# THE
# AMERICAN
# JOURNAL OF SCIENCE.

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FOURTH SERIES

VOL. XXVII—[WHOLE NUMBER, CLXXVII.]

WITH PLATES I–IV.

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NEW HAVEN, CONNECTICUT.
1909.

# ART. XIII.—*Iodyrite from Tonopah, Nevada, and Broken Hill, New South Wales;* by E. H. KRAUS and C. W. COOK.

IN November last the Mineralogical Laboratory of the University of Michigan received a consignment of minerals from the Foote Mineral Company of Philadelphia, Pa., which contained ten selected crystals of iodyrite from Tonopah, Nevada, a new locality for this mineral. Our attention was called to this fact by Mr. W. M. Foote, manager of the company. On examination, several of these crystals showed that they possess a pronounced hemimorphic development, and also several forms which had not as yet been observed on iodyrite. We immediately informed Mr. Foote of these facts and he most cordially placed a very liberal quantity of selected material at our command. He subsequently sent us a specimen from Broken Hill, New South Wales, which contained crystals of a most interesting character.

Through the courtesy of Director H. C. Bumpus and Curator L. P. Gratacap of the American Museum of Natural History of New York City, we were able to examine specimens 2609 and 2610 of their mineral collection. The first of these is from Broken Hill, the second from Chile.

The various contributions on iodyrite are rather fragmentary and also widely separated in time. It was, therefore, deemed advisable to preface the results of our study with a brief survey of the work already done on this mineral.

## *Historical.*

In 1825 Vauquelin* pointed out that certain silver ores from Mexico contained the element iodine, probably in the form of the iodide. This was the first record of the occurrence of the element iodine in the mineral kingdom, it having been previously observed only in plants and animal remains. Cantu† had, however, showed the presence of iodine in traces in certain mineral waters from Asti, Italy. That silver iodide occurs in nature was first definitely pointed out by Domeyko,‡ who in 1844 analyzed material from Chanarcillo, Chile. As to the crystallographic development of this material the only statement made by Domeyko is that rhombohedral-like forms were occasionally observed and also that the structure was more or less lamellar. Domeyko did not make a complete analysis but showed conclusively that the amount of silver in the natural

* Annales de Chimie et de Physique, xxix, 99, 1825.
† Annales des Mines (4), vi, 158, 1844.
‡ Cited by Vauquelin, loc. cit.

compound agreed very closely with that of the artificial product. Crystals from this same locality, which were in the mineral collections of the École de Mines, Paris, were measured by Des Cloizeaux[*] in 1854. Des Cloizeaux assigned the mineral to the hexagonal system and calculated the axial ratio to be $a:c = 1:0{\cdot}81438$. The nine forms observed by him are given in the tabulation on page 217. Although it is not clear that Des Cloizeaux observed hemimorphism, it is, nevertheless, of interest to note that he pointed out the very close similarity of the angles of the natural iodide of silver and the hemimorphic mineral greenockite.

In 1854 Dana[†] suggested the name *iodyrite* for this mineral, although Haidinger[‡] had previously (1845) called it *iodite*. The name iodyrite has become international in spite of the fact that Leymerie[§] introduced *iodargyrite* in 1859.

The next contribution to our knowledge of this compound was made in 1879 by Zepharovich,[‖] who carried out a rather extensive examination of artificial crystals, which had been prepared by Belohoubek. In all Zepharovich observed twelve forms, seven of which had, however, been previously noted by Des Cloizeaux on natural crystals; see the tabulation on page 217. It is of some interest to indicate in this connection that although the hexagonal prism of the first order is, according to Des Cloizeaux, a common form on iodyrite, it was, nevertheless, not observed by Zepharovich on artificial crystals. Zepharovich established a new axial ratio which differed considerably from the one obtained by Des Cloizeaux. According to Zepharovich the ratio is as follows: $a:c=1:0{\cdot}8196$. These values have been generally adopted.[¶] The crystals examined by Zepharovich possessed a pronounced hemimorphic development.

In 1881 Seligmann[**] examined crystals of iodyrite from Dernbach, Nassau, and observed seven forms; see page 217. The development of these crystals was such as to point to hemimorphism in that $i\{20\bar{2}1\}$, $o\{10\bar{1}1\}$, and $u\{40\bar{4}1\}$ were observed above the prism of the first order while $i'\{20\bar{2}\bar{1}\}$ was noted below. Seligmann also examined crystals from Chile and on these noted four forms which had not been observed on either natural or artificial crystals of silver iodide; see page

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[*] Annales de Chimie et de Physique, xl, 85, 1854.

