CRYSTALLOGRAPHY OF LIVINGSTONITE

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ABSTRACT

Crystallographic measurements on livingstonite from Huitzuco, Guerrero, Mexico—the first to be made on this species—give the following data: Monoclinic; prismatic—$2/m$; $a:b:c=3.7572:1:5.3660$; $\beta=104°10'$. Elongated [010]. Forms: $c\{001\}$ perfect cleavage, $a\{100\}$, $d\{101\}$, $e\{\bar{1}01\}$, $p\{\bar{1}11\}$, $q\{122\}$; uncertain: $\{\bar{1}\bar{1}.1.0\}$, $\{011\}$, $\{111\}$, $\{\bar{1}22\}$. Space group, $C_{2h}^5-P2_1/c$; $a_0=15.14$, $b_0=3.98$, $c_0=21.60$; $\beta=104°$. Cell content (provisional), $Hg_4Sb_{16}S_{28}$.

Livingstonite, a sulphide of antimony and mercury, was named in 1874.[1] The lead-gray color and prismatic habit suggested similarity with stibnite, but as yet no crystallographic measurements have been published.

A matrix specimen with embedded crystals of livingstonite from the type locality, Huitzuco, Guerrero, Mexico, was kindly provided for study by Dr. W. F. Foshag of the United States National Museum. The crystals are minute needles, 0.25 to 0.5 mm. long and less than 0.1 mm. thick, soft and flexible and difficult to handle. Eight of these were measured by Dr. H. Berman on the two-circle goniometer. They proved to be monoclinic, acicular, elongated with [010], which is the convenient zone of reference. This zone exhibits the forms $c\{001\}$, $a\{100\}$, $d\{101\}$, $e\{\bar{1}01\}$. The forms determined with certainty, each by several good measurements, are: $c\{001\}$, $a\{100\}$, $d\{101\}$, $e\{\bar{1}01\}$, $p\{\bar{1}11\}$, $q\{122\}$; in addition, single observations were found to correspond to the symbols: $\{\bar{1}\bar{1}.1.0\}$, $\{011\}$, $\{111\}$, $\{\bar{1}22\}$. Until confirmed, these are best regarded as uncertain forms. Like development of equally frequent right- and left-hand ends indicates holohedral symmetry.

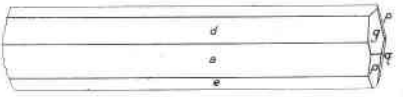

FIG. 1. A typical crystal of living stonite.

Table 1 gives the geometrical elements of livingstonite, derived from the best measurements, and the mean measured and calculated two-circle angles for the accepted forms. The polar elements and angles refer to the projection on the plane normal to [010], the axis of prismatic development of the crystals.

[1] Barcena, M., *El Minero Mexicano;* notice in *Am. Jour. Sci.*, vol. **8,** p. 145, 1874.

TABLE 1

Livingstonite—$HgSb_4S_7$. Monoclinic; prismatic—$2/m$
$a:b:c=3.7572:1:5.3660$; $\beta=104°10'$
$r_2:p_2:q_2=0.1922:0.2745:1$; $\mu=$ 75°50′

Forms	Measured		Calculated	
	ϕ_2	ρ_2	ϕ_2	ρ_2
c 001	75°50′	90°00′	75°50′	90°00′
a 100	0 39	90 00	0 00	90 00
d 101	29 53	90 00	30 05½	90 00
e $\bar{1}01$	140 29	90 00	140 40½	90 00
p $\bar{1}11$	140 29	16 23	140 40½	16 23
q 122	47 00	14 34	45 19	14 41

STRUCTURE CELL AND SPACE GROUP

These were determined with Dr. Berman's assistance by a rotation photograph about [010] and Weissenberg photographs of the zero and first layer lines about the same axis, using copper radiation.

$$a_0=15.14\pm0.04,\ b_0=3.98\pm0.01,\ c_0=21.60\pm0.04;\ \beta=104°$$
$$a_0:b_0:c_0=3.80:1:5.43;\ V=1262\times10^{-24}$$

The ratio of the cell sides is in fair agreement with the morphological ratio, $a:b:c=3.758:1:5.366$, which is remarkable for the relative shortness of the b-axis.

The molecular weight of the cell content (M) is given by $M=dV/A$, where d is the density $(4.81)^2$, V is the volume of the unit cell (1262×10^{-24}), A is the reciprocal of Avogadro's number. Whence $M=3679$.

Using Venable's analysis of livingstonite,[2] the atomic content of the unit cell is given as follows:

	Wt. per cent	Mol. ratio	$M\times$Mol. ratio/100
S	23.75	0.738	27.15
Sb	53.75	0.442	16.26
Hg	22.52	0.112	4.12

Accepting the numbers in the last column as 28, 16, 4, respectively, the cell formula is $Hg_4Sb_{16}S_{28}$ or $4(HgSb_4S_7)$. Since both the analysis and density represent early determinations the above cell formula cannot be regarded as entirely certain.

The space group of livingstonite is $C_{2h}^5-P2_1/c$, which is determined by the holohedral symmetry and the following facts:

$h0l$ halved when h is odd
$h0l$ halved when l is odd
$h0l$ halved when $h+l$ is odd
010 halved.

[2] Dana, *System of Mineralogy*, p. 109, **1892.**