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ELYITE, BASIC LEAD-COPPER SULFATE, A NEW MINERAL FROM NEVADA

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ABSTRACT

Elyite, $Pb_4Cu(SO_4)(OH)_8$, was found at Ward, Nevada where it occurs in voids in massive sulfides showing incipient oxidation to supergene galena, serpierite, and langite.

The color is violet with a pale streak; $H = 2$, $G_{meas} \sim 6$, $\rho_{calc.} = 6.321$ gcm.$^{-3}$. Good cleavage on {001}, and crystals are sectile. Crystals are monoclinic $2/m$ and show: a {100}, c {001}, d {$\bar{5}$01}, k {120}, l {310}, and h {211}. Twinning in {001} common. $\alpha = 1.990$, $\beta = 1.993$, $\gamma = 1.994$.

Cell dimensions are $a = 14.248$Å, $b = 5.768$, $c = 7.309$; $\beta = 100°26'$, $P2_1/a$. $Z = 2$. The strongest lines (in Å) are 7.189 (99), 6.999 (100), 4.456 (25), 3.627 (21), 3.341 (31), 3.136 (32), 3.081 (29), 3.047 (30), 2.995 (73), and 2.884 (37).

Chemical analyses gave (averaged and calculated to 100%): PbO 79.40%, CuO 7.76%, SO_3 6.90%, and H_2O 5.93% which leads to $Pb_4Cu(SO_4)(OH)_8$.

OCCURRENCE

Elyite was found in 1964 during mining operations by Silver King Mines, Inc. at Ward, Nevada. The mineral was only observed in the Caroline tunnel, and these workings have since been obliterated by open-pit mining.

The sulfide ores occurring in the tunnel were locally massive chalcopyrite, sphalerite, galena, and pyrite with only minor amounts of euhedral quartz as gangue. In those areas showing incipient oxidation, elyite was found with langite (Williams, 1964), serpierite, and supergene galena. Voids in the sulfide masses tend to be partly filled with earthy brown to black galena, and elyite crystals occur in this earthy material. Langite and serpierite are later. In specimens exhibiting later minerals such as brochantite or cerussite the elyite had disappeared.

Only a few specimens of elyite were preserved, and the total supply doubtless is less than 50 milligrams. A specimen has been deposited at the British Museum (Natural History).

PHYSICAL PROPERTIES

Elyite is a lovely violet color (Royal Horticultural Society, 83.B, Munsell 5P 4/10) with a pale violet to white streak. The luster is silky in fibrous crystal groups. The hardness on Mohs' scale is 2 and crystals are sectile. Fluorescence was not observed in either long or short wave length U. V. Cleavage on {001} is good but difficult to observe owing to

TABLE 1

CHEMICAL ANALYSES OF ELYITE

	1	2	3	4	5	6	7
PbO	81.9	81.4		.366	81.65	79.40	79.40
CuO	8.03	7.94		.100	7.98	7.76	7.07
SO_3	6.45	7.76		.089	7.10	6.90	7.12
H_2O			6.1	.339	6.1	5.93	6.41
					102.83	99.99	100.00

1, 2 analyses performed by R. F. Symes on electron probe at British Museum (Natural History)

3 gravimetric analysis by J. A. Allen (Phelps Dodge Corporation) on 82 µg, loss occurred between 550°C and 720°C

4 ratios

5 average of analyses 1, 2, 3

6 average analysis recalculated to 100%

7 $Pb_4Cu(SO_4)(OH)_8$

the minuteness of crystals which never exceed 0.15 mm in length. The crystals are prismatic to fibrous and occur as radiating sprays or tufts, sometimes matted, which are perched upon or embedded in earthy galena. The specific gravity was estimated as about 6 from the rate of settling in glycerine using more accurately known minerals as bracketing standards.

Chemistry

Microchemical tests upon elyite showed copper, lead, and sulfate. Tests for halogens were negative. Qualitative analysis by electron probe verified these findings and duplicate analyses for Cu, Pb, and S were then performed using linarite, anglesite, lead and copper as standards. The results of these anlyses are shown in Table 1.

Water was determined gravimetrically with the loss occurring above 550° C, and its presence verified in the closed tube.

