III-2. Halides and chalcogenides

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NOTATION

a, b, c   unit cell dimensions (U. C. D.) in $\overset{\circ}{A}$

M   number of formula units in the unit cell

D_m measured density in g/cm^3

D_x calculated density in g/cm^3
         (from X-ray data, atomic weight based on ^{12}C and
         $N = 6.0240 \times 10^{23}$ atoms/g-mol)

When the accuracy of the measurements is known, the convention is used that the figures following the ± sign have the same power of ten as does the last significant figure of the reported quantity (i.e. 4.3772 ± 2 should be read as 4.3772 ± 0.0002).

Editor's Note: The transformation temperatures listed in the following tables do not always agree with those given in Part I owing to the experimental difficulties of locating such temperatures accurately. There are also modifications listed in Part III which do not appear in the preceding sections because their formation may depend on the mode of preparation and they are not necessarily stable thermochemically.

TABLE VIII. BINARY COMPOUNDS

Compound	Structural type	Crystal system and space group	U.C.D. (Å)	M	D_x (D_m)	References	Notes
BeO	wurtzite	hexagonal P6₃mc	a = 2.696 c = 4.394		2.99	[1]	
	NaCl or zincblende	cubic	a = 3.796		3.029 (3.01-3.09)	[2]	1
	like Zn and ZnO					[3]	
		hexagonal P6₃mc	a = 2.68 c = 4.36			[4]	
	wurtzite	hexagonal P6₃mc	a = 2.694 c = 4.392	2	3.00 (3.01)	[5, 6]	2 3
	wurtzite	hexagonal P6₃mc	a = 2.6979 c = 4.380		(3.008)	[9]	
		hexagonal	a = 2.70 c = 4.39			[10]	
	wurtzite	hexagonal P6₃mc	a = 2.698 c = 4.379	2	3.01	[11]	
		hexagonal P6₃mc	at 21°C a = 2.6979±1 c = 4.3772±2		(3.0100±3)	[12]	
	wurtzite	hexagonal P6₃mc	c/a = 1.622		3.008	[13]	
BeO (synthetic)	distorted wurtzite type	hexagonal P6₃	a = 2.6979±2 c = 4.3772±2		3.0100	[14]	

Material	Structure / atomic positions	Lattice parameters	Z	Density	Ref.	Notes
BeO	wurtzite, $P6_3mc$, Be in 1/3 2/3 0, 1/3 1/3 1/2, O in 1/3 2/3 Z, 2/3 1/3 1/2 + Z, Z = 0.3786 ± 15	a = 2.6984, c = 4.2770	2		[15]	
BeO ~ amorphous polycrystalline	irradiation effects				[16,17,18]	
		a = 2.6980, c = 4.3762			[19]	see Table IX
		a = 2.6984±2, c = 4.3770±2			[20]	see Table X; Figs 17, 18
BeO					[21,22,23,24]	
BeO	wurtzite, $P6_3mc$	a = 2.693±2, c = 4.370±10			[25]	4
BeO > 2050±25°C	cubic	a = 4.76			[26]	
> 2080±50°C	cubic				[27]	5
BeO (high temp.)	hexagonal $P6_3mc$, 2 Be in 2(b) z = 0.25, 2 O in 2(b) z = 0.625	a = 2.695, c = 4.39	2	3.01	[28]	6
BeO at 2000°C					[28]	(see also 10, and Tables XI, XII) 7
β-form	tetragonal $P4_2/mnm$ (probable), O in 4f, Be in 4g, $x_O = 0.310$, $x_{Be} = 0.336$	a = 4.75, c = 2.74 at 2100°C	4	2.69	[30]	8
β-BeO at 2100°C	related to rutile	a = 4.75, c = 2.74	4	2.69	[32]	9

TABLE VIII (cont.)

Compound	Structural type	Crystal system and space group	U.C.D. (Å)	M	D_x (D_m)	References	Notes
BeS	zincblende (sphalerite)	cubic F$\bar{4}$3m F$\bar{4}$3m	a = 4.853 a = 4.857±5 a = 4.8624±5	4 4 4	(2.36) 2.373	[6] [25] [43]	
BeSe	zincblende	cubic F$\bar{4}$3m	a = 5.129±4	4	4.315	[44]	
BeTe	zincblende	cubic F$\bar{4}$3m	a = 5.615±6	4	5.090	[45]	
BePo	zincblende	cubic F$\bar{4}$3m	a = 5.838±6	4	7.3	[46]	
BeF$_2$	deformed β-cristobalite deformed C9	tetragonal	a = 6.60 c = 6.74	8	(2.1)	[47]	
	similar to α-quartz	hexagonal	a =4.72 c = 5.18			[48]	
	α-quartz	hexagonal	a = 4.76 c = 5.18			[49]	see Fig. 19
γ-BeF$_2$ > 337°C	quartz-like	hexagonal	a = 4.74 c = 5.15			[50]	11
BeF$_2$		cubic hexagonal	a = 6.97 a = 4.750 c = 5.188	8	2.00	[51] [52]	12
BeF$_2$ (high press.)		monoclinic (pseudo hexagonal)	a = 6.88±1 b = 11.92 c = 6.88 β = 120°	16	2.55	[53]	

Compound	Description	Crystal system	Lattice parameters	Z	Density	Ref.	Ref. no.
β-BeF₂ (low temp.) cristobalite		tetragonal	a = 6.608 c = 6.764	8	(2.15)	[54] [133]	13
α-BeF₂ (high temp.) cristobalite		cubic	a = 6.794	8		[54]	
	quartz-like	hexagonal	a = 4.750 c = 5.161	3		[54] [133]	
	resembles very much α-tridymite	b.c.o'r.	a = 10.03±1 b = 13.10±2 c = 16.27±2			[55]	
BeF₂ <420–680°C>		b.c.o'r.	a = 10.03±1 b = 13.10±2 c = 16.30±1			[56]	14
	low cristobalite	tetragonal	a = 6.60 c = 6.74			[57]	
		hexagonal	a = 4.72 c = 5.18			[57]	
BeF₂ at 25°C non-crystalline	β-quartz with 6% random vacancies	hexagonal P6₂2	a = 4.90 c = 5.38 positional parameter u = 0.211			[58]	
BeF₂ vitreous							15,16,17
BeCl₂					(1.901)	[65]	18,19
BeCl₂	Cl in x = 0.109 y = 0.203 z = 0 Be in x = 0 y = 0 z = 0.25	o'rhombic Ibam	a = 9.86 b = 5.36 c = 5.26	4	1.91 (1.899)	[66]	

TABLE VIII (cont.)

Compound	Structural type	Crystal system and space group	U.C.D. (Å)	M	D_x (D_m)	References	Notes
β-BeCl₂ <340-405°C>		b.c.o'r.	a = 16.08 b = 14.48 c = 10.10			[67]	
BeBr₂ α-form		o'rhombic Ibam	a = 10.32 b = 5.52 c = 5.54	4	(3.465) 3.55 (3.465)	[65] [67]	
BeI₂ <350°C Form I		tetragonal	a = 6.12±1 c = 10.63±2	4	(4.325) 4.38 (4.325)	[65] [71]	
>350°C Form II (high temp, pressure)		o'rhombic	a = 16.48±2 b = 16.70±1 c = 11.63±1	32	4.36	[71]	
α-form		o'rhombic Ibam	a = 11.18 b = 5.94 c = 6.04	4	4.35 (4.35)	[67]	
β'-form <290-370°C>		b.c.o'r.	a = 18.00 b = 16.69 c = 11.43			[67]	
β-form >370°C		tetragonal	a = 5.84 c = 5.70	2	4.47	[67]	

NOTES TO TABLE VIII

1. The calculation is not certain.

2. Be-O = 1.71 Å [7].

3. BeO and BeO . H₂O have been studied; Debye-Scherrer diagrams given, but no U.C.D. [8].

FIG. 18.   Change in a-parameter with integrated fission neutron dose.   The dashed line represents the change in a-parameter with dose at 75–100°C for specimens which have not cracked under irradiation [20].
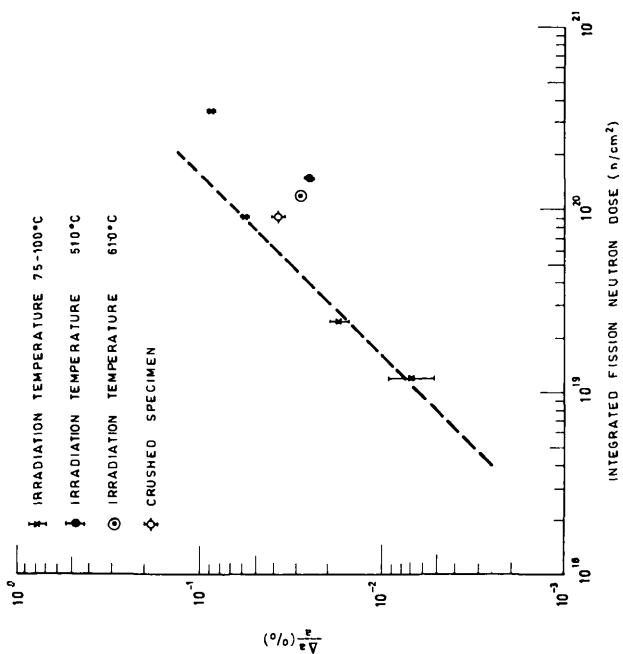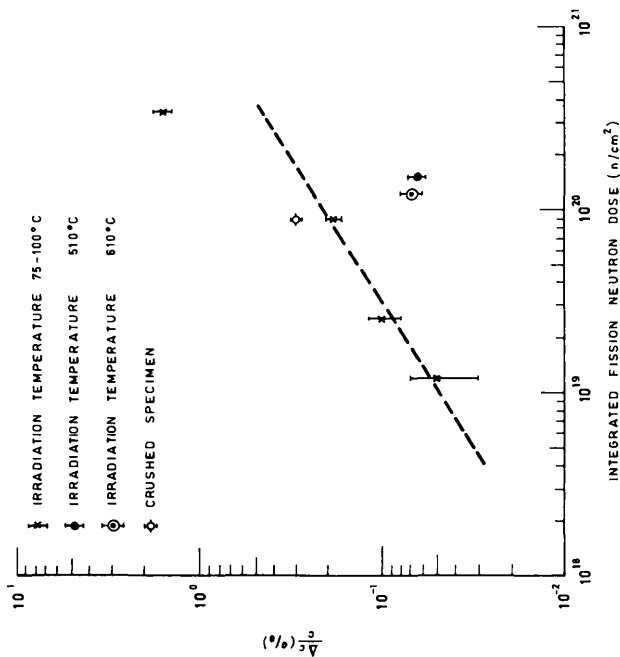
FIG. 17.   Change in c-parameter with integrated fission neutron dose at various irradiation temperatures.   The dashed line represents the change in the c-parameter with dose at 75–100°C for specimens which have not cracked under irradiation [20].

4.   The same structure applies also at 1100°C and 2200°C.

5.   Powder diagram given, but no U.C.D.

6.   Neutron diffraction data.

7.   Neutron diffraction study of high-temperature BeO.   The positions of the Be atoms agree well with X-ray data.

NOTES TO TABLE VIII (cont.)

