Sulpharsenites of Lead from the Binnenthal[1].

Part III.—Baumhauerite, a new mineral; and Dufrenoysite.

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With an analysis by H. Jackson, M.A.

[Read November 12, 1901.]

Baumhauerite[2], $4\dot{Pb}S.3As_2S_3$.

FOR this new mineral I propose the name baumhauerite in honour of Dr. H. Baumhauer, Professor of Mineralogy in the University of Freiburg, Switzerland, who has done so much to elucidate this complicated group of sulpharsenites of lead.

CRYSTALLOGRAPHY.

System: Oblique. $a : b : c = 1{\cdot}136817 : 1 : 0{\cdot}947163$; $\beta = 82°42\frac{3}{4}'$.
These elements are calculated from the angles $100 : 101 = 50° 27'$, $101 : 001 = 32° 15\frac{3}{4}'$ and $010 : 11\bar{1} = 50° 33'$ measured on crystal No. I.

The crystals closely resemble dufrenoysite and jordanite in appearance. They may be distinguished from dufrenoysite by the marked oblique development of the zone [100,001], and from jordanite by the absence of twin striations and by the colour of the streak. The edges in the pyramid zone and between planes in the zone [100,010] are more or less rounded. The orthopinacoid (100), which is the direction of cleavage, is always largely developed and has a brilliant lustre; it is sometimes finely striated parallel to the axis of symmetry, and sometimes shows unsymmetrical markings. The best developed zone on the crystals is [100,001]. The prism zone [100,010] is sometimes deeply furrowed as in rathite and dufrenoysite. Sometimes similar planes on opposite sides of (010) give different angles; this may possibly be due to twinning about a plane making a small angle with (100),

[1] Part I.—General Description and Chemical Analyses, with a Crystallographic account of Jordanite. This Magazine, 1900, vol. xii, pp. 282-97. Part II.—Rathite. This Magazine, 1901, vol. xiii, pp. 77-85. These two parts have been published together in Zeits. Kryst. Min., 1901, vol. xxxv, pp. 321-44.

[2] A preliminary notice of this new mineral was published in 'Nature,' Oct. 10, 1901, vol. lxiv, p. 577, but no name was then given to it.

as has been observed on rathite and dufrenoysite. The pyramid planes are fairly numerous but small. Table I given below contains the list of ninety-five forms which have been observed on the crystals. The positions of most of these forms are indicated on the stereographic projection (fig. 1).

There are four habits to be distinguished:—

I. Characterized by the large development of (010) (fig. 2).

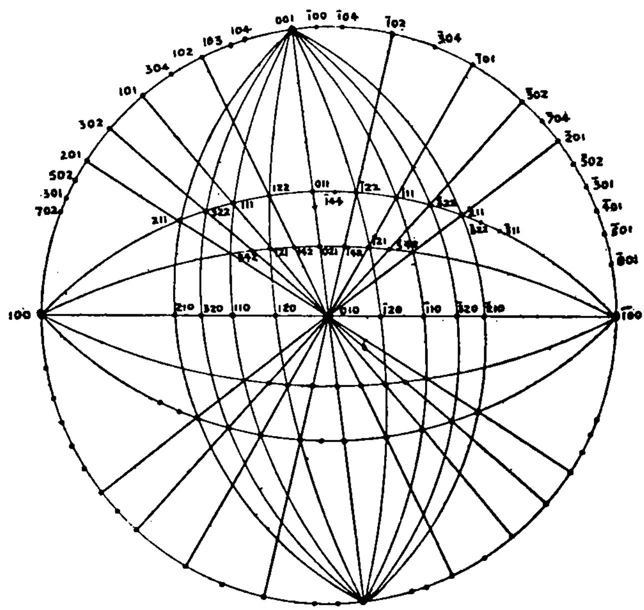

FIG. 1.—Stereographic projection of baumhauerite, showing most of the observed forms.

II. Plate-like crystals with (100) large, somewhat resembling jordanite in shape (fig. 3).

III. Rhombic prisms with small terminations, resembling habit I of dufrenoysite (p. 164).

IV. Simple rhombic-shaped crystals resembling Berendes' drawing of dufrenoysite.

The colour of baumhauerite is lead-grey to steel-grey, sometimes tarnished with iridescent colours. The lustre is metallic and brilliant. The streak chocolate colour. The mineral is opaque. There is a very perfect cleavage parallel to the orthopinacoid (100). Fracture conchoidal. Hardness 3. Specific gravity 5·330.

Baumhauerite occurs, usually as isolated crystals, with the other sulpharsenites of lead in the white crystalline dolomite in the bed of the Lengenbach, Binnenthal; this is the only locality known for the mineral.

Two crystals have been examined by Prof. Baumhauer and his results are given below. My own observations have been made on thirteen crystals, two of which I obtained at Binn in 1898, and the others in August, 1901. There is little doubt that many museums[1] contain specimens of this new mineral under the name of dufrenoysite or jordanite.

TABLE I.—LIST OF FORMS OBSERVED ON BAUMHAUERITE.

Symbol.	Indices.	Symbol.	Indices.	Symbol.	Indices.	Symbol.	Indices.
a	100	$-\frac{5}{8}g$	508	$+\frac{2}{5}g$	$20\bar{5}$	$-2q$	121
b	010	$-\frac{1}{2}g$	102	$+\frac{3}{8}g$	$30\bar{8}$ *B.*	$-p$	111
c	001	$-\frac{2}{5}g$	205	$+\frac{1}{3}g$	$10\bar{3}$ *B.*	$+2q$	$12\bar{1}$
$-30h$	30.0.1	$-\frac{1}{3}g$	103	$+\frac{1}{4}g$	$10\bar{4}$	$+p$	$11\bar{1}$
$-\frac{25}{2}h$	25.0.2	$-\frac{1}{4}g$	104	$+\frac{2}{13}g$	$2.0.\overline{13}$	$+u$	$21\bar{1}$
$-\frac{13}{2}h$	13.0.2	$-\frac{1}{6}g$	106	$+\frac{1}{9}g$	$10\bar{9}$	$-4x$	342
$-5h$	501	$-\frac{1}{7}g$	107	$+\frac{1}{12}g$	$1.0.\overline{12}$	$-2x$	322
$-\frac{9}{2}h$	902	$-\frac{1}{9}g$	109			$+2x$	$32\bar{2}$
$-4h$	401	$+8h$	$80\bar{1}$	$4r$	140	$-4n$	142
$-\frac{7}{2}h$	702	$+\frac{11}{2}h$	$11.0.\bar{2}$	$2r$	120	$-2n$	122
$-3h$	301	$+5h$	$50\bar{1}$	$\frac{4}{3}r$	340	$+4n$	$14\bar{2}$
$-\frac{13}{5}h$	13.0.5	$+4h$	$40\bar{1}$	r	110	$+2n$	$12\bar{2}$
$-\frac{5}{2}h$	502	$+3h$	$30\bar{1}$	$\frac{9}{8}s$	980	$-2y$	522
$-\frac{13}{6}h$	13.0.6	$+\frac{5}{2}h$	$50\bar{2}$	$\frac{3}{2}s$	320	$+2y$	$52\bar{2}$
$-2h$	201	$+\frac{11}{5}h$	$11.0.\bar{5}$	$\frac{9}{5}s$	950	$+z$	$31\bar{1}$
$-\frac{13}{7}h$	13.0.7	$+2h$	$20\bar{1}$	$2s$	210	$-w$	411
$-\frac{3}{2}h$	302	$+\frac{13}{7}h$	$13.0.\bar{7}$	$\frac{17}{8}s$	17.8.0	$-3W$	10.3.3
$-\frac{7}{5}h$	705	$+\frac{7}{4}h$	$70\bar{4}$	$\frac{5}{2}s$	520	$-3V$	16.3.3
$-\frac{4}{3}h$	403	$+\frac{5}{3}h$	$50\bar{3}$ *B.*	$\frac{8}{3}s$	830	$+4m$	$14\bar{4}$
$-\frac{7}{6}h$	706 *B.*	$+\frac{8}{5}h$	$80\bar{5}$ *B.*	$3s$	310	$-10T$	4.10.5
$-\frac{13}{12}h$	13.0.12	$+\frac{3}{2}h$	$30\bar{2}$	$\frac{10}{3}s$	10.3.0		
$-h$	101	$+h$	$10\bar{1}$	$\frac{11}{3}s$	11.3.0	k	011
$-\frac{5}{6}g$	506	$+\frac{3}{4}g$	$30\bar{4}$	$\frac{11}{2}s$	11.2.0	$2k$	021
$-\frac{4}{5}g$	405	$+\frac{2}{3}g$	$20\bar{3}$			$\frac{1}{2}l$	012
$-\frac{3}{4}g$	304	$+\frac{1}{2}g$	$10\bar{2}$				

