CRYSTALLOGRAPHY OF VEATCHITE

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ABSTRACT

Some terminated crystals of veatchite, the newly discovered borate from Lang, California, have been measured on the goniometer, the elements calculated, and fourteen forms observed. Using the published x-ray determination of the unit cell, the elements are:

$$a:b:c:=0.163:1:0.998 \qquad \beta=121°02'$$
$$p_0:q_0:r_0=6.1227:0.8551:1 \qquad \mu=58°58'$$
$$r_2:p_2:q_2=1.1694:7.1599:1$$
$$p_0'=7.1455 \qquad q_0^1=0.9980 \qquad x_0'=0.6017$$

The following forms are recorded, and an angle table calculated for them: $b(010)$, $f(014)$, $g(013)$, $h(023)$, $d(011)$, $j(043)$, $o(031)$, $l(310)$, $q(230)$, $n(120)$, $k(140)$, $t(160)$, $s(180)$, $p(\bar{1}66)$. In addition there are a number of other poorly developed prisms and domes, and one other posssible pyramid.

The new calcium borate, veatchite, was described by Switzer,[1] but he gave no crystallographic data, owing to the lack of suitable material. His description reminded the writer to re-examine some material from Lang which had been given him some time ago. The specimen proved to have a considerable amount of veatchite, some of it in distinct crystals. The identification was confirmed by a close agreement of properties, the only important difference being the observed angle made by the secondary cleavage with the prism zone. Switzer reported this as 67° (±1),[2] but the writer determined it, both crystallographically and microscopically, to be slightly under 59°. The indices of refraction were in essential agreement, and the angle −38°, $Z:c$, was confirmed. Specific gravity, by Clerici solution (2.58±.01), was slightly lower than Switzer's value. The luster is pearly on the perfect cleavage, and vitreous elsewhere, and cleavage flakes closely resemble gypsum.

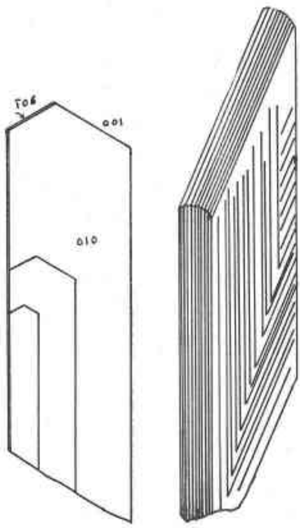
OCCURRENCE

The writer's material is contained in a single hand specimen which shows a vein of colemanite in shale. A visit to the locality, and careful search has so far failed to uncover any additional specimens. The colemanite is not solidly massive, but has many open spaces, with well developed crystal faces. In one instance a minute crystal of secondary colemanite was observed, perched on the surface of a larger crystal. The veatchite occurs entirely in the colemanite vein, growing in the spaces between the colemanite crystals. In some parts it is in "nests" of

[1] Switzer, George, Veatchite, a new calcium borate from Lang, California, *Am. Mineral*, **23**, 409–411, 1938.

[2] *Loc. cit.*, 409.

radiating plates, filling these spaces completely. In others, it does not take up the entire space, and occurs in part as terminated crystals. These crystals are quite varied in size and habit, ranging from capillary fibers one-fourth to nearly a centimeter in length, to broad flat plates one to five or six millimeters across, in the case of single crystals. In addition there are larger platy aggregates up to a centimeter or so in length and breadth. The more slender prismatic forms are usually single individuals, growing in tufted or radiating masses, often nearly parallel. The platy forms are more usually aggregates of several units, in essentially parallel position. Figure 1 shows one of these, of microscopic size,



FIGS. 1 AND 2. Crystal developments of Veatchite.

with its largest dimension under .5 mm. Here three crystals are grown together, showing the development of (010) terminated on top by the clinodome zone and a negative pyramid which lies in the $(\bar{1}06)$ zone. The bottom is truncated by the poorer cleavage. The prism zone is almost absent, but is shown under the microscope by the varying thickness of a very narrow edge of the crystal. Most of the larger crystals are tabular and similar but do not show the development of the pyramid.

In general, veatchite is later than the colemanite, and deposited on it. In one or two cases, however, veatchite crystals are partially or wholly enclosed by colemanite, indicating a closer age relationship, or possibly replacement of colemanite by veatchite, although the limited amount of material at hand does not permit a definite conclusion to be reached.

Crystallography

As noted, the crystals are frequently parallel or sub-parallel groups of flattened and elongated individuals, but a number of single ones were obtained for measurement. Ten of these were measured on the two-circle goniometer, and a number of others examined, but not measured, as they showed few faces and none which had not been previously observed. Because of the flattened prismatic habit the crystals are easily adjusted, but many of the readings, except on (010), were quite unsatisfactory. All crystals showed (010), and likewise a series of faces, usually very narrow and often indeterminate, in the prism and in the clinodome zones. Pyramids were noted on only two of the crystals measured, but so poorly developed as to give very unsatisfactory readings. One of these $(\bar{1}66)$ may perhaps be considered sufficiently good to record, as its presence is confirmed by its development in the same zone on microscopic crystals. This zone is marked $(\bar{1}06)$ in figure 1.

The side pinacoid faces (010) are usually good, but often characterized by panelling, or striations parallel to the prism and clinodome zones, respectively. Figure 2 shows a typical crystal, although the striations are frequently not so pronounced.

