	I.	II.	Mean.
Silver . . .	=92·454		
Mercury . .	= 7·022	7·369	7·195
Iron oxide . .	= 0·033		
Lime . . .	= 0·055		
Silver chloride	= 0·088		
Insol. part . .	= 1·328		
	100·980		

Calculated.

$Ag_{12}Hg$.	
Silver	=92·84
Mercury	= 7·16
	100·00

This is an amalgam having the formula $Ag_{12}Hg$, and is new to science. These two amalgams are the only ones which I have examined; and they both yield ratios which appear to indicate the existence of actual chemical compounds.

Travellers journeying through the Straits of Magellan stop at Punta Arenas. At this station the natives offer for sale washed gold in laminated grains and scales against its weight in sovereigns. A specimen of this gold, presented to the Mineral Department by my friend Mr. C. L. Claude, of Valparaiso, proved to have the following composition:—

Gold	=91·760
Silver	= 7·466
Copper	= 0·248
Iron oxide . . .	= 1·224
	100·698

XVIII. *Crystallographic Notes.* *By* L. Fletcher, *M.A.*, *Fellow of University College, Oxford, Assistant in the Mineralogical Department, British Museum.*

[Plate V.]

I. *Copper.*

The following forms have already been described as occurring on native copper:—

(100) (110) (111) (210) (520) (310) (311) (412) (18 10 5).

The forms (3 1 1), (4 1 2), (1 8 10 5) have not been observed on any of the crystals in the collection of the British Museum. The form (3 1 1) was described by Rose* as occurring on some rude crystals from Nijni-Tagilsk: the crystals were always twinned, and their faces dull and not very plane. Schrauf† has observed the same form on some artificial crystals of this metal. The same mineralogist‡ describes crystals from Wallaroo in South Australia which exhibit the hemihedral form $\pi(2\,1\,0)$. Zerrenner§ has observed an imperfect development of this hemihedral form on a crystal from Bolivia, whilst a second crystal on the same specimen presented the combination of (2 1 0) with slight (4 1 2) and (1 1 0). The form (1 8 10 5) was observed by Vom Rath ‖ on crystals of a specimen from Lake Superior. The form (3 1 0) was observed (1877) by Jeremejew¶ on some crystals from Syryanow in the Altai district; and he incidentally remarks that, of all the native metals or alloys, it has only been met with on amalgam. We shall see later that it also occurs on both native silver and native gold.

To the list of observed forms must now be added

(4 1 0) (5 3 0) (7 3 0) (7 4 0) (4 1 1) (5 1 1) (5 3 1).

The form (3 1 0) has also been observed on crystals from other localities than the above.

Where not stated to the contrary, the instrument employed for the determination of the angles was a reflecting goniometer. As images often could not be obtained, the position of a face was in general determined by its maximum illumination. For more accurate determination of the angles, in some cases the faces were slightly oiled, while in others thin reflecting plates were fixed upon them. A few of the observed and calculated angles are given in each instance.

In the case of some of the above new forms the indices have been marked on the crystals for some years: they are confirmed by the measurements given below.

A crystal removed from a specimen from Lake Superior

* *Reise nach dem Ural*, von G. Rose, vol. i. p. 313 (1837).

† Tschermak, *Mineral. Mittheil.* 1873, p. 290.

‡ *Ibid.* 1872, p. 53. § *Ibid.* 1874, p. 94.

‖ Groth's *Zeitschrift für Krystallographie*, 1878, p. 169.

¶ *Ibid.* 1877, p. 398.

presented a symmetrical development of the combination (1 0 0) (1 1 0) (3 1 0):—

		Observed.	Calculated.
3 1 0 . 3 $\bar{1}$ 0	. .	36° 30′–37° 20′	36° 52′
3 1 0 . 1 1 0	. .	25° 15′	26° 34′

A specimen, from the Bank Mines near Ekaterinburg is a fine ramose mass of crystals, in a matrix of grey crystalline limestone. Some of the crystals present the combination (1 1 1) (1 0 0) (1 1 0) (3 1 0), much shortened along a trigonal axis:—

		Observed.	Calculated.
		° ′	° ′
1 1 0 . 3 1 0	. .	26 5	26 34
1 0 0 . 3 1 0	. .	18 50	18 26
1 0 1 . 0 1 3	. .	47 40	47 52

Other crystals on this specimen have quite a different habit, and present a symmetrical development of the combination (1 0 0) (1 1 0) (1 1 1) (4 1 1), the faces of the cube being predominant, as shown in fig. 1:—

		Observed.	Calculated.
		° ′	° ′
1 1 1 . 4 1 1	. .	34 45	35 16
1 1 0 . 4 1 1	. .	33 5	33 33

Several specimens from Lake Superior present forms previously unobserved. The first we shall mention is a parallel aggregation of cubes: on some of the crystals the faces of a tetrakishexahedron are developed. The indices of this form were found to be (4 1 0):—

		Observed.	Calculated.
1 0 0 . 4 1 0	. .	14° 1′	14° 2′

In this case images were obtained.

The second is a fine tetrakishexahedron, almost an inch in diameter and very symmetrically developed; the form proved to be (5 3 0):—

		Observed.	Calculated.
		° ′	° ′
5 3 0 · 5 $\bar{3}$ 0	. .	62 45	61 56
5 3 0 . 3 5 0	. .	27 15	28 4
3 5 0 . 0 5 3	. .	42 45	42 40

Blurred images were obtained with this crystal.

