

A CHEMICAL, OPTICAL AND X-RAY STUDY OF SCAWTITE FROM BALLYCRAIGY, LARNE, N. IRELAND

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ABSTRACT

A new chemical analysis of scawtite shows that this mineral is a carbonated calcium silicate hydrate. The scawtite examined was collected at Ballycraigy, Larne, N. Ireland, where it occurs in a vesicle in larnite rocks in association with the mineral tobermorite. Proof of the identity of the material from Ballycraigy and scawtite from Scawt Hill was provided by comparing the optical and cell constants of the two minerals.

The following data were obtained for scawtite from Ballycraigy:

Optical constants: $\alpha = 1.595$, $\beta = 1.605$, $\gamma = 1.622$, all $\pm .001$.

$$2V = 75^{\circ}5' \quad 2V \text{ calculated} = 74^{\circ}$$

Unit cell constants: An *A*-face centered cell was chosen adopting the orientation originally proposed by Tilley.

$$a = 6.61 \text{ \AA}, \quad b = 15.22 \text{ \AA} \quad \text{and} \quad c = 10.98 \text{ \AA}, \quad \beta = 115^{\circ}24'$$

The optical and crystallographic directions were related thus:

$$\beta = b, \quad \gamma \wedge a = 30^{\circ}, \quad \text{and} \quad \gamma \wedge c = 34.5^{\circ}.$$

The formula unit for scawtite, as found from the new analysis, was



Evidence is presented which suggests that scawtite is related structurally to wollastonite.

OCCURRENCE

The occurrence of scawtite at Ballycraigy, Larne, N. Ireland, has already been noted (McConnell 1954, p. 295). Scawtite was found lining a single vesicle in larnite rocks from the dolerite-chalk contact at this locality. The mineralogy of this contact has not yet been described in detail but is closely similar to that of the Scawt Hill contact described by Tilley (1931).

Scawtite also occurs at Ballycraigy as an alteration product of some other mineral. Scawtite pseudomorphs after spurrite have been described by Tilley (1938). Consequently the primary mineral at Ballycraigy may well have been spurrite.

The vesicle examined was lined with transparent crystals of scawtite which were covered with delicate tuft-like aggregates of tobermorite. The crystal habit of scawtite was not observed for this reason.

Scawtite was found to have an *H.* of 5, *G.* of 2.77, and two cleavages at right angles. The cleavages were observed in crushed material.

OPTICAL PROPERTIES

The optic axial plane was parallel to the poorer of the two cleavages and fragments orientated parallel to the perfect cleavage showed an off-centered optic axial interference figure. The optical constants as determined by the immersion technique were: $\alpha=1.595$, $\beta=1.605$ and $\gamma=1.622$, all $\pm .001$. $2V$ was positive and universal stage measurements indicated a value of $75^{\circ}5'$ for this angle. The calculated value for $2V$ was 74° .

X-RAY STUDY

A single crystal x -ray study was carried out on a small but perfect single crystal of scawtite from the vesicle described above. The mineral was

TABLE 1. THE d SPACINGS OF SCAWTITE FROM BALLYCRAIGY

8.36	vw	2.54	vw	1.81	w
7.93	vw	2.52	w	1.777	w
5.99	m	2.49	m	1.766	w
4.99	vw	2.39	vw	1.671	vw
4.52	m	2.33	vw	1.632	vw
4.19	m	2.23	m	1.602	vw
3.80	m	2.21	w	1.554	vw
3.55	m	2.17	vvw	1.535	w
3.21	m	2.15	vvw	1.503	w
3.03	vs	2.12	vw	1.472	vw
2.99	vs	2.01	m	1.320	w
2.96	w	1.89	s	1.313	w
2.78	m	1.87	m	1.141	vw

The x -ray powder photograph was taken on a 19 cm. powder camera using $\text{Cu-K}\alpha$ radiation. The d spacings are given in \AA units. Scale of decreasing intensities vs, s, m, w, vw, and vvw as estimated from visual comparison.

found to be monoclinic as suggested by Tilley (1930, p. 223) and the cleavage zone axis was selected as a in agreement with the orientation figured by him. The cell constants were determined from b axis zero, first and sixth layer line Weissenberg photographs, a c axis zero layer line Weissenberg and oscillation photographs for all three axes. The b axis Weissenberg photographs indicated that either an A -face centered or an I lattice could be chosen. The cell dimensions of both as determined from these photographs were;

$$\begin{array}{llll} A \text{ cell; } & 115^{\circ}24', & a = 6.64 \text{ \AA}, & c = 11.09 \text{ \AA} \\ I \text{ cell; } & 100^{\circ}48', & a = 6.64 \text{ \AA}, & c' = 10.18 \text{ \AA}. \end{array}$$

