SVANBERGITE FROM NEVADA[1]

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ABSTRACT

Svanbergite, $SrAl_3(SO_4)(PO_4)(OH)_6$, has been found for the first time in North America near Hawthorne, Nevada. It has the following properties: Point group $\bar{3}\,2/m$ (?); probable space group $R\,\bar{3}\,m$; unit cell dimensions: $a_0 = 6.99$ Å, $c_0 = 16.75$ Å, Specific gravity = 3.22. Optical properties: uniaxial (+), $\omega = 1.635$, $\epsilon = 1.649$. Chemical composition: Al_2O_3 36.91%, Fe_2O_3 0.24, CaO 3.25, SrO 12.84, P_2O_5 16.70, SO_3 17.34, H_2O 12.51.

INTRODUCTION

Svanbergite, $SrAl_3(SO_4)(PO_4)(OH)_6$, is a rare member of the alunite group. The locality described here is the first occurrence in North America. Previously known localities are: Horrsjöberg and Westanå, Sweden, and Chalmoux, Soâne-et-Loire, France.

The new locality for svanbergite is the Dover andalusite mine, 12 miles northeast of Hawthorne, Mineral County, Nevada. It was first noted there by Mr. M. Vonsen, of Petaluma, California in 1939. An independent discovery was made by Mr. Edgar H. Bailey of the U. S. Geological Survey in 1944.

The Dover mine is in the foothills of the southwestern end of the Gillis range. It may be reached from Hawthorne over a paved road for six miles to Thorne, and thence six miles east on a dirt road from Thorne.

The svanbergite occurs in well formed crystals imbedded in, or emplanted on, green pyrophyllite. The pyrophyllite is abundant in the andalusite-corundum ore, which has been mined periodically and in small quantities.

The material used in this study was very kindly supplied by Mr. M. Vonsen and Dr. John Peoples, both of Petaluma, California, and is now on deposit in the U. S. National Museum (USNM 105688).

MORPHOLOGY

Svanbergite from Nevada is found in sharp, well-formed crystals ranging in size from less than a millimeter to a maximum of about four millimeters. The smaller crystals are pale yellow in color, while the larger ones are medium reddish brown and often have a lighter colored core. The crystals are always attached to the matrix so that the form development at only one end of the *c* axis can be observed.

The dominant form is the rhombohedron *s* $\{01\bar{1}2\}$, and the resultant habit is pseudo-cubic. This rhombohedron appears either alone, or modi-

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fied by smaller faces of the basal pinacoid and other rhombohedrons, and rarely by the prism m $\{10\bar{1}0\}$. Typical crystals are illustrated in Fig. 1.

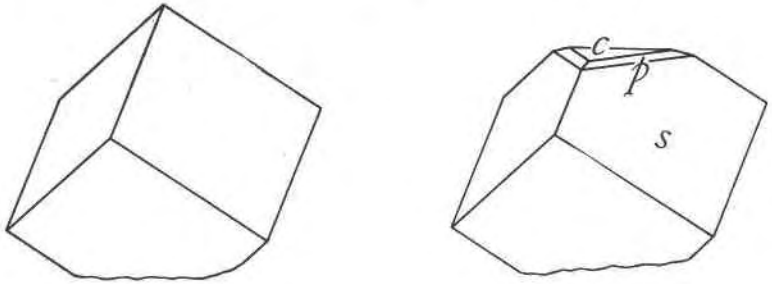

FIG. 1

The morphological data of svanbergite from Nevada are summarized in Table 1. The forms are indexed on the basis of the axial ratio indicated by x-ray studies of svanbergite from Sweden by Ygberg[1] and Pabst,[2] as well as those by the writer on Nevada material.