The same simple form is shown by a crystal projecting from some massive copper and associated with laumontite and calcite. The angles were measured with the hand-goniometer:—

	Observed.	Calculated.
$530.5\bar{3}0$ . . .	60°	61° 56′
350.053 . . .	44	42 40

The same form (5 3 0), but in combination with the cube, is shown by a fourth specimen from Lake Superior. The angles were measured with the hand-goniometer:—

	Observed.	Calculated.
$530.5\bar{3}0$ . .	$63\frac{1}{2}$°	61° 56′
530.350 . .	27	28 4

A fifth specimen, from the same locality, presents some very sharply defined crystals associated with massive copper, native silver, and calcite. The crystals present a symmetrical development of the combination (5 3 0) (5 3 1) (1 0 0), as shown in fig. 2. The angles were measured with the hand-goniometer:—

	Observed.	Calculated.
035.053 . . .	$27\frac{1}{2}$°	28° 4′
$351.35\bar{1}$ . . .	$19\frac{3}{4}$	19 28
351.350 . . .	$10\frac{1}{4}$	9 44

The remaining specimens to be mentioned are all spinel-like twins, and are much shortened along that trigonal axis which is perpendicular to the twin-plane.

A specimen from Lake Superior presents some large crystals drused with quartz. One of the smaller and very sharply defined crystals was shown by help of the reflecting goniometer to be a spinel-like twin of the combination (1 0 0) (1 1 0) (7 3 0).

	Observed.	Calculated.
073.037 . .	43° 14′	43° 36′
037.001 . .	23 5	23 12
037.307 . .	32 12 } 32 17 }	32 21

The remaining specimens are from the Relistian Mines, Cornwall.

The first specimen is a dendritic aggregation of crystals, mostly indistinct. One crystal, however, from which good measurements could be obtained, proved to be a spinel-like twin of the combination (1 1 1) (7 4 0), having the habit shown in fig. 3; in which the lines formed by the recurrence of dots and dashes denote reentrant edges :—

	Observed.	Calculated.
740.$\bar{7}$40 . .	60° 2′	59° 30′
740.470 . .	31 0	30 30
111.740 . .	38 3	38 1½
740.704 . .	41 22 } 41 52 }	41 4

It will be seen later that this form (7 4 0) is also presented by crystals of native silver from Chili.

The second and third specimens present crystals which are spinel-like twins of the combination (1 1 1) (2 1 0) (5 1 1) and have the habit shown in fig. 4. The faces of the form (5 1 1) lying in any octant are always striated perpendicularly, or approximately so, to the edges they form with the octahedron-face in the same octant:—

	Observed.	Calculated.
111.210 . .	39° 37′ } 39 53 }	39° 14′
201.210 . .	36 9 } 36 18 }	36 52
111.511 . .	38 35	38 56
$\bar{1}$11.115 . .	55 about	56 15

The fourth and fifth specimens present crystals very similar to the last, having the habit shown in fig. 5. The observed angles, however, accord better with those of the combinations (1 1 1) (5 2 0) (5 1 1):—

		Observed.	Calculated.
Fourth specimen	111.151	38° 50′	38° 56′
	$\bar{1}$11.151	57 28	56 15
Fifth specimen	520.502	29 30	30 27
	520.111	41 30	41 22

whilst on the latter specimen four different angles from an octahedron-face to a face of the form (5 1 1) in the same octant gave measurements 37° 0′, 38° 40′, 39° 10′, 39° 15′ respectively, the calculated angle being 38° 56′.

II. *Silver.*

The following forms have already been described as occurring on native silver:—

(1 0 0) (1 1 0) (1 1 1) (2 1 0) (5 2 0) (4 1 0) (2 1 1) (3 1 1).

The form (7 5 1) has been observed by Dauber* on an artificial crystal. The forms (2 1 0), (5 2 0), (4 1 0), (2 1 1) have not been observed on any of the crystals in this collection. The form (2 1 1) is given by Groth in his Catalogue of the Strassburg collection, but is possibly a misprint for (3 1 1): (5 2 0) was observed by Sadebeck †; the forms (2 1 0) (4 1 0) have been confirmed by the same crystallographer. To the list of observed forms must now be added (3 1 0) and (7 4 0).

A specimen, originally labelled "Arquerite, Chili," but from which analysis proves the entire absence of mercury, consists of a group of beautiful crystals of native silver associated with cerargyrite and crystallized calcite in a limestone cemented by talc. A crystal presenting the habit shown in fig. 6, was found to be a spinel-like twin of the combination (1 0 0) (3 1 0) (7 4 0) shortened along that trigonal axis which is at right angles to the twin-plane. The following are some of the angles obtained:—

	Observed.	Calculated.
1 0 0 . 3 1 0 . .	18° 24′ : 18° 33′ : 18° 16′	18° 26′
	19° 27′ : 18° 51′	
7 4 0 . 4 7 0 . .	29° 59′ : 30° 14′	30° 30′
7 4 0 . 3 1 0 . .	11° 48′ : 11° 30′ : 11° 0′	11° 19′
3 0 1 . 3 1 0 . .	26° 4′	25° 50½
0 7 4 . 3 0 1 . .	81° 10′ about	80° 58′

We have seen above that both these new forms also occur on native copper.

III. *Gold.*

The forms already described as occurring on native gold are:—

(1 0 0) (1 1 0) (1 1 1) (2 1 0) (4 1 0) (2 1 1)
(3 1 1) (8 1 1) (4 2 1) (19 11 1).

