UNITED STATES DEPARTMENT OF THE INTERIOR
Harold L. Ickes, Secretary
GEOLOGICAL SURVEY
W. C. Mendenhall, Director

Professional Paper 180

THE MINERALS OF FRANKLIN AND STERLING HILL SUSSEX COUNTY, NEW JERSEY

BY
CHARLES PALACHE

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1935

For sale by the Superintendent of Documents, Washington, D.C. - - - - - - - Price 30 cents

Physical properties.—Chlorophoenicite is light grayish green in natural light but is pink or light purplish red in artificial light, hence its name, from Greek words for those colors. It is optically biaxial and negative; the plane of the optic axes is the plane of symmetry; $2V = 83° \pm 2°$; r>v (strong); $\alpha = 1.682$, $\beta = 1.690$, $\gamma = 1.697$. The cleavage is good parallel to the orthopinacoid, the luster is vitreous to pearly, especially on cleavage surfaces, and the hardness is 3 to 3.5. The specific gravity is 3.46.

Composition.—Chlorophoenicite is a hydrous manganese-zinc arsenate containing some magnesium, calcium, and iron.

Analysis of chlorophoenicite

[W. F. Foshag (231), analyst]

	Percent	Molecular ratio	
MnO	34.46	0.486	
ZnO	29.72	.365	
FeO	.48	.007	0.951 = 10×0.095
MgO	1.34	.033	
CaO	3.36	.060	
As_2O_5	19.24	.084	= 1×0.084
H_2O	11.60	.644	= 7×0.092
	100.20		

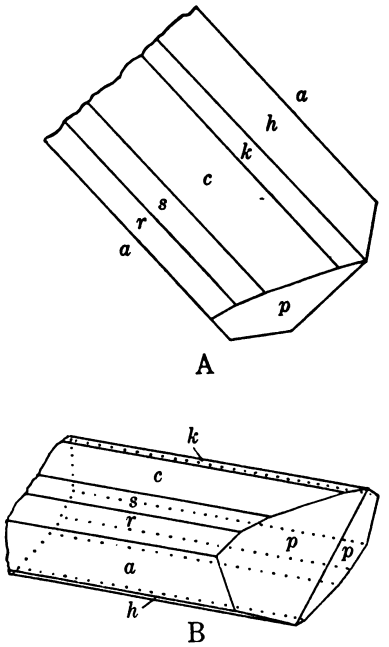

FIGURE 192.—Crystal of chlorophoenicite showing the forms $c(001)$, $a(100)$, $s(106)$, $r(102)$, $k(104)$, $h(203)$, and $p(111)$. Franklin. A, Plan; B, clinographic projection.

The analysis yields the empirical formula $10(Mn,Zn)O.As_2O_5.7H_2O$, although the arsenic is rather low for that composition. The formula may be interpreted as $(Mn,Zn)_3As_2O_8.7(Mn,Zn)(OH)_2$. Heated in the closed tube the mineral gives off water at a low temperature and turns black with a brilliant luster but does not fuse. Before the blowpipe it is fusible with difficulty, without decrepitation.

Occurrence.—Chlorophoenicite, discovered by Gage in 1923, was described in a preliminary paper by Foshag and Gage (231) and more fully by Foshag, Berman, and Gage in 1924. It was first found in pillars of ore between the 500- and 600-foot levels in the mine at Franklin, where crystals of it were implanted on the surfaces of cracks and slickensides in massive franklinite-willemite ore, associated with crystals of leucophoenicite and calcite and more rarely of tephroite. Its slender needles resemble rather closely crystals of transparent willemite.

Chlorophoenicite has also been found in radiate aggregates of acicular crystals on the 900-foot level in the mine at Sterling Hill, associated with calcite and barite.

In 1928 Palache (257) described flattened prisms that were doubtfully identified as clinozoisite, though their optical characters did not agree very closely with those of that mineral. Later study by Bauer and Berman (273) has shown that the crystals are undoubtedly chlorophoenicite, and that name should be substituted for clinozoisite in lists of Franklin minerals.

Another interesting occurrence of chlorophoenicite was seen in a single specimen from Franklin. In a cavity in a carbonate vein is an aggregate of needles of chlorophoenicite, thin bundles of needles being grouped with great regularity as a six-rayed star. Although this may be a twin aggregate, it seems more likely that the growth was controlled by a calcite crystal that was partly replaced along definite crystallographic directions by chlorophoenicite and then wholly removed, leaving this skeletal growth of fibers.

MAGNESIUM CHLOROPHOENICITE

$(Mg,Mn)_3As_2O_8.7(Mg,Mn)(OH)_2$. Monoclinic

Habit.—Magnesium chlorophoenicite is found in fibers, grouped in radial aggregates implanted on the surface of a narrow open vein composed of zincite and carbonates. Some of the rosettes have a diameter of two-fifths of an inch.

The only specimen was collected by the late George Stanton in the Franklin mine on the 750-foot level at pillar 859.

Physical properties.—The fibers are white or colorless but are stained brown on some surfaces. They show the same single excellent cleavage lengthwise of the fibers that is characteristic of chlorophoenicite. The specific gravity is 3.37.

Optical properties.—The mineral is optically biaxial and positive, with a small optic angle. The plane of the optic axes is across the fibers—that is, parallel to the plane of crystal symmetry. The extinction angle could not be measured on the material available; r<v (strong); $\alpha = 1.669$, $\beta = 1.672$, $\gamma = 1.677$, all ± 0.003 (Berman).

