Communications from the Oxford Mineralogical Laboratory.

Mineralogical Notes: Zinc-Blende; Galena; Pyrites; Lead.

By Prof. H. A. Miers, M.A., F.R.S.,

With Analyses by E. G. J. Hartley, B.A.

[Read Nov. 15th, 1898.]

1. *Zinc Blende with Metallic Lustre.*

A SPECIMEN in the University Museum consists of black tetrahedral blende, exhibiting perfect *metallic* lustre; indeed, the brilliant steely cleavage surfaces of the mineral and its metallic tarnish raised a doubt whether it could really be blende; but in very thin fragments viewed by transmitted light it is seen to be brown in colour.

The crystals are bright tetrahedra, a combination of {111} {1$\bar{1}$1} {110} {211} {2$\bar{1}$1}, and are accompanied by chalcopyrite, quartz and kaolin, on a matrix of chloritic vein-quartz containing iron pyrites. The locality of the specimen is not known, but it may well be Cornish.

Mr. E. G. J. Hartley analysed the mineral at my request with the object of ascertaining whether the metallic appearance is due to any unusual constituent. He obtained the following numbers:—

				Calculated for 5ZnS.FeS.
Zn	...	56·83	...	56·72
Fe	...	9·29	...	9·77
Cu	...	·07		
Mn	...	trace		
S	...	33·42	...	33·51
		99·61		100·00

Thus the mineral is a ferriferous zinc-blende corresponding almost exactly to the formula 5ZnS.FeS. The specific gravity estimated on 1·1314 gram is about 3·8.

The lustre is so unlike that of ordinary blende, that the question arises whether the union of ZnS and FeS in *molecular* proportions has not given rise to a mineral having properties distinct from those of a mere isomorphous mixture of the two sulphides.

2. *Zinciferous Galena.*

A small specimen of galena in the University Museum consists of brilliant cubes of galena disposed on quartz and associated with a little iron pyrites. The corners of the cubes are truncated by faces of the octahedron, which exhibit a very marked laminar structure.

The following analysis by Mr. Hartley shows that the mineral contains nearly 5 per cent. of zinc, although no traces of zinc-blende are observed when the crystals are finely crushed.

				Calculated for 4PbS.ZnS.
Pb	...	78·47	...	78·63
Zn	...	4·97	...	6·17
Fe	...	·67		
S	...	15·07	...	15·20
		99·18		100·00

The mineral therefore corresponds to the formula 4PbS.(Zn,Fe)S, in which, as in the preceding mineral, the proportions are molecular.

Many examples of zinciferous galena have been previously recorded, but in none of them has the substance been in such distinct crystals as in the present instance, and there is no certainty that they were not mixtures of galena and blende.

The present specimen is stated to be from Bingham, Salt Lake, Utah.

Through the kindness of Professor J. E. Talmage I have received a specimen of the massive galena from the same locality. This specimen contains no zinc, but only a small proportion of iron.

3. *A tetartohedral (?) crystal of Pyrites.*

A specimen of pyrites which has the appearance of the well known specimens from Gilpin Co., Colorado, and is probably from that locality, presents the peculiarity shown diagrammatically in Fig. 1.

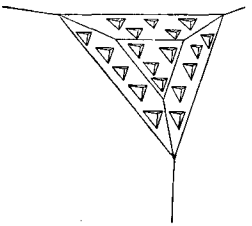

FIG. 1.

The crystals are brilliant combinations of cube with the pentagonal dodecahedron {210}, and are associated with a little galena and blende. The corners of the cubes are rough, and present at first sight the aspect of a rounded etched surface. Closer inspection shows that the cube corners are really replaced by brilliant faces of {111} and {211}, but that these faces are penetrated by a number of parallel and minute sub-individuals whose corners project so as to constitute a drusy surface. These latter corners are simply formed by cube faces without a trace of the octahedron or of {211}. They are clearly not etched planes, nor are they merely small individuals deposited on the large cubes; for they emerge from the latter, and near the edges they can be traced continuously into it.

