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Cassiterite, "Sparable Tin," from Cornwall.

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DURING the last few years some fresh specimens of Sparable Tin have been raised from various mines in Cornwall; a description of this variety may therefore be of interest to the Society.

The value of this description of the new finds will perhaps be increased by combining with it an account of the specimens of Sparable Tin from different mines now to be found in our museums and private collections. Through the kindness of those gentlemen who own or have charge of these collections, I have been enabled to see and examine many of the interesting specimens which they contain.

The name "Sparable Tin" is peculiar to Cornwall, and has been given to this variety of Cassiterite on account of its so-called resemblance to the sparable nail of the cobbler.[1]

[1] Sparable may be the corruption of Sparrow-bill, so-called from its shape; *O.E.* Sparwa, a sparrow, literally 'a flutterer'; or the meaning of sparable nail may be simply that which spars or rivets, since *A.S.* 'sparriam' means to fasten or rivet.

The crystals are always sharply pointed, having the ditetragonal pyramid *z* {321} largely developed together with an elongated striated prism.

In 1814 Mr. William Phillips published in the *Transactions of the Geological Society* a most valuable and interesting monograph on Oxyd of Tin, with eleven large plates of drawings of the different forms of Tin, and the accuracy of his work is proved by the fact that the angle which he found for the element of Cassiterite is accepted to-day.

On page 340 he says, "If it should hereafter more generally appear that some modifications of the primitive crystal of this substance are principally the production of particular districts, as I am led to suspect will be the case, might not an investigation of the nature and peculiarities of the veins and of the countries through which they pass tend to throw some light on the circumstances or laws by which the several modifications are produced: may not these circumstances be supposed in some degree to depend on the purity of the substance entering into combination with it? The Bohemian oxyd has not hitherto been observed to assume so great a diversity of crystalline forms as the Cornish, which, by the analysis of Klaproth already noticed, appears to be by far the most pure."

To this suggestion we are able to add to-day, that the slower the growth the greater is the modification of the form, and that minute impurities when not chemically combined have apparently no effect upon the crystalline structure, though when an isomorphous interchange of elements takes place a marked change is observed in the crystallographic element—but to the question, "What is the law which governs the different habits or modifications of crystals?" we can add nothing at the present time; all that we can do is to describe the modes of occurrence and the associated minerals for crystals of very similar combination, and leave the physicists of the future to deduce a law by the aid of such material. With this end in view I have brought together descriptions of the various specimens of the Sparable Tin of Cornwall.

Literature.

1814.	Phillips.	Trans. Geol. Soc. p. 336.
1822.	Haüy.	Traité de Minéralogie.
1823.	Phillips.	Mineralogy, third Edition, p. 250.
1852.	Miller.	Phillips' Mineralogy, p. 235.
1856.	Gadolin.	Verh. Russ. Min. Ges. p. 184.
1855.	Nordenskiöld.	Pogg. Ann. 101, p. 637.
1864.	Hessenberg.	Mineralogische Notizen, VI. p. 18,

LITERATURE—*Continued.*

1877. Becke. Min. Mitth. Vol. I. p. 243.
1882. Collins. Min. Mag. Vol. IV. p. 1.
1889. Busz. Zeits. f. Kryst. XV. p. 623.

TABLE OF FORMS.

