SAMPLEITE, A NEW MINERAL FROM CHUQUICAMATA, CHILE

C. S. Hurlbut, Jr., *Harvard University, Cambridge, Mass.**

Abstract

Sampleite is found characteristically in crusts; small platy crystals give poor crystallographic measurements. Orthorhombic; dipyramidal—$2/m2/m2/m$. $a_0=9.70$ Å, $b_0=38.40$ Å, $c_0=9.65$ Å. $a_0:b_0:c_0=0.2526:1:0.2513$. Cleavage: {010} perfect, {100} and {001} good. H. = 5, G. = 3.20. Color: light blue-green in crystals, light blue in crusts. Opt.: (−), $2V=5°-20°$, $r>v$, $X=b=1.629$—deep blue, $Y=a=1.677$—light blue, $Z=c=1.679$—colorless. Chemical formula—$8[NaCaCu_5(PO_4)_4Cl\cdot 5H_2O]$. Named after Mr. Mat Sample of the Chile Exploration Company, Chuquicamata, Chile.

Early in 1940 the Chile Exploration Company sent to the Department of Mineralogy of Harvard University a number of specimens of several unidentified minerals from its mine at Chuquicamata, Chile. One of these minerals, a copper iodate, studied by Berman and Wolfe in 1940[1] proved to be a new mineral and was named *bellingerite*. A blue and green platy mineral still remained unidentified and there was insufficient material to carry out a complete study. About one year later more specimens of this mineral were received and the writer undertook the separation and purification of a sample for chemical analysis. The Chile Exploration Company kindly offered to make the analysis in their chemical laboratory. This analysis was incomplete because of an inadequate sample. It was not until April 1941 when a sufficiently larger amount of material was received that a complete analysis was made by F. A. Gonyer.

This mineral is named *sampleite* after Mr. Mat Sample, Assistant General Manager of the Chile Exploration Company at Chuquicamata, Chile. The name seems most fitting because of Mr. Sample's interest and assistance in the mineralogical work carried out by members of the geologic staff during the many years he was Mine Superintendent at Chuquicamata.

Occurrence

Mr. Lester G. Zeihen of the Chile Exploration Company, who found the mineral, gives the following information on its occurrence: Sampleite was first noted on the northwest ends of benches C-3, D-1, and D-2 as earthy crusts and crack fillings associated with gypsum, atacamite, jarosite and limonite in a highly sericitized rock. Later it was observed near the southeast ends of benches C-3, D-1, D-2 and E-1, where it oc-

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[1] Berman, H., and Wolfe, C. W., Bellingerite, a new mineral from Chuquicamata, Chile: *Am. Mineral.*, **25**, 505–512 (1940).

curs as micaceous rosettes and aggregates of small platy individual crystals in small cracks. Here it is commonly associated with dendrites of manganese and iron oxides, gypsum, specular hematite, and libethenite in sericitized and kaolinized quartz monzonite and granodiorite. Ultimately it was found to be not uncommon in the higher inactive benches of the mine especially on the east side of bench B-2, where it is associated with limonite and atacamite in a quartz monzonite, and has a micaceous appearance. In all the occurrences mentioned above sampleite is present under highly oxidized near-surface conditions. It appears to be the most recent mineral deposited with the exception of gypsum.

Crystallography

Morphology. The available crystals of sampleite are exceedingly thin, flattened on (010). Although the tabular nature is evident in the drawing, its thickness is relatively greater than that of the crystal so that the terminating faces can be more readily shown. The average crystal dimensions are 0.3 mm.×0.2 mm.×0.03 mm. Sampleite is pseudotetragonal with the *b* crystal axis corresponding to the pseudotetragonal axis *c*. When lying on the dominant *b* face, the crystals have a square outline with the *p* faces truncating at approximately 45°. This pseudotetragonal symmetry is also shown in the optical properties and in the unit cell dimensions.

Goniometric measurements were poor and only approximate angular readings could be made. Most of the faces are present on the crystals as fine lines, while the pyramid *p* shows only as tiny points. Form *b*{010} is the only one that gives good reflections. The measurements made on five crystals are given below in Table 1. The elements given were obtained from *x*-ray measurements, since they appear more reliable than those obtained from morphological data.