The form (3 2 1) has been observed by Lang‡ on an artificial

* *Annalen der Chemie und Pharmacie*, vol. lvii. 1851.

† Tschermak, *Mineral. Mittheil.* 1878, p. 293.

‡ Philosophical Magazine, 1863, vol. xxv. p. 435.

crystal. The forms (4 1 0) (8 1 1) were first observed by Lewis*. The forms (2 1 1), (4 2 1), (19 11 1)† have not been observed on any crystals in this collection. To the list of observed forms must now be added (3 1 0).

A specimen from Beresowsk in the Urals presents the habit shown in fig. 7, and proves to be a spinel-like twin of the combination (3 1 0) (1 0 0) having no reentrant angles. Eight different angles between a cube-face and an adjacent face of the tetrakishexahedron gave values varying between 16° and 19°, and having 18° for mean, the calculated angle being 18° 26′; 3 0 1 . 3 1 0, observed $24\frac{3}{4}°$, calculated $25° 50\frac{1}{2}′$.

Some crystal-sprays from various localities in the Philippines proved to be composed of small crystals presenting the known form (3 1 1) and occasionally twinned about the octahedron-plane.

IV. *Bismuth.*

The crystals of this mineral are generally very indistinct. The following forms are given by Miller:—(1 1 1) cleavage, (0 1 1) cleavage, (1 0 0) : $(\bar{1}\,1\,1)$ cleavage; and it is stated that the occurring combinations are (1 1 1) $(\bar{1}\,1\,1)$, and (1 1 1) (0 1 1) $(\bar{1}\,1\,1)$. Dana gives the following forms:—(1 1 1) cleavage, $(5\,\bar{1}\,\bar{1})$ cleavage, (1 0 0) $(\bar{1}\,1\,1)$ cleavage, $(\bar{1}\,2\,2)$: perhaps 2R $(5\,\bar{1}\,\bar{1})$ is a misprint for $-\frac{1}{2}$R $(0\,1\,\bar{1})$. The mineral crystallizes from fusion in the form (1 0 0).

In this collection crystals from Wittichen and Johanngeorgenstadt presented one of the combinations mentioned by Miller, namely (1 1 1) $(\bar{1}\,1\,1)$.

To the list of observed forms must now be added the form $(\bar{1}\,3\,3)$. A specimen from Siebenschlehn near Schneeberg, in Saxony, shows crystals of bismuth associated with quartz. Of two crystals, one presented the new form $(\bar{1}\,3\,3)$ in combination with a largely developed $(\bar{1}\,1\,1)$ and a slight (1 0 0); while the other presented the combination of $(\bar{1}\,3\,3)$ $(\bar{1}\,1\,1)$ with slight (1 1 1), the latter face being probably due to cleavage: the habit of the former crystal is seen in figure 8.

* Philosophical Magazine, 1877, vol. iii. p. 456.

† See a paper by Helmhacker in Tschermak, *Mineral. Mittheil.* 1877, p. 12.

First Crystal.

	Observed.	Calculated.
$\bar{1}11.\bar{1}33$ . .	21° 46′: 21° 21′: 22° 20′	21° 19′
$\bar{1}33.100$ . .	106° 44′: 105° 18′	106° 42′
$\bar{1}33.3\bar{1}3$ . .	82° 15′: 82° 8′: 81° 31′	83° 34′
$\bar{1}11.1\bar{1}1$ . .	109° 7′: 110° 42′	110° 32′

Second Crystal.

$\bar{1}11.\bar{1}33$ . .	21° 22′	21° 19′

A third crystal from the same specimen presented the combination ($\bar{1}$ 1 1) (1 0 0) (1 1 1), and a cleavage face (0 1 1).

V. *Sulphur.*

Forms already described as occurring on native sulphur:—
(1 0 0) (0 1 0) (0 0 1) (1 1 0) (2 1 0) (3 1 0) (0 1 1) (0 1 3) (1 0 1) (2 0 3) (1 0 3) (1 1 1) (1 1 2) (1 1 3) (1 1 5) (1 1 9) (3 1 3) (3 1 5); and also (1 1 7) (3 1 1), (1 3 1) (4 3 4).

In Dana's 'Mineralogy,' (0 1 4) is given in mistake for (0 1 3), owing to a misprint in a paper of Hessenberg. The last four forms were observed by Brezina* on some crystals from Oker: (1 3 1) (4 3 4) were observed on only two of these crystals.

The form (1 3 1) has since been observed by Zepharovich † slightly developed on a crystal from near Miss in Carinthia.

The forms (3 1 0), (2 0 3), (1 1 9), (4 3 4) have not been met with on any crystals in this collection.

Some crystals were removed from a specimen of unknown locality: the colour of the crystals resembles very much that of some specimens from the Lipari Isles, while the accompanying rock is a highly altered scoriaceous lava. One crystal, about 3 millimetres in diameter, presented the combination

(1 0 0) (1 0 1) (1 1 0) (1 1 1) (1 1 2) (1 1 3) (3 1 1) (3 1 3) (3 1 5),

of which (3 1 1) is one of the rare forms due to Brezina: the form (1 1 2) has been long known, but did not occur on

* *Berichte d. Akad. d. Wissensch. Wien,* vol. lx. p. 539, 1869.