Letter.	Symbol.	Author.	Locality.	Remarks.	
c	001	Phillips	Cornwall	Very rare	on Sparable Tin
a	100	,,	,,	Very often present	,,
m	110	,,	,,	Always present	,,
h	210	,,	,,	Not common	,,
r	320	,,	,,	Very often present	,,
r_1	430	,,	,,	Very common	,,
l	870	Busz	Huel Nancy	Very narrow	,,
k	14 13 0	Gadolin	Pitkaranta	Not observed	,,
e	101	Phillips	Cornwall	Always narrow	,,
w	501	,,	,,	Not observed	,,
x	114	Gadolin	Pitkaranta	,,	,,
y	335	Phillips	Cornwall	,,	,,
σ	223	Gadolin (s_1)	Pitkaranta	,,	,,
s	111	Phillips	Cornwall	Always present	,,
i	552	,,	,,	Very often present, very narrow	
5 *p*	551	Gadolin	Pitkaranta	Not observed	on Sparable Tin
n	661	Solly	Cornwall	Sometimes well developed	,,
η	771	Gadolin	Pitkaranta	Not observed	,,
p	12 12 1	Solly	Carn Brea and Tregurtha	Well developed	,,
q	18 18 1	,,	Huel Fanny	Largely developed	,,
ψ	120 120 1	,,	Cornwall	Sometimes well developed	,,
t	313	Phillips	Bohemia	Not observed	,,
z	321	,,	Cornwall	Characteristic form	,,
d	432	Solly	Maudlin mine	Narrow and rare	,,
ν	752	Becke	Huel Nancy	,, ,,	,,
θ	13 11 2	Solly	Mary Hutchins	Rare and narrow	,,
ξ	761	Hessenberg	Wheal Harris?	Not observed?	,,
ε	871	Busz	Cornwall	,, ?	,,
v	21 14 18	Gadolin	Pitkaranta	,,	,,
u	19 16 7	,,	,,	,,	,,
u_1	742	,,	,,	,,	,,
u_2	17 13 6	,,	,,	,,	,,
u_3	942	,,	,,	,,	,,
ζ	3 11 2	,,	,,	,,	,,
k_2	?	Phillips	Cornwall	?	

The above list of forms, with the names of the authors who first observed them, will be found to differ from Becke's list, as he has ignored Phillips' work.

Miller has left out f_3, f_2 and k_2 of Phillips as forms not observed by him, though, if we accept his angles, f_3 would be the plane η (771) observed by Gadolin on crystals from Pitkaranta and Cornwall;

Phillips.	Gadolin.
$f_3\, m = 8°54'$.	$\eta\, m = 8°32'$ calculated.

f_2 might be the n (661) observed by me on many crystals;

Phillips.	Solly.
$f_2\, m = 10°40'$.	$n\, m = 9°56\frac{1}{2}'$ calculated.

From his figure 175, this should have the same indices as Miller's face i, but $i\, m = 22°49'$.

k_2 only appears in the third edition of Phillips' *Mineralogy*, and from his figure it should have the indices (28 14 3), as it lies in the zones [210, 001] and [$\bar{1}$10, 771]; but the angles $k_2\, s = 43°40'$ and $k_2\, m = 8°55'$ are not those of (28 14 3).

Some of the Cornish crystals have minute planes lying either in the zone [430, 321] or [110, 321], but they are rounded or too dull to give any reliable measurements.

The planes $v\, u\, u_1\, u_2\, u_3$ observed by Gadolin on crystals from Pitkaranta are omitted by Nordenskiöld, and I have not found them on the Cornish crystals.

Becke in his list of forms has given i (552), but in his stereographic projection has placed it at the intersection of the zones [100,321] [110,111], which would give to the plane the indices (221), a form not yet observed.

In the zone [110,111] it will be noticed that the indices of the planes of the form $\{h\, h\, k\}$ observed on Sparable Tin are (661) (12 12 1) (18 18 1) (120 120 1), that is to say h is a multiple of 6.

The face (120 120 1) is often largely developed, and extends into the prism zone, being only inclined at 30′ to that zone.

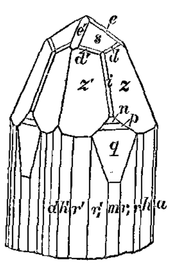

Fig. 1.

Fig. 1 exhibits a combined view of all the planes except c, ψ, ν, θ observed on crystals of Sparable Tin with a characteristic development.

Hemimorphism.

Is Cassiterite hemimorphic?

Rutile, which is isomorphous with Cassiterite, is sometimes hemimorphically developed.

The more or less transparent crystals often have a dark crystal growth in the centre, the form of which is decidedly hemimorphic. See Fig. 2.

I hope to be able to show that it is so from the other varieties of Cassiterite in a future paper.

Twins.