8.   α(hexagonal) < 2050 ± 50°C < β(tetragonal).   Expansion of single crystals: 5.9 ± 1% in the direction of the c-axis on heating through the transition temperature. X-ray measurements show a 6.3% expansion parallel to the c-axis.

9.   β-BeO crystals (grown on the sample) which are prismatic with a square cross-section. Evidence for tetragonal symmetry.

10. Temperature dependence of lattice constants [33]

Temperature (°C)	c-axis (Å)	c/a
20	2.700	
225	2.703	
400	2.708	1.63(3)
700	2.715	
1000	2.723	

Linear thermal expansion coefficients (β) of a crystal of BeO (hexagonal) [34]

Temperature (°C)	10^{-6} β
20 - 300	8.22
20 - 600	8.44
20 - 1200	9.02

Coefficient of thermal expansion [35]

Temperature (°C)	a-axis (Å)	c-axis (Å)
0 - 1700	11.32×10^{-6}	10.95×10^{-6}
1200 - 1700	14.79×10^{-6}	14.95×10^{-6}

Beryllium oxide exhibits a thermal arrest during rapid heating and cooling.

Transformation temperature = 2144 ± 40°C (heating) [36]
                           = 2062 ± 40°C (cooling) [36]
                           = 2050 - 2100°C   [40]

Temperature dependence of the lattice constants of BeO [38]:

$$a_{t_2} = a_{t_1} + \Delta a_{t_2} \pm X_a$$
$$c_{t_2} = c_{t_1} + \Delta c_{t_2} \pm X_c$$

$$\Delta a_{t_2} = -5.303 \times 10^{-4} + 1.871 \times 10^{-5} (t_2) + 8.064 \times 10^{-9} (t_2)^2 \,\text{Å}$$
$$\Delta c_{t_2} = -7.274 \times 10^{-4} + 2.562 \times 10^{-5} (t_2) + 1.265 \times 10^{-8} (t_2)^2 \,\text{Å}$$

X_a and X_c (see Table XI) are the corrections calculated from the delta equations, for the difference between 28°C and the temperature at which the lattice constants, a_{t_1} and c_{t_1}, have been determined for the BeO material as received.
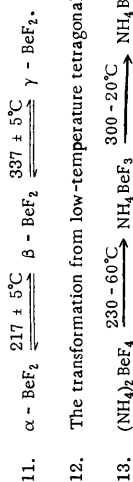
Expansion of BeO [39]:

$$\%_0 = 5.86 \times 10^{-4} (t - 20) + 4.82 \times 10^{-7} (t - 20)^2 - 1.39 \times 10^{-10} (t - 20)^3 \pm 1.44 \times 10^{-2}$$

where t = temperature in °C.

Variation of lattice parameters with temperature [41]:

$$a = (2.6993 \pm 0.0006) [1 + (7.35 \pm 0.3) \times 10^{-6} t + (2.04 \pm 0.19) \times 10^{-9} t^2]$$
$$c = (4.3767 \pm 0.0008) [1 + (6.99 \pm 0.2) \times 10^{-6} t + (1.83 \pm 0.16) \times 10^{-9} t^2]$$
$$c/a = (1.6214 \pm 0.0002) [1 - (4.25 \pm 1.15) \times 10^{-7} t - (1.85 \pm 0.80) \times 10^{-10} t^2]$$

11. $\alpha - BeF_2 \overset{217 \pm 5°C}{\rightleftharpoons} \beta - BeF_2 \overset{337 \pm 5°C}{\rightleftharpoons} \gamma - BeF_2.$

12. The transformation from low-temperature tetragonal BeF_2 to the cubic form has been found to occur at a temperature of 130°C.

13. $(NH_4)_2 BeF_4 \overset{230-60°C}{\longrightarrow} NH_4 BeF_3 \overset{300-20°C}{\longrightarrow} NH_4 Be_2 F_5 \overset{320°C}{\longrightarrow} BeF_2$

$\alpha \overset{130°C}{\rightleftharpoons} \beta$ (stable)

$\alpha \overset{220°C}{\rightleftharpoons} \beta$ (quartz-like modification)

14. $BeF_2 \overset{108-140°C}{--------\!\!\rightarrow}$ high-temperature stable modification.

15. For a review on BeF_2 structures, see Ref.[59].

16. The relations observed in the various binary systems suggest that the quartz structure is the form stable at higher temperatures and that the cristobalite structure is metastable or is the lower temperature modification. Another possibility is that the cristobalite form is the stable phase for only a few (< 5°C) degrees below the melting point of BeF_2 [61].

17. BeF_2 vitreous: The same tetrahedral type as SiO_2 [62]. Glassy BeF_2 is a composite of various structures [63, 64].
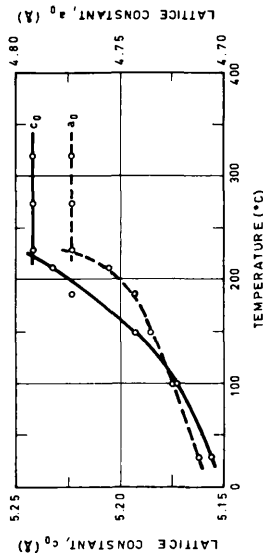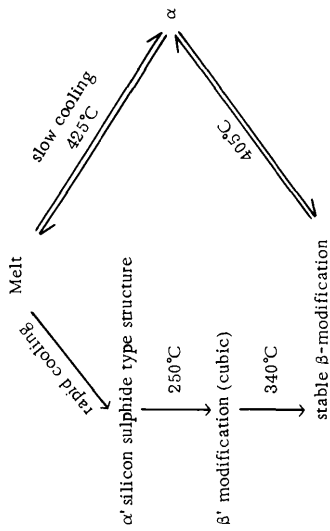

FIG. 19. Curves illustrating change in lattice constants of quartz form of BeF_2 as a function of temperature [61].

NOTES TO TABLE VIII (cont.)

