YEATMANITE, A NEW MINERAL, AND SARKINITE FROM FRANKLIN, NEW JERSEY

CHARLES PALACHE, *Harvard University*, L. H. BAUER, *Franklin, N. J.*, AND HARRY BERMAN, *Harvard University.*

ABSTRACT

Yeatmanite, $(Mn, Zn)_{16}Sb_2Si_4O_{29}$, is a new mineral from Franklin, N.J. It is triclinic, pseudo-orthorhombic, with multiple twinning on $b(010)$ and macroscopic twinning on (023). Elements (x-ray): $a:b:c=0.7811:1:0.4775$. $\alpha=103°49'$; $\beta=101°45'$; $\gamma=87°12'$. Cleavage perfect ∥(100); H. 4, G. 5.02±.10. Biaxial, negative; X near a[100], Y near b[010], $Z \wedge c[001]=3\frac{1}{2}°$. Indices (Na): $nX=1.873$, $nY=1.905$, $nZ=1.910$, all ±0.003. 2V about 49°, r<v, dispersion moderate. Clove-brown crystalline plates embedded in willemite. The composition of sarkinite, associated with the yeatmanite, differs from the Långban material only in having 5.38 per cent of zinc.

In the spring of 1937 a few specimens were found in the mine at Franklin, in which an unfamiliar pink mineral attracted attention. Mr. Bauer examined this mineral and made micro-chemical tests which revealed the presence of arsenic, manganese and zinc. Optical tests showed the characters of sarkinite, a mineral found before only at Långban and Pajsberg in Sweden. The sarkinite is embedded in green willemite, the two forming together a narrow vein in massive granular ore. In the willemite is a very small amount of an additional mineral in the form of clove-brown plates, which proves to be a new species. It is described in the following pages and to it has been given the name yeatmanite, in honor of Pope Yeatman, the distinguished mining engineer, who has been closely associated during recent years with mining and milling operations at Franklin.

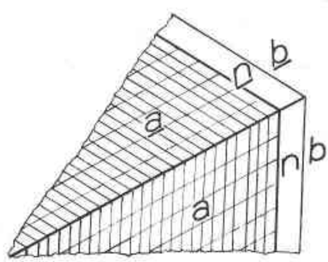

FIG. 1. Yeatmanite crystal twinned on (023).

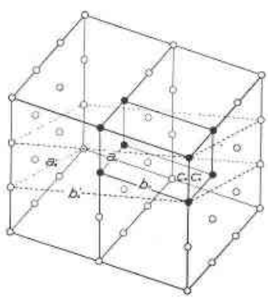

FIG. 2. Yeatmanite lattice.

Yeatmanite. The plates of yeatmanite are embedded in willemite and reach a maximum dimension of 1.3×0.7 cm. with a thickness of 1 mm.

Generally irregular in outline or lath-shaped, one or two were found with pseudohexagonal crystal form as shown in Fig. 1. This is clearly a twin crystal and was at first taken to be composed of orthorhombic individuals. Optical examination, however, proved that the striae shown on the broad face are due to lamellar twinning on {010} and that the individual is really triclinic. The few angles measured are insufficient to define the elements of the crystal, which was, however, analyzed by x-ray data as shown below. The tabular face of the plates was taken as {100} and the direction of twinning striae on that face as the vertical. The measurements obtained are as follows:

$$a(100) \wedge b(010) = 90°00' \text{ circa}$$
$$a(100) \wedge n(210) = 20°00' \text{ circa}$$
$$b(010) \wedge n(210) = 60°00'$$

The x-ray study was made on one member of such a twin as is shown in Fig. 1. Weissenberg photographs were made of the equatorial and first layers, with $c[001]$ as rotation axis. The first layer line shows a symmetry plane {010} corresponding with the twin plane of the lamellae determined by optical examination of the same crystal. No other plane of symmetry could be detected in the x-ray photograph. This evidence, together with the optical data, leads to the conclusion that yeatmanite is triclinic. Calculation of the simplest triclinic cell yields:

$a_0=9.029$, $b_0=11.56$, $c_0=5.52$ all $\pm.01$Å. $\alpha=103°49'$, $\beta=101°45'$, $\gamma=87°12'$ (The angles are probably not more accurate than $\pm 1°$.)

Crystallographic elements calculated from these values are: $a:b:c=0.7811:1:0.4775$; $\alpha=103°49'$, $\beta=101°45'$, $\gamma=87°12'$; $p_0'=0.6245$, $q_0'=0.4918$, $x_0'=0.2080$, $y_0'=0.2461$, $\lambda=76°27'$, $\mu=78°35'$, $\nu=90°00'$.

Forms: a{100}, b{010}, n{210}, {023}—the last observed only as a twin plane.