† *Jahresberichte des Vereines "Lotos" in Prag,* 1878.

the crystals from Oker. Another fragment from the same specimen, and about 4 millimetres in diameter, was found to consist of two interpenetrant crystals, one individual presenting the combination

(1 0 0) (0 1 0) (0 0 1) (0 1 1) (0 1 3) (1 0 1) (1 1 0)
(1 1 1) (1 1 3) (1 1 5) (1 1 7) (3 1 1) (3 1 3) (3 1 5),

of which both of the forms (3 1 1) (1 1 7) are due to Brezina, and in this crystal are largely developed; the old form (0 1 1) presented by this individual was not present on Brezina's crystals. The second individual presented the combination

(0 0 1) (1 0 3) (1 1 1) (3 1 1) (3 1 3) (3 1 5).

Some small crystals from the Wheatley Mines, Phœnixville, Chester Co., Pennsylvania, were found to be exceedingly rich in the development of planes, and likewise showed some of the rare forms mentioned above.

A crystal of about 1 millim. diameter, from a specimen in which the sulphur was associated with anglesite, galena, and copper pyrites, was found to present the following combination:—

(0 1 1) (0 1 0) (1 1 0) (1 1 5) (1 1 3) (1 1 2) (1 1 1)
(1 0 1) (3 1 3) (1 1 7) (3 1 1).

A second specimen from the same mine showed the association of sulphur with cerussite and quartz; a crystal of about 1 millim. diameter presented the following forms, the magnitude of the faces being approximately in descending order:—

(1 0 0) (2 1 0) (0 1 1) (1 1 5) (1 0 3) (3 1 5) (1 1 0)
(3 1 1) (1 1 2) (0 0 1) (1 0 1) (0 1 0) (1 1 1) (1 1 3)
(1 1 4) (1 1 7) (1 3 1) (3 1 3).

Of these forms, (1 3 1), (3 1 1), (1 1 7) were first observed on the crystals from Oker; (2 1 0), (0 1 1), (1 1 2) are old forms, which did not occur on those crystals; while (1 1 4) has not been previously described: the faces of the latter form were about the same size as those of the forms (1 1 3), (1 1 7). The following measurements were obtained by the method of maximum illumination:—

	Observed.	Calculated.
115.114 . .	$6^\circ\ 0'$	$5^\circ\ 55'$
$\bar{1}13.\bar{1}14$ . .	8 0	8 8

VI. *Nagyagite.*

This mineral, which never seems to present very perfect crystals, has been long assumed to belong to the tetragonal system. Lately Schrauf* has pointed out that the crystals he has examined present a rhombic rather than a tetragonal development of planes; while from the measurement of angles of the crystals, and of the striations upon the basal plane, he thinks that the crystals really belong to even a lower type of symmetry than the rhombic. Assuming, however, rhombic axes, he gives the following indices of observed planes:—

(0 1 0) (1 6 0) (1 3 0) (1 2 0) (0 5 1) (0 3 1) (0 1 1)
(2 5 2) (1 2 1) (3 4 3) (1 1 1).

All the planes, with the exception of the basal plane (0 1 0), are almost linear. He measured five crystals, and found that in three (1 2 0) was associated with (0 1 1), whilst tetragonal symmetry would have required (0 2 1); in a fourth (1 2 0) is associated with (0 3 1), while the fifth presented no measurable planes in these zones. On one, and only one, of these crystals (1 3 0) and (0 5 1) occur; (1 2 1) occurs on three crystals, (1 1 1) on two, (2 5 2) and (3 4 3) each on a single crystal. From the above, Schrauf hopes that it may be possible to distinguish between the two domes.

To the above forms may be added (1 1 0), (1 3 1), (1 4 1).

Six crystals were measured; and of these five were removed from the same specimen; and all came from the old locality, viz. Nagyag in Transylvania. The following angles were obtained by the method of maximum illumination:—

	Observed.	Calculated.
010 . 131 . .	59° 0′	59° 24′
010 . 141 . .	51 45	51 45

In four crystals (0 2 1) occurs at the same time as (0 1 1), whilst in two crystals (1 1 0) and (0 1 1) occur together: (2 5 2) was met with on three crystals, (3 4 3) on two, (1 2 1), (1 1 1) on one and the same, (1 3 1), (1 4 1) each on a single crystal. We therefore must agree with Schrauf that the domes appear to show a different development of planes; but still we can give no rule by which one dome may be distinguished from the other.

* Groth's *Zeitschrift für Krystallographie,* 1878, p. 239.

VII. *Realgar.*

Forms already described as occurring on realgar:—

(1 0 0) (0 1 0) (0 0 1) (1 0 1) (2 0 1) (0 1 2) (0 1 1) (0 3 2) (2 3 0) (1 1 0) (4 3 0) (2 1 0) (5 2 0) (2 1 2) (1 1 1) (2 3 2) (4 1 2) (6 1 2) (4 2 1) $(\bar{2}\,1\,2)$.

To these Scacchi adds* (1 2 0), (4 1 0), $(\bar{2}\,1\,4)$, (2 1 4). Hessenberg† confirms the forms (1 2 0), (4 1 0), and adds further the forms $(\bar{1}\,0\,1)$, (6 1 0), (2 1 1), (6 7 0), (2 2 1). To the above Dana, in his list of observed forms, adds (4 1 4), while he omits (6 7 0). Groth, in his Catalogue of the Strassburg collection, confirms the existence of the form (6 7 0), and adds (4 3 2), considering that Hessenberg's (2 2 1) was in reality this same form.