There is only one law, namely, the twin axis is normal to a face of the form {101}, the twin plane and face of composition being the same; the crystals are sometimes juxtaposition twins often repeated on the same face, or penetration twins consisting of two or more crystals twinned about different faces of the form {101}, or simple penetration twins. The last mode of twinning is rare: I have only observed it on crystals from the Dolcoath district, see Fig. 3; two Sparable Tin crystals having the face

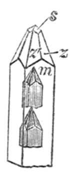

Fig. 2.

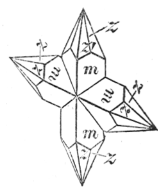

Fig. 3.

of composition the twin plane are fairly common in some mines, but Sparable Tin differs from other forms of Cassiterite in being nearly always simple.

Aggregations.

The mode of aggregation is very similar to that seen in crystals of tourmaline. A number of crystals are grown together very nearly parallel to their axis of tetragonal symmetry. This want of parallelism is perceived by the unequal angle between the *s* planes, which varies as much as 30′ in an apparently simple crystal. The prism planes also are seldom parallel.

Cleavage.

Miller gives *a* and *m*, not very distinct; *e*, traces. I have found that crystals of Sparable Tin often cleave with great facility parallel to only one of the *m* planes. This points to *m* being a face of union as well as a cleavage plane, and may be accounted for by aggregation.

Optical Characters.

Double refraction positive.

Refractive indices for red light:—

$\omega = 1{\cdot}9793$ $\qquad\qquad$ $\varepsilon = 2{\cdot}079$

Very slightly dichroic.

Hardness.

The hardness for the massive brown and fibrous variety is only 6, while that of the brilliant black crystals is 7.

Specific Gravity.

The specific gravity varies a good deal.

Black crystals from Tipuani	...	7·021	(Forbes)
Colourless crystals from Tipuani	...	6·832	,,
Honey-yellow crystals from Oruro	...	6·704	,,
Very pure crystals from Carabuco	...	6·4	,,
Black Sparable Tin from Dolcoath	...	6·92	(Solly)

Chemical Composition.

Pure Cassiterite is not known. Dr. E. Ludwig found $SnO_2 = 98°·74\%$ $SiO_2 = 0·19$ $Fe_2O_3 = 0·12$ $CaO = 0·41$ in a crystal from Schlackenwald, all other analyses show a small percentage of Ta, Ti, Mn, Si and Fe; this is probably due, as Dr. Ludwig thinks, to imperfect analysis and separation of impurities.

Elements.

The element adduced by Miller and agreeing with Phillips's angle has been repeatedly obtained from different crystals, and is therefore adopted in calculating the following angles:—

001, 101 = 33°55′2″ $a : c = 1 : 0·67247$

ah	=	26°34′	zc	=	67°35′	$zz_,$	=	20°54′	$z_,z_{,,}$	=	61°41′
ar	=	33°41′	tc	=	35°20′	$tt_,$	=	29°58′	$t_,t_{,,}$	=	21°4′
$ar_,$	=	36°52′	dc	=	59°15′	$dd_,$	=	13°58′	$d_,d_{,,}$	=	59°57′
al	=	41°11′	νc	=	70°55′	$\nu\nu_,$	=	17°53′	$\nu_,\nu_{,,}$	=	66°38′
ak	=	42°52′	θc	=	80°5′	$\theta\theta_,$	=	9°23′	$\theta_,\theta_{,,}$	=	78°2′
am	=	45°	ξc	=	80°50′	$\xi\xi_,$	=	8°21′	$\xi_,\xi_{,,}$	=	79°59′
			εc	=	82°2′	$\varepsilon\varepsilon_,$	=	9°31′	$\varepsilon_,\varepsilon_{,,}$	=	81°25′

$m\psi$	=	0°30′	md	=	31°42′	$m\varepsilon$	=	8°50′
mq	=	3°20′	mt	=	58°41′	$m\xi$	=	10°10′
mp	=	5°	$ss_,$	=	58°18′	$m\theta$	=	11°
$m\eta$	=	8°32′	$ss_{,,}$	=	87°8′	$m\nu$	=	21°15′
mn	=	9°56′	nz	=	16°32′	mz	=	25°
$m5p.$	=	11°52′	pz	=	20°34′	me	=	66°45′
mi	=	22°49′	qz	=	22°1′	ce	=	33°55′
$ms_,$	=	46°26′				cw	=	73°26′
$m\sigma$	=	57°37′				as	=	60°51′
my	=	60°17′				$at_,$	=	79°28′
mx	=	76·37′						

The following description of the various occurrences of Sparable Tin begins with the specimens of the Mary Hutchins mine in Devonshire, and moves westwards to the Land's End.