B. refers to the planes observed only by Baumhauer.

[1] Measurement of a crystal which had been labelled as dufrenoysite in the British Museum gave angles agreeing with those of baumhauerite.—L. J. S.

Table II.—Calculated and measured angles of Baumhauerite.

	Calculated.	Measured (Solly).							Measured (Baumhauer).			
										Crystal 2.		
		Crystal I.	Crystal II (1).	Crystal II (2).	Crystal III.	Crystal IV (1).	Crystal IV (2).	Crystal V.	Crystal 1.	Fragment (1).	Fragment (2).	Fragment (3).
Zone [100,001]												
100 : 30.0.1	2°43′					2°40						
: 25.0.2	6 27					6 27						
: 13.0.2	12 6					12 0						
: 501	15 27				15°30′							
: 902	17 0½				17 0		16°50′					
: 401	18 54½						18 40	19° 0′				
: 702	21 15½		21°15′			21 16	21	21 14	21°20′ *a*			
: 301	24 14		24 14	24°15′	24 14	24 14	24 12	24 12			24°16½′	24°17′
: 13.0.5	27 14	27°10′	27 14	27 15	27 14							
: 502	28 6	28 6				28 6	28 5	28 7	28 6	28°11½′	{ 27 56 28 0½ }	28
: 13.0.6	31 22	{ 31 6 31 55 }			31 20							
: 201	33 16½	33 16	33 16		33 16	33 17	33 16		33 20½	33 19½	{ 33 14½ 33 15 }	33 15½
: 13.0.7	35 5		35 5									
: 302	40 24½		40 24	40 22	40 24	40 25			{ 40 22½ *a* 40 23½ }	40 27½	40 17	40 15 *a*
: 705	42 9	41 21½										
: 403	43 22		43 22									
: 706	46 49								46 45½ *a*			
: 13.0.12	48 31½		48 30			48 32						
: 101	50 27	50 27	50 27	50 27	50 27	50 27	50 26		{ 50 27 50 27 }	50 27½	50 25	50 23 *b*
: 506	54 39	54 40			54 42							
: 405	55 32				55 30							

: 304	56 55½	56 55½			56 55							
: 508	60 34½	60 35			60 34						59 14½ *b*	
: 102	64 30½	64 30			64 30	64 30	64 50		{64 35 64 35}	64 27½	{64 29½ 64 32}	{64 29 64 30½}
: 205	67 53	67 50									67 17	
: 103	70 10½				70 10	70 12			70 23			
: 104	73 10½	73 9			73 10½				73 22½	73 9½ *a*	73 5	73 12 *a*
: 106	76 16½	76 16			76 16	76 25					75 46 *b*	
: 107	77 10				77 12							
: 109	78 23½				78 23						79 27 *b*	
: 001	82 42¾	82 43			82 43		82 45		83 6½ *b*		82 40	{82 32½ *b* 82 42}
100 : $80\bar{1}$	10 23			10 10		10 24						
: $11.0.\bar{2}$	15 5							15 0				
: $50\bar{1}$	16 34		16 34		16 34							
: $40\bar{1}$	20 34½			20 33		20 34		20 34				
: $30\bar{1}$	26 58	26 58	26 57	26 50	26 58	26 58	26 51	27 0	{27 0 26 52½}		27 4	26 59½
: $50\bar{2}$	31 44	31 44	31 44½	31 45	31 44	31 44	31 50	31 45	{31 38 31 44½}	31 44	31 54	31 48½
: $11.0.\bar{5}$	35 23½		35 24									
: $20\bar{1}$	38 16	38 16	38 15½	38 12	38 16	38 16	38 14		{38 21½ 38 29}	38 2½	38 12½	
: $13.0.\bar{7}$	39 5		39 8									
: $70\bar{4}$	42 27	42 26½	42 27	42 30	42 27	42 27			{42 25 42 33}		42 31½	42 29½
: $50\bar{3}$	44 0								44 3½			
: $80\bar{5}$	45 19½								45 16			
: $30\bar{2}$	47 25	47 25	47 25			47 25	47 20		{47 22½ 47 27½}		47 24	47 25
: $10\bar{1}$	60 19	60 19	60 19		60 19	60 19	60 20		{60 13½ 60 31½}		60 20	{60 24½ 60 25}
: $30\bar{4}$	68 25				68 23	68 25						
: $20\bar{3}$	71 21½					71 21			71 8			
: $10\bar{2}$	77 32			77 30	77 34	77 32	77 31		{77 31½ 77 32}		{77 33 *a* 77 34}	77 48½ *a*

a = only fairly good; *b* = bad.

	Calculated.	Measured (Solly).							Measured (Baumhauer).			
		Crystal I.	Crystal II (1).	Crystal II (2).	Crystal III.	Crystal IV (1).	Crystal IV (2).	Crystal V.	Crystal 1.	Crystal 2. Fragment (1).	Crystal 2. Fragment (2).	Crystal 2. Fragment (3).
: 20$\bar{5}$	81°22′				81°30′							
Zone [100,001]												
100 : 30$\bar{8}$	82 22½								82°20′			
: 10$\bar{3}$	84 1										84°7½′ *b*	84°6′ *b*
: 10$\bar{4}$	87 20	87°29′	87°20′	87°18′	87 20	87°20′	87°18′		{ 87 12½ 87 17¼ }	87°18′		
: 2.0.$\bar{1}\bar{3}$	90 3½	{ 89 24 90 40 }			{ 90 20 90 40 }	{ 90 15 90 30 }						
: 10$\bar{9}$	92 20	92 20					92 50		92 56¾			
: 1.0.$\bar{1}\bar{2}$	95 12½	95 20			95 12		95 15					
: 001	97 17¼	97 17			97 17	97 18						
Zone [100,010]												
100 : 11.2.0	13 51½			13 55								
: 11.3.0	20 18½			20 20								
: 10.3.0	22 9		22 9									
: 310	24 20½		24 20									
: 830	26 58½	27 0	26 58									
: 520	28 30		28 30						28 27	28 30	28 42	
: 17.8.0	32 34		32 30									
: 210	34 9½	34 9	34 10						34 5	34 4		
: 950	37 1	37 0	37 0									
: 320	42 8	42 7½	42 8	42 7				42 10	41 57	42 11	41 55	
: 980	50 20½			50 18								
: 110	53 37	53 37								53 24	53 24½	
: 340	61 4½	61 4										
: 120	69 46½	69 46½						69 46		69 46¾		
: 140	79 34	79 32										
: 010	90 0	90 0								{ 90 0½ 90 13 }	89 55	

a = only fairly good; *b* = bad.