TABLE 1. MORPHOLOGICAL DATA OF SVANBERGITE FROM NEVADA

Form	No. of times observed	Quality	ρ		
			Measured range	Weighted mean	Calculated value
c 0001	4	good	0°00′– 0°02′	0°01′	0°00′
m $10\bar{1}0$	2	fair	90°01′–90°05′	90°02′	90°00′
p $01\bar{1}5$	2	fair to poor	28°57′–29°32′	28°57′	28°33′
s $01\bar{1}2$	10	excellent to fair	53°39′–53°43′	53°41′	53°41′
d $02\bar{2}1$	2	poor	79°42′–79°45′	79°43′	79°35′
t $10\bar{1}7$	2	fair to poor	21°26′–21°36′	21°31′	21°14½′
u $10\bar{1}4$	4	fair to poor	34°22′–34°26′	34°24′	34°13½′
e $10\bar{1}1$	3	poor	68°56′–69°50′	69°24′	69°49′

The original descriptions of svanbergite from Sweden and France were made without benefit of x-ray studies, hence the dominant rhombohedron was indexed as $\{10\bar{1}1\}$. X-ray work shows that the dominant rhombohedron is $\{01\bar{1}2\}$ when the crystal setting is made to correspond to the rhombohedral cell. In Table 2 the forms found by previous workers on svanbergite from Sweden and France are correlated with those of the

[1] Ygberg, E. R., Svanbergite from Horrsjöberg: *Arkiv för Kemi, Mineralogi och Geologi*, **20A**, no. 4, 1–17 (1945).

[2] Pabst, A., Some computations on svanbergite, woodhouseite and alunite: *Am. Mineral.*, **32**, 16–30 (1947).

TABLE 2. SVANBERGITE: CORRELATION OF FORMS

Previous work to Switzer: $0\bar{1}00/00\bar{1}0/\bar{1}000/0002$

Dauber[1] $c=1.2063$	Seligman[2] $c=1.2008$	Lacroix[3] $c=1.2437$	Ygberg[4] $c=1.2111$	Switzer $c=2.3565$
		a' 0001		c 0001
				m $10\bar{1}0$
				p $01\bar{1}5$
r $10\bar{1}1$	$10\bar{1}1$	p $10\bar{1}1$	r $10\bar{1}1$	s $01\bar{1}2$
$4r$ $40\bar{4}1$	$40\bar{4}1$	e^3 $40\bar{4}1$	n $40\bar{4}1$	d $02\bar{2}1$
	$50\bar{5}1$	$e^{11/4}$ $50\bar{5}1$		t $10\bar{1}7$
				u $10\bar{1}4$
	$02\bar{2}1$	e' $02\bar{2}1$	s $02\bar{2}1$	e $10\bar{1}1$

[1] Dauber, H., Ueber Svanbergit und Beudantit: *Pogg. Ann.*, **10**, 579 (1857).

[2] Seligman, G., Mineralogische Notizen II: *Zeit. Krist.*, **6**, 227–229 (1882).

[3] Lacroix, A., Mineralogie de la France, **IV**, 592–595 (Paris, 1910).

[4] *Op. cit.*, Ygberg gives $\rho_{10\bar{1}1}=54°37'$ from which he incorrectly calculates the axial ratio $c=1.2111$. The correct value is $c=1.2194$.

TABLE 3. SVANBERGITE ANGLE TABLE

Hexagonal—R; hexagonal scalenohedral—$\bar{3}\ 2/m$ (?)

$a:c=1:2.3565$; $\alpha=61°44'$; $\rho_0=r_0=2.7210:1$; $\lambda=108°45'$

	ϕ	$\rho=C$	A_1	A_2
c 0001 111	—	0°00′	90°00′	90°00′
m $10\bar{1}0$ $2\bar{1}\bar{1}$	30°00′	90 00	90 00	30 00
t $10\bar{1}7$ 322	30 00	21 14½	71 43	90 00
u $10\bar{1}4$ 211	30 00	34 13½	60 51	90 00
e $10\bar{1}1$ 100	30 00	69 49	35 37½	90 00
p $01\bar{1}5$ 221	−30 00	28 33	90 00	65 33
s $0\bar{1}12$ 110	−30 00	53 41	90 00	45 45
d $02\bar{2}1$ $11\bar{1}$	−30 00	79 35	90 00	31 36
o $05\bar{5}2$ $77\bar{8}$	−30 00	81 38	90 00	31 02½

Nevada crystals. It will be seen that four of the forms found on the Nevada crystals are new for this mineral.