Forms

Only those forms which occur frequently, or in good position, should be considered as established, and according to this criterion many observations made on these crystals must be discarded, or at least held in abeyance for future possible confirmation. Accordingly, only the probable forms have been indicated by letters, and occasional comment is made on their reliability.

1. *b*(010). This form occurs on every crystal, usually on both sides. Readings are good, and the maximum variation is only a few minutes from 180° apart.

2. *n*(120).

	Observed		Calculated	
	ϕ	ρ	ϕ	ρ
	73°34′	90°00′	74°23½′	90°00′
	75 08	90 00		
	73 02	90 00		
	73 00	90 00		
	73 04	90 00		
av.	73 45			

Readings only fair, but the form occurs five times, and may be considered established.

3. *k*(140).

	Observed		Calculated	
	ϕ	ρ	ϕ	ρ
	58°28′	90°00′	60°49′	90°00′
	59 50	90 00		
	59 58	90 00		
	59 36	90 00		
	59 46	90 00		
av.	59 32			

4. *t*(160).

	ϕ	ρ	ϕ	ρ
	49°46′	90°00′	50°02′	90°00′
	50 38	90 00		
	51 14	90 00		
av.	50 32			

5. *g*(013).

	ϕ	ρ	ϕ	ρ
	59°16′	34°54′	61°04′	34°31′
	59 36	34 48		
	59 16	35 04		
	59 04	35 00		
av.	59 19	34 56		

Agreement with calculated angle is poor, but (013) is by far the nearest to any relatively simple indices.

6. *h*(023).

	ϕ	ρ	ϕ	ρ
	41°52′	41°50′	42°07½′	41°53½′
	41 36	42 20		
	43 36	41 30		
	42 22	41 30		
	40 54	42 05		
av.	42 04	41 51		

7. *l*(310).

	ϕ	ρ	ϕ	ρ
	87°26′	90°00′	87°20′	90°00′
	88 10			
av.	87 49			

8. *s*(180).

	ϕ	ρ	ϕ	ρ
	42°02′	90°00′	41°47′	90°00′
	42 32			
av.	42 17			

9. *f*(014).

	Observed		*Calculated*	
	ϕ	ρ	ϕ	ρ
	68°04′	32°56′	67°29′	33°05′
	67 06	33 06		
av.	67 35	33 01		

10. *d*(011).

	ϕ	ρ	ϕ	ρ
	33°56′	47°08′	31°05′	49°22′
	32 44	48 04		
	33 20	47 41		

Not entirely satisfactory, but the nearest likely indices.

11. *j*(043).

	ϕ	ρ	ϕ	ρ
	24°20′	54°44′	24°20′	55°36′
	24 52	55 16		
av.	24 36	55 00		

12. *o*(031).

	ϕ	ρ	ϕ	ρ
	10°14′	72°09′	11°22′	71°52′
	10 48	74 10		
av.	10 31	73 10		

13. *q*(230).

	ϕ	ρ	ϕ	ρ
	79°54′	90°00′	78°10′	90°00′
	77 04	90 00		
av.	78 29			

14. ($\bar{1}66$)

	ϕ	ρ	ϕ	ρ
	−30°16′	49°24′	−30°36½′	49°13½′

Included, because although measured only once, its zone has been observed on the microscopic crystals, and its agreement with the calculated position is good.

In addition to these, the base and pinacoid *a* occur only once each with a fair signal, but are nearly always represented in their respective zones by a continuous band of reflections. Other faces occurring only once, or marked by a brighter spot in the train of signals reasonably close to the calculated position, are the following: in the prism zone, (320), (110), (560), (130), (150), (170); in the clinodome zone, (0.1.30) [three readings, probably vicinal to 001], (017), (016), (027), (025), (035), (056), (065), (054); a pyramid, possibly ($\bar{1}$.6.12,).

The accompanying angle table includes calculations for the better established forms only.

ELEMENTS AND ANGLE TABLE

$a:b:c=0.163:1:0.998$ $\beta=121°02'$
$p_0:p_0:r_0=6.1227:0.8551:1$ $\mu=58°58'$
$r_2:p_2:q_2=1.1694:7.1599:1$

$p_0'=7.1455$ $q_0'=0.9980$ $x_0'=0.6017$*

Forms	ϕ	ρ	ϕ_2	$\rho_2=B$	C	A
b 010	0°00′	90°00′	——	0°00′	90°00′	90°00′
l 310	87 20	"	0 00	87 20	59 00½	2 40
q 230	78 10	"	"	78 10	59 42	11 50
n 120	74 23½	"	"	74 23½	60 14	15 36½
k 140	60 49	"	"	60 49	63 15	29 11
t 160	50 02	"	"	50 02	66 43½	39 58
s 180	41 47	"	"	41 47	69 54½	48 13
f 014	67 29	33 05	58 58	77 56	12 04	59 43
g 013	61 04	34 31	"	74 05	15 55	60 17
h 023	42 07½	41 53½	"	60 18½	29 41	63 23½
d 011	31 05	49 22	"	49 28	41 24½	66 56
j 043	24 20	55 36	"	41 15½	48 45	70 07½
o 031	11 22	71 52	"	21 17	68 42	79 12½
p $\bar{1}66$	−30 36½	49 13½	120 33½	49 19½	40 41	112 40½

* In the abstract of this paper, printed for the December meeting, this value was given wrongly, due to an arithmetical error. The author.