Composition.—Magnesium chlorophoenicite is similar in composition to chlorophoenicite but contains

magnesium in place of all the zinc and part of the manganese of that mineral. The following analysis was made in the chemical laboratory of the department of mineralogy at Harvard University on about 0.4 gram of material that could not be completely purified without loss of too much of the mineral itself.

Analysis of magnesium chlorophoenicite

	1	2		4	5
SiO_2	3. 36	0. 056			
Fe_2O_3	3. 85	. 024			
ZnO	8. 90	. 109			
MgO	29. 95	. 743	0. 743 / . 188 = 10×0. 093	39. 64	39. 31
MnO	15. 57	. 219		18. 05	17. 29
As_2O_5	21. 16	. 092	. 092 = 1× . 092	28. 00	28. 04
H_2O	10. 81	. 601	. 601 = 7× . 086	14. 31	15. 36
$CaCO_3$	6. 29	. 063			
	99. 89	------		100. 00	100. 00

1. Magnesium chlorophoenicite, Franklin. F. A. Gonyer (277), analyst.
2. Molecular equivalents of the constituents.
3. Molecular ratio of remainder after deducting 5.55 percent of franklinite, 6.29 percent of calcite, and 12.49 percent of willemite.
4. Composition of remainder recomputed to 100 percent.
5. Composition of mineral computed from formula, assuming the molecular ratio of MnO to MgO as 1 to 4.

The material analyzed was known to contain calcite and willemite, and in interpreting the analysis the assumption was made that all the ZnO and SiO_2 found was contained in willemite and that all the Fe_2O_3 found was contained in franklinite. On this assumption the material contained 24.32 percent of impurities, consisting of 6.29 percent of calcite, 12.48 percent of willemite, and 5.55 percent of franklinite. The molecular ratio of the remainder gives the empirical formula $10(Mg,Mn)O.As_2O_5.7H_2O$, which is of the same form as that of chlorophoenicite but differs in containing magnesium in place of zinc, the molecular ratio of MgO to MnO being 4 to 1.

The difference in composition is reflected in the lower specific gravity, lower refractive indices, and opposite optical sign of the mineral as compared with chlorophoenicite. This may explain the fact previously discovered that some specimens of what was taken to be chlorophoenicite are optically positive.

HOLDENITE

$8MnO.4ZnO.As_2O_5.5H_2O$. Orthorhombic

$a:b:c = 0.3802:1:0.2755$

Forms.—$c(001)$, $b(010)$, $a(100)$, $m(110)$, $l(120)$, $n(130)$, $e(011)$, $f(031)$, $d(102)$, $p(111)$, $q(211)$, $r(311)$, $s(131)$, $w(151)$, $t(251)$, $x(182)$, and $u(7.16.2)$.

Habit.—Holdenite is found in crystals tabular parallel to the face taken as the macropinacoid, the largest crystal on the specimen being a third of an inch in greatest diameter. The crystals differ little in habit and about two-thirds of the forms are found on all of them. The base was seen but once, and $n(130)$ and $e(011)$ were each found well developed on but two crystals. The forms $f(031)$, $w(151)$, and $x(182)$ were also found on only one crystal, the most complex measured, shown in figure 193. The pyramid $u(7.16.2)$, seen on all the crystals, with relatively large faces has a considerable range in its angular position. As shown in the figure, it is in a zone with $t(251)$ and $s(131)$, and the angles measured on this one crystal agree well with the computed values. On other crystals, however, the angles are different and on some have values that correspond approximately to the simpler indices (491), but the deviation is considerable, and preference was given to the more complex symbol.

Physical properties.—Holdenite has a poor cleavage parallel to the brachypinacoid. Its hardness is 4, and its specific gravity, determined by floating in Clerici solution, is 4.07. The color ranges from clear pink to deep red and yellowish red. The mineral is biaxial and positive; the plane of the optic axes is parallel to the brachypinacoid, with the acute bisectrix emerging normal to the macropinacoid. $2V = 30°20'$ (measured), 28°58′ (computed); r>v (easily perceptible). $\alpha = 1.769$ (parallel to c axis), $\beta = 1.770$ (parallel to b axis), $\gamma = 1.785$ (parallel to a axis) (Larsen).

Composition.—Holdenite is a basic arsenate of manganese and zinc in which the molecular ratio of manganese to zinc is approximately 2 to 1.

Analysis of holdenite

	1	2	3	4
SiO_2	2. 01	0. 033		
As_2O_5	17. 40	. 076	0.076 = 1×0.076	18. 96
MnO	37. 75	. 532	.532	46. 78
FeO	1. 80	. 025	.025	
ZnO	28. 08	. 345	.279 / 0.914 = 12× .076	26. 83
CaO	3. 80	. 067	.042	
MgO	1. 45	. 036	.036	
H_2O	6. 62	. 367	.367 = 5× .073	7. 43
PbO	Trace	------		
Mn_2O_3	Trace	------		
Al_2O_3	Trace	------		
	98. 91	------		100. 00

1. Slightly impure material. E. V. Shannon (248), analyst.
2. Molecular equivalents of no. 1.
3. Molecular ratio of remainder after deducting 2.49 percent of calcite and 7.38 percent of willemite.
4. Composition computed from the derived formula.

About 0.42 gram of nearly pure material was prepared by Mr. Berman for analysis. The presence of calcite was proved optically and by the effervescence of grains on solution in acid, but the sample was not large enough to permit the determination of CO_2. The assumptions were made that the deficiency of the analysis, 1.09 percent, represents CO_2, that the SiO_2 was present in willemite, and that the material therefore contained 2.49 percent of calcite and 7.38 percent of willemite. After deducting the molecular equivalents of those constituents from column 2 the