18.   BeCl$_2$ [68]:

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                        α
            slow cooling
              425°C          405°C
        Melt
   rapid cooling
        α' silicon sulphide type structure
             │ 250°C
             ▼
        β' modification (cubic)
             │ 340°C
             ▼
        stable β-modification
```

19.   Theoretical derivation of the relative arrangement of chains in BeCl$_2$ crystals [69].

Vapour phase electron diffraction indicates that the BX$_2$ molecules are linear [70]:

Compound	Be-X (Å)
BeF$_2$	1.40 ± 3
BeCl$_2$	1.75 ± 2
BeBr$_2$	1.91 ± 2
BeI$_2$	2.10 ± 2

TABLE IX. EFFECT OF IRRADIATION ($T_{ir} \cong 400°C$) AND ANNEALING ON THE UNIT CELL DIMENSIONS OF BeO [19]

Characteristics of the material	Period (h)	Density: 3.00 Grain size: 25 μm a-axis (Å)	c-axis (Å)	Density: 2.65 Grain size: 15 μm a-axis (Å)	c-axis (Å)	Density: 2.67 Grain size: 13 μm a-axis (Å)	c-axis (Å)
U.C.D.							
Before irradiation		2.6980	4.3762	2.6980	4.3761	2.6981	4.3766
After irradiation		2.6990	4.3883	2.6991	4.3883	2.6991	4.3883
Annealing temperature (°C)							
350	112			2.6990	4.3881		
450	50			2.6990	4.3877		
	100			2.6989	4.3882		
500	1/4			2.6988	4.3874		
	1/2	2.6990	4.3876	2.6988	4.3884		
	1	2.6989	4.3882	2.6988	4.3884		
	2			2.6988	4.3885		
	4			2.6986	4.3884		
	8			2.6988	4.3879		
600	1/4	2.6987	4.3879	2.6989	4.3883		
	1/2	2.6988	4.3879	2.6988	4.3883		
	1	2.6988	4.3882	2.6989	4.3881		
	2	2.6989	4.3878	2.6988	4.3882		
	4	2.6989	4.3878	2.6988	4.3881		
	8	2.6988	4.3880				

TABLE IX (cont.)

Characteristics of the material		Density: 3.00 Grain size: 25 μm		Density: 2.65 Grain size: 15 μm		Density: 2.67 Grain size: 13 μm	
U.C.D.		a-axis (Å)	c-axis (Å)	a-axis (Å)	c-axis (Å)	a-axis (Å)	c-axis (Å)
Before irradiation		2.6980	4.3762	2.6980	4.3761	2.6981	4.3766
After irradiation		2.6990	4.3883	2.6991	4.3883	2.6991	4.3883
Annealing temperature (°C)	Period (h)						
700	1/4	2.6987	4.3883	2.6988	4.3881		
	1/2	2.6987	4.3877	2.6987	4.3886		
	1	2.6988	4.3881	2.6987	4.3883		
	2	2.6987	4.3878	2.6996	4.3885		
	4	2.6986	4.3878	2.6987	4.3881		
	8	2.6987	4.3880	2.6987	4.3881		
800	1/4	2.6986	4.3885	2.6995	4.3881		
	1/2	2.6987	4.3878	2.6986	4.3877		
	1	2.6986	4.3882	2.6986	4.3877		
	2	2.6987	4.3880	2.6985	4.3880		
	4	2.6986	4.3883				
	8	2.6986	4.3880				
820	1/4					2.6988	4.3874
	2			2.6986	4.3883		
	4			2.6985	4.3883		

Characteristics of the material		Density: 3.00 Grain size: 25 μm		Density: 2.65 Grain size: 15 μm		Density: 2.67 Grain size: 13 μm	
U.C.D.		a-axis (Å)	c-axis (Å)	a-axis (Å)	c-axis (Å)	a-axis (Å)	c-axis (Å)
Before irradiation		2.6980	4.3762	2.6980	4.3761	2.6981	4.3766
After irradiation		2.6990	4.3883	2.6991	4.3883	2.6991	4.3883
Annealing temperature (°C)	Period (h)						
820 (cont.)	8						
	50			2.6985	4.3885	2.6985	4.3872
	100					2.6985	4.3871
875	1/4					2.6984	4.3875
	1/2					2.6986	4.3871
	1					2.6985	4.3869
	2					2.6984	4.3871
	4					2.6987	4.3869
	8					2.6987	4.3872
900	1/4	2.6986	4.3880	2.6985	4.3885		
	1/2	2.6986	4.3879	2.6985	4.3884		
	3/4			2.6985	4.3880		
	1	2.6987	4.3878				
	1½			2.6985	4.3880		
	2	2.6986	4.3879				

TABLE IX (cont.)

Characteristics of the material		Density: 3.00 Grain size: 25 µm		Density: 2.65 Grain size: 15 µm		Density: 2.67 Grain size: 13 µm	
U.C.D.		a-axis (Å)	c-axis (Å)	a-axis (Å)	c-axis (Å)	a-axis (Å)	c-axis (Å)
Before irradiation		2.6980	4.3762	2.6980	4.3761	2.6981	4.3766
After irradiation		2.6990	4.3883	2.6991	4.3883	2.6991	4.3883
Annealing temperature (°C)	Period (h)						
900 (cont.)	3			2.6985	4.3879		
	4	2.6986	4.3875				
	6			2.6985	4.3878		
	12			2.6985	4.3875		
1000	1/4					2.6985	4.3873
	1/2					2.6984	4.3863
	1					2.6985	4.3865
	2					2.6984	4.3862
	4					2.6984	4.3859
	8					2.6983	4.3857
1100	1/4					2.6984	4.3847
	1/2					2.6983	4.3846
	1					2.6983	4.3839
	2					2.6981	4.3831
	4					2.6981	4.3822

Characteristics of the material		Density: 3.00 Grain size: 25 μm		Density: 2.65 Grain size: 15 μm		Density: 2.67 Grain size: 13 μm	
U.C.D.		a-axis (Å)	c-axis (Å)	a-axis (Å)	c-axis (Å)	a-axis (Å)	c-axis (Å)
Before irradiation		2.6980	4.3762	2.6980	4.3761	2.6981	4.3766
After irradiation		2.6990	4.3883	2.6991	4.3883	2.6991	4.3883
Annealing temperature (°C)	Period (h)						
1100 (cont.)	8					2.6981	4.3811
	16					2.6982	4.3793
	24					2.6980	4.3779
	32					2.6982	4.3778
	40					2.6982	4.3779
	55					2.6982	4.3779
	70					2.6982	4.3777
	86					2.6981	4.3774

Note: The accuracy of a and c is ± 0.0002 Å and ± 0.0005 Å, respectively.

TABLE X. LATTICE PARAMETER CHANGES FOR SPECIMENS IRRADIATED UNDER VARIOUS CONDITIONS [20]

Specimen group	Dose (nvt)	Irradiation temperature (°C)	State of specimen	Δc/c (%)	Δa/a (%)
A	1.2×10^{19}	75 - 100	solid	0.04 ± 0.02	0.008 ± 0.001
B	2.5×10^{19}	75 - 100	solid	0.09 ± 0.02	0.018 ± 0.001
C	9×10^{19}	75 - 100	solid	0.19 ± 0.02	0.056 ± 0.001
C	-	-	crushed	0.31 ± 0.02	0.035 ± 0.001
D	3.5×10^{20}	75 - 100	weak and friable	1.4 ± 0.2	0.086 ± 0.001
E	1.2×10^{20}	510 ± 5	solid	0.065 ± 0.02	0.026 ± 0.001
F	1.1×10^{20}	610 ± 5	solid	0.07 ± 0.02	0.027 ± 0.001
G	1.5×10^{20}	650 ± 5	solid	-	-

TABLE XI. ROOM-TEMPERATURE CORRECTION FACTORS[a] [38]

Temperature (°C)	X_a [b] (Å)	X_c [b] (Å)
16	+ 0.00022	+ 0.00031
17	+ 0.00020	+ 0.00028
18	+ 0.00019	+ 0.00026
19	+ 0.00017	+ 0.00023
20	+ 0.00015	+ 0.00020
21	+ 0.00013	+ 0.00018
22	+ 0.00011	+ 0.00015
23	+ 0.00009	+ 0.00013
24	+ 0.00007	+ 0.00010
25	+ 0.00005	+ 0.00007
26	+ 0.00003	+ 0.00005
27	+ 0.00001	+ 0.00002
28	0.00000	0.00000
29	- 0.00001	- 0.00002
30	- 0.00003	- 0.00005
31	- 0.00005	- 0.00007
32	- 0.00007	- 0.00010
33	- 0.00009	- 0.00013
34	- 0.00011	- 0.00015
35	- 0.00013	- 0.00018

[a] These values are added to, or subtracted from, the room temperature lattice-constant values.

[b] X_a and X_c are the corrections calculated from the delta equations, for the difference between 28°C and the temperature at which the lattice constants, a_{t_1} and c_{t_1}, have been determined for the BeO material as received.

