# SCAWTITE FROM CRESTMORE, CALIFORNIA

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## ABSTRACT

An occurrence of scawtite has been discovered in the contact zone at Crestmore, California. This is the first on record for California, and the fourth known anywhere, to date. The mineral is in bundles of thin tabular crystals, strongly resembling in habit and mode of occurrence the original find at Scawt Hill. Crystals are in general poor, but it has been possible to make approximate measurements on selected individuals, and to confirm these with *x*-ray study of single crystals. The forms present are as follows: {100}, {110}, {120}, {130}, {010}, and {101}. The *a*-pinacoid is always dominant, with the prisms narrow and poorly developed. The mineral is monoclinic, probable space group $I\ 2/m$, with the following unit cell dimensions:

$$a_0 = 10.22\ \text{Å}, \qquad b_0 = 15.42\ \text{Å}, \qquad c_0 = 6.70\ \text{Å}$$
$$a{:}b{:}c \qquad 0.6628{:}1{:}0.4345 \qquad \beta = 100°29'$$

Powder photographs, which can be completely indexed, show the following spacings and intensities for the stronger lines: 3.04 Å—10, 3.01 Å—5, 2.49 Å—5, 2.236 Å—5, 1.898 Å—6.

The crystals have been oriented with Tilley's {001} as {100}, giving simpler indices for the forms, and a less oblique unit cell.

## OCCURRENCE

Specimens collected on the 910 foot level of the Commercial quarry, Crestmore, California, showed a colorless mineral in thin veins in a matrix of massive diopside-wollastonite-spurrite rock. Where the veins are incompletely filled, crystals of this mineral are abundantly developed. Examination showed these crystals to be nearly square tablets with one edge always bevelled, and almost invariably occurring in sub-parallel aggregates, exactly like bundles of shingles. Chemical and optical tests showed the mineral to be scawtite, which has been found in similar crystalline groups only at Scawt Hill, County Antrim, Ireland, Tilley (1930), and Ballycraigy, Larne, N. Ireland, McConnell (1954). One other occurrence is known, but only as microscopic lath-like grains in a thin section of contact zone material from south of Neihart, Montana, Taylor (1935).

The Crestmore occurrence matches closely that described by Tilley, the mineral being one of the latest in the hydrothermal series, and having precisely the same habit. In general, the scawtite is the latest mineral to form in the veins in which it appears, overlying and enveloping calcite crystal. However, in at least one specimen, small bead-like calcite crystals were noted perched on the surface and edges of the scawtite. In another, delicate tufts of white needles and blades of an unidentified mineral occur closely associated with the scawtite, and seem to be essentially contemporaneous with it. Many scawtite veins show a zone of radiating clusters of a bladed unidentified mineral usually along one side of the vein, upon which the scawtite has been deposited. The blades of the unknown mineral are extremely thin obliquely rhombic plates, with extinction parallel to the longer edge of the rhomb.

Associated with the massive scawtite in one or two of the veins, are fine-grained sugary aggregates of bultfonteinite, which also appears in similar massive veins of afwillite, which was recently identified from Crestmore by Switzer and Bailey (1953). A description of this mineral, with $x$-ray study, is in preparation, and will be presented shortly.

## PROPERTIES AND MORPHOLOGY

Sections parallel to the broad plates show parallel extinction, with the acute bisectrix emerging just outside the field of view, and giving a positive figure. 2 V is large (Tilley notes 74° ±.) A fair cleavage is present parallel to {010}, and sections with this orientation show an extinction angle of approximately 28°. Tilley records a cleavage parallel to {100}, but this may well be a parting, due to twinning on this face. Many rod-like inclusions with much lower index were observed in some sections. Indices of refraction of the Crestmore material check satisfactorily with recorded values.

The Crestmore scawtite is readily soluble in HCl, with moderate effervescence, leaving a residual skeleton of silica. It gives good microchemical tests for $SiO_2$ and CaO. In the closed tube the mineral decrepitates, and gives off water. Before the blowpipe it is infusible, but whitens and glows when heated intensely. No strong flame coloration was observable.

Using the large face as the front pinacoid, the following forms were observed: {100} always present and dominant, but usually somewhat uneven, and showing thin slabs of subsidiary crystals, {010} usually present, very shiny; {101} always present, normally shiny, and almost always giving multiple reflections, due to the aggregation of many flat crystals; {130} narrow, but often present as one or two faces; {120} and {110} narrow, and rarely present. Two faces of {011} are present on one crystal. It was possible to select crystals which were simple enough to measure on the reflecting goniometer, although without any great degree of precision. Only doubtful numerical indices could be assigned to the prisms from these measurements, but these could be confirmed from the $x$-ray measurements. Using these $x$-ray data, the angle table for observed forms has been calculated, and is presented below in Table 1.

Actual measurements for rho of {101} range from 39° 15′ to 43° 40′, with best probable values of about 42°. For {130} several readings gave 26° 33′ or 27° 18′; for {120} 40° 12′; and for {110} 56° 31′.