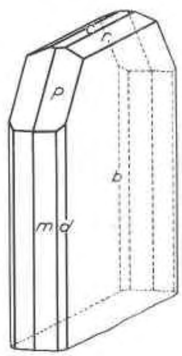

Fig. 1. Sampleite

TABLE 1. SAMPLEITE: ANGLE-TABLE

Orthorhombic; dipyramidal—$2/m\ 2/m\ 2/m$

$a_0:b_0:c_0=0.2526:1:0.2513$; $p_0:q_0:r_0=0.9948:0.2513:1$

$q_1:r_1:p_1=0.2526:1.0052:1$; $r_2:p_2:q_2=3.9794:3.9587:1$

	Goniometric Measurements			Calculated using structural elements	
Forms	No. of faces	ϕ	ρ	ϕ	ρ
c 001	3	—	0°	—	0°00′
b 010	10	0°	90	0°00′	90 00
m 110	5	77	90	75 49	90 00
d 150	4	39	90	38 22	90 00
r 021	10	0	25½	0 00	26 41
p 111	7	77	45½	75 49	45 44

X-Ray Crystallography. A rotation photograph and zero and first-layer line Weissenberg photographs were taken with $c[001]$ the axis of rotation. The absolute dimensions of the axes are:

$$a_0=9.70\text{ Å},\ b_0=38.40\text{ Å},\ c_0=9.65\text{ Å}$$

The ratios of these dimensions, $a_0:b_0:c_0=0.2526:1:0.2513$, are believed to be better than the ratios $a:b:c=0.2339:1:0.2319$ as obtained from the morphological measurements.

An *x*-ray powder picture of sampleite was taken, and the spacings obtained from its measurement are listed below. It is hoped that similar data will be given in descriptions of other new species so that the mineralogist will have one more tool to aid in the identification of the mineral.

I	*d*	*I*	*d*
2	6.798	5	2.588
9	4.345	4	2.420
1	3.893	1	2.177
1	3.569	1	1.930
1	3.237	1	1.801
10	3.073	6	1.710
1	2.800	1	1.440
3	2.693	1	1.373

I = intensity, d = spacing.

PHYSICAL PROPERTIES

Sampleite occurs in platy crystals with a highly perfect cleavage parallel to $b\{010\}$, the platy direction of the crystals. There is also a good cleavage parallel to $a\{100\}$ and $c\{001\}$, thus giving cleavage in the three pinacoidal directions. The hardness is about 4. The specific gravity, determined by suspension in methylene iodide and measurement on a microbalance is 3.20. When in crystals the color is light blue-green. In crusts the color is light blue with a pearly luster. Before the blowpipe sampleite fuses at 2 to a black globule coloring the flame bright green.

Optical Properties

	n–Na		
$X=b$—deep blue	1.629	±0.001	opt. (−)
$Y=a$—light blue	1.677		$2V=5°–20°$
$Z=c$—colorless	1.679		$r>v$

Chemical Composition

The first sampleite prepared for analysis was sent to the chemical laboratory at Chuquicamata and was analyzed by Mr. F. J. Ojeda. His analysis, given in the following table, is inaccurate because of insufficient material.

Table 2. Sampleite: Chemical Analysis

	1	2	3	4	5	6
CuO	43.2	43.37	44.12	.5545	38.65	40
P_2O_5	29.1	31.55	32.10	.2260	15.76	16
CaO	4.7	5.73	5.83	.1039	8.14	8
MgO	—	.51	.52	.0129		
K_2O	—	1.47	1.49	.0159	4.61	4
Na_2O	1.8	3.06	3.11	.0502		
H_2O	13.5	9.57	9.74	.5409	37.70	40
Cl	tr.	3.89	4.00	.1122	7.82	8
Insol.	3.5	1.48				
		100.67	100.91			
Less O		.89	.91			
		99.78	100.00			
Insol.		1.48				
		98.30				

1. Analysis of sampleite by F. J. Ojeda recalculated in oxides comparable with those in 2.
2. Analysis of sampleite by F. A. Gonyer.
3. Analysis 2 recalculated to 100%.
4. Molecular proportions.
5. Number of oxides in the unit cell, computed by multiplying the values in column 4 by the molecular weight, $M_0=6971$.
6. Ideal cell content.

Content of Unit Cell. The cell volume, 3,594 Å^3, and the measured specific gravity, 3.20, give the molecular weight of the cell contents, $M_0=6971$. Multiplying this value by the molecular proportions, the cell content given in column 5 is found. Assuming the figures given in column 6 to be correct, the unit cell content can be expressed as $Na_8Ca_8Cu_{40}(PO_4)_{32}Cl_8 \cdot 40H_2O$ or $8[NaCaCu_5(PO_4)_4Cl \cdot 5H_2O]$.