>a:b:c</i>	= 1.0381:1:1.7437	2.079:1:2.026
$\beta$	= 90° 28'	120° 25'
$\rho_0 q_0$	= 1.680 1.744	1.026 1.793
$\mu$	= 89° 32'	59° 35'

Coordinate angles have been calculated from the axes given above and are shown together with the measured angles of the forms found by us in Table 2.

TABLE II.

	Calculated		Measured	
	$\phi$	$\rho$	$\phi$	$\rho$
<i>c</i> (100)	90° 00'	90° 00'	90° 00'	90° 00'
$\rho$ (001)	90 00	30 25	90 00	30 28
<i>q</i> (110)	29 47	90 00	29 49	90 00
<i>k</i> (210)	48 51	90 00	48 50	90 00
<i>g</i> (120)	15 58	90 00	.....	.....
<i>q</i> (011)	15 46	65 10	15 45	65 08
<i>x</i> (013)	40 16	42 15	40 55	42 00
$\tau$ (101)	90 00	60 38	.....	.....
<i>a</i> (I02)	-90 00	0 27	-90 00	-0 19
<i>s</i> (302)	-90 00	50 08	.....	.....
$\omega$ (111)	40 31	69 55	40 32	69 52
$\lambda$ (211)	54 58	74 34	54 51	74 35
<i>o</i> (211)	-40 46	69 59	.....	.....



TABLE III.  
INTERFACIAL ANGLES OF PHOSPHOPHYLLITE

	L. and S. measured	L. and S. calculated	P. and B. calculated
$a \wedge c$	89° 32'	89° 32'	89° 33'
$\rho \wedge c$	59 24	59 39	59 35
$s \wedge c$	39 50	39 50	39 52
$q \wedge c$	60 06	60 10	60 13
$k \wedge c$	41 05	41 05	41 09
$\pi \wedge c$	75 46	75 42	75 44
$\pi \wedge \pi$	52 25	52 21	52 24
$\omega \wedge c$	121 34	121 38	121 40
$\omega \wedge \omega$	91 07	91 00	91 08
$\lambda \wedge c$	37 40	37 49	37 52
$\lambda \wedge \lambda$	67 10	67 3	67 10

OPTICAL PROPERTIES. In the original description the optical data are incomplete. The following observations by Dr. Larsen, referred to the new position of the crystals, are in part new; Biaxial (-).  $2V$  about  $50^\circ$ .  $Z=b$   $Y \wedge a = 50^\circ \pm Bx_a$  about normal to  $c(100)$ .  $\alpha = 1.594$ ,  $\beta = 1.614$ ,  $\gamma = 1.616$ .

## 2. HEMATITE FROM FRANKLIN, NEW JERSEY.

A small specimen of Franklin ore with a surface dotted with tiny black cube-like crystals was sent to the Harvard Mineralogical Laboratory for determination by Mr. Jenkins, chief chemist of the New Jersey Zinc Company in 1926. The best crystals were covered with a film of red substance ( $Fe_2O_3?$ ) which easily scaled off revealing the splendid metallic lustre. Measurement showed the crystals to be hematite with a habit and a group of forms rare for this mineral. Although a common mineral at Franklin, measurable crystals of hematite have hitherto been unknown there and the observations seem worthy of record.

The dominant form is the unit rhombohedron which determines the cuboid habit as shown in figure 2. The single modifying form there shown is really one of a group shown in figure 3, the enlarged detail of one coign of the crystal. Although so minute, these faces are clean cut and brilliant, giving excellent goniometer readings. Figure 4 shows a twin crystal, twinning on the ordinary law parallel to  $c(0001)$ , the composition plane parallel to a face of the first order prism. The faces are the same as on the simple crystals but symmetrical distortion parallel to the composition plane gives the oblong or in some cases hexagonal habit to the twin groups.

The forms found are as follows:

Letter		Symbol		Letter		Symbol	
Dana	G <sub>2</sub>	Bravais		Dana	G <sub>2</sub>	Bravais	
<i>c</i>	0	(0001)		<i>s</i>	60	(22 $\bar{4}$ 1)	
<i>r</i>	-1	(10 $\bar{1}$ 1)		$\chi$	$-2\frac{1}{2}$	(12 $\bar{3}$ 2)	
<i>e</i>	$-\frac{1}{2}$	(01 $\bar{1}$ 2)		$\psi$	$-\frac{4}{5}$ $\frac{1}{5}$	(12 $\bar{3}$ 5)	
<i>n</i>	20	(22 $\bar{4}$ 3)		<i>P</i>	$-\frac{8}{7}$ $\frac{2}{7}$	(24 $\bar{6}$ 7)	

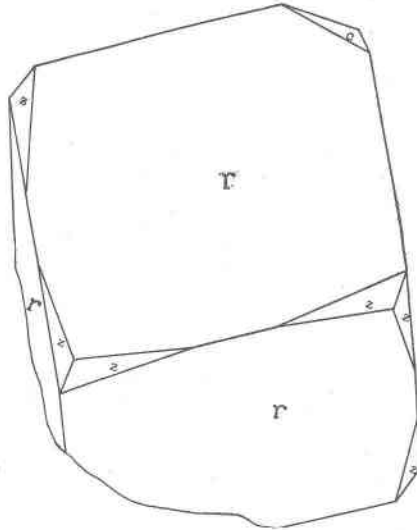


Figure 2. Hematite, Franklin, N. J.