I would suggest that these are completely interpenetrant twinned crystals of tetartohedral habit in which an unmodified cube corner of one individual protrudes through each tetrahedron face of its companion. They are in that case analogous to the twins of sodium chlorate, or to those growths of ullmannite which I have previously described as evidence of the tetartohedral nature of that member of the pyrites group (*Min. Mag.* 1891, IX. 211).

Further evidence of twinning is afforded by very minute facets barely discernible on the edges of the small projecting cubes; these are faces of {120} supplementary to those on the adjacent part of the large crystal. The same twinning probably accounts for the presence of the two supplementary forms {210} {120} on the crystals from the same locality described by E. F. Ayres (*American Journ. Sci.* 1889, 37, 236).

4. *On some Crystal Forms of Lead: a study in crystal-measurement.*

[Read June 21st, 1898.]

WHEN a piece of cast lead is subjected to the action of dilute nitric acid, it becomes etched in such a way that the surface is divided into drusy patches, each of which has a silky appearance, and can be distinguished from its neighbours when a bright light falls upon it, since numerous points on each patch reflect light together.

This indicates that each patch belongs to one crystalline individual, and the etching proves the whole mass to have a coarsely crystalline structure like a meteoric iron or a nugget of gold. In the specimen to which this note more particularly refers, the patches (*i.e.* the constituent crystal grains) are about 3 mm. in diameter.

Examined under the microscope, the drusy surface is seen to consist of minute crystals, having in some patches a rectangular, and in others a hexagonal outline. Sometimes crystals of hexagonal contour have three

ribs radiating from the centre to the corners of the hexagon, suggestive of a skeletal growth.

In some of the patches the drusy surface is seen to consist of numbers of microscopic, but very perfect and brilliant crystals, which are ranged in parallel position. Some of these present the appearance of cubes or square prisms, but others have the aspect of hexagonal prisms terminated by pyramidal facets. The latter are so perfect that at first sight one can hardly believe them to be crystals of lead, and their appearance is so different from that of the crystals of square outline that they might well be supposed to be a hexagonal modification. On the other hand, it seems more probable that the crystalline structure of the lead is cubic throughout, and that the hexagonal outlines are due to the etched surface being nearly perpendicular to a cube diagonal, while the square outlines belong to those parts which are nearly perpendicular to a cube axis. According to this view each patch is a single crystal grain of lead on which "sub-individuals" have been developed by the action of the solvent, their habit being due to the orientation of the parent crystal and the direction in which it is intersected by the surface.

The hexagonal prisms sometimes project, either perpendicularly or obliquely, from what appears to be clearly a rough etched surface of the lead, although they are themselves perfectly smooth and bright; and Mr. A. Dick, from whom I received the specimen to which this description particularly applies, is of opinion that these crystals have not been developed by the mere etching away of surrounding material, but are deposited as lead crystals from the solvent. They certainly present a very different appearance from some negative cubes which have evidently been etched into the lead, and from some cubic outlines which remain between these negative crystals. According to this view the minute sub-individuals deposited on each patch become orientated in parallel position by the crystal on which they are laid down.

However this may be, the hexagonal prisms are crystals of the most perfect nature, with lustrous facets, and their true symmetry can only be determined by measurement of their angles.

The crystals are far too small, and in any case too soft, to be isolated and measured in the ordinary way; and indeed it seemed hopeless to attempt any goniometrical measurement of such material,

However, by taking advantage of the fact that each patch consists of a considerable number of *parallel* crystals, and by using the two-circle or theodolite-goniometer, I have been able to measure the crystals with complete success and to identify their faces.

A small etched button of the lead which I received from Mr. Dick, having been mounted on the theodolite goniometer, it was possible to make a series of measurements, taking account only of the light reflected from one of the small drusy patches. By reason of the large number of parallel facets yielding each reflection, it was easy to obtain an image from faces which were almost invisible; and although the images, as is usually the case with those reflected by a number of parallel crystals, were not perfectly sharp, they were quite reliable to three or four minutes.