TABLE II (*continued*).

CALCULATED AND MEASURED ANGLES OF BAUMHAUERITE.

	Calculated.	Measured (Solly.) I.	II (2)	IV.	V.
	° ′	° ′	° ′	° ′	° ′
Zone [100,011].					
100 : 16.3.3	19 39½			19 40	
: 411	25 14½		25 15	25 16	
: 10.3.3	29 18		29 20		
: 522	36 20		36 23		
: 322	49 32½	49 32	49 33		
: 111	59 3½	59 4	59 4	59 3	59
: 122	70 54½	70 54	70 55	70 56	
: 011	84 42	84 40	84 43	85 0	
100 : 81$\bar{1}$	35 1½	35 0			
: 52$\bar{2}$	40 26	40 20	40 30		
: 21$\bar{1}$	47 22½	47 20	47 22		
: 32$\bar{2}$	56 17½	56 17	56 17		
: 11$\bar{1}$	67 31	67 31	67 31	67 30	67 30
: 12$\bar{2}$	80 53	80 54	80 54	80 55	
: 14$\bar{4}$	88 4	88 2			
: 01$\bar{1}$	95 18				
Zone [100,021].					
100 : 342	61 15½	61 10			
: 121	68 55	68 50			
: 4.10.5	72 14	72 15			
: 142	77 27	77 27			
: 021	86 35	86 30			
100 : 12$\bar{1}$	75 6	75 5			
: 14$\bar{2}$	84 6½	84 10			
: 02$\bar{1}$	93 25				
Zone [010,001].					
010 : 021	28 1½	28 3			
: 011	46 47	46 49			
: 012	64 50½	64 50			
Zone [010,101].					
010 : 121	34 24	34 30			
: 111	53 51½	53 52			

	Calculated.	Meas. I.
Zone [010,10$\bar{1}$].	° ′	° ′
010 : 12$\bar{1}$	31 17	31 20
: 11$\bar{1}$	50 33	50 33
Zone [010,20$\bar{1}$].		
010 : 21$\bar{1}$	59 36½	59 38
Zone [010,302].		
010 : 342	39 9½	39 12
: 322	58 27	58 27
Zone [010,30$\bar{2}$].		
010 : 32$\bar{2}$	55 6½	55 7
Zone [010,102].		
010 : 142	30 19	30 19
: 122	49 28	49 29
Zone [010,10$\bar{2}$].		
010 : 14$\bar{2}$	28 23½	28 33
: 12$\bar{2}$	47 14	47 14
: 11$\bar{2}$	76 59	77 0
Zone [001,110].		
001 : 111	46 56	46 56
: 110	85 41	85 41
: 11$\bar{1}$	128 9½	128 9
Zone [001,320].		
001 : 322	50 56	50 55
: 320	84 36	84 35
: 32$\bar{2}$	121 55	121 55
Zone [001,210].		
001 : 210	83 58½	83 59
: 21$\bar{1}$	116 21½	116 20
Zone [001,120].		
001 : 122	43 47	43 47
: 121	61 28	61 25
: 120	87 29	87 29
: 12$\bar{1}$	124 31	124 30
: 12$\bar{2}$	132 42½	132 42

DESCRIPTION OF INDIVIDUAL CRYSTALS.

Crystal I (fig. 2).—A small highly modified crystal of habit I. The clinopinacoid (010) and the orthopinacoid (100) are large. There are fifty-four forms developed on this crystal, including numerous pyramid planes; a list with the measured angles is given in Table II.

In the orthodome zone [100,001] at about 90° from (100) there are a number of narrow planes in oscillatory combination, suggesting that the crystal may be repeatedly twinned on (100), but the rest of the zone shows no indication of twinning.

Crystal II (fig. 3).—This is a fine crystal of habit II; it is highly modified and plate-like in form. It broke into pieces on removal from the matrix of dolomite, and part of it was used for the chemical analysis.

The (100) face is large; the planes in the zones [100,010], [100,011] and [100,001] are narrow but well defined and give excellent reflections. The planes in the zone [100,021] were pitted and rough, so only approximate measurements could be obtained. The crystal has a slight iridescent tarnish. Forty-six forms were determined, a list of which together with the measurements appears in Table II under crystal II (1) and (2).

Crystal III.—A small crystal belonging to habit II; it is much modified, with rounded pyramid and dome zones. Thirty-three forms were determined in the zone [100,001] and are recorded in Table II.

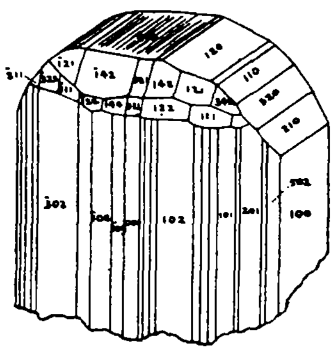

FIG. 2.—Baumhauerite (Habit I).

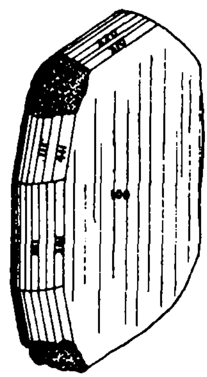

FIG. 3.—Baumhauerite (Habit II).

Crystal IV.—This crystal I found in 1898. I had four similar crystals, but one was used for analysis. They belong to habit II and resemble crystal II by the large development of the (100) face, but most of the planes in the dome and pyramid zone are much rounded. Thirty-three forms were determined in the zone [100,001].

Crystal V. This crystal closely resembles Berendes' figure of dufrenoysite. I obtained it in 1898, and it was not till I removed the crystal from the matrix of dolomite that its difference from dufrenoysite was perceived. The lustre of the upper faces resembles that of ground glass, but that portion of the crystal which rested on the matrix is bright. Fourteen forms were determined and are recorded in Table II.

Crystal VI (fig. 4). This is a very large crystal and measured $22 \times 9 \times 4$ mm. A small portion was broken off and used for analysis.