Oscillation photographs about a , b and c gave the following values for the cell dimensions of the A cell.

$$a = 6.61 \text{ \AA}, \quad b = 15.22 \text{ \AA} \quad \text{and} \quad c = 10.98 \text{ \AA}, \quad \text{all} \pm 0.05 \text{ \AA}$$

Both I and A cells had a calculated mass of $2743 \cdot 10^{-24}$ gms. The optical directions of scawtite had the following orientation to the crystallographic axes chosen:

$$\beta = b, \quad \gamma \wedge c = 34.5^\circ, \quad \gamma \wedge c' = 71^\circ \quad \text{and} \quad \gamma \wedge a = 30^\circ.$$

A list of the d spacings of scawtite from Ballycraigy are given in Table 1.

CHEMICAL STUDY

Attempts were made to find the correct formula unit for scawtite using the molar ratios of SiO_2 , CaO and CO_2 given by Tilley and Hey (1930, p. 223). This proved to be impossible. From this it was inferred that either the mineral from Ballycraigy was not scawtite or the analysis cited was in error. The only crystals of the original scawtite sample available were preserved in a crystal mount. One of these crystals was mounted on the Weissenberg camera. An oscillation photograph about b and a zero layer line Weissenberg photograph about the same axis proved conclusively that scawtite and the mineral from Ballycraigy were identical. It was concluded that the original analysis was in error. Since the original analysis was carried out on a very small sample using ordinary analytical techniques the possibility of such an error has been admitted by Hey (personal communication).

In order to determine, qualitatively, the composition of scawtite the scawtite rock mentioned in the first section was analyzed. This analysis was made by J. H. Scoon of the Department of Mineralogy and Petrology, Cambridge. Optical examination of the analyzed material showed that it consisted essentially of scawtite. Minor amounts of calcite were present. X-ray powder photographs of the material were identical with those of pure scawtite. This analysis showed that the CO_2 content of scawtite could not be greater than 9% and that scawtite contained water. It was also shown that the total combined H_2O and CO_2 could be determined as loss in weight on ignition.

Approximately 30 milligrams of pure scawtite were separated from the vesicle from Ballycraigy. A preliminary separation of scawtite and tobermorite was effected by using heavy liquids and the product was then handpicked under a microscope.

Using the information derived from the preliminary analysis described above, the following microtechnique was developed for the analysis of the pure scawtite sample.

The apparatus consisted of a silica glass ignition tube to which an H_2O absorption tube was attached by means of a ground glass joint. A second absorption tube was added to collect the CO_2 evolved. Each of these

absorption tubes weighed approximately three grams and weight increase was determined by means of a semimicrochemical balance.

When in use a platinum boat containing the sample to be analyzed was placed in the ignition tube and a gentle current of dried CO_2 free air was drawn through the apparatus. After ignition the sample was analyzed in the normal way for CaO and SiO_2 .

During the ignition of the pure scawtite sample a delicate film of moisture was seen to travel along the ignition tube indicating that water had been evolved.

The results of this analysis, as shown below, were considered to be sufficiently accurate to warrant the calculation of a formula unit from the determined cell constants and density.

CHEMICAL ANALYSIS OF SCAWTITE FROM BALLYCRAIGY

	Per Cent	
SiO_2	43.5	6.00
R_2O_3	1.2	
CaO	46.1	6.80
H_2O^-	0.1	
H_2O^+	4.3	1.98
CO_2	4.4	0.83
	99.6	

This analysis was carried out jointly by J. H. Scoon and the author.

All weighings were made on a semimicrochemical balance. The formula unit chosen was 7CaO , 6SiO_2 , $2\text{H}_2\text{O}$, CO_2 , $Z=2$. This formula unit may also be written $\text{Ca}_6\text{Si}_6\text{O}_{18}2\text{H}_2\text{O}:\text{CaCO}_3$ and when written in this way indicates that scawtite may be regarded as a carbonated xonotlite ($\text{Ca}_6\text{Si}_6\text{O}_{18}2\text{H}_2\text{O}$).

Single crystals of scawtite when heated to a temperature of 850°C . were found to have their optical birefringence reduced. This was thought to be associated with decarbonation. *X*-ray powder photographs of the heated material were identical with those of wollastonite. The orientation of the wollastonite to the parent scawtite has not yet been determined.

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On completing the above research the author was informed that Professor Murdoch of the Department of Geology, University of California at Los Angeles was also working on the mineral scawtite.

The author is indebted to Professor Murdoch for subsequently sending him a specimen of scawtite from Crestmore and a manuscript copy of his results. The two investigations overlap to an extent sufficient to prove the identity of the minerals studied, and taken together, provide an integrated account of the morphology, occurrence and chemistry of the mineral scawtite.

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