Another series of measurements could then be made upon another of the drusy patches and compared with the first. The lead button can be adjusted to any convenient position at the beginning of each such series.

As a result of the measurements it was found that the hexagonal prisms have the form of Fig. 3, and that they are really a cubic combination similar to those represented in Fig. 2, but elongated along the ditrigonal axis.

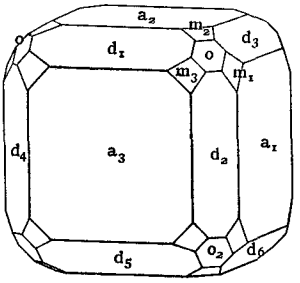

FIG. 2.

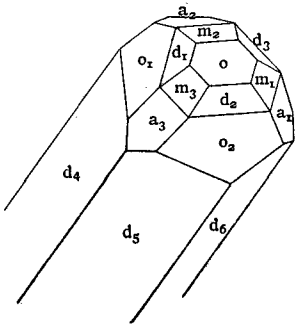

FIG. 3.

The following are the readings obtained from a single patch, A being the reading on the horizontal circle, and B the reading on the vertical circle for each face; the basal plane *o* having been adjusted perpendicular to the axis of the vertical circle, so that the image from *o* remains centred as the vertical circle B is rotated.

		A.		B.
o	...	161°11	...	...
a_1	...	286 23	...	30°35′
m_1	...	131 36	...	30 35
d_1	...	196 24	...	210 58
o_1	...	231 40	...	210 30
a_2	...	215 56	...	270 31
m_2	...	190 43	...	270 38
d_2	...	125 58	...	90 38
o_2	...	90 39	...	90 38
a_3	...	106 29	...	150 36
m_3	...	131 42	...	150 49
d_3		196 25	...	330 13
d_4	...	71 6	...	180 35
d_5	...	71 0	...	120 35

In the following table the readings are reduced to 0°0′ (A) for the face o, and to 0°0′ (B) for the zone $a\ m\ o$.

		A.		B.
o	...	0° 0′	...	...
a_1	...	54 48	...	0° 5′
m_1	...	29 45	...	0 5
d_1	...	35 13	...	0 28 + 180°
o_1	...	70 29	...	0 0 + 180
a_2	...	54 45	...	60 1 + 180
m_2	...	29 32	...	60 8 + 180
d_2	...	35 13	...	60 8
o_2	...	70 32	...	60 8
a_3	.	55 10	...	120 6
m_3	...	29 39	...	120 19
d_3	...	35 14	...	119 43 + 180
d_4	...	90 5	...	150 5
d_5	...	90 11	...	90 5

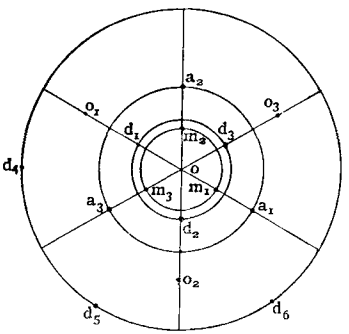

FIG. 4.

From these numbers it may be seen that the faces occupy the position shown in the accompanying stereographic projection, Fig. 4, and belong to the following forms :—

$$a\{100\},\ o\{111\},\ d\{110\},\ n\{311\},$$

for which the theoretical readings on circle A are

$$54°44',\ 70°31',\ 35°16',\ 29°30'.$$

The above observations conclusively establish the cubic nature of these apparently hexagonal crystals of lead.

This communication shows how it is possible under certain conditions to obtain accurate measurements from faces almost too small to be visible, and belonging to a crystal which cannot be isolated. Such measurements can only be made by means of the theodolite goniometer.

The method could possibly be applied to other cases of parallel crystals forming a drusy surface, such as those etched upon meteorites and gold nuggets.