Fig. 4 is an exact drawing of the crystal. The largely developed faces (100) consist of a number of thin laminae parallel to (100) of decreasing size; the edges are rounded in an unsymmetric manner conformable with the oblique symmetry of this mineral. The crystal is elongated along the axis of symmetry. I had three other very similar crystals, one of which was used for analysis. The following is a list of the forms that were determined on these crystals: (100), (702), (301), (502), (13·0·6), (201), (13·0·7), (302), (705), (403), (13·0·12), (101), (506), (102), (103), (104), (001), (30$\bar{1}$), (50$\bar{2}$), (11·0·$\bar{5}$), (13·0·$\bar{7}$), (70$\bar{4}$), (30$\bar{2}$), (10$\bar{1}$), (30$\bar{4}$), (10$\bar{2}$), (10$\bar{4}$), (10$\bar{9}$), (1·0·$\overline{12}$), (520), (210), (320), (110), (52$\bar{2}$), (21$\bar{1}$), (32$\bar{2}$).

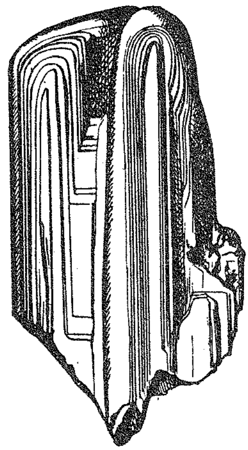

FIG. 4.—Baumhauerite.

Crystals measured by Prof. Baumhauer.

In answer to my letter to Professor Baumhauer, proposing to give his name to this new mineral, he informed me that he had found two crystals of the same mineral in the Freiburg Museum. One of the crystals was detached, and the other was broken into three pieces in freeing it from the matrix. In sending me the results of his measurements, he asked that they might be included in the present paper. On reference to the above Table II, where these are given, it will be noticed that many of his angles are in close agreement with those obtained by myself: for example, the measured values for (100):(101) and (100):(10$\bar{2}$) are identical. In the prism zone [100,010] his measurements are, however, not in quite such close agreement and vary amongst themselves. The dislocation of the planes in this zone I have pointed out on p. 151.

The forms {706}, {50$\bar{3}$}, {80$\bar{5}$}, {30$\bar{8}$} and {10$\bar{3}$}, noted by Baumhauer, are not present on my crystals; on the other hand, he finds no definite pyramid planes such as are especially well developed on many of my crystals.

Chemical Analysis.

The following is Jackson's account of his analysis made on portions of crystals II, IV, and VI.

The mineral was examined and analysed as described in a former communication (this Magazine, 1900, vol. xii, p. 289). One quantitative analysis only was made, which gave the following results:—

Weight of mineral taken	=	·7785 gram.
„ $PbCl_2$	=	·5108 „
„ $BaSO_4$	=	1·382 „
„ As_2S_3	=	·3371 „

These give a percentage composition agreeing closely with the formula $4PbS.3As_2S_3$ [1]:—

	Found.	Calculated.
Pb	48·86	48·75
S	24·39	24·61
As	26·42	26·64
	99·67	100·00

The density of the crystals used had been determined as 5·329.

Of the previous analyses made on Binnenthal sulpharsenites of lead, the following one by Uhrlaub in 1855 (No. 8 in the table of analyses, Min. Mag., 1900, vol. xii, 287) appears to be referable to baumhauerite:—

Pb.	S.	As.	Ag.	Total.	Sp. gr.
47·58	24·66	25·74	0·94	98·92	5·405

Dufrenoysite, $2PbS.As_2S_3$.

Literature.

Damour, 1845, Ann. Chim. Phys., ser. 3, vol. xiv, p. 379. Analyses.
Von Waltershausen, 1855, Ann. Phys. Chem. (Poggendorff), vol. xciv, p. 115. Characters and Analyses.
Des Cloizeaux and Marignac, 1855, Ann. des Mines, ser. 5, vol. viii, p. 389. Crystallography.
Vom Rath, 1864, Ann. Phys. Chem. (Poggendorff), vol. cxxii, p. 373. Characters.
Berendes, 1864, Inaug.-dissert. Bonn. Analyses.
Baumhauer, 1894, Zeits. Kryst. Min., vol. xxiv, p. 85. Crystallography.
König, 1894, Zeits. Kryst. Min., vol. xxiv, p. 86. Analysis.
Baumhauer, 1897, Zeits. Kryst. Min., vol. xxviii, p. 551. Crystallography.
Guillemain, 1898, Inaug.-dissert. Breslau. Analyses.

The name dufrenoysite was given by Damour in 1845 after the French mineralogist P. A. Dufrénoy. From his analyses (see p. 167) of the massive material, he deduced the formula $2PbS.As_2S_3$, but, as pointed out by von Waltershausen in 1855, he made his crystallographic observations on the cubic mineral binnite (=tennantite).

[1] This formula, $4PbS.3As_2S_3$, has previously been assigned by Jackson to the new Binnenthal mineral liveingite, of which I have given a preliminary description in Proc. Cambridge Phil. Soc., 1901, vol. xi, p. 239. The analysis of liveingite agrees, however, more closely with the formula $5PbS.4As_2S_3$.

Waltershausen, in 1855, figured a crystal which may be either dufrenoysite, baumhauerite or rathite; it cannot be sartorite on account of the large development of the (010) and (101) faces. The density he gives is 5·393, which agrees fairly well with that of baumhauerite (5·330), but the amount of lead (44·56 per cent.) found by Uhrlaub indicates a mineral lying between sartorite (Pb = 42·68) and baumhauerite (Pb = 48·75).

Des Cloizeaux and Marignac in 1855 described three crystals under the name of dufrenoysite. One of their crystals, of which a drawing is given[1], was of a large size, measuring 33 × 12 × 7 mm.; it had dull and rough faces, but with the hand-goniometer measurements were obtained, which agreed, Des Cloizeaux states, with the angles measured by Heusser on a sartorite crystal which he called binnite. Below is a comparison of these angles with vom Rath's calculated values for sartorite.

Des Cloizeaux (Dufrenoysite).	vom Rath (Sartorite).
$p : a^{\frac{1}{2}} = 31° 50'$	$001 : 011 = 31° 45'$
$p : a^{\frac{1}{4}} = 51 \quad 9$	$001 : 021 = 51 \quad 4$

Vom Rath, in his paper on dufrenoysite, considered this large crystal of Des Cloizeaux's, on account of its size and cleavage, to be dufrenoysite. If, however, importance is to be attached to the measurements of the dome zone, the crystal must be sartorite, as these dome planes are an invariable guide in distinguishing this species. The size is also not unusual for sartorite; I have some crystals nearly as large. The other two crystals described and figured (figs. 3, *3a*, and 4) by Des Cloizeaux and Marignac are without doubt jordanite. Their fig. 3 represents a jordanite crystal twinned about (10$\bar{1}$) (= g^1 of Des Cl.); the plane (010) (= p of Des Cl.) shows characteristic twin lamination, which however is absent in the zone [010,101] (=[p, m] of Des Cl.). Des Cloizeaux lays much stress upon the existence of two cleavages p, good, and g^1, less perfect, at right angles to one another; I have pointed out (Min. Mag. xii, p. 294) similar cleavages, (010) and (10$\bar{1}$), on jordanite.