To these may be added (3 2 0), (3 1 0), (6 5 0), (0 3 4), (1 1 2), (6 1 6), (15 1 15): the plane (4 1 4) given by Dana has also been observed. The unconfirmed form $(\bar{2}\,1\,4)$ of Scacchi has been met with largely developed. The forms (5 2 0), (2 1 4), $(\bar{1}\,0\,1)$, (6 1 0), (2 1 1), (6 7 0), (2 2 1), (4 3 2) have not been met with on crystals of this collection.

A specimen from the Solfatara near Naples presents some small crystals of realgar in a scoriaceous mass. Three crystals were measured: the first presented the above-mentioned forms $(\bar{2}\,1\,4)$, (4 1 4) in combination with old forms; the second showed the rich combination

(0 1 0) (2 3 0) (1 1 0) (6 5 0) (4 3 0) (3 2 0) (2 1 0) (4 1 0) (1 0 0) (0 3 2) (0 1 1) (0 1 2) (0 0 1) (2 3 2) (1 1 1) (2 1 2) (1 0 1) (4 1 2) (2 0 1) $(\bar{2}\,1\,2)$.

The forms (3 2 0), (6 5 0) have not been heretofore described.

	Observed.	Calculated.
	° ′	° ′
010.320 . .	48 11	48 43
010.650 . .	42 24	42 21

* Liebig and Kopp's *Jahresberichte*, 1852, p. 844.

† Hessenberg, *Min. Notiz.* i. and iii.

The third crystal presented the combination

(010) (120) (230) (110) (430) (210) (310) (410) (100) (032) (011) (012) (001) (101) (201) (232) (111) (212) (412).

		Observed.	Calculated.
010.310	. .	66° 27′	66° 18′.

A specimen from Moldawa presents some crystals with prism-development; they are associated with spongy quartz containing disseminated iron pyrites. A crystal having the habit shown in fig. 9 presented the following combination:—

(010) (120) (230) (110) (210) (100) (032) (011) (034) (012) (001) (111) (212) (412) (201) (112).

The planes (034), (112) have not been previously observed.

		Observed.	Calculated.
011.034	. .	8° 15′	7° 57′

The plane (112), which is somewhat largely developed on this crystal, is that assumed by Naumann and Hessenberg as parametral plane; it was found to be in the zones [111.001], [100.212].

		Observed.	Calculated.
		° ′	° ′
$1\bar{1}2.212$	. .	54 20	54 41
11'2.111	. .	23 20	24 $3\frac{1}{2}$
112.212	. .	18 12	18 41

An isolated crystal from Felsobanya, of rich colour and very clear, having the habit shown in fig. 10, was found to present the following combination:—

(001) (210) (110) (430) (320) (100) (010) (410) (212) (111) (012) (011).

We have seen above that this form (320) was also observed on a Solfatara crystal:—

		Observed.	Calculated.
430.320	. .	3° 30′	3° 23′.

A specimen from one of the Transylvanian localities presents some beautiful crystals, associated with stibnite and native arsenic in barytes: on a large crystal still on the specimen there is a plane between (2 1 2) and (1 0 1), developed as in fig. 11. From measurement of a smaller crystal which was removed from the specimen, the indices of this plane would appear to be (4 1 4), the plane given by Dana. On this same small crystal are two other minute planes, affording measurements which accord with (6 1 6), (15 1 15):—

	Observed.	Calculated.
	° ′	° ′
010.212 . . .	64 54	64 59
212.414 . . .	11 52	11 53
414.616 . . .	4 21	4 18
616.15 1 15 . .	5 8	5 16
15 1 15.101 . .	3 13	3 34

VIII. *A Twin of Zircon**.

Although zircon, rutile, and cassiterite have been long looked upon as isomorphous, zircon has been, till within the last three years, remarkable for the absence of the twin growth which is so usual a feature in the other two species. In 1878 Herr Otto Meyer†, in a paper relative to the rocks met with in the St. Gotthard tunnel, called attention to the fact that zircon was present in considerable quantity as a microscopic constituent of some of the crystalline schists, and further observed that the minute crystals were occasionally twinned according to the same twin plane (1 0 1) as the crystals of rutile and cassiterite. In the same year Herr Hussak‡ mentioned his discovery of simple microscopic twins of zircon according to the same law in the eklogite from Styria, and of both simple and polysynthetic twins in the mica schist of the St. Gotthard tunnel. One of the crystals was measured by him, and found to be 0·16 millim. long and 0·04 millim. broad.

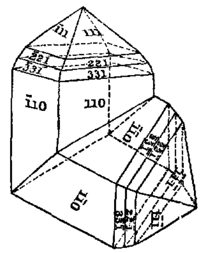
Very lately large crystals of zircon have been found at Ren-

* Read May 30, 1881.

† *Zeitschrift der Deutschen geologischen Gesellschaft*, 1878, Band xxx. p. 10.

