X-ray data on stokesite.

By P. Gay, M.A., Ph.D.

and K. O. Rickson

Dept. of Mineralogy and Petrology, Downing Place, Cambridge.

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Summary. An X-ray examination of the type specimen of stokesite gave a 14·41, b 11·61, c 5·23 Å.; space-group *Pnna*. The unit cell contains $4[CaSnSi_3O_{11}H_4]$ and is derived from Hutchinson's morphological unit by the transformation [010/001/100]. X-ray powder data are given.

STOKESITE, a tin-bearing silicate, occurs on a matrix of axinite from Roscommon Cliff, St. Just, Cornwall. The transparent well-crystallized mineral resembles selenite, but a careful examination by Hutchinson (1899, 1900) established it as a new mineral species. Goniometric and optical measurements, together with micro-chemical analyses, were carried out, and these showed that the mineral belonged to the orthorhombic holosymmetric class ($a:b:c = 0.3463:1:0.8033$) and that an empirical formula $CaSnSi_3O_{11}H_4$ was probable. Since that time no further occurrence has been described, and the original crystal and fragments in the Museum of the Department of Mineralogy and Petrology, Cambridge, remain the only known example of this mineral. X-ray data for this material are reported in this paper.

A small fragment obtained from a thick section in the museum collection was examined by oscillation and Weissenberg methods using Cu-$K\alpha$ radiation. The diffraction patterns confirmed the orthorhombic symmetry, with cell dimensions a 14·41, b 11·61, c 5·23 Å. (all ± 0.03), and the systematic absences showed that the space-group is *Pnna*. Powder photographs of material from the same section were taken with Cu-$K\alpha$ radiation. The observed spacings are given in table I, together with the spacings for the first eighteen lines calculated from the cell dimensions; there is good agreement between the observed and calculated values. The three strongest lines are at 3·99, 2·89, 7·25 Å., though the line at 2·89 Å. is obviously a doublet at least.

From an examination of the X-ray data it is apparent that although the correct parametral plane was chosen in the morphological description,

TABLE I. Powder data for stokesite.

$d_{obs.}$	$I.$	$hkl.$	$d_{calc.}$	$d_{obs.}$	$I.$	$d_{obs.}$	$I.$
7·25	s	200	7·21	2·23	m	1·534	vw
5·82	m	020	5·81	2·15	m	1·521	vw
4·95	vw	101	4·92	2·12	m	1·511	m
4·79	w	011	4·77	2·04	m	1·486	m
4·54	m	111	4·53	1·992	vw	1·451	w(b)
		220	4·52	1·938	w	1·440	vw
3·99	vs	211	3·98	1·906	w	1·427	w(b)
3·76	w	121	3·75	1·877	vw	1·384	m
3·55	m	301	3·54	1·832	m	1·370	vvw
3·43	m	410	3·44	1·808	w	1·322	m
		221	3·42	1·774	m	1·309	w
3·03	m	131	3·04	1·755	vw	1·302	w
2·89	vs(b)	400	2·90	1·726	w	1·253	vw
		411	2·87	1·711	m	1·235	vw
		231	2·86	1·694	vw	1·194	vvw(b)
2·69	m	240	2·69	1·678	m	1·178	vvw(b)
2·65	vw	421	2·64	1·593	w	1·141	vw
		430	2·64	1·556	ms	1·128	w
2·62	w	002	2·62	1·545	vw	1·125	w
		331	2·61				
2·52	vw	501	2·52				
2·47	vw	511	2·47				
2·39	m	241	2·39				
		022	2·38				
2·36	vw	122	2·36				
		431	2·36				
		610	2·35				
2·27	m	222	2·26				
		440	2·26				

the morphological axes would not lead to the conventional space-group symbol; the relationship between the old morphological axes and those chosen in this study is $a_m = c_x$, $b_m = a_x$, $c_m = b_x$. If the axial ratio obtained from the cell dimensions is transformed to correspond with the original morphological orientation, a value $a:b:c = 0.3627:1: 0.8056$ is obtained, in satisfactory agreement with Hutchinson's determination. The original morphological and optical data may also be described in terms of the new axial orientation: dominant forms {100} and {211}, with perfect {101} cleavage and imperfect {100} cleavage; α (1·609) ∥ c [001], β (1·6125) ∥ a [100], γ (1·619) ∥ b [010], 2 $V_\gamma = 69\frac{1}{2}°$ for Na light).

Analyses on two portions of 100 mg. each gave Hutchinson 43·1 % SiO_2, 33·3 % SnO_2, 13·45 % CaO, 8·6 % H_2O. Using these figures, and the density of 3·185, the contents of the unit cell are $Ca_4Sn_{3.8}Si_{12.3}O_{44.4}H_{16.3}$, which suggests the idealized formula $CaSnSi_3O_{11}H_4$ (identical

with that proposed by Hutchinson) with $Z = 4$. With the small amount of mineral available it was not possible to make any further chemical determination. Dr. J. V. P. Long kindly determined the calcium and tin contents by the X-ray emission micro-analytical technique (Castaing, 1951); his results of $13 \cdot 3 \pm 0 \cdot 6 \%$ CaO and $33 \cdot 7 \pm 1 \cdot 9 \%$ SnO_2 confirm, within the experimental error, the original analysis.

Hutchinson suggested that stokesite had a formal resemblance to catapleiite ($Na_2ZrSi_3O_{11}H_4$). However, powder photographs of stokesite show little resemblance to those of catapleiite, which has trigonal symmetry. Further it has been found that catapleiite contains three-membered $(SiO_3)_3$ rings like benitoite (Belov, 1942); the $5 \cdot 23$ Å. c-axis of stokesite suggests that the Si–O tetrahedral arrangement is more closely related to the normal band or sheet silicate structures. Such speculations can only be resolved by a detailed structure determination, which should not be an intractable problem owing to the presence of the heavy tin atoms in special positions; it is hoped that a structure determination will be carried out at a later date.

References.

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