TABLE XII. COMPARISON OF BeO EXPANSION VALUES AT 100°C INTERVALS TO 2000°C [38]

Temperature (°C)	Ref. [38]			U.S. Bureau of Mines [a]			NBS [b] Dilat. (%)
	a-axis (%)	c-axis (%)	Average [c] (%)	a-axis (%)	c-axis (%)	Average [c] (%)	
28	0.00_0	0.00_0	0.00_0	0.00^d	0.00^d	0.00^d	0.00 (0.00)
100	0.05_1	0.04_2	0.04_8	0.05	0.04	0.05	-
200	0.12_9	0.10_9	0.12_3	0.12	0.10	0.11	0.12 (0.10)
300	0.21_3	0.18_2	0.20_3	0.20	0.17	0.19	-
400	0.30_3	0.26_0	0.28_9	0.28	0.25	0.27	0.28 (0.26)
500	0.40_0	0.34_5	0.38_1	0.37	0.33	0.36	-
600	0.50_2	0.43_5	0.47_9	0.47	0.42	0.45	0.48 (0.45)
700	0.61_0	0.53_1	0.58_3	0.57	0.51	0.55	-
800	0.72_4	0.63_2	0.69_3	0.68	0.61	0.66	0.69 (0.65)
900	0.84_4	0.74_0	0.80_9	0.80	0.71	0.77	-
1000	0.97_0	0.85_3	0.93_1	0.92	0.83	0.89	0.92
1100	1.10_2	0.97_2	1.05_9	1.05	0.94	1.01	-
1200	1.24_0	1.09_7	1.19_2	1.19	1.07	1.15	1.16
1300	1.38_4	1.22_8	1.33_2	1.33	1.20	1.28	-
1400	1.53_4	1.36_4	1.47_7	1.48	1.33	1.43	1.40
1500	1.69_0	1.50_7	1.62_9	1.63	1.48	1.58	-
1600	1.85_2	1.65_5	1.78_6	1.79	1.62	1.74	1.66

Temperature (°C)	Ref. [38]			U. S. Bureau of Mines [a]			NBS [b] Dilat. (%)
	a-axis (%)	c-axis (%)	Average [c] (%)	a-axis (%)	c-axis (%)	Average [c] (%)	
1700	2.02_0	1.80_9	1.95_0	1.96	1.78	1.90	1.78
1800	2.19_4	1.96_8	2.11_9	2.13	1.94	2.07	-
1900	2.37_4	2.13_4	2.29_4	2.31	2.11	2.24	-
2000	2.56_0	2.30_6	2.47_6	2.50	2.28	2.43	-

[a] Grain, Campbell (1962). The values listed were computed from the reported data; those at 1200°C and above were extrapolated from the lower temperature data.

[b] Geller, Yavorsky (1954). The values in parentheses were determined interferometrically; the others were determined using a sapphire-rod dilatometer.

[c] Hidnert, Souder (1950). A computational method for calculating the bulk (average) linear expansion.

[d] These data were reported to begin at 25°C.

TABLE XIII. TERNARY COMPOUNDS

Compound	Structural type	Crystal system and space group	U.C.D. (Å)	M	D_x (D_m)	References	Notes
BeAl₂O₄ (chrysoberyl)	olivine	o'rhombic Pnma	a = 9.390 b = 5.470 c = 4.420	4	3.710 (3.60-3.86)	[72,73]	
	olivine	o'rhombic Pnma	a = 9.404 b = 5.4756 c = 4.4267	4	3.699	[74,75,76]	
		o'rhombic	a = 4.43 b = 9.41 c = 5.48 (see Table XIV)			[77]	1 see Table XIV
BeAl₆O₁₀						[78,79]	2
BeO-CaO						[81]	3
Be₃Ca₂O₅		cubic Fm3m	a = 14.00±1	24	2.71 (2.70)	[82]	4
Be₁₇Ca₁₂O₂₉		cubic F43m	a = 14.023±5	4	2.64±1	[83]	
BeCr₂O₄		o'rhombic Pnma	a = 9.792 b = 5.663 c = 4.555	4	4.654 (4.42)	[84] [85]	5 see Fig.20
	chrysoberyl	o'rhombic Pnma	a = 10.0 b = 5.8 c = 4.5		(1.13)	[86]	6
BeFe₂O₄						[87]	
BeGa₂O₄						[88]	
BeGa₄O₇		hexagonal	a = 7.78 c = 2.98			[85]	7

Compound	Structure type	System / Space group	Lattice parameters	Z	Density	Ref	Notes
Be₂Gd₄O₅ (metastable)		o'rhombic	a = 3.603±3, b = 9.85±3, c = 10.51±2			[89]	
Be₂GeO₄	phenacite	trigonal R̄3	a = 12.65, c = 8.37			[90]	
	phenacite	trigonal R̄3	a = 12.77±1, c = 8.41±1		3.868	[91]	
		trigonal R̄3	a = 12.756, c = 8.425	18	3.892	[92, 84]	
	phenacite	trigonal R̄3	a = 12.745±3, c = 8.434±2	18		[93]	see Figs 21-24
Be₁₂GeO₂₀		cubic	a = 10.145±5			[303]	
β-Be(OH)₂	Zn(OH)₂ (C31)	o'rhombic (pseudo-tetragonal) P2₁2₁2₁	a = 4.621±5, b = 7.039±8, c = 4.535±5	4	1.94 (1.924)	[94]	
Be(OH)₂ (metastable)		tetragonal	a = 10.88, c = 7.83			[95]	
BeIn₂O₄		cubic I2₁3	a = 10.10			[97]	
Be₂La₂O₅		monoclinic C2/c	a = 7.5356±6, b = 7.3476±17, c = 7.4387±6, β = 91°33'±1'	4	6.061±3	[98]	
		o'rhombic	a = 3.81, b = 9.95, c = 11.07	4		[99]	8
Be₂La₆O₁₁		hexagonal				[99]	8

TABLE XIII (cont.)

Compound	Structural type	Crystal system and space group	U.C.D. (Å)	M	D_x (D_m)	References	Notes
$Be_2Li_2O_3$		monoclinic	$a = 14.89 \pm 1$ $b = 5.020 \pm 5$ $c = 8.547 \pm 7$ $\beta = 101.6 \pm 2°$	12	2.54 (2.52)	[100]	9
		pseudo-rhombic	$a_{hex} \approx b = 4.98 \pm 5$ $c_{hex} = 43.72 \pm 5$			[100]	
$Be_4N_6O_{17}$		cubic Pa3	$a = 14.04 \pm 2$	8	2.04 (2.05 ± 1)	[101, 102]	
$Be(PO_3)_2$		monoclinic $P2_1/n$	$a = 6.966 \pm 4$ $b = 12.875 \pm 8$ $c = 4.844 \pm 3$ $\beta = 106.73 \pm 2°$	4		[103]	
$BeSO_4$	BPO_4 $BaAsO_4$ 2Be in 2(c) 0 1/2 1/4 2S in 2(a) 0 0 0 8O in 8(g) 0.14 0.24 0.13	tetragonal $I\bar{4}$	$a = 4.488$ (average) $c = 6.90$	2	2.542 (2.443)	[110] [105, 106, 108]	10
$\beta\text{-}BeSO_4$ <590–635°C>		o'rhombic (pseudo-tetragonal)	$a = 6.58 \pm 1$ $b = 4.606 \pm 5$ $c = 4.675 \pm 5$		2.51 2.46 (2.54)	[106] [107]	
$\gamma\text{-}BeSO_4$ >635°C		f.c.c.	$a = 6.65 \pm 3$			[107]	

Compound	Type	System / Space group	Lattice parameters	Z	Density	Ref.	Figs
BeSeO₄							
Be₂SiO₄	phenacite	trigonal R3̄	a = 12.46 ⎫ average c = 8.24 ⎭	18	2.967 (2.97–3.00)	[109]	11
Be₂SiO₄ synthetic	phenacite	trigonal R3̄	a = 12.42±1 c = 8.24±1		2.985	[112, 113, 114, 115, 116]	
Be₂SiO₄ natural	phenacite	trigonal R3̄	a = 12.43±1 c = 8.24±1		2.983	[91]	
	phenacite	trigonal R3̄	a = 12.472 c = 8.252	18	2.960	[91]	
	phenacite	trigonal R3̄	a = 12.474±3 c = 8.251±2			[117, 118]	see Figs 21, 23, 25, 26
Be₃SrO₄		hexagonal P6̄2c	a = 4.5961±2 c = 8.9300±4	2	3.6306±5 (3.4±1)	[93]	
Be₃Sc₂O₅		o'rhombic	a = 7.13±1 b = 9.01±1 c = 18.5±1	10	3.94±4 (3.84±5)	[119]	
Be₉Sc₂O₁₁		hexagonal	a = 4.60 c = 8.94			[82]	12
(BeO)₀.₁ (TiO₂)₀.₉	rutile	tetragonal	a = 4.585 c = 2.952			[120, 121]	13
BeTiO₃						[122]	
Be₂TiO₄						[123]	
BeY₂O₄		o'rhombic Pmcn	a = 3.5315±5 b = 9.8989±10 c = 10.4000±10	4	4.582±2	[123]	
BeY₂O₅		o'rhombic Pmcn?	a = 3.51±1 b = 9.88±1 c = 10.36±2	4	5.10±3 (5.10±2)	[124] [82]	

TABLE XIII (cont.)

Compound	Structural type	Crystal system and space group	U.C.D. (Å)	M	D_x (D_m)	References	Notes
BaBeF$_4$	BaSO$_4$	o'rhombic Pnma	a = 8.73 b = 5.65 c = 6.613	4	4.53 (4.17)	[125, 126]	
		o'rhombic	a = 8.89 b = 5.311 c = 7.302	4	4.45 (4.17)	[127]	
		o'rhombic	a = 8.89 b = 5.31 c = 7.01	4	4.40 (4.17)	[128]	see Table XV
		For solid solution see Table XV					
BeCaF$_4$		tetragonal	a = 6.64 c = 6.22			[129]	
		tetragonal I4$_1$/amd	a = 6.90±2 c = 6.07±1			[130]	
γ-BeCsF$_3$		o'rhombic	a = 7.19 b = 4.45 c = 11.98	4	3.45 (3.43)	[132]	
BeCsF$_3$		o'rhombic Bmmb or Bm2b or B2mb	a = 6.09 b = 4.81 c = 12.88	4		[131]	