TABLE 1. SCAWTITE ANGLE TABLE

Monoclinic, Space Group *I* 2/*m*

$a_0:b_0:c_0=10.22:15.42:6.70,\ \beta=100°29'$
$a:b:c=0.6628:1:0.4345$
$p_0:q_0:r_0=0.6556:0.4273:1$
$r_2:p_2:q_2=2.3406:1.5344:1$
$p_0'=0.6667,\ q_0'=0.4345,\ e_0'=0.1850$

| | $\phi$ | $\rho$ | $\phi_2$ | $\rho_2$=B | A | C |
|---|---|---|---|---|---|---|
| *b* 010 | 90°00′ | 0°00′ | — | 0°00′ | 90°00′ | 90°00′ |
| *a* 100 | 90 00 | 90 00 | 0 00 | 90 00 | 79 31 | 0 00 |
| *k* 130 | 27 05 | 90 00 | 0 00 | 27 05 | 85 14 | 62 55 |
| *l* 120 | 37 29½ | 90 00 | 0 00 | 37 29½ | 83 37½ | 52 30½ |
| *m* 110 | 56 54½ | 90 00 | 0 00 | 56 54½ | 81 12 | 33 05½ |
| 011 | 23 04 | 25 17 | 79 20 | 66 52 | 80 22 | 23 08 |
| *d* 101 | 90 00 | 40 25 | 49 35 | 90 00 | 29 54 | 49 35 |

One poor prism face with $\phi=18°03'$ was observed. This might doubtfully be {290} (calculated $\phi=18°50'$).

Transformation formula, Murdoch/Tilley $=00\bar{1}/010/100$.

## *X*-RAY STUDY

By careful selection it was possible to isolate two crystals which were satisfactory for single crystal *x*-ray measurement, although even these were multiple, but with orientations so slightly varied as not to make trouble. One of these was rotated about *c*, and the other about *b*, so that all three directions could be adequately measured. Rotation, equator and first-layer line Weissenberg photographs were taken with filtered iron radiation, and the three cell-dimensions were calculated from these. Translations on the *b* and *c* axes were measured on the rotation photographs, and the layer-line pictures measured, using both top and bottom halves of the films. From these measurements, using as many as four or five orders of diffraction, and correcting for lack of uniformity in crystal dimensions, the values of $a_0$, $b_0$ and $c_0$ were calculated. The values thus arrived at are as follows:

$a_0$ 10.22 ± 01 Å, $b_0$ 15.42 ± 01 Å, $c_0$ 6.70 ± 01 Å.

$\mu$, measured directly on the Weissenberg film, and checked on the Schneider construction, is 79°31′, so that beta is 100°29′. Systematic

