On a Specimen of Proustite containing Antimony.

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THE specimen which is the subject of the present note is a magnificent piece of Proustite from Chañarcillo, Chili, which has been recently acquired for the British Museum. It is a mass of lustrous crystals, measuring about 3 inches by 2½ inches, and nearly 3 inches in height.

The specimen has a peculiar cockscomb appearance, due partly to the habit of the crystals and partly to the way in which they are grouped; the lower part consists of Proustite, interpenetrated by a little minutely crystalline white Calcite, which on one side of the specimen extends partly over the crystals in the form of darker coloured acute rhombohedra.

The larger Proustite crystals have the aspect of rough triangular pyramids, with blunt apices and a ragged outline due to the smaller crystals which protrude along their edges.

The forms present are *e*, $\{110\}$, $-\frac{1}{2}R$; *s*, $\{11\bar{1}\}$, $-2R$; *v*, $\{20\bar{1}\}$, $R3$; *P*, $\{32\bar{3}\}$, $-2R\frac{3}{2}$.

In the larger crystals the faces *s* are prominent and form the blunt apex, while the lower parts are drusy and uneven and composed of the forms *P* and *v*, with curved faces of steep scalenohedra and prisms; on these crystals the form *e* only makes its appearance as linear planes, which traverse the faces of *s* and give rise to step-like projections upon them.

The smaller crystals, on the other hand, have the usual scalenohedral habit due to the predominance of *v* and are terminated by *e*, below which is the form *s* in oscillatory combination with *e* and truncating the acute edges of the scalenohedron *v*.

Intermediate between these two habits are some on which *s* and *P* are the predominating forms, although the terminations consist of *e* faces in superposed lamellæ.

The faces of *e*, *s*, *v* and *P* are all very bright; *v* is striated parallel to the lateral edges of the primary rhombohedron $\{100\}$ *R*; *P* has curved striæ nearly parallel to its intersections with *s*; the striæ upon *e* parallel to *s* and *e*, and those upon *s* parallel to *e*, are due to oscillatory combinations; the faces themselves are smooth.

The smaller crystals are invariably grouped upon the larger in twin position according to the two laws, (1) twin planes {211} $\frac{1}{4}R$: (2) twin planes {100} R. There are no doubly terminated crystals.

Except for the variations in habit the whole specimen appears to be homogeneous throughout, and has the aspect of ordinary Proustite.

Measurements (Miers).—The crystals best suited for measurements are those of scalenohedral habit, in which both the rhombohedra *e* and *s* have perfectly smooth lustrous faces. The angle between the *e* faces must be used to determine the exact form in preference to any other angle, since minute differences in the element of a rhombohedral crystal will make themselves more evident in the angles of flat rhombohedra and faces near the summit of the crystal than among such as lie near the prism zone, where the angular values are the same for all such crystals.

Three of these crystals (*A B C*) were measured with the following results, in which e_1 e_2 e_3 denote the three faces of $-\frac{1}{2}R$ which terminate each crystal.

		A	B	C
e_1 e_2	...	42°44′53″	42°45′50″	42°45′43″
e_2 e_3	...	42°45′57″	42°45′50″	42°46′23″
e_3 e_1	...	42°46′50″	42°46′33″	42°46′27″
Mean	...	42°45′53″	42°46′4″	42°46′11″

Final mean ee=42°46′3″

A fourth crystal, upon which the faces *s* were particularly well developed, gave the following values:—

s_1 s_2 = 99°21′13″
s_2 s_3 = 99°21′43″
s_3 s_1 = 99°21′50″
Mean ss = 99°21′35″ observed.
99°21′50″ calculated from ee.

In all the above measurements each angle is the mean of three observations, and may be regarded as reliable to about 15″.

The angle of the primary rhombohedron R {100}, calculated from the value ee = 42°43′3″, is 72°12′4″.

It is clear then that the rhombohedron angle of these crystals may be taken as 72°12′ within very close limits.

Analyses (Prior).—Two analyses were made: in analysis A material taken from the underside of the specimen was used, while analysis B was made on the four crystals actually measured, together with other small and

perfect crystals of precisely the same appearance all taken from the upper part of the specimen.

The material used in analysis A, although taken from the underside of the specimen, was crystalline, and when examined for adhering and enclosed impurities under the lens and during the process of crushing, seemed to be perfectly homogeneous and to all appearance true Proustite.

In both analyses the mineral was decomposed in a current of chlorine: the volatile chlorides of sulphur, arsenic and antimony were absorbed by a mixture of hydrochloric and tartaric acids, while the silver was left in the residue as chloride. The solution containing the arsenic and antimony was evaporated down to a small bulk with constant addition of potassium chlorate, and was then treated for the separation of the arsenic and antimony.