BeCs$_2$F$_4$		o'rhombic Pna2$_1$	a = 8.20±2 b = 10.89±2 c = 6.32±1	4		[135]	
β-BeCs$_2$F$_4$		o'rhombic	a = 10.81 b = 6.22 c = 8.01	4	4.32 (4.23)	[132]	

BeCs₃F₅	SiSr₃O₅	tetragonal P4/ncc	a = 7.983±2 c = 11.775±7	4	4.42	[136]	
α-Be₂CsF₅		hexagonal	a = 4.78 c = 6.55	1		[134]	
β-Be₂CsF₅		o'rhombic	a = 7.00 b = 8.21 c = 8.81	4		[132]	
BeKF₃	BeNH₄F₃	o'rhombic	a = 5.475±1 b = 4.514±1 c = 12.080±5	4	2.34 (2.33)	[137]	
BeK₂F₄	K₂SO₄	o'rhombic	a = 5.704±3 b = 9.916±4 c = 7.28±1	4	2.63	[139]	14
	K₂SO₄	o'rhombic Pmcn	a = 5.63 b = 9.83 c = 7.29	4	2.69 (2.649)	[140]	
		o'rhombic Pn2₁a	a = 7.35 b = 5.75 c = 9.91			[141]	15
BeK₃F₅		tetragonal P4/ncc	a = 7.1785±5 c = 10.742±6	4	2.66	[136]	
Be₂KF₅		hexagonal	a = 4.58 c = 6.06	1		[134]	
		o'rhombic	a = 4.63 b = 7.94 c = 6.04	2	2.27	[138]	16
BeLiF₃	similar to pyroxenes					[130]	
BeLi₂F₄	phenacite	trigonal R3̄	a = 13.25 } average c = 8.89	18		[130, 142, 143, 144, 145, 304]	

TABLE XIII (cont.)

Compound	Structural type	Crystal system and space group	U.C.D. (Å)	M	D_x (D_m)	References	Notes
BeLi₂F₄ α-form	phenacite	trigonal R3̄	a = 13.105±2, c = 8.842±2			[133, 50]	17
		o'rhombic	a = 10.08±3, b = 12.45±2, c = 4.92±1			[130]	18
		o'rhombic	a = 13.23, b = 8.87, c = 22.9			[144]	
(high-temp. form)		hexagonal or tetragonal	a_hex = 8.06, c_hex = 12.65, a_tetr = 7.63, c_tetr = 8.83 } at 420°C			[130]	
γ-BeLi₂F₄	spinel	cubic	a = 6.08±2			[50]	
			a = 12.16±4			[133]	
BeNaF₃ <343°C	wollastonite β-CaSiO₃	monoclinic P2₁/b	a = 15.25, b = 7.17, c = 6.93, β = 95±2°	12	2.35 (2.35)	[48, 61, 146, 147]	
>343°C	structure different					[61]	
BeNa₂F₄ <325-578°C>	α-K₂SO₄	hexagonal	a = 5.32, c = 7.08 } at 340°C		2.508	[152]	19
α-form	glaserite	hexagonal P3̄m1	a = 5.24, c = 6.92 } at 300°C	2		[130, 61]	
			a = 5.27, c = 6.96 } at 450°C	2	(2.60)	[130]	

Compound	Structure type	Crystal system / space group	Lattice parameters	Z	Density	Refs	No.
$BeNa_2F_4$ α'-form	low K_2SO_4	o'rhombic Pmcn (at 240–250°C)	a = 5.22 b = 9.40 c = 6.72	4	2.64 (2.64)	[130]	20
β-form		monoclinic	a = 5.50 b = 6.75 c = 9.30 β ≈ 95°	4	2.53 (2.65) at 20°C	[130,61]	
γ-form	olivine	o'rhombic Pnma	a = 10.91 b = 6.58 } average c = 4.90	4	2.47 (2.47, 2.45)	[133,148,149, 150,151]	
	olivine	o'rhombic Pnma	a = 10.90±4 b = 6.56±2 c = 4.89±2	4	2.488 (2.471)	[153,130]	
		o'rhombic Pnma	a = 10.925±15 b = 6.572±1 c = 4.896±1			[154]	
γ₂-form		trigonal	a = 4.93±3 c = 8.98±3			[130]	21
γ'-form (187–265°C)		monoclinic	a = 5.59 b = 8.06 c = 7.90 β = 80°40'	4	2.48 (2.477)	[152]	
δ-form		hexagonal	a = 8.314 c = 4.86	3	2.24 (2.41)	[155]	
$BeNa_3F_5$	$SiCa_3O_5$	trigonal R3m	a = 6.90±1 c = 24.36±3	9		[130]	
$Be_2Na_3F_7$		o'rhombic	a = 4.89 b = 11.09 c = 21.49	8		[305]	
$BeRbF_3$	$BaSiO_3$ (high temp.)	o'rhombic	a = 5.789 b = 4.619 c = 12.87	4		[156,158]	22

TABLE XIII (cont.)

Compound	Structural type	Crystal system and space group	U.C.D. (Å)	M	D_x (D_m)	References	Notes
BeRbF₃ (cont.)	BaSiO₃ (high temp.)	o'rhombic Pmmm?	a = 5.82 b = 4.53 c = 12.57	4	3.04 (3.03)	[157]	
		o'rhombic P2₁2₁2₁	a = 5.74 b = 4.64 c = 12.38	4		[131]	
BeRb₂F₄	K₂SO₄ (low temp.)	o'rhombic Pcmn	a = 10.14 b = 5.86 } average c = 7.68	4	3.74 (3.243) 3.69 (3.64)	[140] [140] [157] [157, 162]	
		o'rhombic Pn2₁a	a = 7.66 b = 5.86 c = 10.10			[141]	
BeRb₃F₅	SiSr₃O₅	tetragonal P4/ncc	a = 7.563±3 c = 11.196±10	4	3.77	[136]	
γ-Be₂RbF₅		o'rhombic	a = 4.68 b = 8.00 c = 6.17	2	2.85 (2.809)	[159]	23
Be₂RbF₅		monoclinic (pseudo-o'rhombic) C2/m	a = 7.99 b = 4.70 c = 6.12 β ≈ 90°	2	(2.809)	[160, 161]	
Be₂RbF₅		triclinic C1̄ or C1	a = 7.98 b = 4.69 c = 6.12 α = 89°40' β = 91° γ = 90°27'			[160, 161]	

BeSrF$_4$	o'rhombic	a = 6.787 b = 8.307 c = 5.291	4	3.87 (3.87)	[163]
BeTl$_2$F$_4$	o'rhombic Pmcn	a = 5.87 b = 10.43 c = 7.68	4	5.70 (6.650)	[140]
Be(NH$_4$)$_2$Cl$_4$	o'rhombic Pnma	a = 11.90 b = 9.15 c = 6.90	4	1.65	[164]
BeK$_2$Cl$_4$	o'rhombic Pnma	a = 11.94 b = 8.80 c = 6.86	4	2.11	[164]
BeNa$_2$Cl$_4$	o'rhombic	a = 13.36 b = 8.12 c = 6.06	4	1.99 (1.98)	[306]

NOTES TO TABLE XIII

1. About 70% of the Al^{3+} ions in chrysoberyl can be replaced by V^{3+} ions. The cell dimensions of the orthorhombic cell increase [77].

2. The existence is deduced by powder methods.

3. BeO.CaO and BeO.MgO studied, but no U.C.D. reported.

4. The results are in good agreement with those reported by ADER, M., BINGLE, J., Argonne National Lab., Chem. Eng. Div. Quarterly Progress Report (April–June 1956) p.106.

5. The two compounds (BeO.Al$_2$O$_3$ and BeO.Cr$_2$O$_3$) form a complete series of solid solutions (Fig.20). The following compounds have been reported (no U.C.D.): 3BeO.B$_2$O$_3$; BeO.3Al$_2$O$_3$; nBeO.La$_2$O$_3$; and nBeO.Y$_2$O$_3$. No reaction has been observed between BeO and Sc$_2$O$_3$, In$_2$O$_3$ and Fe$_2$O$_3$.

6. The systems BeO-TiO$_2$; BeO-TiO$_2$-ZrO$_2$; BeO-CeO$_2$; BeO-CeO$_2$-ZrO$_2$; BeO-ZrO$_2$; BeO-Cr$_2$O$_3$; BeO-Cr$_2$O$_3$-ZrO$_2$ have been studied, but no U.C.D. given.

7. Powder diagram reported, but no U.C.D.

NOTES TO TABLE XIII (cont.)

8. $Be_2La_6O_{11}$ seems to exist in a homogeneous range $3La_2O_3 \cdot 2BeO\text{-}La_2O_3 \cdot BeO$. The results for $La_2Be_2O_5$ are not in good agreement with those reported in Ref. [98].

9. c_{hex} coincides with a_{monocl}.

10. Reversible transitions of $BeSO_4$ found at 588°C and 639°C. Powder diagrams of $BeSO_4 \cdot 2H_2O$ and $BeSO_4$ given.

11. Powder diagrams without indexing have been given for $BeSeO_4$, $BeSeO_4 \cdot 4H_2O$, and $BeSeO_4 \cdot 2H_2O$.

12. Formed by heating $2SrO(OH)_2 \cdot 9Be(OH)_2$ to 1000°C.

13. No change of the lattice dimensions found when the parameters of pure TiO_2 were compared with $0.9\ TiO_2$, $0.1\ BeO$ composition. $BeO\text{-}TiO_2$ form no compounds with each other.

14. K_2BeF_4 is of the same type as K_2SO_4; they form together a continuous series of solid solutions.

15. The C_{2v}^9-$Pn2_1a$ space group is given on the basis of crystal structure analysis and not D_{2h}^{16}-$Pbnm$ as in Ref. [139].

16. The powder photographs are better indexed on the basis of an orthorhombic cell than on a hexagonal one. Compare Ref. [134].

