

THE OCCURRENCE AND PROPERTIES OF CHLOROPHOENICITE, A NEW ARSENATE FROM FRANKLIN, NEW JERSEY

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INTRODUCTION

In a preliminary paper the writers¹ gave a short description of a new arsenate collected at Franklin during the year 1923. This mineral was found during mining operations between the 500 and 600-foot levels of the mine of the New Jersey Zinc Co. where it occurred in the pillars of ore that were being taken out at that time. Specimens of this arsenate were apparently very rare and all possible specimens of the mineral were procured for study. In all about a dozen specimens were obtained and several of the better ones were sacrificed for a sample for analysis. A larger specimen from which the material for analysis was taken is preserved in the United States National Museum (No. 94964, U. S. N. M.). A number of crystals from this specimen were taken for crystal measurement but better ones were found on a specimen in the Holden collection of Harvard University (No. 81224), the crystallographic data given being based on these.

This arsenate mineral proved upon chemical analysis to be new and the name chlorophoenicite was given to it. The name is derived from the Greek *χλωρος* (green) and *φοινικος* (purple red) in allusion to the remarkable property it possesses of changing its color from light green in natural light to a light purplish red in artificial light.

OCCURRENCE

The chlorophoenicite occurs in cracks in the franklinite-willemite ore associated with tephroite, willemite, leucophoenicite, calcite, and zincite. Of these minerals the chlorophoenicite is later than all the minerals except the calcite. The sequence is apparently willemite and tephroite-leucophoenicite-chlorophoenicite-calcite. The willemite forms fine grained masses of minute acicular crystals. The

¹ Journ. Wash. Acad. Sci., vol. 14, pp. 362-363, 1924.

leucophoenicite is almost always present in small clear rose to purplish red prismatic crystals. The presence of this clear leucophoenicite is a good indication that chlorophoenicite may be present. Calcite occurs massive and covers many of the earlier minerals or is found as small hexagonal prisms. The chlorophoenicite is perched on all these minerals or rests directly on the franklinite-willemite ore, but rarely is inclosed in some calcite. The crystals are haphazardly arranged although they show at times a crudely radiating grouping. Two types of crystals were distinguished, long needle-like crystals forming an open reticulated mass or short, stumpy ones forming small groups of a few individuals or small crusts.

Several other arsenates have been found in the same workings from which the chlorophoenicite came, notably the silico-arsenate of manganese, schallerite and the arsenate of calcium and lead, hedyphane.

CRYSTALLOGRAPHY

All the chlorophoenicite occurs in distinct crystals that reach a maximum size of 8 mm. in length and less than 1 mm. in thickness. The needles are always deeply striated parallel to the elongation and the terminal faces are etched and dull. Measurements of the crystals showed that they belong to the monoclinic system and that the plane of symmetry lies across the needles. The mineral is therefore elongated parallel to the ortho-axis *b*.

The data upon which the crystallographic calculations are based were obtained on rather inferior crystals, which, however, were the only ones available. The crystals were all warped in the zone of elongation and also considerably striated in that direction. Fourteen crystals were measured none of them exceeding 0.5 mm. in length. For convenience they were mounted with the elongated zone vertical and the resulting angular values, though in comparatively poor agreement, were averaged. The data obtained with the two circle goniometer are given in the table below.

Measurements of crystal forms of chlorophoenicite

	Number of readings	Maximum		Minimum		Average	
		° /	° /	° /	° /	° /	° /
1	18	75 22	90 00	72 59	90 00	74 26	90 00
2	14	1 04	90 00	-1 08	90 00	00 00	90 00
3	1					66 34	90 00
4	1					54 23	90 00
5	3	88 22	90 00	86 29	90 00	87 36	90 00
6	13	110 12	90 00	106 00	90 00	110 00	90 00
7	18	38 45	37 20	37 30	35 20	38 43	36 24

In the table on page 2 the angles were measured from the cleavage face taken as 010. The angles transposed to the normal position are given below.