[†] System of Mineralogy, 4th edition, 95, 1854.

[‡] Chester, A Dictionary of the Names of Minerals, 1896, 134.

[§] Chester, loc. cit.

[‖] Zeitschr. Kryst., iv, 119, 1879.

[¶] Dana, System of Mineralogy, 6th edition, 1892, 160; Groth, Tabellarische Uebersicht der Mineralien, 4th Auflage, 1898, 50; Naumann-Zirkel, Elemente der Mineralogie, 14te Auflage, 1901, 505.

[**] Zeitschr. Kryst. vi, 229, 1881.

217. These crystals were apparently holohedral in their development.

The work of Seligmann was followed in 1885 by a description of crystals of iodyrite from Lake Valley, New Mexico, by Genth and vom Rath.[*] Only three forms were noted by them, but they describe an interesting type of twin crystal, the individuals of which possess a rhombohedral development. A plane parallel to a face of $e\{30\bar{3}4\}$ acts as the twinning plane. A twin of this character is reproduced by Dana.[†]

The only other work on iodyrite up to the present time, which has come to our knowledge, is that by Spencer[‡] in 1901. Spencer describes crystals from Broken Hill, New South Wales. The simple crystals were tabular or short prismatic and showed practically the same forms as observed by Seligmann on crystals from Chile; see page 217. Spencer, however, noted extremely interesting twins possessing a pseudo-cubical development. These twins are interpreted by him as being composed of four individuals of a trigonal character. The twinning law is the same as that observed by Genth and vom Rath, namely, $e\{30\bar{3}4\}$. Repeated attempts were made by Spencer to obtain etch figures but without success.

### *Iodyrite from Broken Hill, New South Wales.*

The crystals examined from this locality occur on a specimen of limonite and psilomelane, which was placed at our disposal by the Foote Mineral Company of Philadelphia, Pa. The crystals are very small, being from 1 to $2^{mm}$ in length and in all cases show an apparently holohedral development. The color is a rather bright lemon yellow. The faces are not nearly as brilliant as those possessed by the crystals from Tonopah, Nevada, which will be described later. Although it was necessary in making our readings to rely almost entirely upon the maximum shimmer or luster, we, nevertheless, feel that considerable confidence may be placed in the results thus obtained. The following forms, $c\{0001\}$, $c'\{000\bar{1}\}$, $m\{10\bar{1}0\}$, $a\{11\bar{2}0\}$, $u\{40\bar{4}1\}$, and $u'\{40\bar{4}\bar{1}\}$, were definitely determined. Another form of a pyramidal character was also noted, but our readings in this case were somewhat unreliable so that we do not feel warranted in making a statement as to its probable indices. The crystals possess

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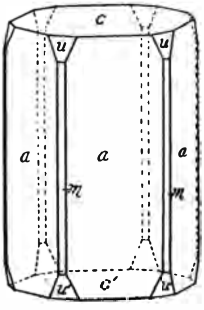

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[*] Zeitschr. Kryst., x, 473, 1885.

[†] System of Mineralogy, 6th edition, 1892, 160.

[‡] Zeitschr. Kryst., xxxv, 460, 1901.

a prismatic habit, $a\{11\bar{2}0\}$, being by far the predominating form. The prism $m\{10\bar{1}0\}$ occurs as very narrow faces truncating the edges of $a\{11\bar{2}0\}$. This is the first time that the simultaneous occurrence of the prisms of the two orders on a single individual of either the artificial or natural compound has been recorded. Furthermore, the prism, $a\{11\bar{2}0\}$, had not previously been observed on natural crystals. The general type of development, possessed by these crystals, is clearly shown by figure 1.