17. Li_2BeF_4 has two polymorphic transitions at 178±5°C and 362±5°C.

18. Possibly a hydrate.

19.
$$(H_2O)\ 187\pm5°C\ \gamma' \xleftrightarrow{265\pm15°C} \alpha' \xleftrightarrow{326\pm5°C} \alpha \xleftrightarrow{578\pm5°C} liquid$$
with 175 ± 15, $93\pm5°C$, $53\pm5°C$, β, γ.

$BaNa_2F_4$ - forms
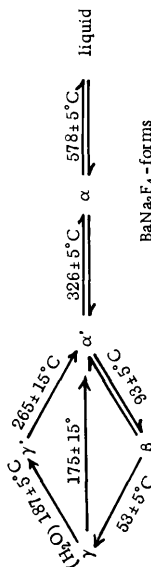
20. Heating: $\gamma \xrightarrow{225°C} \alpha' \xrightarrow{320°C} \alpha\text{-}Na_2BeF_4$.

   Cooling: $\alpha\text{-}Na_2BeF_4 \xrightarrow{rapidly} \alpha' \xrightarrow{115°C} \beta \xrightarrow{crushing} \gamma$-form

   metastable

21. γ_2-Na_2BeF_4 may be a hydrate.

22. α-$RbBeF_3 \xrightarrow{322°C} \beta$.

   α-$Rb_2BeF_4 \xrightarrow{692°C} \beta \xrightarrow{528°C} \gamma$.

23. There are three polymorphic forms of $RbBe_2F_5$:
$$\gamma \xleftrightarrow{80°C} \beta \xleftrightarrow{301°C} \alpha \xleftrightarrow{462°C} liquid.$$

FIG. 21. Variation of lattice constants in the system Be_2SiO_4-Be_2GeO_4 [93].

FIG. 20. Variation of unit cell parameters in the solid solution series BeO, Al_2O_3-BeO, Cr_2O_3 [85].
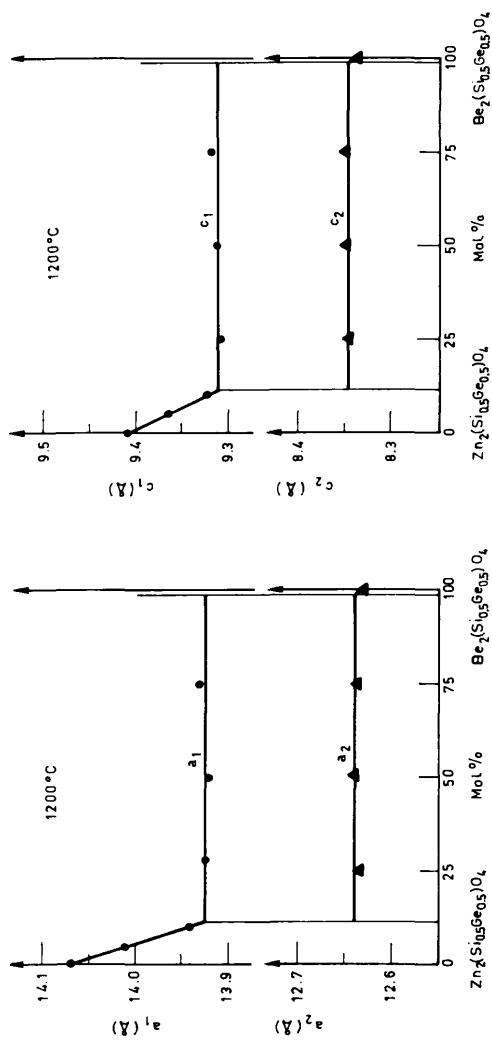
NOTES TO TABLE XIII (cont.)
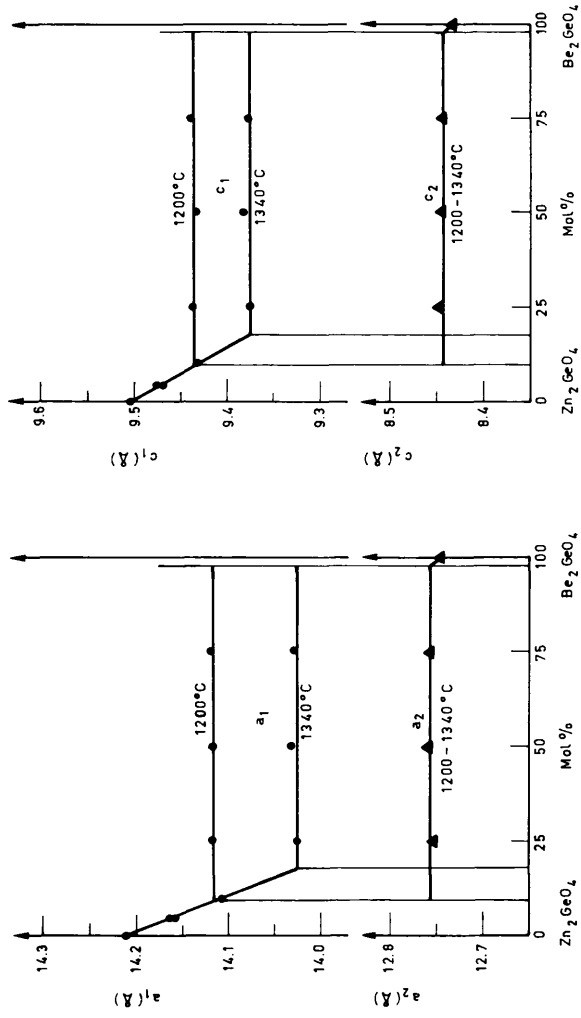
FIG. 22.   Variation of lattice constants in the system Zn_2GeO_4-Be_2GeO_4 [93].

FIG. 23. Variation of lattice constants in the section $Zn_2(Si_{0.5}Ge_{0.5})O_4$–$Be_2(Si_{0.5}Ge_{0.5})O_4$ [93].

NOTES TO TABLE XIII (cont.)
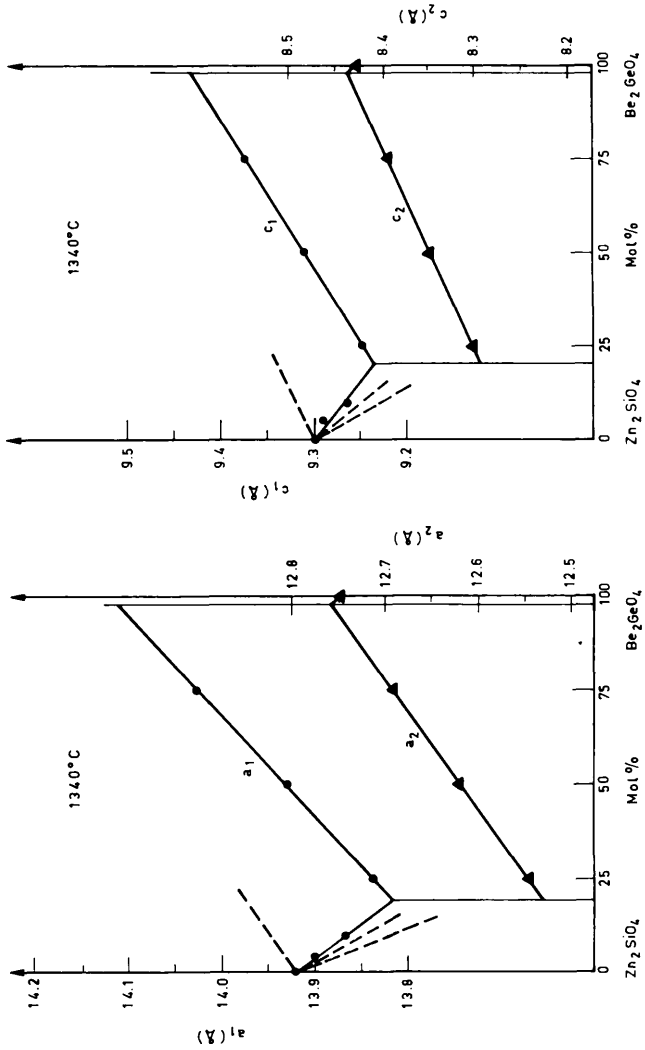
FIG. 24. Variation of lattice constants in the system Zn_2SiO_4-Be_2GeO_4. The dotted lines m, n and k are discussed in the text [93].
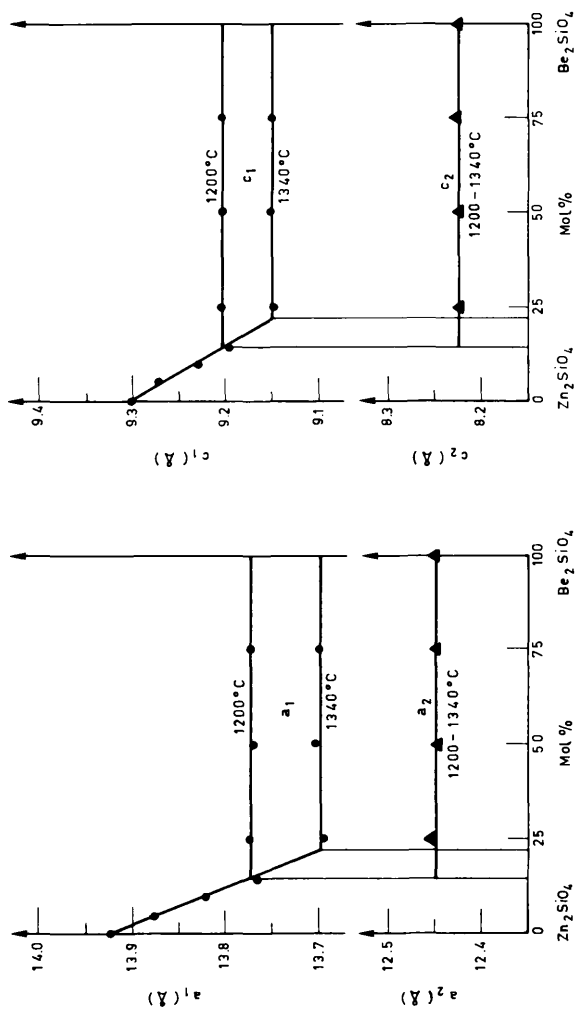
FIG. 25.   Variation of lattice constants in the system Zn_2SiO_4-Be_2SiO_4 [93].

NOTES TO TABLE XIII (cont.)
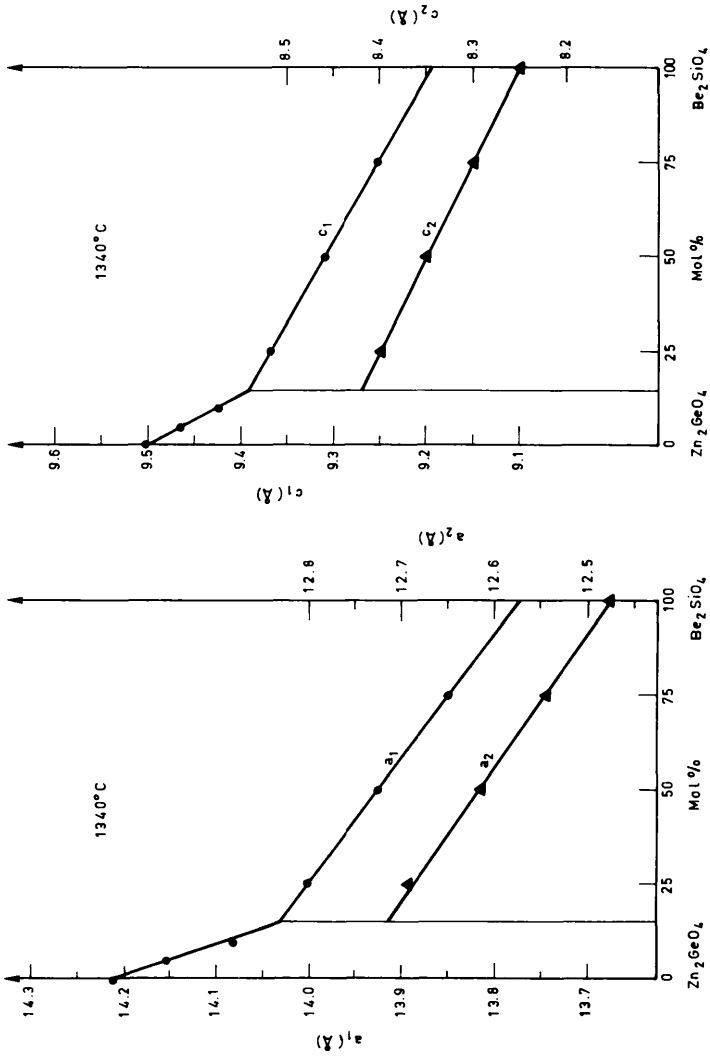
FIG. 26.   Variation of lattice constants in the system Zn_2GeO_4-Be_2SiO_4 [93].

TABLE XIV. LATTICE PARAMETERS (Å) OF $(Al, V)_2BeO_4$ SOLID SOLUTION [77]

$\dfrac{V^{3+}}{Al^{3+} + V^{3+}} \times 100$ (%)	0	5	10	20	30	40	50	67	80
aA	4.43	4.44	4.44	4.46	4.47	4.48	4.49	4.51	4.53
bB	9.41	9.45	9.48	9.55	9.61	9.68	9.74	9.84	9.87
cC	5.48	5.49	5.50	5.53	5.55	5.58	5.61	5.65	5.67

TABLE XV. LATTICE PARAMETERS OF $BaBeF_4$ - $PbBeF_4$ SOLID SOLUTIONS (o'rhombic, $M = 4$) [128]

Composition	U.C.D. (Å)			D_x	D_m
	a-axis	b-axis	c-axis		
$BaBeF_4$	8.89	5.31	7.01	4.40	4.17
60.5% $BaBeF_4$ - 39.5% $PbBeF_4$	8.75	5.32	7.00	5.06	
29% $BaBeF_4$ - 71% $PbBeF_4$	8.58	5.325	6.94	5.65	
$PbBeF_4$	8.435	5.341	6.875	6.23	6.14

TABLE XVI. COMPLEX COMPOUNDS

Compound	Structural type	Crystal system and space group	U.C.D. (Å)	M	D_x (D_m)	References	Notes
$Al_4B_{11}Be_4CsH_4O_{29}$ (rhodizite)		cubic P43m	a = 7.317 ± 1	1	3.47 (3.44)	[307]	
$Al_4B_{10}Be_3(K, Na)_2Li_4O_{27}$		cubic P4̄3m	a = 7.303 ± 25	1	(3.4)	[165]	
$(Al, Si)_2Be(Ca, Na)_2(O, F)_7$ (meliphanite)	melilite	tetragonal P4̄2₁m or P4̄	a = 7.47, c = 4.92	2		[219]	
		tetragonal	a = 10.58, c = 9.98	8		[171]	
$Al_3BeCaH_2(Li, H)O_{12}Si_2$ (bityite)		monoclinic	a = 4.98, b = 8.67, c = 18.74, β ≈ 90°	4	3.14 (3.07)	[166]	
$Al_2BeCa_4H_4O_{28}Si_9$ (bavenite)		o'rhombic	a = 19.38, b = 23.11, c = 4.96	4	2.77 (2.74)	[167]	
$Al_2BeCa_4O_{26}Si_9 . H_2O$ (bavenite)		o'rhombic P222 or Pmm or Pmmm	a = 9.67, b = 11.53, c = 4.95	1		[168]	
$(Al, Be)_4Ca_4(SiO_3)_9 . xH_2O$ (bavenite; pilinite)						[169]	1
$Al_2Be_4Ca_4K_2O_{60}Si_{24} . H_2O$ (milarite)		hexagonal P6/mcc	a = 10.54, c = 13.96	1	2.46 (2.55-2.59)	[170]	
$Al_2Be_4Ca_4K_2O_{60}Si_{24}$ (milarite)		hexagonal P6/mcc	a = 10.43, c = 13.85	1	2.489 (2.57)	[172, 173]	

Formula	Type	System / Space group	Lattice parameters	Z	Density	Ref.	
$AlBeClNa_4O_{12}Si_4$		neatly cubic	$a = 8.72$		(2.28)	[174]	
$AlBe(Cl,S)Na_4O_{12}Si_4$		tetragonal $I\bar{4}$	$a = 8.583 \pm 4$ $c = 8.817 \pm 4$	2	2.36 (2.30)	[308]	
$AlBeCrO_4$	Mg_2SiO_4	o'rhombic Pnma	$a = 4.52$ $b = 9.75$ $c = 5.63$	4	4.07	[88]	
Alkali-beryl (Cs_2O 4.13%)	beryl	hexagonal	green: $a = 9.202 \pm 12$ $c = 9.183 \pm 7$		2.62 (2.72)	[175]	
			milkwhite: $a = 9.202 \pm 10$ $c = 9.209 \pm 5$		2.63 (2.75)	[175]	
			rose: $a = 9.200 \pm 12$ $c = 9.227 \pm 8$		2.73 (2.78)	[175]	
Alkali-beryl (Cs_2O 11.3%)	beryl	hexagonal P6/mmc	$a = 9.208$ $c = 9.266$			[176]	
$AlBeFeO_4$	Mg_2SiO_4	o'rhombic Pnma	$a = 4.50$ $b = 9.70$ $c = 5.62$	4	4.22	[88]	
$(Al,Fe)_{16}Be_4Mg_4O_{32}$		hexagonal $C6_32$	$a = 5.72$ $c = 18.38$	4	(3.613 ± 2)	[177]	2
$(Al, Fe^{2+}, Mg)_2 Be_3O_{18}Si_6$	beryl	hexagonal P6/mmc	$a = 9.30$ $c = 9.20$			[178]	
$Be_3(Al, Fe, Mn, Sc)_2(Be, Si)_6O_{18} \cdot 0.87\ H_2O$ (bazzite)	beryl	hexagonal P6/mcc	$a = 9.521$ $c = 9.165$			[179]	
$(Al, Fe^3, Sc)_2 Be_3O_{18}Si_6$ (bazzite)	beryl	hexagonal P6/mcc	$a = 9.50$ $c = 9.18$	2		[180]	
	beryl	hexagonal P6/mcc	$a = 9.51$ $c = 9.11 \pm 1$	2	2.809-2.825 (2.819 ± 2)	[181]	3

TABLE XVI (cont.)

Compound	Structural type	Crystal system and space group	U.C.D. (Å)	M	D_x (D_m)	References	Notes
$(Al, Fe)_2 Be_3 O_{18} Si_6$	beryl	hexagonal P6/mcc	a = 9.23637 ± 4, c = 9.1972 ± 1		(2.67)	[182]	
$AlBeGaO_4$	$Mg_2 SiO_4$	o'rhombic Pnma	a = 4.49, b = 9.61, c = 5.57	4	4.69	[88]	
$AlBeHSiO_5$ (euclase)	euclase	monoclinic P2$_1$/m	a = 4.63, b = 14.30, c = 4.71, β = 101°16'	4	(3.10)	[183]	
	euclase	monoclinic P2$_1$/c	a = 4.62, b = 14.24, c = 4.75, β = 79°44'	4	(3.1)	[184]	
	euclase	monoclinic P2$_1$/a	a = 4.763 ± 5, b = 14.29 ± 2, c = 4.618 ± 5, β = 100°15' ± 5'	4	3.115 (3.095)	[185] [186]	
$Al_4 BeMgO_8$		trigonal R$\bar{3}$m	a = 5.675, c = 41.096	9	3.69 (3.68)	[309]	
$AlBeNa_3 O_8 Si_2$ α-form (low temperature)		b.c.c.	a = 14.23	16	2.682 (2.64)	[187]	
β-form > 890°C		b.c.c.	a = 14.53	16	2.518 (2.62)	[187]	
$Al_{8/3} Be_2 O_{18} Si_6$		hexagonal	a = 7.46, c = 2.87	$\frac{1}{3}$	2.187	[310]	

$Al_{4/3}Be_4O_{18}Si_6$		hexagonal	a = 7.38 c = 2.82	$\frac{1}{3}$	2.199	[310]
$Al_2Be_3O_{18}Si_6$ (beryl)	beryl	hexagonal P6/mcc	a = 9.31 c = 9.22	2		[188]
	beryl	hexagonal P6/mcc	a = 9.21 ± 1 .c = 9.17 ± 1	2	2.661 (2.6 - 2.7)	[189]