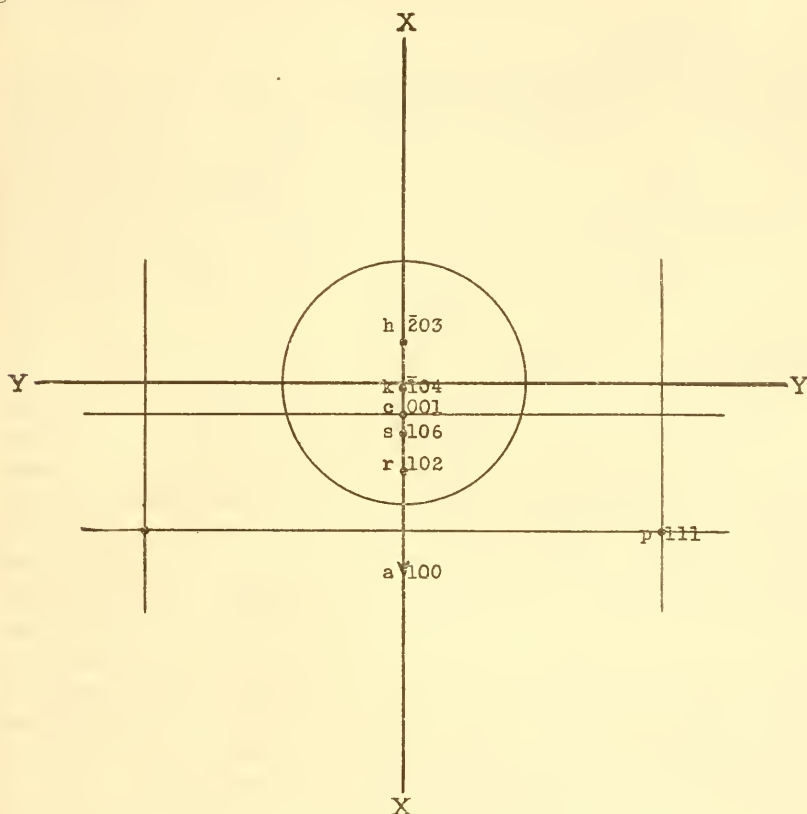


FIG. 1.—GNOMONIC PROJECTION OF THE CRYSTAL FORMS OF CHLOROPHOENICITE

Angles of crystal forms of chlorophoenicite

Letter	Symbol		φ	ρ
	Gold-schmidt	Miller		
<i>c</i>	0	001	90 00	15 34
<i>a</i>	0∞	100	90 00	90 00
<i>s</i>	$+\frac{1}{6}0$	106	90 00	23 36
<i>r</i>	$+\frac{1}{2}0$	102	90 00	36 53
<i>k</i>	$-\frac{1}{4}0$	$\bar{1}04$	90 00	2 23
<i>h</i>	$-\frac{2}{3}0$	$\bar{2}03$	90 00	19 28
<i>p</i>	1	111	29 41	68 01

The distribution of the faces is shown in the gnomonic projection (fig. 1).

From these angles the following elements were calculated:

$$p=0.9135.$$

$$q=2.074.$$

$$r=1.$$

$$e=0.2684.$$

$$\mu=74^{\circ} 26'.$$

$$a=2.357.$$

$$b=1.$$

$$c=2.153.$$

$$\beta=105^{\circ} 34'.$$

The crystals usually show but four forms: c (001), a (100), h ($\bar{2}03$) and p (111). Other forms noted were s (106), r (102) and k ($\bar{1}04$)

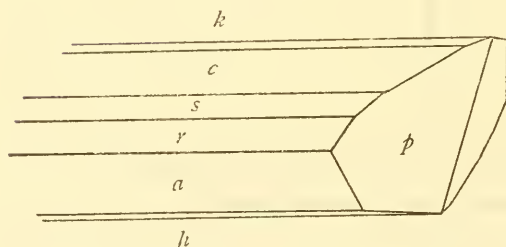
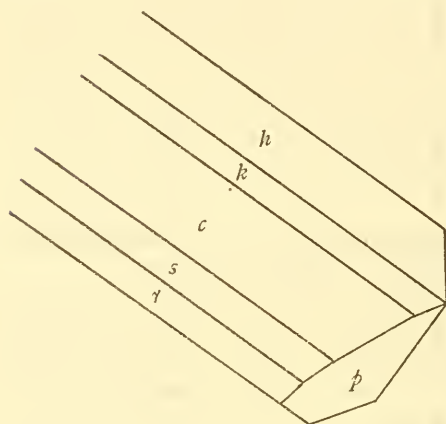


FIG. 2.—ORTHOGRAPHIC AND CLINOGRAPHIC PROJECTION OF CRYSTAL OF CHLOROPHOENICITE

(fig. 2). The base is usually the largest face on the crystal and is always more deeply striated than the other prominent faces. The face h ($\bar{2}03$) is broad. The pinacoid a (100) is usually medium in size and is the brightest face on the crystal. The two terminal faces p (111) are badly etched and reflections from them are always poor. Of the other faces s (106) and r (102) were encountered once as narrow striated faces and k ($\bar{1}04$) three times, likewise narrow and striated.