TABLE 2. *X*-RAY POWDER DATA FOR SCAWTITE

Cu $K_\alpha$ radiation, Angstrom units

| *d/n* | | *hkl* | *I* |
|---|---|---|---|
| *Obs.* | *Calc.* | | |
| 8.40 | 8.418 | 110 | 1 |
| 7.75 | 7.71 | 020 | ½ |
| 6.05 | 6.06 | 011 | 3 |
| | 6.037 | $\bar{1}01$ | |
| 5.03 | 5.11 | 200 | 2 |
| | 5.103 | 101 | |
| 4.76 | 4.778 | 210 | ½ |
| | 4.753 | $\bar{1}21$ | |
| 4.56 | 4.576 | 130 | 4 |
| 4.22 | 4.256 | 121 | 3 |
| | 4.232 | $\bar{2}11$ | |
| | 4.211 | 220 | |
| 4.05 | 4.052 | 031 | ½ |
| 3.83 | 3.81 | 040 | 2 |
| 3.57 | 3.594 | 240 | 3 |
| | 3.584 | 211 | |
| 3.357 Fe | 3.35 | 002 | ½ |
| 3.24 | 3.24 | $\bar{1}12$ | 3 |
| | 3.274 | 310 | |
| 3.04 | 3.03 | 022 | 10 |
| | 3.057 | 240 | |
| | 3.076 | 141 | |
| 3.017 Fe | 3.018 | $\bar{2}02$ | 5 |
| 2.97 Fe | 2.982 | $\bar{3}21$ | 1 |
| | 2.963 | $\bar{2}12$ | |
| 2.91 | 2.92 | 112 | ½ |
| | 2.90 | $\bar{2}41$ | |
| 2.837 | 2.81 | $\bar{2}22$ | ½ |
| 2.79 | 2.806 | 330 | 4 |
| | 2.793 | 051 | |
| 2.56 Fe | 2.57 | 060 | ½ |
| | 2.561 | $\bar{3}12$ | |
| | 2.555 | 400 | |
| 2.543 | 2.55 | 202 | 2 |
| | 2.526 | $\bar{2}51$ | |
| 2.495 | 2.505 | 042 | 5 |
| | 2.472 | $\bar{4}11$ | |
| 2.41 | 2.422 | 222 | ½ |
| 2.35 | 2.365 | 251, $\bar{1}61$ | ½ |
| 2.307 Fe | 2.318 | 332 | ½ |
| 2.285 Fe | 2.288 | 260 | ½ |
| 2.24 | 2.251 | $\bar{4}31$ | 5 |
| | 2.259 | 341 | |
| 2.224 Fe | 2.232 | $\bar{1}03$ | 1 |
| 2.199 Fe | 2.200 | $\bar{4}02$ | ½ |
| | 2.197 | 152 | |
| 2.175 | 2.174 | 013 | ½ |
| 2.164 | 2.151 | 170 | ½ |
| 2.13 | 2.141 | $\bar{2}13$ | 2 |
| | 2.1395 | 312 | |
| 2.107 | 2.107 | 440 | 3 |
| | 2.036 | 431 | |
| 2.007 Fe | 2.012 | $\bar{3}03$ | |
| 1.938 | 1.944 | $\bar{4}51$ | ½ |
| 1.898 | 1.927 | 080 | 6 |
| | 1.891 | 271 | |
| 1.871 | 1.876 | 213 | 1 |
| | 1.872 | 530 | |
| 1.817 | 1.811 | 262 | ½ |
| 1.791 Fe | 1.801 | 451 | 1 |
| | 1.789 | 053 | |
| 1.778 Fe | 1.782 | 521 | ½ |
| 1.756 | 1.761 | $\bar{5}32$ | ½ |
| | 1.743 | $\bar{2}53$ | |
| 1.682 | 1.683 | 550 | ½ |
| 1.640 | 1.637 | 620 | 1 |
| | 1.638 | 014 | |
| 1.610 | 1.618 | $\bar{2}24$ | 2 |
| | 1.611 | 024, 253 | |
| | 1.613 | $\bar{6}31$ | |
| | 1.609 | $\bar{2}04$ | |
| 1.589 Fe | 1.590 | $\bar{3}14$ | ½ |
| | 1.584 | 512 | |
| 1.577 | 1.576 | $\bar{6}02$ | ½ |
| 1.566 Fe | 1.572 | 114 | ½ |
| 1.560 | 1.553 | 291 | ½ |
| 1.543 | 1.547 | 381 | 2 |
| | 1.542 | 0.10.0 | |
| 1.530 | 1.537 | 282 | ½ |
| | 1.526 | $\bar{3}34$ | |
| 1.508 | 1.515 | 413, 044 | 1 |
| | 1.510 | 134 | |
| | 1.509 | $\bar{4}04$ | |
| 1.486 Fe | 1.488 | $\bar{6}51$ | ½ |
| 1.479 | 1.477 | 1.10.1 | 1 |
| 1.457 | 1.459 | $\bar{7}01$ | 1 |
| | 1.460 | $\bar{6}13$ | |
| 1.443 | 1.442 | 224 | 1 |
| 1.375 | 1.376 | 314 | ½ |
| 1.319 | | | 1 |
| 1.270 | | | 1 |
| 1.244 | | | ½ |
| 1.237 | | | ½ |
| 1.228 | | | ½ |
| 1.212 | | | ½ |
| 1.1515 | | | ½ |
| 1.132 | | | ½ |
| 1.111 | | | ½ |
| 1.102 | | | ½ |
| 1.094 | | | ½ |
| 1.0887 | | | ½ |
| 1.0687 | | | ½ |
| 1.0578 | | | ½ |
| 1.0375 | | | ½ |
| 1.008 | | | ½ |
| .9836 | | | ½ |
| .9277 | | | ½ |
| .8882 | | | ½ |
| .7890 | | | ½ |
| .7780 | | | ½ |

extinctions in the chosen orientation, leaving only $h+k+l$ even, indicate a body-centered lattice. Other possible settings, with beta about 107°, or Tilley's orientation, with beta 115°24′ would give a base centered lattice, but the first was chosen as following a common custom of employing the unit cell with least possible obliquity. In addition this orientation gives simpler indices.

Powder photographs were taken with copper and with iron radiations and can be satisfactorily indexed. In the following, Table 2, giving the spacings and intensities, the symbol Fe indicates the presence of multiple lines shown on the copper film as single, or broadened lines, which have been resolved by the iron radiation. For example, a very strong, broad line on the copper film at about 3.04 Å is resolved in the iron into a definite triplet, 10, 5 and 1 in intensity.

Independently of the author, Mr. J. D. C. McConnell (this journal, pp. 510–514), working in the laboratory of the Department of Mineralogy at Cambridge University, has completed a study of scawtite from the Scawt Hill and Ballycraigy occurrences. Our results are in close agreement, and are interesting as showing practically identical conditions of formation, habit, etc., in two widely separated localities.

His observation of water in the mineral, overlooked in the original description, has been confirmed by the author for the Crestmore occurrence.

## REFERENCES

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*Manuscript received July 14, 1954.*