Vom Rath says in his paper that he knows of only four crystals of dufrenoysite. (1) A crystal measuring 20 × 8 mm., in the possession of Herr Wiser of Zurich, which was brought from the Binnenthal by Dr. Ch. Heusser and lent to vom Rath for measurement. (2) A very large crystal, belonging to Dr. Jordan, over 25 mm. across and weighing 18·5 grams. Vom Rath considered the low density (5·337)

[1] Fig. 2, plate vii of the memoir quoted above.

of the crystal to be due to the cavities it contained. This crystal, he says, has a habit similar to Wiser's crystal. The faces are dull, rough, and pitted, but the horizontal striae on the (111) faces are distinct. Vom Rath does not seem to have been able to measure this crystal; I think it is most probably baumhauerite, not dufrenoysite. (3) Another crystal, about 25 mm. across, was goniometrically measured, and a portion of it was used for analysis. Sp. gr. = 5·569. The percentage of lead found by Berendes was 53·62 and 52·02, while 57·18 is required by the dufrenoysite formula. He considered the deficiency in the lead to be due to loss in analysis. (4) A smaller crystal, now in the Royal University Museum at Berlin; of this crystal he gives no details.

Baumhauer, in 1894, described some loose crystals with rounded terminal faces and with striated and channelled prisms; on one end of some of the crystals the (110) faces are developed. With the hand-goniometer the angle between 100:110 was measured as 42° to 43°. He found the density to be 5·553. The only measurements obtained on the reflecting goniometer were from small crystal fragments lining cavities in the large rough crystals. One of the large crystals was analysed by Professor König, who found that the chemical composition agreed closely with the theoretical one required for dufrenoysite.

Baumhauer in 1897 described a large crystal measuring $18 \times 18 \times 6$ mm. It is deeply striated and furrowed parallel to the macrodiagonal, and on it he recorded eleven new forms.

Guillemain in 1898 gave the results of an analysis confirming the accepted formula of dufrenoysite.

It will be seen from the above summary of the literature that dufrenoysite is a comparatively rare mineral, and that the crystals are usually of a large size.

The axial ratios calculated by vom Rath from his measured angles $001:023 = 45°\,35'$ and $001:101 = 58°\,30'$ are $a:b:c = 0{\cdot}9381:1:1{\cdot}5309$. The present examination of eight crystals proves, however, that this mineral does not crystallize in the rhombic system but in the *oblique* system with the elements:—

$$a:b:c = 0{\cdot}650987:1:0{\cdot}612576;\ \beta = 90°\,33\tfrac{1}{2}'$$

as calculated from $100:101 = 47°\,2\tfrac{1}{4}'$, $101:001 = 43°\,31\tfrac{1}{4}'$ and $010:212 = 77°\,22'$ measured on crystal No. I (p. 167), which gives very sharp reflected images.

The plane (001) of vom Rath is the plane of symmetry (010), his (100) becomes (001), and (010) becomes (100). The parametral plane (111) remains unchanged.

The crucial zone [100,001] is well developed on crystals I and IV, and the faces give very sharp reflections, but as a rule this zone is ill-defined and has rough faces. The pyramid planes in the + and − zones are seldom equally developed, and often only one of these zones is present on the crystals: the face (111) is usually smooth, while $(11\bar{1})$ is deeply striated parallel to the zone-axis [110].

The crystals are sometimes aggregated together in a manner resembling that of twin aggregations: these are described under crystal VI (p. 170).

The following table brings together for comparison the measurements obtained by vom Rath, Baumhauer and myself of the principal faces in the important zones.

	Calculated (Solly).	Rath 1st crystal.	Rath 2nd crystal	Baumhauer 1st crystal.	Baumhauer 2nd crystal.	Solly crystal I.	" II.	" III.	" IV.	" V.
	° ′	° ′	° ′	° ′		° ′	° ′	° ′	° ′	° ′
100 : 101	47 2¼			46 56		47 2			47	
: $10\bar{1}$	46 26¾						46 26			46 27
101 : 001	43 31¼	43 15		43 0	43°–44°	43 31				
$\bar{1}01 : 00\bar{1}$	42 59¾						43 0			42 59
010 : 120	37 31½	37 15		37 24½	37°38′	37 31	37 30	37 31	37 30	37 32
: 230	45 41	45 35		45 38	45 26	45 41		45 41	45 40	45 43
: 110	56 56¼	56 46				57 0	56 58		56 56	
: 021	39 13	39 10	39 12	39 14	39 53	39 13	39 12	39 16		39 14
: 032	47 25	47 24	47 11½	47 22½	47 31	47 25	47 23	47 25		47 24
: 011	58 30½	58 30	58 29	58 33½	57 58½	58 30½	58 29	58 30		58 29
: 012	72 58½	72 58		72 57	72 25	72 57	72 58	73 0		72 50
: 232	56 5			56 12		56 4			56 3	
: $\bar{2}32$	56 20						56 25	56 23		56 21
: 111	65 51¼	65 54		65 51½		65 50			65 51	
: $\bar{1}11$	66 3½						66 3	66 4	66 4	66 3
: 212	77 22	77 29		77 19	77 18	77 22				
: $\bar{2}12$	77 29			77 32½			77 29	77 30		77 29

The planes in the zone [010,101] are usually small, smooth, or finely striated parallel to their intersections, and are associated with numerous minute pyramid planes; while the planes in the zone $[010,10\bar{1}]$ are often largely developed, deeply striated or furrowed, with dull rough surfaces, and sometimes accompanied by planes in the zone $[010,20\bar{1}]$. The planes in the zone [100,010] are very numerous and some of them have high indices; this may be due to a tendency on the part of the crystal to repeated twinning about a plane inclined at a small angle to (010): such distortion in the position of the planes in this zone is often seen in a similar zone on rathite. The planes in the zone [010,001] are very numerous and usually exhibit fine striations parallel to their intersections with one another. The planes (210), (032), (012), (011) are large; while (410), (530), (052), (031) are medium in size; (110) is often well developed, but rough or pitted. The clinopinacoid (010) is sometimes large and smooth, but sometimes small and finely striated, parallel to the zone-axis [100]. The pinacoids (100), (001) are occasionally well developed, and the former shows distinct unsymmetric markings as is illustrated in fig. 6.

Table III contains the list of ninety-nine known forms, of which

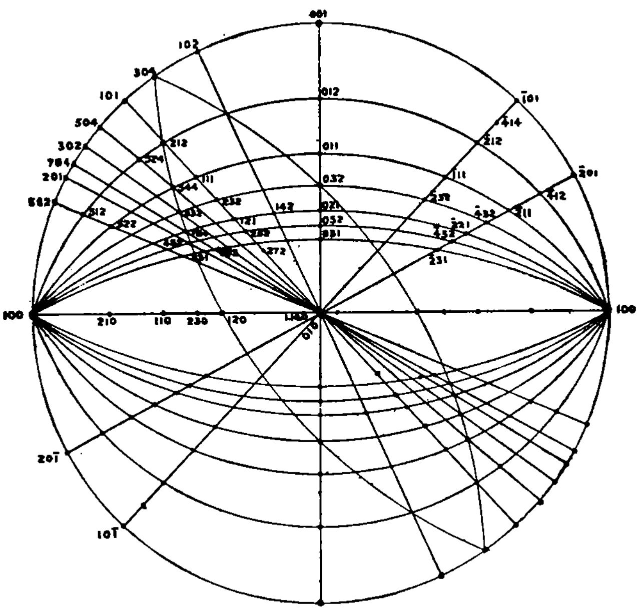

FIG. 5.—Stereographic projection of dufrenoysite, showing most of the observed forms.

seventeen had been recorded by vom Rath and eleven by Baumhauer. Baumhauer's planes (027) = (270) and (049) = (490) I have not found. The positions of many of the forms are indicated in the stereographic projection, fig. 5.