PHYSICAL PROPERTIES

The crystals have a good cleavage parallel to the front pinacoid, a (100). No other cleav-

OPTICAL PROPERTIES

ages could be detected. The crystals are brittle and break easily across the prisms as well as along the cleavage. The crystals easily scratch gypsum; calcite can be scratched by rubbing it across a crystal but fluorite seems to be unaffected. Its hardness then is 3 to 3.5.

Chlorophoenicite is grayish green in color but has a suggestion of pink on the pyramid faces. Under strong artificial light the crystals take on a purplish red or reddish gray color, deeper in tint on the

pyramid faces than on the dome zone. The lustre of the crystals is vitreous to pearly, the pearly lustre being more pronounced on the front pinacoid face to which the good cleavage is parallel. Some of the larger crystals have a slight iridescent tarnish.

The plane of the optic axes lies across the needles, that is, it lies in the plane of symmetry. Cleavage flakes show the emergence of an optic axes only slightly off center. The dispersion is strong with ρ greater than ν). Plates showing the emergence of an optic axis have anomalous interference colors characteristic of axes with high dispersion. $2V$ measured with a micrometer ocular is $83^\circ \pm 2^\circ$. The optical character is negative. The indices of refraction measured by the oil immersion method were found to be as follows:

$$\alpha = 1.682$$

$$\beta = 1.690$$

$$\gamma = 1.697$$

The specific gravity, calculated from the relation $\frac{n-1}{d} = k$ (Gladstone's rule) is 3.55.

CHEMICAL PROPERTIES

The color changes on heating from green to black and the mineral evolves abundant water, the crystal faces becoming rough and porous. Before the blowpipe the crystals become black, coloring the flame a faint pale blue and glow with a bright light. The crystals fuse only with difficulty. The mineral is soluble in acids and the solution reacts for arsenic, manganese, and zinc.

Material for analysis was obtained by carefully picking the clean crystals from the specimen which were then crushed and examined under the petrographic microscope and the sample found to be essentially pure. The amount available for analysis was one-quarter of a gram. Upon analysis the following results were obtained:

TABLE 1.—*Composition of chlorophoenicite*

	Actual analysis	Theoretical composition	Ratios	
Water (H ₂ O)-----	11. 60	11. 4	0. 644	7. 05×9. 02
Lime (CaO)-----	3. 36	-----	. 0599	-----
Magnesia (MgO)-----	1. 34	-----	. 0332	-----
Ferrous oxide (FeO)-----	0. 48	-----	. 0067	10. 55×9. 02
Manganous oxide (MnO)-----	34. 46	38. 5	. 4853	-----
Zinc oxide (ZnO)-----	29. 72	29. 3	. 3669	-----
Arsenic pentoxide (As ₂ O ₅)-----	19. 24	20. 8	. 0836	. 92×9. 02
	100. 20	100. 0	-----	-----

The analysis yields the formula $1\text{RO} \cdot \text{As}_2\text{O}_5 \cdot 7\text{H}_2\text{O}$, in which RO is essentially manganese and zinc with magnesia, lime and ferrous

oxide as minor constituents. The ratio of manganese to zinc is about 3:2. The theoretical composition for these ratios is given in Table 1. The formula may also be written $R_3As_2O_8 \cdot 7R(OH)_2$. It is therefore a hydroxyarsenate of manganese and zinc in which the ratio of hydroxide to the arsenate is remarkably high.

RELATIONSHIPS

In respect to the ratio of the arsenate to the hydroxide this mineral is quite exceptional. No other arsenate or phosphate approaches this ratio. Chondrarsenite, to which the formula $Mn_3As_2O_8 \cdot 3Mn(OH)_2$ had been assigned, is now known to be sarkinite, $Mn_3As_2O_8 \cdot Mn(OH)_2$. The doubtful mineral xantharsenite to which the formula $5MnO \cdot As_2O_5 \cdot 5H_2O$ has been assigned approaches nearest to chlorophoenicite. A specimen of this mineral from the collection of Colonel Washington A. Roebling has the following optical properties: Yellow structureless veins, biaxial positive, 2V medium, $\alpha = 1.705$, $\beta = 1.710$, $\gamma = 1.720$. Neither the chondrarsenite nor the xantharsenite have been found in crystals. They show considerably more arsenic and less bases and differ appreciably in certain optical features. Chlorophoenicite is apparently quite distinct from either of these and is not related closely to any known mineral.

