CRYSTALLOGRAPHY OF DOLEROPHANITE

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Crystals of dolerophanite, Cu_2SO_5, formed during the eruption of Mt. Vesuvius in October 1868, were described by Scacchi (1873). V. Goldschmidt (1886) chose a different orientation from that of Scacchi and calculated new elements. Dana (1892) adopted Scacchi's elements, but interchanged the *a*- and *c*-axes. Strandmark (1902), working with artificial crystals found in copper slag, selected a still different orientation; and Zambonini (1935), in an exhaustive study of the morphology, adopted Strandmark's orientation but calculated new elements based on more reliable measurements.

Table 1. Dolerophanite: Correlation of Settings

Forms	Scacchi	Goldschmidt	Dana (1892)	Strandmark-Zambonini
a 100	*g*	*g*	*g*	*g*
b 010	*C*	*C*	*b*	*C*
c 001	*A*	*A*	*a*	*A*
m 110	*t*	*t*	*t*	*t*
o 410	–	–	–	*o*
ω 011	–	–	–	*ω*
l 201	–	–	–	*l*
μ $\bar{3}04$	–	–	–	*u*
j $\bar{4}05$	–	–	–	*j*
d $\bar{1}01$	*d*	*d*	*d*	*J*
B $\bar{4}03$	*B*	*B*	*C*	*B*
e $\bar{2}01$	*e*	*e*	*e*	*e*
f $\bar{4}01$	*f*	*f*	*f*	*f*
v 111	–	–	–	*v*
r $\bar{1}12$	*r*	*r*	*r*	*r*
p $\bar{3}14$	*p*	*p*	*p*	*p*
n $\bar{1}33$	*n*	*n*	*n*	*n*
s $\bar{1}11$	*s*	*s*	*s*	*s*
q $\bar{3}12$	*q*	*q*	*q*	*q*
h $\bar{8}03$	–	*h*	–	*h*
y 601	–	–	–	*y*

An x-ray crystallographic study shows that the orientation and unit of Goldschmidt correspond with the face-centered lattice generally chosen by x-ray crystallographers, and the orientation of Strandmark is the corresponding body-centered lattice of the same network. The transformations of other orientations to the Goldschmidt orientation and unit are:

Scacchi to Goldschmidt	—$\bar{1}$00/040/303
Dana to Goldschmidt	—00$\bar{1}$/040/303
Strandmark to Goldschmidt	—$\bar{1}$0$\bar{1}$/0$\bar{1}$0/001

The correlation of forms is given in Table 1. The letters used here are those of Scacchi except that the pinacoids and unit prism have been given letters conforming to standard usage.

The accepted forms of dolerophanite are shown on the gnomonic projection (Fig. 1). A typical crystal is illustrated in Fig. 2.

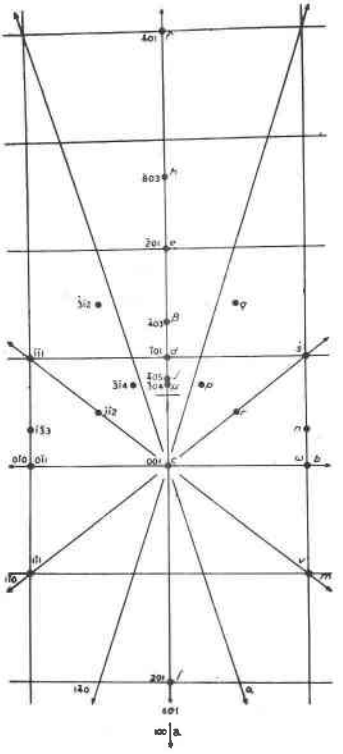

FIG. 1. Gnomonic projection of the accepted forms of dolerophanite.

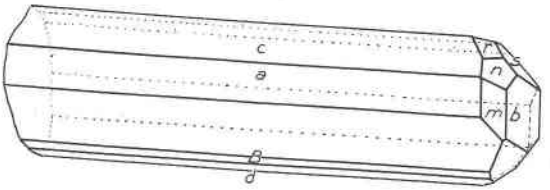

FIG. 2. Typical crystal of dolerophanite.

Since Zambonini's measurements are probably the best, his elements, transformed to Goldschmidt's orientation are adopted in the angle table (Table 2).