There are two distinct habits:—

Habit I. The crystals are elongated parallel to the zone-axis [100]; the plane (010), parallel to the direction of cleavage, is large and smooth.

The zone [010,001] is largely developed, while the zone [100,010] is small; the pyramid zones are absent or ill-defined (fig. 8).

Habit II. The crystals are elongated along the axis of symmetry; (010) is small and finely striated parallel to its intersections with (001). In the zone [100,001] the planes (100), (101), (001), (10$\bar{1}$) are well developed.

TABLE III.—LIST OF FORMS OBSERVED ON DUFRENOYSITE.

Symbols.	Indices.	Rath.	Baumhauer.	Symbols.	Indices.	Rath.	Baumhauer.	Symbols.	Indices.	Rath.	Baumhauer.
a	100	*b*		$\frac{4}{3}s$	430			$\frac{1}{8}l$	018		
b	010	*c*		$\frac{5}{3}s$	580			$\frac{1}{4}l$	014		
c	001	*a*		2*s*	210			$\frac{1}{5}l$	015		
−*h*	101	{ *m*		8*s*	810			$\frac{1}{6}l$	016		
+*h*	10$\bar{1}$			4*s*	410			$\frac{1}{9}l$	019		
−$\frac{5}{2}h$	502			6*s*	610						
−2*h*	201			14*s*	14·1·0			−$\frac{7}{2}q$	272		
+2*h*	20$\bar{1}$							−$\frac{5}{2}q$	252		
−$\frac{7}{4}h$	704			9*k*	091			−2*q*	121		
−$\frac{3}{2}h$	802			8*k*	081			−$\frac{3}{2}q$	232		{ $\frac{3}{2}P$
−$\frac{5}{4}h$	504			$\frac{11}{2}k$	0·11·2			+$\frac{3}{2}q$	23$\bar{2}$		
−2*i*	102			5*k*	051			− *p*	111	{ *o*	
				$\frac{9}{2}k$	092			+ *p*	11$\bar{1}$		
14*r*	1·14·0			4*k*	041	$\frac{1}{4}d$		−2*t*	212	{ 2*o*	
5*r*	150			$\frac{7}{2}k$	072		207	+2*t*	21$\bar{2}$		
$\frac{7}{2}r$	270		027	3*k*	031		108	+$\frac{4}{3}t$	84$\bar{3}$		
3*r*	180		018	$\frac{11}{4}k$	0·11·4			−4*t*	414		{ 441
$\frac{5}{2}r$	250		025	$\frac{5}{2}k$	052		205	+4*t*	41$\bar{4}$		
$\frac{9}{4}r$	490		049	$\frac{7}{3}k$	073			− *y*	522		
2*r*	120	$\frac{1}{2}f$		$\frac{9}{4}k$	094			−$\frac{1}{2}y$	512		
$\frac{9}{5}r$	590			$\frac{11}{5}k$	0·11·5			−8*u*	281		
$\frac{7}{4}r$	470		047	2*k*	021	$\frac{1}{2}d$		+8*u*	28$\bar{1}$		
$\frac{5}{3}r$	350			$\frac{15}{8}k$	0·15·8			−$\frac{5}{2}u$	452		
$\frac{8}{5}r$	580			$\frac{7}{4}k$	074			+$\frac{5}{2}u$	45$\bar{2}$		
$\frac{3}{2}r$	280	$\frac{2}{3}f$		$\frac{17}{10}k$	0·17·10			+2*u*	22$\bar{1}$		
$\frac{7}{5}r$	570			$\frac{5}{3}k$	058			+$\frac{3}{2}u$	48$\bar{2}$		
$\frac{4}{3}r$	840			$\frac{3}{2}k$	082	$\frac{2}{3}d$		+ *u*	21$\bar{1}$		
$\frac{5}{4}r$	450			$\frac{4}{3}k$	048			+$\frac{1}{2}u$	41$\bar{2}$		
$\frac{6}{5}r$	560			$\frac{5}{4}k$	054			−8*z*	882		
$\frac{7}{6}r$	670			*k*	011	*d*		− *v*	544		
$\frac{12}{11}r$	11·12·0			$\frac{5}{6}l$	056			−$\frac{1}{2}v$	524		
r	110	*f*		$\frac{3}{4}l$	034			−8*Z*	784		
$\frac{12}{11}s$	12·11·0			$\frac{3}{5}l$	035			−9*Y*	598		
$\frac{7}{6}s$	760			$\frac{1}{2}l$	012	2*d*		−4*n*	142		

TABLE IV.—CALCULATED ANGLES OF DUFRENOYSITE.

Zone [100,001]	° ′	° ′	° ′
° ′	010 : 430 = 63 58½	010 : 013 = 78 27½	010 : 412 = 81 47½
100 : 502 = 23 7	: 530 = 68 40	: 014 = 81 17½	Zone [010,20$\bar{1}$]
: 201 = 28 6½	: 210 = 71 58	: 015 = 83 0	010 : 23$\bar{1}$ = 49 20
: 704 = 31 24	: 310 = 77 45½	: 016 = 84 10	: 45$\bar{2}$ = 54 24
: 302 = 35 30	: 410 = 80 45½	: 019 = 86 6	: 22$\bar{1}$ = 60 8½
: 504 = 40 36	: 610 = 83 48½	Zone [010,101]	: 43$\bar{2}$ = 66 45½
: 101 = 47 2½	: 14.1.0 = 87 20	010 : 272 = 32 31	: 21$\bar{1}$ = 74 1½
: 102 = 65 15½	Zone [010,001]	: 252 = 41 44½	: 41$\bar{2}$ = 81 51
: 001 = 90 33½	010 : 091 = 10 16½	: 121 = 48 7	Zone [010,502]
100 : 20$\bar{1}$ = 27 51½	: 081 = 11 32	: 232 = 56 5	010 : 522 = 76 28½
: 10$\bar{1}$ = 46 26½	: 0.11.2 = 16 31½	: 111 = 65 51¼	: 512 = 83 8½
: 00$\bar{1}$ = 89 26½	: 051 = 18 4	: 212 = 77 22	Zone [100,012]
Zone [010,100]	: 092 = 19 56	: 414 = 83 36½	100 : 51$\bar{2}$ = 24 3½
010 : 1.14.0 = 6 15½	: 041 = 22 12	Zone [010,10$\bar{1}$]	: 524 = 41 53½
: 150 = 17 5	: 072 = 25 0	010 : 23$\bar{2}$ = 56 20	: 212 = 48 19
: 270 = 23 40½	: 031 = 28 33	: 34$\bar{3}$ = 59 24	: 012 = 90 32
: 130 = 27 7	: 0.11.4 = 30 41½	: 11$\bar{1}$ = 66 3½	: $\bar{2}$12 = 132 17
: 250 = 31 34	: 052 = 33 8½	: 21$\bar{2}$ = 77 29	: $\bar{4}$12 = 151 4
: 490 = 34 19	: 073 = 34 58½	: 41$\bar{4}$ = 83 40	Zone [100,011]
: 120 = 37 31½	: 094 = 35 57½	Zone [010,102]	100 : 522 = 26 35½
: 590 = 40 28½	: 0.11.5 = 36 34¼	010 : 142 = 41 56½	: 544 = 45 9
: 470 = 41 16½	: 021 = 39 13	Zone [010,504]	: 111 = 51 33
: 350 = 42 40	: 0.15.8 = 41 2½	010 : 544 = 68 15½	: 011 = 90 28½
: 580 = 43 50	: 074 = 43 0½	: 524 = 78 43½	: $\bar{1}$11 = 129 2
: 230 = 45 41	: 0.17.10 = 43 50	Zone [010,302]	: $\bar{2}$11 = 148 13
: 570 = 47 39	: 053 = 44 24	010 : 332 = 61 55	Zone [001,210]
: 340 = 49 2½	: 032 = 47 25	Zone [010,704]	001 : 21$\bar{2}$ = 44 58
: 450 = 50 52	: 043 = 50 45½	010 : 734 = 57 26½	: 210 = 90 31½
: 560 = 52 0	: 054 = 52 33½	Zone [010,201]	: 21$\bar{1}$ = 117 13
: 670 = 52 47	: 011 = 58 30½	010 : 231 = 49 6½	: 21$\bar{2}$ = 133 33½
: 11.12.0 = 54 37	: 056 = 62 57½	: 452 = 54 11½	Zone [001,110]
: 110 = 56 56½	: 034 = 65 19½	: 221 = 60 0½	001 : 111 = 48 34½
: 12.11.0 = 59 10½	: 035 = 69 49	: 432 = 66 35½	: 110 = 90 28
: 760 = 60 50	: 012 = 72 58	: 211 = 73 54	: 11$\bar{1}$ = 131 56½