Description of Specimens.

Mary Hutchins, Plympton, Devon.

Small black to brown crystals with sub-metallic to adamantine lustre, very much massed together with crystals of quartz. The crystals are often twinned. Twin plane e (101); the z planes large; small s; well developed m; narrow a and r; n (661) well developed, often rounded. This plane is new, its position was determined by the zones [321, 340] [231, 430].

$n\,m$ found 9°30′ Calculated 9°56′

Also a very small plane θ (13 11 2) lying in zones [010, 661] and [110, 321].

$\theta\,m$ found 10°30′ Calculated 11°

Callington, Cornwall.

The British Museum has a specimen labelled Callington with small light brown crystals with iron-stained pearlspar.

Forms s z and prism planes.

Maudlin mine, Lanlivery.

The Penzance Museum possesses a specimen from this mine, and the British Museum a number of loose crystals.

The crystals on the Penzance specimen have the forms z and s equally developed, prism long, m large and rough, narrow r, a small and bright, narrow e and very narrow i. A new plane d (432) lying in zones [321, 111] [010, 231].

$d\,s$ found 16°—17° Calculated 16°54′

$d\,z_1$ found 14°—15° Calculated 14°13′

The following minerals have been found in this mine: chlorite, chalcedony, chalybite, covelline, cronstedtite, fluor, garnet, jasper, melanterite, mispickel, opal, pyrites, pyrrhotine, scheelite, and wolfram.

St. Austell District.—Polgooth mine.

Minute crystals in compact chlorite.

z and m well developed, small e; associated with calcite, compact and semi-transparent. The other minerals found in the mine are amethyst, dolomite, erythrine, pyrites, smaltine, and copper pyrites.

Gavrigan Stream Works, St. Mewan.

These crystals are described by Phillips as being about the size of a common quill and exhibiting the faces $m\,z$ large, small s e, and e small and rare.

Redruth District.—Huel Fanny.

Phillips has described these crystals. The Penzance Museum possesses a specimen. The crystals are of a light brown colour and very minute. The form q (18 18 1) is largely developed, sometimes very brilliant, giving good reflections but more often dull and rounded. s and z small, narrow i, prism well developed, m large, narrow a r_1 and h.

$q\ m$ found 3° and 3°30′	Calculated 3°20′

The crystals were found in a shallow part of a copper vein, with redruthite and wolfram, sometimes imbedded in copper pyrites and coated with chlorite and quartz.

Carn Brea mine, Illogan.

This is a new occurrence. In form and appearance the crystals resemble those from Dolcoath, but are much more modified. The faces z and m large, small s, narrow r, and very narrow r_1.

One crystal is very interesting, as a new face p (12 12 1) is largely developed, being equal in size to the z planes. The angles obtained were very good.

$z\ z_1$ found 20°54′	Calculated 20°54′
$m\ p$ found 4°58′	Calculated 5°0′

The crystals are associated with chlorite and quartz, calcite and brown oxide of iron.

Camborne District.—Dolcoath mine.

The crystals are often very fine, of a jet black colour shading into a dark brown with adamantine lustre.

The oldest specimen I have seen is one in the late Sir W. W. Smyth's collection found in 1859. Mr. J. M. Williams, of Caer-hays, Cornwall, has a specimen which was raised in 1861, and is associated with limpid fluor and chlorite.

About 1878 a number of fine specimens were raised from the 314 fathom level. Notable specimens are those belonging to Mr. C. C. Ross at Carne, the Penzance Museum, and also the British Museum.