	beryl	hexagonal	a = 9.185 ± 35 c = 9.216 ± 24	2	(2.651)	[190]
	beryl	hexagonal	a = 9.188 c = 9.189	2		[191]
	beryl	hexagonal	a = 9.206 c = 9.205	2		[192]
	beryl	hexagonal P6/mcc	a = 9.22 c = 9.18	2		[181]
	beryl	hexagonal P6/mcc	a = 9.215 c = 9.192	2	2.640	[74,75]
	beryl	hexagonal P6/mmc	a = 9.210 c = 9.199	2		[176]
$AsBeHO_4$		tetragonal	a = 9.16 c = 9.73			[194]
$AsBe_2HO_5 \cdot 4H_2O$		monoclinic	a = 8.55 b = 36.90 c = 7.13 $\beta = 97°49'$	12	2.199	[195]
$AsBeH_4NO_4$		tetragonal P$\bar{4}$2$_1$c	a = 12.96 c = 9.73	16	2.70 (2.66)	[194]
$(As_{1-x}P_x)BeH_4NO_4$						[196] 4
$Be_3(As_{1-x}P_xO_4)_2$						[196] 5

TABLE XVI (cont.)

Compound	Structural type	Crystal system and space group	U.C.D. (Å)	M	D_x (D_m)	References	Notes
BBe_2FO_3	hambergite	o'rhombic Pbca	a = 9.74 b = 12.24 c = 4.43	8	2.41 (2.28)	[197]	
BBe_2HO_4 (hambergite)		o'rhombic Pbca	a = 9.755 ± 2 b = 12.201 ± 2 c = 4.426 ± 1	8	2.36	[199, 198]	
		o'rhombic	a = 9.75 b = 12.20 c = 4.43	8	2.365 (2.359)	[200]	
$BBe_2HO_4 \cdot H_2O$		trigonal P321	a = 4.43 b = 5.34	1	2.047	[201, 202]	6
$BBe_2(OH,F)O_3 \cdot H_2O$? (berborite)		hexagonal	a = 4.43 c = 5.33	1	2.086	[311]	
$B_2O_3 - BeO - LiO_2$						[203]	
$Ba_4Be_5F_4O_{17}P_4 \cdot nH_2O$ (n = 0.3 - 0.4)		tetragonal	a = 4.89 c = 16.74	1	4.44 (4.31)	[312]	
$BaBe_2O_7Si_2$		o'rhombic Pmma or Pmma	a = 9.79 b = 11.61 c = 4.63	4	4.09	[204, 313, 314]	
		o'rhombic $Pn2_1a$	a = 9.8 b = 11.65 c = 4.63	4		[205]	
$BeCO_3 \cdot 4H_2O$		hexagonal	a = 5.12 c = 15.77			[216]	
$BeCa(F,OH)O_4P$ (herderite)		monoclinic $P2_1/c$	a = 4.81 b = 7.69 } average c = 9.89 β = 90°6'	4	3.00	[206, 207]	

Formula (name)		System / Space group	Lattice parameters	Z	Density	Ref.
$Be(Ca, Na)_2(O, OH, F)_7 Si_2$ (leucophanite)		o'rhombic $P2_12_12$	$a = b = 7.38 \pm 2$, $c = 9.96 \pm 2$	4		[208, 219]
$Be_3 Ca_3 F_2 Li_2 O_{12} Si_3$		cubic $I4_132$	$a = 12.879 \pm 4$		(2.9 – 3.0)	[209]
$BeCaFPO_4$ (herderite)	datolite	monoclinic $P2_1/a$	$a = 9.80$, $b = 7.68$, $c = 4.80$, $\beta \approx 90°$	4	3.00	[210, 233]
$Be_2 CaFe^{3+} LaO_{10} Si_2$ (calciogadolinite)		monoclinic	$a = 4.76$, $b = 7.75$, $c = 10.15$, $\beta = 90°30'$	2	4.16	[315]
$Be_2 CaFe^{3+} YO_{10} Si_2$ (calciogadolinite)		monoclinic	$a = 4.69$, $b = 7.56$, $c = 9.97$, $\beta = 90.0°$	2	3.94	[315]
$Be_2 CaGa^{3+} YO_{10} Si_2$ (calciogadolinite)		monoclinic	$a = 4.67$, $b = 7.57$, $c = 9.99$, $\beta = 90.0°$	2	4.07	[315]
$Be_4 Ca_2 H_{12} O_{12} \cdot H_2 O$		hexagonal	$a = 9.68$, $c = 9.13$			[120]
$Be_3 CaH_2 O_{10} P_2 \cdot 4H_2 O$		monoclinic	$a = 8.43$, $b = 39.5$, $c = 7.12$, $\beta = 94°58'$	8	2.042 (2.14)	[316]
$Be(Ca, Mn)O_4 P$ (beryllonite)		monoclinic $P2_1/n$	$a = 8.16$, $b = 7.79$, $c = 14.08$, $\beta = 90°$	12	2.831	[211]

TABLE XVI (cont.)

Compound	Structural type	Crystal system and space group	U.C.D. (Å)	M	D_x (D_m)	References	Notes
$Be(Ca, Mn)O_4Si$		monoclinic pseudo-hexagonal	$a_{hex} = 16,11$ $c_{hex} = 7,60$ (monoclinic: $a:b:c$ $= 2,0834:1:2,1130$ $\beta = 120°9')$	24	3,47	[212]	
$Be_3CaMn_2O_{12}Si_3$ (trimerite)		monoclinic $P2_1/c$?	$a = 16,14$ $b = 7,62$ $c = 27,92$ $\beta = 90°09'$	16	3,507 (3,47)	[317]	
$Be_2CaO_8P_2$ (hurlbutite)		o'rhombic Pmmm	$a = 8,29$ $b = 8,80$ $c = 7,81$	4	2,88 (2,877)	[207]	
		monoclinic $P2_1/a$	$a = 8,29$ $b = 8,80$ $c = 7,81$ $\beta \approx 90°$	4	2,89	[213]	
$BeCa_2O_7Si_2$	akermanite	tetragonal $P\bar{4}2_1m$	$a = 7,48 \pm 2$ $c = 5,044 \pm 3$	2	3,03 (3,034 ± 2)	[215A, 215B]	
	akermanite	tetragonal $P\bar{4}2_1m$	$a = 7,501$ $c = 4,931$	2	3,03 (3,08)	[214]	
$Be(ClO_4)_2 \cdot 4H_2O$						[217]	7
$Be(F, OH)(Fe, Mn)O_4P$		monoclinic	$a = 10,47?$ $b = 10,40$ $c = 4,75$ $\beta = 102°49'$	8	3,35 (3,183)	[218]	

Compound	System / Space group	Lattice parameters	Z	Density	Ref.	Notes
Be(F, OH)$_2$Fe$_3$O$_9$Si$_3$	o'rhombic Pna2$_1$	a = 9.49 ± 1, b = 12.23 ± 4, c = 7.10 ± 3	4	(3.568)	[220, 221]	
Be(Fe, Mn)HO$_5$P (väyrynenite)	monoclinic P2$_1$/a	a = 5.411 ± 5, b = 14.49 ± 2, c = 4.730 ± 5, β = 102°45' ± 5'	4	3.23 (3.215 ± 5)	[222]	
Be$_2$Fe$_2$(Mg, Mn, Na)O$_{16}$P$_4$·6H$_2$O (faheyite)	hexagonal	a = 9.43, c = 16.00	3	2.670 (2.660)	[223]	
Be$_3$(Fe, Mn, Zn)$_4$O$_{12}$SSi$_3$	cubic P$\bar{4}$3n	a = 8.19	2	3.315 (3.316)	[224]	
	cubic P$\bar{4}$3n	a = 8.525	2	(3.2)	[225]	
	cubic P$\bar{4}$3n	a = 8.25	2	3.23 (3.166 - 3.202)	[226]	
	cubic	a = 8.16		(3.56)	[227]	
	cubic P$\bar{4}$3n	a = 8.196	2	3.38 (3.31 ± 1)	[228]	
Be$_3$Fe$_4$O$_{12}$SSi$_3$	cubic	a = 8.18	2	3.40 (3.35)	[229]	
Be$_3$(Fe$_{0.25}$Sc$_{1.75}$)O$_{18}$Si$_6$ (beryl)	hexagonal P6/mcc	a = 9.552, c = 9.163			[230]	For syntheses of scandium-beryls see Table 2 in Ref. [230]
Be$_2$FeO$_{10}$Si$_2$Y$_2$ (gadolinite)	monoclinic P2$_1$/c	a = 4.68, b = 7.53, c = 9.89, β = 90,55° average	2	4.46 average (4.2) average	[117, 210, 231, 232, 233]	

TABLE XVI (cont.)

Compound	Structural type	Crystal system and space group	U.C.D. (Å)	M	D_x (D_m)	References	Notes
BeHMnO$_5$P		monoclinic	a = 10.47 b = 14.40 c = 4.75 β = 102°49' ± 10'	8	3.14 (3.182)	[234, 235]	
BeHNaO$_8$Si$_3$ (eudidymite)		monoclinic C2/c	a = 12.70 b = 7.34 c = 14.01 β = 102°34'	8		[236]	8
		monoclinic C2/c	a = 12.63 b = 7.35 } average c = 14.00 β = 103°43'	8		[237, 239]	
(epididymite)		o'rhombic Pnam	a = 12.71 b = 7.33 c = 13.62	8		[237]	8
		o'rhombic Pnam	a = 12.63 b = 7.32 c = 13.58	8		[238]	
		o'rhombic Pnma	a = 12.66 b = 13.48 c = 7.34	8		[240, 241]	
Be$_6$H$_2$Na$_8$O$_{23}$Si$_6$. H$_2$O (sodalite)		cubic	a = 15.93			[187]	
BeH$_4$NO$_4$P		tetragonal P42$_1$c	a = 12.80 c = 9.65	16	2.05 (2.07)	[194]	
BeHO$_4$P		tetragonal	a = 9.05 c = 9.65			[194]	

Formula	Crystal system / space group	Lattice parameters	Z	Density	Ref.
$BeHO_4P \cdot H_2O$ $BeH_4O_5P_2$ $BeH_4O_5P_2 \cdot H_2O$					[242]
$Be_2HO_4P \cdot 4H_2O$	monoclinic C2/c or Cc	a = 8.55, b = 36.90, c = 7.13, β = 97°41'	12	1.806 (1.805)	[243]
$Be_3H_4O_6Si \cdot H_2O$ (beryllite)				(2.196)	[244]
$Be_4H_2O_5Si_2$ (bertrandite)	o'rhombic Cmc2₁	a = 8.73, b = 15.31, c = 4.58	4	2.58	[245, 246]
	o'rhombic Cmc2₁	a = 8.70, b = 15.26, c = 4.56	4	2.61 (2.599)	[247, 248]