The physical characters to be noted are the following:—

The colour is lead-grey to steel-grey, and the crystals are seldom tarnished. Streak chocolate colour. Opaque. There is a perfect cleavage parallel to the plane of symmetry (010). Hardness 3. Specific gravity 5·569 (vom Rath), 5·553 (Baumhauer), 5·52 (König), 5·50 (Solly).

Respecting the mode of occurrence, it may be noted that dufrenoysite is found only in isolated crystals in the dolomite or in cavities with similar crystals, unaccompanied by the other minerals commonly found in the dolomite. According to previous observers, only large crystals have been found, while those found since 1898 are small or moderately large. The only known locality is the bed of the Lengenbach, Binnenthal.

The published chemical analyses which have been made of dufrenoysite are collected together in the following table:—

	Pb.	S.	As.	Ag.	Cu.	Fe.	Total.
$2PbS.As_2S_3$	...57·18	22·10	20·72				100·00
König	...57·42	22·55	20·89				100·86
Guillemain	...57·38	21·94	21·01				100·33
„	...56·73	21·18	20·04				97·95
Damour	...56·61	22·30	20·87	0·17	0·22	0·32	100·49
„	...55·40	22·49	20·69	0·21	0·30	0·44	99·53
Berendes	...53·62	23·27	21·76	0·05		0·30	99·00
„	...52·02	23·11	21·35				96·48

Description of Specimens.

The crystallographic observations have been made on eight loose crystals; three crystals on the matrix of dolomite were also examined. All of them have been found since 1898.

The largest specimen is an aggregation of a number of fine crystals resembling habit I; the largest crystal of the group measures about 15 mm. in length and the same in breadth. A small crystal which is described as No. VII was removed from this specimen.

Crystal I. (Fig. 6.)

This crystal, found in 1901, is remarkably brilliant; the planes are very smooth and give sharp reflections. The size is 13 × 10 × 5 mm. It is elongated along the axis of symmetry, and (010) is small (habit II).

Zone [010,100].

	Calculated.	Measured.		Calculated.	Measured.
010 : 130	= 27° 7′	27° 5′	010 : 110	= 56°56¼′	57°
: 120	= 37 31½	37 31	: 12.11.0	= 59 10½	59
: 590	= 40 28½	40 28½	: 760	= 60 50	61
: 470	= 41 16½	41 16	: 530	= 68 40	68 40
: 580	= 43 50	43 50	: 210	= 71 58	71 57
: 230	= 45 41	45 41	: 310	= 77 45½	77 45
: 570	= 47 39	47 39	: 410	= 80 45½	80 45
: 340	= 49 2½	49 2	: 610	= 83 48½	83 48
: 560	= 52 0	52 0	: 14.1.0	= 87 20	87 21
: 670	= 52 47	52 47	: 100	= 90 0	90 0
: 11.12.0	= 54 37	54 40			

The planes (100) and (210) are large. The plane (2Ī0) has a deep furrow across the centre of the face, apparently parallel to the zone-axis [120]. This furrow has been observed on two other crystals; that it is intimately connected with the growth of the crystal is certain, but its crystallographic significance cannot be determined at present.

	Calculated.	Measured.		Calculated.	Measured.
Zone [010,001]					
010 : 031	=28°33	28°33′	010 : 054	=52°33½′	52°32′
: 0.11.4	=30 41½	30 41	: 011	=58 30½	58 30½
: 052	=33 8½	33 8	: 056	=62 57½	63
: 094	=35 57½	35 57	: 034	=65 19½	65 18
: 021	=39 13	39 13	: 012	=72 58½	72 58
: 0.15.8	=41 2½	41	: 013	=78 27½	78 27
: 074	=43 0½	43	: 014	=81 17½	81 17
: 032	=47 25	47 25	: 016	=84 10	84 10
: 043	=50 45½	50 45	: 001	=90 0	90 0

The planes (021), (032), (011), (012) are well developed.

	Measured.		Measured.
Zone [100 : 001]			
100 : 101 =	*47° 2¼	101 : 001 =	*42° 31¼

The planes (100), (101), (001) are well developed. There are some very small planes between (100) and (101) which are probably (502), (201), (704), (302) and (504), but I could obtain no distinct images.

	Calculated.	Measured.		Calculated.	Measured.
Zone [010,101]					
010 : 252	=41°44½′	41°44′	010 : 111	=65°51¼′	65°50′
: 121	=48 7	48 7	: 212	= —	*77 22
: 232	=56 5	56 4	: 101	=90 0	90 0

The plane (212) is very good, and the others are well defined. There are also other small pyramid planes. The planes (544), (524), (332), (784), (452), (522), and (512) were determined by measurement and zones.

	Calculated.	Measured.		Calculated.	Measured.
Zone [100,012]			Zone [100,011]		
100 : 512	=24° 3½′	24°	100 : 522	=26°35½′	27°
: 524	=41 53½	41 50	: 544	=45 9	45
: 212	=48 19	48 19	: 111	=51 33	51 35
: 012	=90 32	90 32	: 011	=90 28½	90 28
Zone [100,021]			Zone [100,052]		
100 : 784	=44 1	43	100 : 452	=44 20	44 15
: 121	=59 30½	59 30	: 252	=63 1	63 0
: 021	=90 21	90 21	: 052	=90 18½	90 19

Zone [304,120] contains the planes (212), (544), (332), (784), (452) and (120).

Zone [010,504] „ „ (524), (544).