‡ Tschermak, *Mineralogische und Petrographische Mittheilungen*, 1878, p. 277.

frew in Canada. The largest specimen which has yet reached this country weighs 408 grams: it is a simple crystal presenting the forms {1 1 0}, {1 1 1}, and {2 2 1}. A second specimen, weighing 52·785 grams, is of great interest as showing the twinning of zircon on a far from microscopic scale. The habit of the individual crystals and the general aspect of the twin will be evident from the accompanying figure. The forms present are the prism {1 1 0}, and the pyramids {1 1 1}, {2 2 1}, {3 3 1}; while on one quoin there is a well-developed face, which proved upon measurement to belong to the ditetragonal pyramid {3 1 1}. The angle between two corresponding prism-faces of the different individuals was found by measurement to be 44° 47′, a result sufficiently near to the calculated value 44° 50′ to prove that the growth is really due to twinning about the above-mentioned plane (1 0 1).



A twin of zircon.

The crystals are of a brownish colour, and are in parts quite transparent; the faces have an adamantine lustre; the specific gravity is 4·552, and approaches that of the specimens of the same mineral from the Ilmen Mountains.

IX. *Skutterudite**.

[Plate VI.]

The first mention of this mineral was made in 1827 by Breithaupt†, to whom it had been submitted by his brother-in-law on returning from a voyage in Norway. Though none of the specimens presented crystal-faces, Breithaupt found that there were distinct cleavages parallel to the sides of a cube, for which reason he assigned to the species the name of Tesseral-Kies. Cleavages, more or less interrupted and indistinct, were found to exist parallel to planes truncating the edges and quoins of this cube, indicating that the crystallisation was that characteristic of the cubic system.

* Read May 30, 1881.

† "Ueber eine neue Kies-Species von Skutterud," Pogg. *Ann.* vol. ix. p 115 (1827).

Breithaupt went a step further, and, from traces of separation which manifested themselves in the direction of the octahedral planes, hazarded the conjecture, since (curious to say) verified, that the crystals would prove to present the octahedron as the predominant form. The specimens were of a bright metallic lustre and of a tin-white colour. The specific gravities of five different fragments were determined to be 6·659, 6·681, 6·718, 6·748, 6·848, and thus had a considerable range. As, however, after breaking up the fragments, it was seen that the first three included particles of quartz and actinolite, Breithaupt regarded the true specific gravity as lying between 6·748 and 6·848. The hardness was greater than that of cobaltite or Cobaltkies; and as blowpipe examination had indicated that cobalt and arsenic were the chief constituents, Breithaupt suggested the secondary title of Hartkobaltkies. The associated minerals were cobaltine, copper pyrites, glassy actinolite, serpentine, quartz, and sometimes also cobalt-bloom.

Ten years later Scheerer* met with a mineral which examination led him to regard as identical with that previously described by Breithaupt. A quantitative analysis, afterwards confirmed by Wöhler†, gave the following result:—

Arsenic	77·84
Cobalt	20·01
Sulphur	0·69
Iron	1·51
Copper	traces
	100·05

a composition expressed by the formula $CoAs_3$.

The description given by Scheerer agrees very closely with that of Breithaupt; though he found the mineral not only in its massive condition, but also as isolated crystals. These had the form of octahedra, modified by the cube dodecahedron and an icositetrahedron: the inclination of the faces of the latter form to the adjacent face of the octahedron, as measured was 19° 27′, proving clearly that the icositetrahedron was

* "Ueber zwei norwegische Kobalterze von den Skutteruder Gruben," Pogg. *Ann.* vol. xlii. p. 553 (1837).

† Pogg. *Ann.* vol. liii. p. 591.

{2 1 1}, for which the calculated angle is 19° 28′; the faces of this particular icositetrahedron truncate the edges of the dodecahedron. He further observes that this form {2 1 1} was present on every crystal he had examined. Scheerer notices also the interesting fact that the crystals are often found implanted upon crystals of cobaltite, and states that he had not been able to trace any regularity in the relative position of the crystals of the two species. As the term Tesseralkies might be taken to imply that the mineral crystallises in the form of cubes, he suggests Arsenikkobaltkies as a more appropriate name.

In Haidinger's 'Handbuch der bestimmenden Mineralogie' (1845) the mineral appears under still another title—Skutterudite, suggestive of the locality where the crystals are found.

In Brooke and Miller's edition of 'An Elementary Introduction to Mineralogy by the late William Phillips,' published in 1852, the forms presented by Skutterudite are given as {1 0 0}, {1 1 0}, {1 1 1}, and {2 2 1}, and the angles according with this description are calculated. It will be observed that the form {2 1 1} described by Scheerer is not mentioned, but that a new form, {2 2 1}, a triakisoctahedron, is substituted. In 1862 vom Rath*, apparently not having referred to the original paper of Scheerer, and assuming that the information contained in the last-mentioned 'Mineralogy' incorporated all the results of observation up to that date, determined anew the form {2 1 1}, and also added a triakisoctahedron {3 3 2}, a tetrakishexahedron {3 1 0}, and a hexakisoctahedron {6 4 3}.

The prominent forms, according to both Scheerer and vom Rath, are the octahedron {1 1 1}, the dodecahedron {1 1 0}, and the icositetrahedron {2 1 1}; while, according to the latter mineralogist, the additional forms {3 3 2}, {3 1 0}, {6 4 3} are only subordinately developed. The disposition of the faces of this hexakisoctahedron {6 4 3} will be more easily imagined, if it be remarked that they cut off the edges of intersection of the octahedron with the tetrakishexahedron {3 1 0}. With regard to the faces of the triakisoctahedron, vom Rath observes that they are small and unsuited for measurement, but that in one case he had been able to measure the angle made with the adjacent face of the octahedron as lying between $9\frac{1}{2}$° and $10\frac{1}{2}$°;

* "Neue Flächen am Tesseralkies," Pogg. *Ann.* vol. cxv. p. 480.

whence he concludes that the form is not {2 2 1}, as given by Miller, which requires an angle of 15° 48′, but {3 3 2}, for which the calculated angle is 10° 2′.