A pseudo-orthorhombic cell containing six triclinic units has the attitude shown in Fig. 2 and the dimensions $a_0'26.53$, $b_0'22.43$, $c_0'5.52$Å. This multiple cell is also produced by twinning on {010} and this identity probably accounts for the twin structure.

Optical properties. The crystal used for the x-ray study was also used for optical examination. The acute negative bisectrix is apparently normal to the a{100} face and the plane of the optic axes is inclined $3\frac{1}{2}°$ to the trace of the twin plane b{010} as seen on a{100}. Refractive indices measured with phosphorus methylene iodide liquids are as follows: nX$=1.873$, nY$=1.905$, nZ$=1.910$, all $\pm.003$ for sodium light. The dispersion is moderate $r<v$ and the axial angle is about 40° as estimated. (From the indices of refraction 2V$=49°$.) No pleochroism was noted.

Physical properties. Yeatmanite has an excellent cleavage on a{100}.

It is brittle. The color is deep brown in the larger pieces and light brown in thin fragments. The streak is very light brown. Hardness is 4. The density as determined by H. Winchell on a sample of .073 gm., using a micropycnometer, is 5.02 ± 0.10. This sample contained some willemite and a small percentage of calcite.

Chemistry. A sample of yeatmanite of about 0.45 gram was prepared and analyzed. Its composition and ratios are presented in the first table. A second specimen was found by Mr. Bauer in his collection, of unknown origin. From this a sample of about 0.7 gram was prepared and yielded the figures of Table 2.

YEATMANITE—Sample 1

	1	2	3		4	
SiO_2	13.50	13.59	.226	$= 4\times.057$	Si	3.8
Sb_2O_5	18.01	18.12	.056	$= 1\times.056$	Sb	1.9
MnO	33.00	33.21	.469			
FeO	0.36	0.36	.005	} $.901=16\times.056$	R	15.0
ZnO	34.54	34.72	.427			
H_2O+	0.54	—				
	99.95	100.00				

1. Analysis of 0.45 gram (used in 3 portions). L. H. Bauer, *analyst.*
2. Corrected for water.
3. Molecular proportions.
4. Atoms in unit cell.

YEATMANITE—Sample 2 (treated with dilute HCl)

	1	2	3		4
SiO_2	14.16	14.31	.238	$= 4\times.060$	13.48
Sb_2O_5	18.48	18.68	.058	$= 1\times.058$	18.15
MnO	37.06	37.45	.535		36.53
FeO	0.90	0.91	.013	} $.987=16\times.062$	
ZnO	28.35	28.65	.439		31.84
H_2O+	0.45	—			
CaO	present	—			
	99.40	100.00			100.00

1. Analysis of 0.7 gram (used in 3 portions). L. H. Bauer, *analyst.*
2. Corrected for water.
3. Molecular proportions.
4. Theoretical composition for $(Mn, Zn)_{16}Sb_2Si_4O_{29}$ with Mn:Zn 1:1.

Both analyses yield substantially the same formula, which is $(Mn,Zn)_{16}Sb_2Si_4O_{29}$, with about equal molecular parts of Mn and Zn.

The number of atoms in the unit cell is given in column 4 of the first table, calculated from the volume and density. These values are about 6% too low, and the calculated density, 5.37, differs from the found value by about that amount. This maximum error is the result of cumulative error in three independent sets of data.

Tests. Yeatmanite fuses at about 4 to a black slag. It is easily soluble in dilute HCl. To show the presence of antimony use the following micro test. Dissolve a grain of yeatmanite in a drop of HCl, 1:1. Warm slowly, then add several drops of water and a drop of KI solution, the latter to reduce $SbCl_5$. Then with a capillary tube touch the solution with H_2S gas and note characteristic orange precipitate of Sb_2S_3.

Yeatmanite shows no clear relation to any previously described antimoniosilicate. It is the first mineral to be found at Franklin containing antimony. Its discovery, as well as that of sarkinite, adds two more features of resemblance between the mineral assemblages of Franklin and Långban.

Sarkinite. The pink mineral with which yeatmanite occurs shows no crystals. It is of a lively pinkish red color and shows a trace of cleavage in one direction. The optical properties are: Biaxial, negative; $r<v$. Indices: $nX=1.790$, $nY=1.794$, $nZ=1.798$, all $\pm.003$.

The chemical analysis yields a formula in good agreement with type material of sarkinite, which, however, contains no zinc.

Analysis of Sarkinite, L. H. Bauer, *analyst*

As_2O_5	40.73
SiO_2	0.14
MnO	48.09
ZnO	5.38
FeO	0.18
CaO	0.20
MgO	0.67
Cl	0.05
H_2O (+110°C)	3.22
	98.66

We desire to express our thanks to the officials of the New Jersey Zinc Company for permission to use the chemical data for publication.