The averages of several of the more important readings used for the identification of the forms given above are as follows:

| | Observed | Calculated |
|---|---|---|
| $c : u = (0001) : (40\bar{4}1)$ | 75° 21′ | 75° 13′ |
| $c : m = (0001) : (10\bar{1}0)$ | 90° 4′ | 90° 00′ |
| $m : a = (10\bar{1}0) : (11\bar{2}0)$ | 30° 2′ | 30° 00′ |

Through the courtesy of the American Museum of Natural History of New York, we have been able to examine specimen 2609, which shows some excellently developed crystals. Our examination of this interesting specimen was, however, confined to the use of the hand lense, but it is evident that the crystals are undoubtedly twinned according to the law noted above. Not being able to carry out goniometric measurements on any of the individuals on this specimen, we are unable to state definitely what forms occur upon them.

### *Iodyrite from Tonopah, Nevada.*

The material examined from Tonopah, Nevada, consisted of several thousand isolated crystals and two matrix specimens furnished by the Foote Mineral Company. From a study of the matrix specimens, composed almost entirely of quartz, on which the iodyrite occurs as isolated crystals or in crystalline crusts, it is clearly evident that the mineral is of secondary origin.

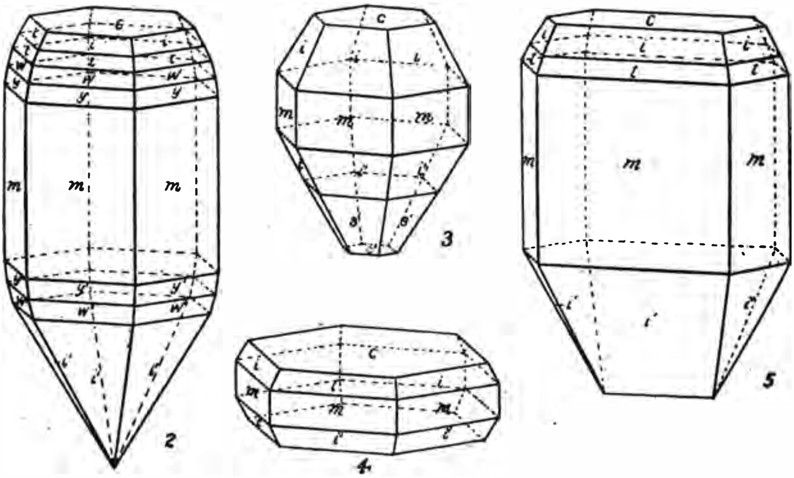
The crystals vary considerably in color and size. Those studied more closely varied from a bright lemon-yellow through the darker shades of yellow to a yellow-green. They measured from 1 to $5^{mm}$ in length. The crystals possess a greasy adamantine luster and occur as simple crystals, parallel groupings, twins, and rosette clusters. In all nine types of development were observed, four of which appear to be characteristic of simple crystals.

Type 1. Crystals of this type possess a pronounced hemimorphic development. They show the following forms: $c\{0001\}$, $m\{10\bar{1}0\}$, $i\{20\bar{2}1\}$, $i'\{20\bar{2}\bar{1}\}$, $t\{70\bar{7}3\}$, $w\{90\bar{9}2\}$,

$w'\{90\bar{9}\bar{2}\}$, $y\{90\bar{9}1\}$, and $y'\{90\bar{9}\bar{1}\}$. Of these forms $m\{10\bar{1}0\}$ predominates. The lower pyramid, $i'\{20\bar{2}\bar{1}\}$, is also rather large. The upper basal pinacoid, $c\{0001\}$, is usually next in size. The other forms generally occur as rather narrow faces. The relative sizes of the faces of the various forms are clearly shown in figure 2. Of the forms observed on crystals of this type, it is well to point out that $t\{70\bar{7}3\}$, $w\{90\bar{9}2\}$, $w'\{90\bar{9}\bar{2}\}$, $y\{90\bar{9}1\}$, and $y'\{90\bar{9}\bar{1}\}$, are all new. The close agreement between the calculated and observed values for these new forms makes us feel confident that they are to be considered as established.

Type 2. A pyramidal habit is a striking characteristic of crystals of this type. The following forms were noted on them: $c\{0001\}$, $c'\{000\bar{1}\}$, $m\{10\bar{1}0\}$, $i\{20\bar{2}1\}$, $i'\{20\bar{2}\bar{1}\}$, and $s'\{15.0.\bar{15}.\bar{8}\}$. Of these forms $s'\{15.0.\bar{15}.\bar{8}\}$ was observed for the first time. The general character of crystals of this type is shown in figure 3, which consists of a combination of the forms just enumerated. Hemimorphism is very pronounced on these crystals.