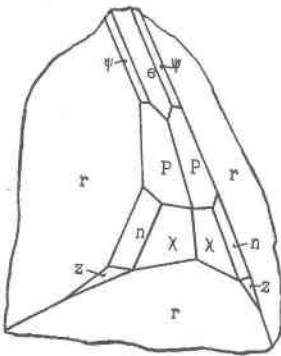


Figure 3. Hematite, Enlargement Detail of one Coign of Figure 2.

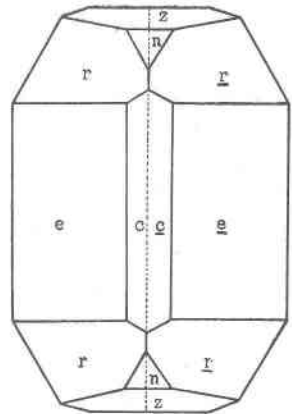


Figure 4. Hematite Twin.

The last three forms are scalenohedrons, none of them of frequent occurrence on hematite, constituting a radial zone.

The hematite is associated with a rhombohedral carbonate probably calcite, and with perfectly white sphalerite ("Cleiothane") in flattened twin crystals.

3. WILLEMITE FROM FRANKLIN, NEW JERSEY.

Beautifully crystallized willemite has been found at Franklin in recent years more frequently than for a long time. Among the many specimens of this mineral for which the Harvard Collection is indebted to Messrs. Jenkins and Bauer, Chemists of the New Jersey Zinc Company, two stand out by reason of their novel habit. One illustrated in figure 5 is noteworthy for its exceedingly thin tabular habit, the prism being present only in traces. These tiny white scale-like crystals accompany canthite with axinite, rhodonite

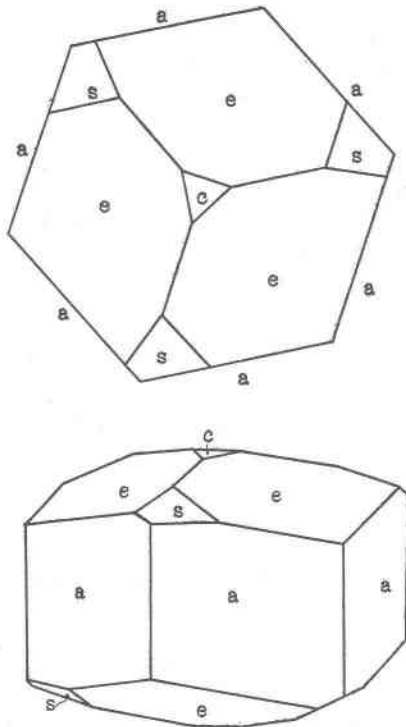


Figure 5. Willemite, Franklin, N. J.

and the hedyphane crystals to be described below. The second novel habit is shown in figure 6, a and b. It is a stout prism, 1.3 cm. diameter by 1 cm. high, of snow white color implanted in parallel growth upon a much more slender prism of glassy willemite and in such a way that both terminations are complete. It is unusual in showing the negative rhombohedron *e* as the chief terminal form. And the distribution of the faces of the second order rhombohedron *s* reveals well the peculiar symmetry of willemite.

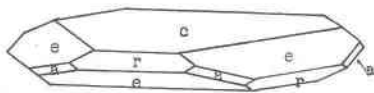
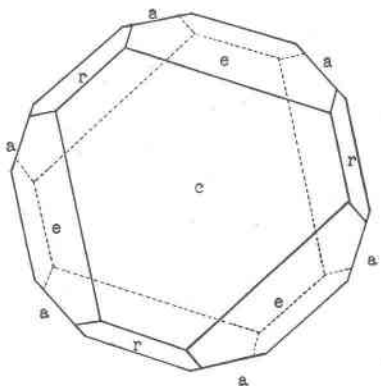


Figure 6. Willemite, Franklin, N. J.

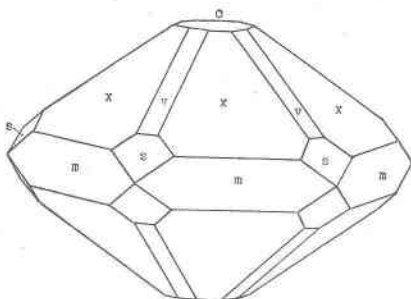


Figure 7. Hedyphane, Franklin, N. J.

Specimens of crystallized willemite which were quite colorless and of almost perfect purity have been analyzed by Mr. Bauer and the optical indices determined by Mr. Berman.

	Per cent	Molecular Ratio
SiO <sub>2</sub>	26.55	.440
ZnO	72.11	.886
FeO	0.075	.001
MnO	0.12	.002
MgO	0.13	.003
Al <sub>2</sub> O <sub>3</sub>	1.00	.010

.440 = 1 × .440

.902 = 2 × .451

The optical indices of these crystals which are by far the purest zinc silicate ever analyzed from Franklin, are as follows:  $\omega = 1.691$ ,  $\epsilon = 1.719$  for white light by the immersion method.

#### 4. HEDYPHANE FROM FRANKLIN, NEW JERSEY.

The hedyphane crystals associated with cahnite and the tabular willemite described above are shown in figure 7. A prism of this hedyphane was cut parallel to the vertical axis and yielded the following optical data:

Uniaxial (+),  $\epsilon = 1.958$ ,  $\omega = 1.948$  for sodium light

Examination of part of the collection of Franklin minerals left by the late F. A. Canfield reveals the fact that hedyphane is more widely distributed there than has been recognized. Several specimens from the Parker Shaft taken out at least twenty years ago show bluish hedyphane associated with axinite, caswellite and hancockite. It was there and in such specimens that the first native lead was found at Franklin. Hedyphane was first identified at Franklin by Foshag and Gage in 1925.