A complete angle table for svanbergite is given in Table 3. The axial ratio used is that obtained on the Nevada crystals. Since strontium of svanbergite is in part replaced by calcium, the axial ratio varies dependent upon the Sr:Ca ratio.

On the basis of x-ray data (see following section) svanbergite could belong to any one of the three point groups, $3m$, 32 or $\bar{3}\ 2/m$. Hendricks[3]

[3] Hendricks, S. B., The crystal structure of alunite and the jarosites: *Am. Mineral.*, **22**, 773–784 (1937).

found alunite to be pyroelectric, although Gossner[4] made similar tests with negative results. Ygberg[5] made etch tests on svanbergite with negative results. Therefore, due to lack of evidence to the contrary, svanbergite has been placed in the centrosymmetrical point group $\bar{3}\ 2/m$.

Structural Data

Rotation, and zero-, first-, second and third-layer Weissenberg photographs, were taken about [0001] of a Nevada svanbergite crystal. These showed the space lattice type to be rhombohedral, and the Laue symmetry to be $\bar{3}\ 2/m(D_{3d})$. The possible space groups are $R\ 3\ m$, $R\ 32$, and $R\ \bar{3}\ m$. In his work on the structure of svanbergite, Pabst[6] adopted the space group R $\bar{3}\ m$. If svanbergite, like alunite, is pyroelectric, the correct space group would be $R\ 3\ m$.[7]

Table 4. Analysis of Svanbergite from Nevada

	1	2	
Al_2O_3	36.91	0.3621	$=3\times0.121$
Fe_2O_3	0.24	0.0015	
CaO	3.25	0.0580	$=2\times0.091$
SrO	12.84	0.1239	
P_2O_5	16.70	0.1176	$=1\times0.118$
SO_3	17.34	0.2166	$=2\times0.108$
H_2O	12.51	0.6942	$=6\times0.116$
	99.79		

1. Analysis by F. A. Gonyer.
2. Molecular ratios.

The unit cell dimensions[8] of Nevada svanbergite, obtained by measurements of rotation and zero-layer photographs about [0001], are as follows:

$$a_o = 6.99 \pm .05 \text{ Å}$$
$$c_o = 16.75 \pm .05 \text{ Å}.$$

These dimensions correspond to an axial ratio of $c:a = 2.3963$.

[4] Gossner, B., Über Sulfate und Phosphate mit ähnlichen Kristallgitter: *Zeit. Krist*, **96**, 488–492 (1937).

[5] *Op. cit.* p. 8.

[6] Op. cit.

[7] Hendricks, S. B., *Op. cit.*

[8] In the calculation of unit cell dimensions and density the following constants were used: $\lambda CuK\alpha = 1.542$; $\rho = 1.66020\ \Sigma A/V$.

Chemistry

Svanbergite from Nevada was analyzed by Mr. F. A. Gonyer of the Department of Mineralogy, Harvard University. The analysis is very similar to those given for material from Westanå and Horrsjöberg, Sweden.

The analysis of Nevada svanbergite is given in Table 4. The unit cell contains $3[(Sr, Ca)Al_3(SO_4)(PO_4)(OH)_6]$. The calculated density, using the unit cell dimensions given in the preceding section, is 3.24, which compares favorably with the measured density of 3.22 ± 0.02.

Optical Properties

Svanbergite from Nevada has the following optical properties:

$$\text{Uniaxial } (+) \quad \left.\begin{array}{l} \omega = 1.635 \\ \epsilon = 1.649 \end{array}\right\} \pm 0.002.$$