Figs. 2–5.



In several instances on crystals of types 1 and 2 the additional new forms were noted: $r\{70\bar{7}4\}$, $x\{70\bar{7}1\}$, and $z\{33.0.\bar{33}.2\}$. These forms are usually to be observed as very narrow faces, and as they do not occur often, we did not deem it necessary to figure them.

Type 3. Crystals of this type of development are not very common. They possess a tabular habit and are apparently holohedral. The forms observed are $c\{0001\}$, $c'\{000\bar{1}\}$, $m\{10\bar{1}0\}$, $i\{20\bar{2}1\}$, and $i'\{20\bar{2}\bar{1}\}$. Figure 4 shows these forms in combination.

Type 4. Due to the predominance of two parallel faces of the prism, $m\{10\bar{1}0\}$, crystals of this type are also tabular. They are, however, hemimorphic, as is clearly shown in figure 5. The figure shows a combination of the following forms: $c\{0001\}$, $m\{10\bar{1}0\}$, $t\{70\bar{7}3\}$, $i\{20\bar{2}1\}$, and $i'\{20\bar{2}\bar{1}\}$. These crystals are by no means as common as those of types 1 and 2.

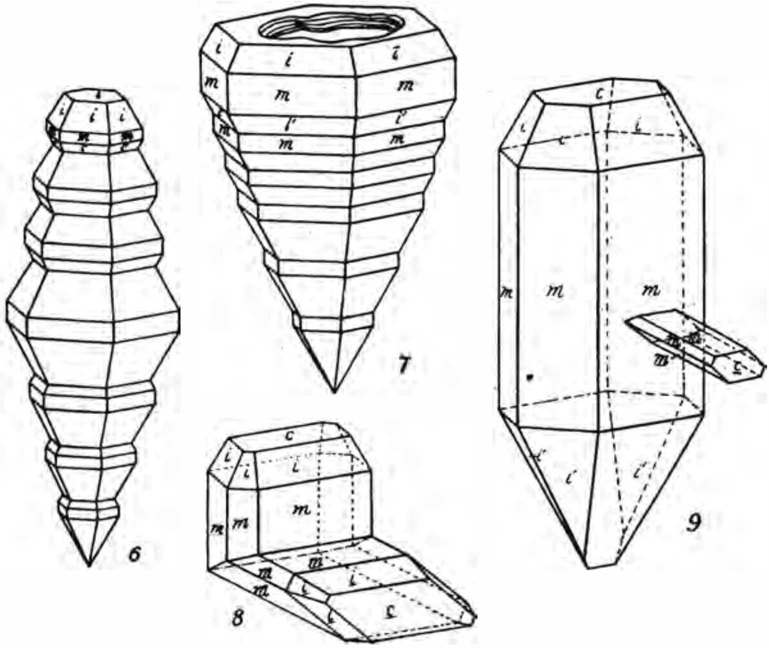
Type 5. Parallel grouping plays an important part in the formation of crystals of this group. This is shown in figure 6. These crystals are made up of several simple individuals which possess, in general, a habit similar to that which is so characteristic of crystals of type 2. Although they show hemimorphism, they are, nevertheless, more or less barrel-shaped, resembling to a large extent the development so often observed on crystals of corundum. The observed forms are $c\{0001\}$, $m\{10\bar{1}0\}$, $i\{20\bar{2}1\}$, and $i'\{20\bar{2}\bar{1}\}$. These crystals are rather common and are sometimes as much as $5^{mm}$ in length.

Type 6. Crystals belonging to this group are more or less carrot- or top-shaped. This is illustrated by figure 7. As is shown by the illustration, these crystals are made up of a number of individuals possessing a tabular development similar to that of type 3 (figure 4). The crystals show the upper base $c\{0001\}$ rather large and are terminated below by the pyramid $i'\{20\bar{2}\bar{1}\}$, thus giving the groups a decided hemimorphic development. In many cases these crystals show a skeletal development in that they are more or less hollow. In figure 7 we show the general character of these crystals and also indicate the skeletal development by figuring a depression in the upper base. In some cases this depression does not extend far into the crystal, while in other instances it extends almost the entire length of the same. The bottom of this depression, which is usually irregular in outline, but sometimes may be hexagonal, is a plane surface, which from the reflections obtained on the goniometer we know to be parallel with base $c\{0001\}$. The sides of the depression are usually characterized by parallel and horizontal corrugations. These can be seen best in the crystal fragments. The forms observed on crystals of this type are $c\{0001\}$, $m\{10\bar{1}0\}$, $i\{20\bar{2}1\}$, and $i'\{20\bar{2}\bar{1}\}$.