The results of the analyses agree well with the theoretical formula $Pb_4Cu(SO_4)(OH)_8$ and the "empirical" cell constants (using the calculated density) are $Pb_{4.00}Cu_{1.10}(SO_4)_{0.97}(OH)_{7.40}$.

In dilute (1:7) cold nitric acid elyite crystals quickly turn to a flocky white mass; in cold 1:5 HCl they are filmed with white $PbCl_2$. They are insoluble in cold or hot water.

Crystallography

Despite the minuteness of the crystals some gave relatively good goniometric data and a number of forms were found. The crystals are invariably elongate on [010] and tabular on c, {001}, the dominant form. Other forms found are: $a\{100\}$, $d\{\bar{5}01\}$, $k\{120\}$, $l\{310\}$, and $h\{211\}$. A typical crystal is shown in Figure 1. Mirror twinning in {001} is common and non-repetitive; never were more than two individuals found in twinned position. Single crystals could be readily separated for X-ray study, for the twin plane is a plane of easy parting.

X-Ray Analysis

A single crystal 0.13 mm long was used for rotation and Weissenburg exposures. Cell constants obtained were used to index the powder pattern, and their refinement was carried on from powder data using a program written by F. B. Millett. The results are $a = 14.248$Å, $b = 5.768$, $c = 7.309$ (all $\pm$ 0.002Å); $\beta = 100°26' \pm 1'$. The space group is $P2_1/a$, and the calculated density is 6.321 gcm^{-3} for $Z = 2$. The indexed powder data are presented in Table 2.

Optics

Elyite is transparent in transmitted light and pleochroic in violet with $Z > Y > X$. The indices of refraction are $\alpha = 1.990$, $\beta = 1.993$, $\gamma = 1.994$ (all $\pm$ 0.001) in Na (D) light, and $2V_x$ is 76° at 480, 68° at 530, 66° at 580, and 64° at 630 nm. The optic orientation is $Y = b$, $X \wedge c$ (in μ) = 35°, 42°, 45°, 49° at 480, 530, 580, and 630 nm respectively. Dispersion is quite noticeable in interference figures.

Discussion

Elyite is not likely to be confused with minerals of similar composition; it differs markedly from linarite in physical properties. No mineral with the same color is similar chemically.

The mineral is named for John Ely, an important figure in the early mining history of eastern Nevada (Ashbaugh, 1963).

The mineral and mineral name have been approved by the Committee on New Minerals and New Mineral Names, IMA.

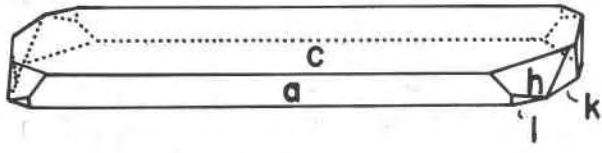

TABLE 2

X-RAY POWDER DATA FOR ELYITE

V-filtered, CrKα radiation; 114 mm. Wilson Camera

I/Io	d(obs.)Å	d(calc.)Å	hkl	I/Io	d(obs.)Å	d(calc.)Å	hkl
99	7.189[a]	7.188	001	18	2.772	2.772	$40\bar{2}$
100	6.999	7.006	200	11	2.663	2.663	$12\bar{1}$
11	4.614	4.617	201			2.667	220
25	4.456	4.453	210	17	2.624	2.628	302
21	3.627	3.628	301			2.624	411
17	3.400	3.401	$40\bar{1}$	20	2.435	2.436	$10\bar{3}$
31	3.341	3.339	102			2.434	$50\bar{2}$
32	3.136	3.136	$30\bar{2}$	13	2.335	2.335	600
29	3.081	3.081	$11\bar{2}$	11	2.243	2.243	$51\bar{2}$
30	3.047	3.050	012			2.244	$11\bar{3}$
73	2.995	2.994	410	3	2.194	2.200	$42\bar{1}$
8	2.970	2.969	$21\bar{2}$	5	2.166	2.169	$40\bar{3}$
12	2.930	2.930	$41\bar{1}$			2.165	610
37	2.884	2.884	020	9	2.011	2.009	$61\bar{2}$
						2.010	$50\bar{3}$
						2.015	213
				plus ten additional lines to 1.497Å			
I/Io	d(obs.)Å						

[a] precision of measured values ± 0.005Å at 7Å decreasing to ± 0.002Å at 2Å, based on five measurements of one film.

Acknowledgements

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