Zone [010,502] „ „ (522), (512).

Crystal II. (Fig. 7.)

This crystal I found in 1898; it belongs to habit II. The pyramids +(11$\bar{1}$) and +(21$\bar{2}$) are well developed, while in the negative octant the faces are small. The zone [010,100] is largely developed; [010,001] is medium in size. The plane (010) is small and finely striated parallel to the direction of the zone-axis [100]. The following planes are present:—(010), (001), (091), (052), (094), (0.11.5), (074), (0.17.10), (032), (011), (035), (012), (015), (019), (250), (120), (350), (230), (110), (272), (121), (23$\bar{2}$), (11$\bar{1}$), (21$\bar{2}$), (10$\bar{1}$), (142), (231), (593). The plane (272) is rough and lies in the zone [032,120].

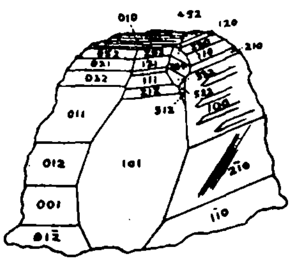

FIG. 6.

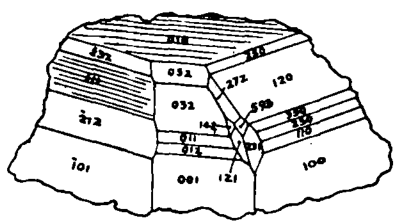

FIG. 7.

Dufrenoysite (Habit II).

	Calculated.	Measured.
001 : $\bar{1}$01	=42°59¾′	43° 0′
010 : 091	=10 16½	10 16
: 0.11.5	=36 34½	36 32
: 0.17.10	=43 50	43 53
: 035	=69 49	69 50
: 015	=83 0	83 1
: 019	=86 6	86 5
: 250	=31 34	31 33
: 350	=42 40	42 43

	Calculated.	Measured.
010 : 23$\bar{2}$	=56°20′	56°18′
: 11$\bar{1}$	=66 3½	66 3
: 21$\bar{2}$	=77 29	77 29
: 10$\bar{1}$	=90 0	90
: 142	=41 57½	41 57
: 231	=49 6½	49 6
: 593	=45 13½	45 14

Crystal III.

A small rounded crystal of habit II.

The following planes are present :—(010), (120), (230), (450), (110), (011), (056), (034), (012), (23$\bar{2}$), (11$\bar{1}$), (21$\bar{2}$), (10$\bar{1}$).

	Calculated.	Measured.
010 : 450	= 50°52′	50°50′
: 11$\bar{1}$	= 66 3½	66 4
: 21$\bar{2}$	= 77 29	77 30

Crystal IV.

A small crystal of habit II with well developed (111) and (11$\bar{1}$), and small (101), (010); the other planes present are (100), (470), (230), (560), (110), (210), (410), (252), (121), (232), (011), (034), (012). The plane (111) is smooth, while (11$\bar{1}$) is striated parallel to the zone-axis [$\bar{1}$10].

	Calculated.	Measured.
100 : 101	= 47° 2¼′	47° 0′
111 : 110	= 41 53½	41 53
110 : 11$\bar{1}$	= 41 28½	41 29

Crystal V.

A small but highly modified crystal of habit II. The faces in the positive octant are well developed. The following planes are present :— (010), (100), (001), (150), (120), (230), (670), (110), (430), (210), (310), (410), (20$\bar{1}$), (10$\bar{1}$), (021), (0.15.8), (074), (0.17.10), (053), (032), (011), (034), (012), (23$\bar{1}$), (45$\bar{2}$), (22$\bar{1}$), (43$\bar{2}$), (21$\bar{1}$), (41$\bar{2}$), (23$\bar{2}$), (34$\bar{3}$), (11$\bar{1}$), (21$\bar{2}$), (41$\bar{4}$).

	Calculated.	Measured.		Calculated.	Measured.
010 : 150	= 17° 5′	17° 3′	010 : 45$\bar{2}$	= 54°24′	54°25′
: 430	= 63 58½	64 0	: 22$\bar{1}$	= 60 8½	60 7
: 053	= 44 24	44 25	: 43$\bar{2}$	= 66 45½	66 45
100 : 20$\bar{1}$	= 27 51½	27 51	: 21$\bar{1}$	= 74 1½	74 1
: 10$\bar{1}$	= 46 26¾	46 27	: 41$\bar{2}$	= 81 51	81 52
: 00$\bar{1}$	= 89 26½	89 26	: 34$\bar{3}$	= 59 24	59 26
010 : 23$\bar{1}$	= 49 20	49 21	: 41$\bar{4}$	= 83 40	83 41

Crystal VI. (Fig. 8.)

This crystal is typical of habit I. The face (010) is large, and the crystal is elongated along the zone-axis [100]. The zone [010,001] is largely developed and finely striated parallel to the zone-axis [100].

Attached to this crystal is a smaller one, which may be a twin growth resembling a growth observed on rathite (Solly, this Magazine, vol. xiii, p. 80). Two distinct images were observed on $\overline{010}$.

	Calculated.	Measured.
010 : $\overline{010}$ twinned about (1.14.0)	= 11°42′	11°57′
,, ,, ,, (1.15.0)	= 12 26	12 21

The planes (001) of each crystal are nearly parallel to one another, but the planes (010), $(0\bar{1}0)$ do not exactly lie in the zone [010,100]. If the crystal were twinned about (001) and (1.14.0) or (1.15.0), such an aggregation as is seen on this crystal VI would be formed. On crystals VII and VIII similar aggregations are found, but the angle between $010:0\bar{1}0$ is 2° 2′ and 1° 12′.

The following planes are present:—(010), (081), (092), (041), (072), (031), (052), (021), (0.15.8), (053), (032), (054), (011), (056), (034), (012), (013), (014), (001), (250), (120), (230), (252), (232), $(11\bar{1})$, $(21\bar{2})$.

	Calculated.	Measured.		Calculated.	Measured.
010:081	=11°32′	11°31′	010:072	=25° 0′	25° ′
:092	=19 56½	19 55	$11\bar{1}:21\bar{2}$	=11 25½	11 25
:041	=22 12	22 12			

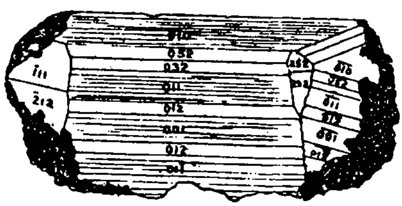

FIG. 8.—Dufrenoysite (Habit I).

Crystal VII.

This crystal of habit I was removed from the large specimen mentioned on page 167. The face (010) is large; the zone $[010,10\bar{1}]$ is deeply striated; the zone [010,101] is small and rough. It exhibits an aggregation similar to crystal VI, as described above.

The following planes are present:—(010), (052), (021), (032), (011), (012), (001), largely developed; (091), (0.11.2), (051), (092), (041), (072), (031), (073), (074), (043), (054), (056), (034), small.

	Calculated.	Measured.
010:0.11.2	=16°31½′	16°31′
:051	=18 4	18 3
:073	=34 58½	34 59

Crystal VIII.

Similar to crystal VII. It exhibits an aggregation similar to VI, as described above.