Type 7. Here belong contact twins with the pyramid $e\{30\bar{3}4\}$ acting as the twinning plane. The two individuals are about equally developed and possess a tabular habit, as shown in figure 8. This tabular habit is due to the predominance of two parallel faces of the prism $m\{10\bar{1}0\}$. These twins are rather common.

Type 8. Figure 9 illustrates clearly the characteristic development of twins belonging to this group. Here one of the individuals is fully developed and generally somewhat tabular in habit. Hemimorphism is pronounced. Attached to the side of the fully developed crystal is the second smaller individual and in the position demanded by the common twinning law *e* $\{30\bar{3}4\}$. The second individual is also more or less tabular. Twins of this character were not as frequently encountered as those of type 7.

Figs. 6–9.



Type 9. Quite a number of contact twins, the individuals of which possess a rhombohedral development, were observed. They resemble very closely the twins from Lake Valley, New Mexico, which were described in 1885 by Genth and vom Rath. The figure given by them is reproduced in Dana's System of Mineralogy.*

In the writings of the earlier contributors to our knowledge of the crystallography of iodyrite much confusion exists as to the occurrence of the pyramidal forms about the upper and

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* 6th edition, 1892, 160.

lower poles. Especially Zepharovich, in reporting upon the forms observed on artificial crystals with a decided hemimorphic development, is not at all clear in his statements as to the occurrence of certain pyramidal forms. In the text these forms are indicated as occurring only below, while in the table of angles they are given as upper forms. It is also rather common for crystallographers, when describing the forms on hemimorphic crystals, to designate the upper and lower forms possessing the same indices by different letters. This is somewhat clearer but still confusing.