Since 1884 some fine specimens similar in habit have been raised from the 260 fathom level. The Jermyn Street Museum and Cambridge University have specimens.

The matrix is invariably chlorite with quartz; I have never observed any tourmaline on the specimens, though Collins has found much acicular schorl in the tin stones which he described in the *Min. Journ.*, Vol. IV.

p. 11; but these specimens were taken from the levels where no Sparable Tin has been found.

The forms are simple, z large, small s, well developed prism, m large, narrow r_1. The crystals are sometimes doubly terminated, often twinned, or sometimes consisting of four twinned crystals (Fig. 3).

Huel Harriett.

(This is a Sett adjoining Dolcoath on the South.)

Mr. C. C. Ross possesses a very fine specimen from this mine. The crystals are jet black with adamantine lustre. The forms are: z large, small s, prism deeply striated, r_1 large, narrow m and a. Hessenberg has described crystals from *Wheal Harris* (probably identical with this mine), on which he observed the new face ξ (761), but he says it is always deeply striated and curved, rarely giving good reflections.

The crystals are dark brown to black, banded in colour, associated with transparent fluor spar with a matrix of chlorite.

Huel Grenville.

The British Museum has a specimen. The crystals are on quartz with white talc. Forms s and z and prism plane; colour, dark brown.

Huel Nancy, Camborne.

The only specimen I have seen from this mine is in the Jermyn Street collection. The crystals are dark brown and very brilliant. Prism planes deeply striated, having a number of narrow planes $h\ m\ r_1\ l$. The planes s and z well developed; also a narrow plane ν (752) lying in zone $m\ z$ which had been observed by Becke on a Cornish crystal, locality unknown. The crystals are on chloritic schist with quartz and chlorite.

Gwinear District.—Wheal Tremayne.

These specimens are fairly numerous. The matrix is "peach" or crystallised chlorite and quartz. The crystals are of a light brown colour with good lustre, often closely aggregated together. Forms observed: z well developed, small s, narrow i, well developed n, prism well developed, m and r. The centre of the crystals is dark, giving the form of three crystals one upon the other.

St. Agnes District.

The British Museum has a specimen from St. Agnes district on chlorite, with quartz, fluor and copper pyrites. It is probably from Huel Park. Forms s and z, narrow, with prism planes; fine lustre; colour dark brown.

Helstone.—Great Wheal Vor.

Nearly all collections contain specimens from this locality. Some are jet-black and polysynthetically grown together, others brown and often highly modified. The matrix is killas associated with chlorite, sometimes with very small limpid crystals of apatite with the forms $(10\bar{1})$ (201) (111). Blende, copper pyrites, mispickel, pyrites, and pearl spar have been found with the tin stone.

The black crystals in the Ross collection have the forms $s\ z\ r_1\ m\ l$, narrow i, polysynthetically grown together with chlorite. The brown crystals associated with apatite are very like the Tremayne crystals, having the same crystallographic and optical characters. The Jermyn Street Museum has a specimen from Metal Shaft raised in 1868.

Quartzose veinstone on massive tin stone.

Tregurtha Down mine, Marazion.

The first specimens were obtained from the shallow workings in 1864, but during 1889 well crystallised specimens have been raised from the 95 fathom level.

They resemble in habit and appearance those from Carn Brea. The forms $s\ z$ well developed, large r_1, small m, very bright p and narrow i.

The crystals are associated with quartz, chlorite, and small well developed crystals of albite, and they are often coated with impure kaolin.

Wheal Owles, St. Just.

Black isolated twinned group of crystals. Forms $s\ z$, narrow $i\ m$ and r. These crystals were given to me by Richard Boyns, Esq., of Wheal Owles.

Land's End.

Phillips describes some loose crystals "from the Land's End." Forms $s\ z$ and rounded $(h\ h\ k)$ largely developed.

It may be remarked from the above descriptions that Sparable Tin is always found in close proximity to an elvan; also that chlorite is always present, while tourmaline and topaz are nearly always absent. The only occurrence of apatite associated with Sparable Tin that I have seen is at Wheal Vor.