As vom Rath considered it unlikely that the subordinate triakisoctahedron present on some crystals should be {2 2 1} and on others {3 3 2}, he suggests that the symbol given by Miller is a mistaken one, and appears to think that the form {2 2 1} may have been determined by inspection and not by measurement. It seems, however, much more probable that the information given by Miller is intended to be merely a statement of the results of Scheerer, and not of a later examination by Miller himself, who could not have failed to remark the existence of the icositetrahedron {2 1 1}, which is so characteristic that it was present on every crystal examined by Scheerer, and in fact can be distinguished on every specimen in the collection of the British Museum. It seems fairly evident, then, that Miller's {2 2 1} was a simple error introduced in the copying of Scheerer's results, and that the angles were afterwards calculated without this error in the translation of the symbol from the German notation being remarked. If this hypothesis be correct, {2 2 1} must be expelled from the list of observed forms.

The next mention of Skutterudite is to be found in an extremely interesting and important paper by Schrauf and Dana on the thermoelectric properties of mineral-varieties*, where they remark that, although the mineral undoubtedly crystallises in the cubic system, and has never been observed to present any hemihedral development, they nevertheless find some specimens to be thermoelectrically positive and others negative.

The bearing of this remark will be more obvious when it is recalled to mind that the investigation of Schrauf and Dana was undertaken with a view to test the accuracy of the induction made by Gustav Rose from his experiments on iron pyrites and cobaltine†—that the opposition in the thermo-

* "Ueber die thermoelektrische Eigenschaften von Mineral-Varietäten," *Sitz.-Ber. Ak. Wien,* vol. lxix. p. 153 (1874).

† "Ueber den Zusammenhang zwischen hemiëdrischer Krystallform und thermo-elektrischen Verhalten beim Eisenkies und Kobaltglanz," Pogg. *Ann.* vol. cxlii. p. 1 (1871).

electric behaviour of different specimens of the same mineral is due to the diplohedral hemisymmetry,—and of his inference that the faces observed on the positive and negative crystals belong only apparently to the same, really to complementary, semiforms. The observation of Schrauf and Dana, that the same thermoelectrical peculiarities are shown by a holohedral mineral of the same crystalline system to which iron pyrites and cobaltine belong, will clearly not strengthen the position taken up by Rose.

It is therefore of some interest to find that the specimens in this Collection prove not only that Skutterudite is undoubtedly hemihedral, but that it presents the particular variety of hemisymmetry which is so characteristic of both iron pyrites and cobaltine.

Brezina* has pointed out that the opposition of thermo-electric properties shown by various specimens of iron pyrites and cobaltine cannot be satisfactorily explained by diplohedral hemisymmetry, and holds that haplohedral hemisymmetry must be at the same time present—that, in other words, the crystals must be tetartohedral in structure; and, assuming that the differences in the specimens are only differences of molecular grouping, Brezina regards iron pyrites and the allied species as being really tetartohedral—a view which as yet there is little, if any, crystallographic evidence to support. It seems, however, more probable that Schrauf and Dana are right in attributing this difference, not to crystalline hemisymmetry, but to slight differences of composition or of density; and the force of their argument will not be very much weakened by the reference of the symmetry of the crystalline forms of Skutterudite to a hemihedral type.

It may be useful to remark that attention was first directed to the hemihedry by the discovery of a crystal of Skutterudite among the specimens of that typically hemihedral mineral cobaltine, to which it was very similar in habit, though different in colour. Closer examination, however, made known the fact that the hemihedrally-developed faces belonged, not to the pentagonal dodecahedron $\pi\{2\,1\,0\}$, so common in both cobaltine and iron pyrites, but to the much rarer form $\pi\{3\,1\,0\}$.

* "Ueber die Symmetrie der Pyritgruppe," Tschermak's *Min. Mittheil.* p. 23 (1872).

In this Collection there are fourteen more or less perfect crystals, presenting respectively the following development:—

No. 1 shows only the octahedron $o\{1\,1\,1\}$ modified by faces of the icositetrahedron $n\{2\,1\,1\}$, as shown in fig. 1 (Pl. VI.).

Nos. 2, 3, 4 show also the faces of the dodecahedron $d\{1\,1\,0\}$, and are represented in fig. 2—each of these four crystals being implanted upon a crystal of cobaltite in the way described by Scheerer and vom Rath. On Nos. 5 and 6 the same forms recur; but some of the quoins are truncated by small planes of the cube $a\{1\,0\,0\}$, probably due to cleavage.

As in all the above forms the poles of the faces lie in dodecahedral planes, the abeyance of symmetry of the latter would have no effect in reducing the number of faces; in other words, so long as only these forms are present it is impossible to distinguish crystallographically whether the structure is characterized by holohedral symmetry or by diplohedral hemisymmetry.

Nos. 7 to 11 present faces of the tetrakishexahedron $f\{3\,1\,0\}$; and it now becomes possible to determine whether the internal structure as shown by the external form is to be regarded as holohedral or hemihedral. As a matter of fact, in each of these crystals the faces of only one semiform $\pi\{3\,1\,0\}$ are found to be present, the number varying with the more or less fractured state of the crystal. This combination is represented in fig. 3, from which, for the sake of simplicity, the small faces of the cube have been omitted. No. 7 presents all the twelve faces required by perfect hemisymmetry; No. 8 shows eight faces, No. 9 shows five, while on Nos. 10 and 11 only two are present; but on none of these crystals can any faces of the complementary semiform $\pi\{1\,3\,0\}$ be distinguished.