| Letter | Artificial | Natural | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Chile | | Dern-bach | Lake Valley | Broken Hill | | Tonopah |
| | Zepharovich | Des Cloizeaux | Seligmann | | Genth & Rath | Spencer | Kraus and Cook | |
| *c* | $\{0001\}$ | $\{0001\}$ | $\{0001\}$ | $\{0001\}$ | $\{0001\}$ | $\{0001\}$ | $\{0001\}$ | $\{0001\}$ |
| *c'* | ---- | $\{000\bar{1}\}$* | $\{000\bar{1}\}$ | $\{000\bar{1}\}$ | ---- | $\{000\bar{1}\}$ | $\{000\bar{1}\}$ | $\{000\bar{1}\}$ |
| *m* | ---- | $\{10\bar{1}0\}$ | $10\bar{1}0$ | $\{10\bar{1}0\}$ | ---- | $\{10\bar{1}0\}$ | $\{10\bar{1}0\}$ | $\{10\bar{1}0\}$ |
| *a* | $\{11\bar{2}0\}$ | ---- | ---- | ---- | ---- | ---- | $\{11\bar{2}0\}$ | ---- |
| $\mu$ | ---- | $\{10\bar{1}2\}$ | ---- | ---- | ---- | ---- | ---- | ---- |
| $\mu'$ | $\{10\bar{1}\bar{2}\}$ | $\{10\bar{1}\bar{2}\}$* | ---- | ---- | ---- | ---- | ---- | ---- |
| *o* | $\{10\bar{1}1\}$ | ---- | ---- | $\{10\bar{1}1\}$ | $\{10\bar{1}1\}$ | ---- | ---- | ---- |
| *o'* | $\{10\bar{1}\bar{1}\}$ | ---- | ---- | ---- | ---- | ---- | ---- | ---- |
| *i* | $\{20\bar{2}1\}$ | $\{20\bar{2}1\}$ | $\{20\bar{2}1\}$ | $\{20\bar{2}1\}$ | $\{20\bar{2}1\}$ | $\{20\bar{2}1$ | ---- | $\{20\bar{2}1\}$ |
| *i'* | $\{20\bar{2}\bar{1}\}$ | $\{20\bar{2}\bar{1}\}$* | $\{20\bar{2}\bar{1}\}$ | $\{20\bar{2}\bar{1}\}$ | ---- | $20\bar{2}\bar{1}$ | ---- | $\{20\bar{2}\bar{1}\}$ |
| $\nu'$ | $\{20\bar{2}\bar{3}\}$ | ---- | ---- | ---- | ---- | ---- | ---- | ---- |
| *f* | ---- | ---- | $\{30\bar{3}1\}$ | ---- | ---- | $\{30\bar{3}1\}$ | ---- | ---- |
| *f'* | ---- | ---- | $\{30\bar{3}\bar{1}\}$ | ---- | ---- | ---- | ---- | ---- |
| *g* | ---- | ---- | $\{30\bar{3}2\}$ | ---- | ---- | $\{30\bar{3}2\}$ | ---- | ---- |
| *g'* | ---- | ---- | $\{30\bar{3}\bar{2}\}$ | ---- | ---- | ---- | ---- | ---- |
| *e* | $\{30\bar{3}4\}$ | ---- | ---- | ---- | ---- | ---- | ---- | ---- |
| *u* | $\{40\bar{4}1\}$ | $\{40\bar{4}1\}$ | ---- | $\{40\bar{4}1\}$ | ---- | ---- | $\{40\bar{4}1$ | ---- |
| *u'* | ---- | $\{40\bar{4}\bar{1}\}$* | ---- | ---- | ---- | ---- | $40\bar{4}\bar{1}$ | ---- |
| $\pi'$ | $\{40\bar{4}\bar{5}\}$ | ---- | ---- | ---- | ---- | ---- | ---- | ---- |
| $\beta'$ | $\{9.9.\bar{1}\bar{8}.\bar{2}\bar{0}\}$ | ---- | ---- | ---- | ---- | ---- | ---- | ---- |
| *r* | ---- | ---- | ---- | ---- | ---- | ---- | ---- | $\{70\bar{7}4\}$ |
| *t* | ---- | ---- | ---- | ---- | ---- | ---- | ---- | $\{70\bar{7}3\}$ |
| *x* | ---- | ---- | ---- | ---- | ---- | ---- | ---- | $\{70\bar{7}1\}$ |
| *y* | ---- | ---- | ---- | ---- | ---- | ---- | ---- | $\{90\bar{9}1\}$ |
| *y'* | ---- | ---- | ---- | ---- | ---- | ---- | ---- | $\{90\bar{9}\bar{1}\}$ |
| *w* | ---- | ---- | ---- | ---- | ---- | ---- | ---- | $\{90\bar{9}2\}$ |
| *w'* | ---- | ---- | ---- | ---- | ---- | ---- | ---- | $\{90\bar{9}\bar{2}\}$ |
| *s'* | ---- | ---- | ---- | ---- | ---- | ---- | ---- | $\{15.0.\bar{1}\bar{5}.\bar{8}\}$ |
| *z* | ---- | ---- | ---- | ---- | ---- | ---- | ---- | $\{33.0.\bar{3}\bar{3}.2\}$ |

* Inasmuch as Des Cloizeaux makes no definite statement as to the development of these crystals, we have considered them as being apparently holohedral.

In order to avoid all confusion we have divided the basal pinacoid and the various bipyramids into upper and lower forms, following the practice of the more recent texts on crystallography. Certain letters are then assigned to the various bipyramids and the basal pinacoid, which, when unprimed, indicate upper forms, when primed, lower forms; thus, $o\{10\bar{1}1\}$, upper; $o'\{10\bar{1}\bar{1}\}$, lower. We believe that this system of nomenclature offers decided advantages over what has been heretofore in use for hemimorphic crystals, in that it does away with all confusion.

In accordance with the plan outlined in the preceding paragraph we have prepared a general summary of all forms thus far reported as occurring on either natural or artificial silver iodide.

