Cassiterite pseudomorphs from Bolivia[1].

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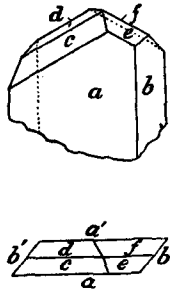
ONE of the peculiarities of Bolivian tin-ores is the frequent occurrence of cindery and cellular masses of cassiterite, which is presumably of secondary origin. But, apart from impressions[2] of quartz crystals, definite crystal-forms are rarely shown by this pseudomorphous cassiterite.

The pseudomorphs to be now described are from the Tres Cruces district[3], and were collected by my son, Mr. A. W. Pearce. The crystallographic determinations have been made by Mr. L. J. Spencer, and the specimens examined by him have been presented to the British Museum. The material consists of cavernous masses of dark brown, finely crystalline and granular cassiterite, associated with which is a pale yellow, ochreous substance. Some of the smaller cavities are bounded by plane surfaces, as if crystals had been dissolved out; while larger cavities are lined with pseudomorphous crystals. These are tabular in habit, and measure 2 to 4 mm. across by 1 mm. in thickness. Their surfaces have a drusy aspect, due to the crystalline development of the minute granules of cassiterite of which the material consists. Some of the pseudo-



Pseudomorph of cassiterite after an unknown mineral from Bolivia.

[1] A preliminary account has appeared under the title: 'Notes on the occurrence of pseudomorphs of oxide of tin after some unknown mineral from Bolivia,' by R. Pearce: Trans. R. Geol. Soc. Cornwall, 1906, vol. xiii, pp. 150-2.

[2] A. W. Stelzner (Zeits. Deutsch. geol. Ges., 1897, vol. xlix, p. 137) mentions cassiterite from Tasna with impressions of hexagonal prisms with basal plane, suggesting that, in this case, the original mineral was apatite. On p. 134 he mentions tin-ore from Chorolque with impressions of an octahedral (?) mineral. M. Roberts (Trans. Inst. Mining and Metallurgy, 1902-3, vol. xii, p. 404) also records the presence at Chorolque of sponge-like lumps of almost pure cassiterite with impressions of crystals. Finally, I. Domeyko (Bull. Soc. Min. France, 1882, vol. v, p. 299) makes mention of impressions of apatite (?) crystals in massive cassiterite from Bolivia.

[3] Tres Cruces (Three Crosses) or, in the Indian language, Quimza Cruz, is a mountain in the province of Inquisivi, department of La Paz, and is situated about 85 miles NNW. of Oruro.

crystals are hollow, and encrusted inside with bright crystal-faces of cassiterite.

Only indistinct and blurred images are reflected from the faces, and even with the δ-eyepiece of the Fuess goniometer only approximate measurements could be obtained. Rather better results were obtained by thinly coating the pseudomorphs with copal-varnish. The angles measured on four crystals are given under I, II, III, and IV respectively.

	I.	II.	III.	IV.
ac	31°	31⅓°	33°	30¾°
ad	80°	78¾°	78¼°	79°
ae	38°	38⅓°	—	—
af	101½°	101⅔°	102°	96°
ag	145°–149°	—	148°	150°
ah	24°–32°	—	—	—
ab	34°–40°	45°	45°	44½°

The plane angles on the face *a* were determined under the microscope to be approximately 120° on each of the four crystals; i. e. the angles between the zones $[acd]:[aef]$ and between $[aef]:[ab]=60°$.

Crystal I is represented in the accompanying figure; *g* is a narrow face on the edge *fa'*, and *h* is a rounded surface between *a* and *b*. Crystals II, III, and IV differ from no. I like the opposite ends of a monoclinic crystal, the faces *b*, *e*, and *f* being on the left-hand side of *a*. From the above table of angles it will be noticed that the angles in the zone $[acd]$ are supplementary to those in the zone $[afg]$, the measurements from *a* in one zone being approximately the same as those from the parallel face *a'* in the other zone: this proves the presence of a dyad axis of symmetry. The crystals are therefore monoclinic, with the plane of symmetry perpendicular to the faces *a* and *b*. They are tabular parallel to what may be taken as the basal pinacoid (*a*), and are attached at one or other end of the dyad axis.

In having plane angles of 120° on the basal plane, the crystals simulate rhombohedral symmetry, like the micas, polybasite and pearceite, xanthoconite, &c. The interfacial angles of the pseudo-crystals do not, however, correspond with the angles of any of these minerals. In general habit the pseudomorphs are not unlike axinite, but here again there is no correspondence between the angles. It must therefore remain doubtful what was the original mineral of these pseudomorphs.

Another suggestion as to what might have been the original mineral

is given by the following partial analysis of the yellow ochreous material associated with the pseudomorphs:—

Fe_2O_3	28·24 per cent.
PbO	17·67
SO_3	16·70
As_2O_5	4·05
Insoluble (mainly cassiterite)	7·0

At 200° C. no loss.

The presence of lead suggests that the pseudomorphs may have originated by the alteration of a sulphostannate of lead. The occurrence of sulphostannates, viz. stannite, canfieldite, teallite, franckeite, cylindrite, and plumbostannite, is a peculiar feature of the silver-tin lodes of Bolivia; and, with the exception of stannite, none of them are known to occur outside this region. Although there is no agreement between the crystalline forms of these minerals and the pseudomorphs described above, it does not seem at all unlikely that some, at any rate, of the pseudomorphous cassiterite of Bolivia may have been formed by the alteration of sulphostannates.