In analysis A this separation was effected by Fischer's method as modified by Hufschmidt, which consists in reducing the arsenic to arsenious acid by means of a ferrous salt, and then distilling off the arsenic trichloride in a current of hydrochloric acid gas. The arsenic in the distillate was precipitated by sulphuretted hydrogen as trisulphide, which was washed with water, alcohol and carbon bisulphide, dried and weighed. The antimony was also precipitated by sulphuretted hydrogen, and the resulting trisulphide, after being washed with water and dried, was heated to $260° - 270°$ in a current of carbonic acid.

In analysis B the separation of the arsenic and antimony was effected by magnesia mixture. In order to free from magnesium tartrate, the precipitate of ammonium magnesium arsenate was dissolved in hydrochloric acid and reprecipitated with ammonia and a little magnesia mixture: finally it was converted into magnesium pyroarsenate. The antimony in the filtrate was precipitated in cold solution by sulphuretted hydrogen as pentasulphide, which was washed with water, alcohol and carbon-bisulphide, dried and weighed.

In both analyses the sulphur was determined in a separate portion of the powdered material by fusion with potassium nitrate and sodium carbonate, and precipitation of the sulphate with barium chloride: the resulting barium sulphate, after being weighed, was warmed with dilute hydrochloric acid according to the method of purification given in Fresenius, *Quant. Anal.*, §132.

Below are the results of the analyses, together with—

α theoretical composition of true Proustite.

β ,, ,, ,, Pyrargyrite.

A′ theoretical composition of a mixture of 83·64 p.c. of Proustite and 16·36 p.c. of Pyrargyrite.

B′ ,, ,, of a mixture of 93·82 p.c. of Proustite and 6·18 p.c. of Pyrargyrite.

	A	A′	B	B′	α	β
Silver ...	64·50	64·50	65·06	65·06	65·40	59·90
Arsenic...	12·54	12·69	13·85	14·23	15·17	—
Antimony	3·62	3·65	1·41	1·38	—	22·31
Sulphur	19·09	19·16	19·64	19·33	19·43	17·79
	99·75	100·00	99·96	100·00	100·00	100·00

Weight of material used in analysis A { For determination of Ag, Sb and As ... 0·7158 gr. / For determination of S 0·4924 ,,

Weight of material used in analysis B { For determination of Ag, Sb and As ... 0·9102 gr. / For determination of S 0·3834 ,,

Specific gravity of the crystals used in analysis B = 5·638.[1]

Results.—Our results may be briefly expressed as follows :—

Rhombohedron angle.	Percentage of As.	Percentage of Sb.	Spec. Grav.
72°12′	13·85	1·41	5·64

The only analyses hitherto made together with crystallographic measurements are those recently published by Rethwisch (Neues Jahrbuch, Beilage Band IV. (1886) p. 31). His results expressed in the same way are :—

	Rhombohedron angle.	Percentage of As.	Percentage of Sb.	Spec. Grav.
Proustite	72°10′10″	15·03	—	5·5553
	71°22′27″	8·01	18·63	5·716
	71°21′30″	2·62	18·58	5·754
Pyrargyite	71°12′58″[2]	—	22·36	5·871

[1] The above value is the mean of numerous determinations taken with all possible precautions on 2·5 grams of material by means of the specific gravity flask. The results varied considerably, the limits being 5·617—5·676. In our opinion the value of the specific gravity determined with the flask from such a small weight of material cannot be relied upon beyond the first place of decimals.

[2] This angle is liable to the objection indicated above, since it is determined from the measurement of the scalenohedron v, $R3$, $\{20\bar{1}\}$; the above value is calculated from the angle $vv = 35°10'47''$. Now an angle of 35°11′51″ would correspond to the rhombohedron angle 71°22′0″, and the measurements were certainly not reliable within one minute.

We have found the rhombohedron angle on some crystals of Proustite from Chañarcillo which are free from any trace of antimony to be 72°11′50″; that is to say, within the errors of observation, absolutely identical with the angle of Proustite containing more than 1 per cent. of antimony; and it will be seen that our crystals have no place in the series which Rethwisch professes to have established.

It may be remarked that Rethwisch does not say whether the material analysed by him consisted of the crystals actually measured; the present analyses show that this is a matter of great importance, since in our specimen, which has all the appearance of being homogeneous, the crystals measured contain 1 per cent., while another part contains 3 per cent. of antimony.

Conclusions.—The analyses prove that the antimony is very unevenly distributed throughout the specimen, and is probably present in smaller quantities in the better crystallised parts; it is even conceivable that the surface of the crystals may contain no antimony; but, however that may be, it is certain that *in the crystals here analysed the presence of more than 1 per cent. of antimony has no appreciable effect upon the rhombohedron angle.*

Whether this is always the case, or whether there are varieties intermediate in form as well as in composition between true Proustite and Pyrargyrite, can only be decided by the examination of a large number of specimens, a task upon which we are now engaged, the results of which, it is hoped, will be shortly published.