As previously stated, p. 211, the axial ratio generally adopted for iodyrite is the one which was established by Zepharovich[*] for artificial crystals. Inasmuch as it is always highly desirable to have ratios based upon reliable observations on the natural compound, we have taken a very large number of readings with the view of establishing a new axial ratio. The values thus obtained differ but slightly from those given by Zepharovich. In order to show the close agreement of the two determinations we place them below and at the same time also add the values obtained by Des Cloizeaux[†] on natural crystals in 1854.

| | $a$ : $c$ |
|---|---|
| Des Cloizeaux | 1 : 0·81438 |
| Zepharovich | 1 : 0·81960 |
| Kraus and Cook | 1 : 0·82040. |

In all fifteen crystals were measured. The observed and calculated angles based upon the axial ratio, given by us, show in nearly all cases very close agreement.

| | | Observed | Calculated |
|---|---|---|---|
| $c : i$ = | $(0001) : (20\bar{2}1)$ | 62° 10′ 30″* | ------ |
| $m : m$ = | $(10\bar{1}0) : (01\bar{1}0)$ | 59° 59′ | 60° 00′ |
| $c : r$ = | $(0001) : (70\bar{7}4)$ | 58° 47′ | 58° 50′ |
| $c' : s'$ = | $(000\bar{1}) : (15.0.\bar{15}.\bar{8})$ | 60° 32′ | 60° 47′ |
| $c : t$ = | $(0001) : (70\bar{7}3)$ | 65° 33′ | 65° 39′ |
| $c : w$ = | $(0001) : (90\bar{9}2)$ | 76° 46′ | 76° 48′ |
| $c : x$ = | $(0001) : (70\bar{7}1)$ | 81° 22′ | 81° 25′ |
| $c : y$ = | $(0001) : (90\bar{9}1)$ | 83° 13′ | 83° 19′ |
| $c : z$ = | $(0001) : (33.0.\bar{33}.2)$ | 86° 20′ | 86° 21′ |
| $i : i$ = | $(20\bar{2}1) : (02\bar{2}1)$ | 52° 30′ | 52° 29′ |
| $m : i$ = | $(10\bar{1}0) : (02\bar{2}1)$ | 63° 43′ | 63° 45′ |

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[*] Loc. cit.

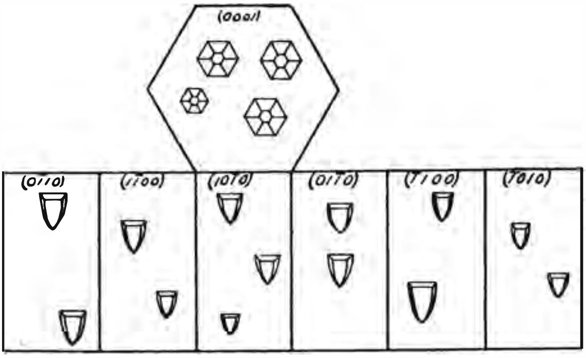
[†] Loc. cit.

## *Etch Figures and Class of Symmetry*

Iodyrite is generally* placed in the class of symmetry which is designated by Groth† as the dihexagonal pyramidal class. This is based entirely upon the geometrical development of the crystals, which, however, might allow of such interpretations as to permit assigning the compound to at least three other classes, since no faces of the most general form have as yet been observed, Hence, it is necessary to rely upon etch figures in order to determine with definiteness the symmetry of iodyrite.

Spencer ‡ indicates that repeated attempts were made to obtain etch figures upon the crystals which he studied from Broken Hill, New South Wales. These attempts were unsuccessful. Spencer, unfortunately, does not mention the solvents which he employed.

FIG. 10.



A solution of potassium iodide is considered by Roscoe and Schorlemmer§ as a good solvent for silver iodide. A solution of N/2 potassium iodide was used by us for the production of etch figures on carefully selected crystals of iodyrite from Tonopah. Although the solution etches the crystals, we were unable after repeated attempts to obtain figures possessing a definite outline.

According to Gmelin‖ silver iodide is soluble in a solution of mercuric nitrate and in a concentrated solution of either

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* See Dana and Naumann-Zirkel, loc. cit.; also Bauer, Lehrbuch der Mineralogie, 2te Auflage, 1904, 439; Klockmann, Lehrbuch der Mineralogie, 4te Auflage, 1907, 403; Groth, Tabellarische Uebersicht der Mineralien, 4te Auflage, 1898, 50.

† Physikalische Krystallographie, 4te Auflage, 1904, 496.

‡ Loc. cit.

§ Treatise on Chemistry, 1907, ii, 468.