Crystal No. 12 is five eighths of an inch (=1·6 centim.) long, and projects from a matrix of quartz and mica. It is particularly interesting as showing the hemihedral development, not only of the above tetrakishexahedron, but also of an hexakisoctahedron having its planes in the edge-zones of the dodecahedron. The angle made by the faces of this new form with the adjacent faces of the form $\{2\,1\,1\}$ was measured by help of the telescopic images to be $10^\circ\,48'$ in one case and $11^\circ\,2'$ in another; there is no doubt, then, that the faces belong to the semiform $\pi\{3\,1\,2\}$, for which the corresponding calculated angle is $10^\circ\,54'$. Fig. 4 represents the actual development of the various faces on that part of the crystal which is not concealed by the matrix: no fewer than ten faces of this semiform $\pi\{3\,1\,2\}$ can be seen, while not a single face of the complementary semiform $\pi\{3\,2\,1\}$ is to be found.

Gustav Rose has remarked that, in cases of diplohedral hemisymmetry, the poles of all the faces present belong in general to one set of systematic triangles: this crystal of Skutterudite forms another of the rare exceptions to this rule, which would require the association of $\pi\{3\,2\,1\}$ instead of $\pi\{3\,1\,2\}$ with the semiform $\pi\{3\,1\,0\}$.

This semiform $\pi\{3\,1\,2\}$ is again to be observed on crystal No. 13, though it is there represented by only a single face. The angle with the adjacent face of the form $\{2\,1\,1\}$ was in this case measured to be $10^\circ\,52\frac{1}{2}'$, a result according well with the calculated angle $10^\circ\,54'$: on the same crystal eight faces of the semiform $\pi\{3\,1\,0\}$ are developed.

The last crystal, No. 14, differs from the rest in showing three faces, which, if the crystal were simple, would undoubtedly be attributed to the complementary semiform $\pi\{1\,3\,0\}$; the crystal, however, still presents a hemihedral habit, since the three faces of this complementary semiform $\pi\{1\,3\,0\}$ only appear at quoins where the faces of $\pi\{3\,1\,0\}$ are missing. It is very possible indeed that the crystal may be twinned about the normal to a dodecahedron-face, as is at times the case in iron pyrites—which theory would likewise account for the presence of reentrant angles, otherwise to be attributed to parallel growth.

The subordinate forms $\{3\,3\,2\}$, $\{6\,4\,3\}$, described by vom Rath, do not seem to be present on any of the above crystals, and must be very rare. In some cases indeed the edges of intersection of the octahedron with the form $\pi\{3\,1\,0\}$ are "rounded off" by very small faces not susceptible of measurement; while the edges of the octahedron itself are bevelled by narrow planes, which, if crystal-faces at all, can only be approximately determined. On one crystal the angles made with the adjacent octahedral faces by the four tautozonal rudimentary planes of the triakisoctahedron were measured by the method of maximum illumination as $18\frac{1}{2}^\circ$, $17\frac{1}{4}^\circ$, 13°, $16\frac{1}{2}^\circ$ respectively—thus suggesting the form $\{2\,2\,1\}$, which requires an angle of $15^\circ\,48'$, and, as we have seen, was given by Miller, no doubt in mistake, as an observed form. On another crystal a series of images could be obtained from each of two faces of the triakisoctahedron; and the limiting-values thus determined for the angle corresponding to the one just mentioned were, in one case $13\frac{1}{2}°–16\frac{1}{4}°$, and in the other $15\frac{3}{4}°–16\frac{1}{2}°$; on a third crystal two similar angles were measured at $15\frac{1}{4}°$ and 19°, thus again indicating the form {2 2 1}.

The range of specific gravity of the crystallised mineral is a little wider than that of the massive as determined by Breithaupt: one crystal presenting no external sign of impurity was found to have a specific gravity of 6·48; a second had a specific gravity of 6·37, but, like the less dense specimens of Breithaupt, evidently contained foreign matter. Two other fairly large crystals had specific gravities of 6·56 and 6·72 respectively; while a small apparently very pure crystal, with smooth lustrous faces, gave a result as high as 6·86.

XIX. *On Rhabdophane, a new Mineral.*

By W. G. Lettsom, *Esq.**

Having ascertained from Monsieur Lecoq de Boisbaudran, who had had the kindness to favour me with a specimen of his new metal gallium, that it would be agreeable to him to examine our British blendes for that metal, I applied to various dealers for specimens thereof, and I also asked a few friends to give me their assistance in the matter. Among the latter was Mr. Ludlam, who with his usual liberality sent me three or four specimens.

Among them was one which in its appearance differed from any British blende that I am familiar with. It was in small mamillated globules, brown, with a peculiar greasy lustre. Having a suspicion that possibly it might not be a blende, I submitted it for examination to that Grand Inquisitor the spectroscope.

* Read November 23, 1878.

[This paper was withheld from publication with the intention that it and the analysis should appear simultaneously. Through some misapprehension this intention has not been carried out, and the analysis has already appeared in the Journal of the Chemical Society for May 1882.—Sec. Cryst. Soc.]