

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

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### ABSTRACT

Elyite,  $\text{Pb}_4\text{Cu}(\text{SO}_4)(\text{OH})_8$ , 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;  $H = 2$ ,  $G_{\text{meas}} \sim 6$ ,  $\rho_{\text{calc.}} = 6.321 \text{ gcm.}^{-3}$ . 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  $a = 14.248 \text{ \AA}$ ,  $b = 5.768$ ,  $c = 7.309$ ;  $\beta = 100^\circ 28'$ ,  $P2_1/a$ .  $Z = 2$ . The strongest lines (in  $\text{Å}$ ) 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%,  $\text{SO}_3$  6.90%, and  $\text{H}_2\text{O}$  5.93% which leads to  $\text{Pb}_4\text{Cu}(\text{SO}_4)(\text{OH})_8$ .

### 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 I

## 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 <sub>3</sub>	6.45	7.76		.089	7.10	6.90	7.12
H <sub>2</sub> O			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  $\mu$ g, loss occurred between 550°C and 720°C

4 ratios

5 average of analyses 1, 2, 3

6 average analysis recalculated to 100%

7  $\text{Pb}_4\text{Cu}(\text{SO}_4)(\text{OH})_8$

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 analyses 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  $\text{Pb}_4\text{Cu}(\text{SO}_4)(\text{OH})_8$  and the "empirical" cell constants (using the calculated density) are  $\text{Pb}_{4.00}\text{Cu}_{1.10}(\text{SO}_4)_{0.97}(\text{OH})_{7.40}$ .

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  $\text{PbCl}_2$ . 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  $a = 14.248\text{\AA}$ ,  $b = 5.768$ ,  $c = 7.309$  (all  $\pm 0.002\text{\AA}$ );  $\beta = 100^\circ 26' \pm 1'$ . The space group is  $P2_1/a$ , and the calculated density is  $6.321 \text{ gcm}^{-3}$  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  $76^\circ$  at 480,  $68^\circ$  at 530,  $66^\circ$  at 580, and  $64^\circ$  at 630 nm. The optic orientation is  $Y = b$ ,  $X \wedge c$  (in  $\mu$ ) =  $35^\circ$ ,  $42^\circ$ ,  $45^\circ$ ,  $49^\circ$  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.

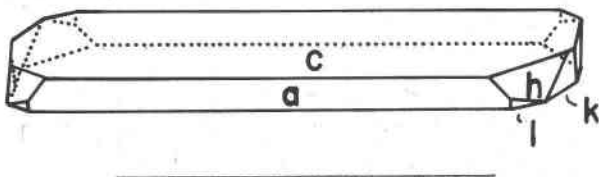


TABLE 2

X-RAY POWDER DATA FOR ELYITE

V-filtered, CrK $\alpha$  radiation; 114 mm. Wilson Camera

$l/l_0$	$d(\text{obs.})\text{\AA}$	$d(\text{calc.})\text{\AA}$	$hkl$	$l/l_0$	$d(\text{obs.})\text{\AA}$	$d(\text{calc.})\text{\AA}$	$hkl$
99	7.189 <sup>a</sup>	7.188	001	18	2.772	2.772	40 $\bar{2}$
100	6.999	7.006	200	11	2.663	2.663 2.667	12 $\bar{1}$ 220
11	4.614	4.617	201	17	2.624	2.628 2.624	302 411
25	4.456	4.453	210	20	2.435	2.436 2.434	10 $\bar{3}$ 502
21	3.627	3.628	301	13	2.335	2.335	600
17	3.400	3.401	40 $\bar{1}$	11	2.243	2.243 2.244	51 $\bar{2}$ 113
31	3.341	3.339	102	3	2.194	2.200	42 $\bar{1}$
32	3.136	3.136	30 $\bar{2}$	5	2.166	2.169 2.165	40 $\bar{3}$ 610
29	3.081	3.081	11 $\bar{2}$	9	2.011	2.009 2.010 2.015	61 $\bar{2}$ 503 213
30	3.047	3.050	012	plus ten additional lines to 1.497 $\text{\AA}$			
73	2.995	2.994	410				
8	2.970	2.969	21 $\bar{2}$				
12	2.930	2.930	41 $\bar{1}$				
37	2.884	2.884	020				
$l/l_0$	$d(\text{obs.})\text{\AA}$						

a) precision of measured values  $\pm 0.005\text{\AA}$  at  $7\text{\AA}$  decreasing to  $\pm 0.002\text{\AA}$  at  $2\text{\AA}$ , based on five measurements of one film.

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