‖ Handbook of Chemistry, 1852, vi, 157.

potassium or sodium chloride. It was, therefore, decided to use a cold concentrated solution of sodium chloride. Immersion in such a solution for fifteen seconds produced excellent microscopic etch figures of an hexagonal outline on the base and located as shown in figure 10. Figures of the general form and position, as illustrated in the diagram, were produced on the prism faces after a treatment of about forty seconds. The position and outline of these figures show conclusively that crystals of iodyrite possess six vertical planes of symmetry and one polar axis of hexagonal symmetry. These elements show that the classification which has been followed, as indicated above, is to be considered as the correct one.

### *Chemical Analysis.*

For the chemical analyses somewhat over a gram of clear, semi-transparent crystal fragments of a pale yellow color was used. This material was from Tonopah, Nevada, and was placed at our disposal by the Foote Mineral Company, to whom we desire at this time to express our thanks for the cordial manner in which assistance was rendered us during this investigation.

As to the analysis only the method of decomposition need be given in detail. This consists of placing a small sample of the finely powdered homogeneous material in an evaporating dish and covering the same with water acidified with one or two drops of concentrated sulphuric acid. A small piece of chemically pure zinc is then suspended in the solution so as to just come into contact with the powdered mineral. Decomposition is generally complete after about twenty-four hours. The hydriodic acid which is liberated passes into solution, while the silver collects in the dish in the finely divided metallic state. In this way any loss of hydriodic acid by volatilization was avoided. For the sake of convenience the zinc was attached to a piece of platinum wire, so that after the decomposition was complete, it could be readily removed and any adhering silver washed off. In order to remove any traces of silver which could not be washed off, the zinc was immersed for an instant in nitric acid. After filtration the metallic silver was dissolved in nitric acid and then precipitated and weighed as the chloride. Silver nitrate was added to the filtrate and the iodine precipitated and weighed as the iodide.

Two analyses were made which show very close agreement and indicate that the composition of iodyrite may be expressed by the formula AgI.

In 1854 J. Lawrence Smith* made two analyses of iodyrite.

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*** Dana, System of Mineralogy, 4th edition, 1855, 506.**

The localities from which the material was obtained are not indicated by Smith. We give below the average results of Smith's analyses. Smith reports that aside from silver and iodine, he found traces of copper and chlorine. Repeated tests were made by us for bromine and chlorine, as also for the metals lead and mercury, which would most likely replace the silver. But in no case did we find the slightest trace of any of them.

The results of the analyses are as follows:

| | Kraus and Cook | | | Smith | Theoretical |
|---|---|---|---|---|---|
| | I | II | Average | | |
| Ag | 45·87% | 46·04% | 45·95% | 46·45% | 45·97% |
| I | 53·92 | 54·09 | 54·01 | 53·02 | 54·03 |
| Total | 99·79 | 100·13 | 99·96 | 99·47 | 100·00 |

We are indebted to Professor E. D. Campbell, Director of the Chemical Laboratory of this University, for suggestions relative to methods of decomposition and analysis.

### *Specific Gravity.*

Considerable variation exists in the values given for the specific gravity of iodyrite or the artificial compound. This variation is clearly shown by the following tabulation:

*Iodyrite.*

| | |
|---|---|
| Bauer* | 5·5 — 5·7 |
| Damour† | 5·677 |
| Dana* | 5·6 — 5·7 |
| Domeyko* | 5·504 |
| Klockmann* | 5·707 |
| Naumann–Zirkel* | 5·6 — 5·7 |
| Vom Rath* | 5·609 |

*Artificial Silver Iodide.*

| | |
|---|---|
| Damour† | 5·669 |
| Deville | 5·540 |

Since the material which we used for the chemical analysis proved to be exceptionally pure, we feel that the values we obtained for the specific gravity are very reliable. Two determinations were made on material which differed slightly in color. There is also a slight difference to be noted in the

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* Loc. cit.

† Rammelsberg, Handbuch der Krystallographisch-Physikalische Chemie, I, 303, 1881.

results. The determinations were made with the common specific gravity flask at room temperature.

The results are:

| | |
|---|---|
| Dark variety | 5·519 |
| Light variety | 5·504 |
| Average | 5·5115 |

These values are much lower than those given by Damour, Dana, vom Rath, Klockmann, and Naumann-Zirkel, but agree fairly well with the determinations of Domeyko on natural crystals and with the value given by Deville for the artificial compound. Our results also fall within the limits set by Bauer.

**Mineralogical Laboratory,**
**University of Michigan,**
**December 22, 1908.**