TABLE 2. ANGLE TABLE OF DOLEROPHANITE, Cu_2SO_5
Monoclinic; prismatic—$2/m$

$a:b:c=1.4842:1:1.2089$; $\beta=122°18\frac{1}{2}'$; $p_0:q_0:r_0=0.8145:1.0217:1$
$r_2:p_2:q_2=0.9787:0.8127:1$; $\mu=57°41\frac{1}{2}'$; $p_0'=0.9637$, $q_0'=1.2089$, $x_0'=0.6324$

Forms		ϕ	ρ	ϕ_2	$\rho_2=B$	C	A
c	001	90°00′	32°18½′	57°41½′	90°00′	0°00′	57°41½′
b	010	0 00	90 00	—	0 00	90 00	90 00
a	100	90 00	90 00	0 00	90 00	57 41½	0 00
m	110	38 33½	90 00	0 00	38 33½	70 32½	51 26½
o	410	72 35½	90 00	0 00	72 35½	59 20	17 24½
ω	011	27 37	53 45½	57 41½	44 23	45 37	68 03
μ	$\bar{3}04$	−90 00	5 13½	95 13½−	90 00	37 32	95 13½
j	$\bar{4}05$	−90 00	7 53½	97 53½	90 00	40 12	97 53½
d	$\bar{1}01$	−90 00	18 20	108 20	90 00	50 38½	108 20
B	$\bar{4}03$	−90 00	33 07½	123 07½	90 00	65 26	123 07½
l	201	90 00	68 39½	21 20½	90 00	36 21½	21 20½
e	$\bar{2}01$	−90 00	52 19½	142 19½	90 00	84 38	142 19½
h	$\bar{8}03$	−90 00	62 42	152 42	90 00	95 00½	152 42
f	$\bar{4}01$	−90 00	72 45½	162 45½	90 00	105 04	162 45½
y	601	90 00	81 08½	8 51½	90 00	48 50	8 51½
r	$\bar{1}12$	13 59	31 55	81 26½	59 08	38 13	82 39½
v	111	52 51½	63 27½	32 04	57 18½	40 38½	44 30½
s	$\bar{1}11$	−15 19½	51 25	108 20	41 04	65 22½	101 55½
r	$\bar{1}33$	14 26	51 18	72 43	40 54	50 46½	78 47
p	$\bar{3}14$	−16 49½	17 31½	95 13½	73 15	40 35½	95 00
q	$\bar{3}12$	−53 22½	45 22½	129 07	64 52½	73 14	124 50

Uncertain forms: $\bar{1}0.0.1$, $\bar{1}3.0.1$, $\bar{1}4.0.1$, $\bar{8}83$, $\bar{2}69$.

X-RAY STUDY

Richmond (1939) determined the lattice constants of dolerophanite. The crystal used for this work was approximately 0.5 millimeter in length and 0.25 millimeter in section. Rotation and Weissenberg photographs were taken about the *b*[010] and *c*[001] axes, using copper radiation.

Reciprocal lattice projections were made of the zero and first layer-line photographs taken about the *b*[010] axis.

The reciprocal lattice chosen to conform to morphological conventions resulted in a body-centered lattice. The alternate face-centered lattice was therefore adopted. The reflections on the Weissenberg photographs, referred to this lattice, are:

(hkl) = with h and k even
$(h0l)$ = with h even
$(0k0)$ = with k even

These criteria, together with the fact that previous morphological investigations indicated holohedral symmetry, give the space group $C_{2h}^3 - C2/m$.

The lattice constants, calculated from the Weissenberg photographs are:

$a_0 = 9.39$ Å
$b_0 = 6.30$ Å
$c_0 = 7.62$ Å

$a_0 : b_0 : c_0 = 1.490 : 1 : 1.209$; $\beta = 122°41\frac{1}{2}'$

Contents of the unit cell. The analysis by Zambonini and a new specific gravity (4.17) determined by Richmond, together with the lattice constants, give the content of the unit cell as shown in Table 3.

TABLE 3. DOLEROPHANITE: CONTENTS OF THE UNIT CELL

	1	2	3		4	5	6
CuO	65.20	66.06	0.830	Cu	0.830	7.98	8
SO_3	33.49	33.94	0.424	S	0.424	4.07	4
Insol.	1.31	—	—	O	2.120	20.20	20
	100.00	100.00					

1. Analysis of dolerophanite; analyst, Zambonini.
2. Analysis recalculated to 100%.
3. Molecular proportions.
4. Atomic proportions.
5. Number of atoms in the unit cell.
6. Theoretical number of atoms in the unit cell.

From column 6 the unit cell contains $4[Cu_2SO_5]$.

Optical Properties

Zambonini gave incomplete optical data. Therefore, Dr. Harry Berman determined the indices of refraction and optical orientation of dolerophanite which, in Goldschmidt's orientation, are:

		Indices (Na)	
X	deep brown	1.715	positive
$Y=b$	brownish yellow	1.820	$2V=85°$
$Z\wedge c=-10°$	lemon yellow	1.880	$r>v$, very strong, crossed dispersion

References

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