$Be_3Mn_4O_{12}SSi_4$ (helvite)	cubic P43n	a = 8.19	2	3.315 (3.316)	[249]
	cubic	a = 8.273 ± 5	2	2.91 (3.20)	[229]
	cubic P43n	a = 8.294 ± 7	2	3.25	[250]
$BeNaO_4P$ (beryllonite)	monoclinic P2₁/c	a = 8.15, b = 7.78, c = 14.28, β = 90°00'	12		[207]
	monoclinic P2₁/n	a = 8.16, b = 7.79, c = 14.08, β = 90°	12		[251, 252]

TABLE XVI (cont.)

Compound	Structural type	Crystal system and space group	U.C.D. (Å)	M	D_x (D_m)	References	Notes
Be_4NaO_7Sb		hexagonal C6mc	a = 5.39 c = 8.84	2		[254]	
		hexagonal C6mc	a = 5.47 c = 8.92	2		[255]	
$BeNa_2O_6Si_2$		o'rhombic Fdd2	a = 21.1 ± 1 b = 21.1 ± 1 c = 6.87 ± 3	24	2.70 (2.66)	[256]	
$Be_{1.5}Na_3O_{13}Si_5$	analcime	cubic	a = 13.35 ± 1			[257]	
$Be_2O_7PbSi_2$ (lead-barylite)		o'rhombic Pnma	a = 9.73 b = 11.56 c = 4.61	4	5.01	[313]	
$BeO_4S.4H_2O$		tetragonal	a = 5.62 c = 5.316	1	1.754 (1.725)	[259]	
		tetragonal I4/mcm	a = 8.02 ± 2 c = 10.750 ± 14	4	(1.725)	[260, 261]	
		tetragonal $\bar{I}4c2$	a = 8.02 ± 2 c = 10.750 ± 14	4	(1.713)	[262, 263]	
		tetragonal I4c2	a = 7.990 ± 1 c = 10.688 ± 6	4	1.733 (1.725) (1.712)	[264, 265]	
		tetragonal I4c2	a = 7.991 c = 10.703	4	1.7206	[266, 267, 268, 269]	
$BeO_4S.6H_2O$		cubic				[258]	
$Be_3O_{12}SSi_3Zn_4$ (genthelvite)		cubic	a = 8.10	2	3.73 (3.70)	[229]	

$Be_3O_{18}Sc_2Si_6$		hexagonal P6/mcc	a = 9.56 c = 9.16			[230]
$Be_2O_{40}SiW_{12} \cdot 31H_2O$		cubic Fd3m	a = 23.3	8	3.60 (3.66)	[270]
$Be_2O_7Si_2Sr$ (strontium-barylite)		o'rhombic Pnma	a = 9.70 b = 11.56 c = 4.61	4	3.52	[313]
$Be_2O_7SiY_2$	melilite	tetragonal P$\overline{4}$2$_1$m	a = 7.283 ± 2 c = 4.755 ± 1	2	4.42	[271]
$(Be_{0.33}Zn_{0.667})_2O_4Si$		trigonal R$\overline{3}$	a = 13.828 c = 9.259			[272]
$Be_9O_{11}Sr_2 \cdot 7H_2O$		hexagonal	a = 11.02 c = 8.54			[120]
$Be_3Ca_2Cs_2F_{12}$	$K_2Mg_2(SO_4)_3$ langbeinite	cubic P2$_1$3	a = 10.672 ± 3	4	1.98	[273]
$Be_3Cd_2Cs_2F_{12}$	langbeinite	cubic P2$_1$3	a = 10.558 ± 3	4	2.53	[273]
$Be_2CdCs_2F_8 \cdot 6H_2O$		monoclinic P2$_1$/a	a = 9.477 ± 4 b = 12.987 ± 5 c = 6.368 ± 5 β = 106.695° ± 1		2.904 ± 4	[274]
$Be_2CdF_8H_8N_2 \cdot 6H_2O$		monoclinic P2$_1$/a	a = 9.427 ± 3 b = 12.810 ± 6 c = 6.214 ± 2 β = 106.746° ± 1		1.972 ± 3	[274]
$Be_2CdF_8Rb_2 \cdot 6H_2O$		monoclinic P2$_1$/a	a = 9.309 ± 5 b = 12.617 ± 6 c = 6.526 ± 5 β = 105.40° ± 1		2.633 ± 4 (2.716)	[274]
$Be_3Cd_2F_{12}Tl_2$	langbeinite	cubic P2$_1$3	a = 10.402 ± 3	4	3.16	[273]

TABLE XVI (cont.)

Compound	Structural type	Crystal system and space group	U.C.D. (Å)	M	D_x (D_m)	References	Notes
$Be_2CoCs_2F_8 \cdot 6H_2O$		monoclinic	a = 9.306 ± 3 b = 12.718 ± 4 c = 6.303 ± 2 β = 106.455° ± 1		2.804 ± 2	[274]	
$BeCoF_4 \cdot 6H_2O$		monoclinic Cc or C2/c	a = 10.103 ± 5 b = 7.215 ± 5 c = 24.28 ± 2 β = 98.363° ± 1	8	1.914 ± 5	[275]	
$Be_3Co_2F_{12}H_8N_2$	langbeinite	cubic P2₁3	a = 10.052 ± 3	4	1.61	[273]	
$Be_2CoF_8H_8N_2 \cdot 6H_2O$		monoclinic	a/b = 0.7405 c/b = 0.4852 β = 106.77°		1.821	[276]	
		monoclinic P2₁/a	a = 9.268 ± 2 b = 12.534 ± 4 c = 6.138 ± 2 β = 106.759° ± 1		1.816 ± 2 (1.821)	[274]	
Be_3CoF_9K	benitoite	hexagonal P6̄c2	a = 6.583 ± 2 c = 9.636 ± 3		2.70	[277]	
$Be_2CoF_8K_2 \cdot 6H_2O$		monoclinic P2₁/a	a = 9.042 ± 8 b = 12.100 ± 5 c = 6.132 ± 3 β = 104.530° ± 1		2.124 ± 3	[274]	
$Be_3Co_2F_{12}K_2$	langbeinite	cubic P2₁3	a = 9.963 ± 3	4	1.82	[278]	
Be_3CoF_9Rb	benitoite	hexagonal P6̄c2	a = 6.686 ± 3 c = 9.669 ± 3		3.04	[279]	

$Be_2CoF_8Rb_2$	monoclinic $P2_1/c$	a = 6.207 ± 2 b = 12.308 ± 1 c = 9.181 ± 2 β = 105.37° ± 7	2	2.492 ± 3	[280]
$Be_2CoF_8Rb_2 \cdot 6H_2O$	monoclinic $P2_1/a$	a = 9.135 ± 4 b = 12.316 ± 3 c = 6.168 ± 2 β = 105.202° ± 1		2.517 ± 2 (2.512)	[274]
$Be_2CoF_8Tl_2 \cdot 6H_2O$	monoclinic $P2_1/a$	a = 9.220 ± 2 b = 12.340 ± 3 c = 6.214 ± 2 β = 105.559° ± 1		3.638 ± 2	[274]
$Be_3Co_2F_{12}Tl_2$	cubic $P2_13$ langbeinite	a = 10.078	4	3.05	[273]
$Be_2Cs_2CuF_8 \cdot 6H_2O$	monoclinic $P2_1/a$	a = 9.381 ± 3 b = 12.609 ± 3 c = 6.269 ± 3 β = 105.684° ± 1		2.827 ± 2	[274]
$BeCsF_4Li$	monoclinic $P2_1/n$ deformed tridymite	a = 9.3113 ± 11 b = 8.7509 ± 12 c = 5.3914 ± 7 β = 90°15'	4	3.37	[282]
	monoclinic $P2_1/n$ pseudo space group Icmm	a = 9.328 b = 5.356 c = 8.736 γ = 89°49'			[281]
$Be_2Cs_2F_8Ni \cdot 6H_2O$	monoclinic $P2_1/a$	a = 9.243 ± 3 b = 12.652 ± 4 c = 6.305 ± 2 β = 106.095° ± 1		2.826 ± 2 (2.820)	[274]

TABLE XVI (cont.)

Compound	Structural type	Crystal system and space group	U.C.D. (Å)	M	D_x (D_m)	References	Notes
Be₂Cs₂F₈Zn.6H₂O		monoclinic P2₁/a	a = 9.505 ± 3 b = 12.734 ± 3 c = 6.319 ± 4 β = 106.666° ± 1		2.763 ± 3	[274]	
BeCuF₄.5H₂O		triclinic	a = 7.146 ± 3 b = 10.685 ± 3 c = 5.942 ± 3 α = 97.47° ± 3 β = 125.57° ± 3 γ = 94.00° ± 3	2	2.197 ± 8	[283]	
Be₂CuF₈H₈N₂.6H₂O		monoclinic P2₁/a	a = 9.242 ± 4 b = 12.414 ± 5 c = 6.220 ± 4 β = 105.799° ± 1		1.828 ± 3 (1.858)	[274]	
		monoclinic P2₁/c	a = 6.227 ± 4 b = 12.417 ± 4 c = 9.213 ± 6 β = 105.95° ± 7	2	1.831 (1.826)	[284]	see Fig.27
		for solid solution see Fig.27					
Be₂CuF₈K₂.6H₂O		monoclinic P2₁/a	a = 8.995 ± 5 b = 11.992 ± 5 c = 6.160 ± 5 β = 103.715° ± 1		2.161 ± 3	[274]	
Be₂CuF₈Rb₂.6H₂O		monoclinic P2₁/a	a = 9.190 ± 4 b = 12.213 ± 5 c = 6.200 ± 2 β = 104.703° ± 1		2.530 ± 3 (2.568)	[274]	

$Be_2CuF_8Tl_2 \cdot 6H_2O$		monoclinic $P2_1/a$	a = 9.240 ± 4 b = 12.297 ± 3 c = 6.225 ± 3 β = 104.815° ± 1		3.646 ± 4	[274]	
BeF_4H_4LiN		hexagonal	a = 10.49 ± 2 c = 8.70 ± 1	4	(1.793)	[285]	
	deformed tridymite	monoclinic $Pc2_1n$	a = 9.3113 b = 5.3914 c = 8.7509 γ = 89°44'	4	1.80	[282]	
		o'rhombic	a = 9.0081 ± 15 b = 5.2267 ± 7 c = 8.6313 ± 13		1.80	[282]	
BeF_3H_4N		o'rhombic	a = 5.789 b = 4.619 c = 12.881	4	1.62 (1.602)	[286]	
		monoclinic $P2_1/n$	a = 5.73 b = 4.61 c = 12.74	4		[131]	
		o'rhombic $P2_12_12_1$	a = 5.766 ± 3 b = 4.624 ± 3 c = 12.823 ± 2	4		[287]	10
$BeF_4H_8N_2$		o'rhombic Pnma	a = 5.8 ± 1 b = 10.2 ± 1 c = 7.5 ± 1	4	1.80	[288]	
		o'rhombic	a = 5.87 b = 10.47 c = 7.62	4	1.46 (1.685)	[286]	
		o'rhombic Pnma	a = 5.88 ± 3 b = 10.40 ± 6 } average c = 7.50 ± 4	4	1.75 (1.683)	[276,291]	

TABLE XVI (cont.)

Compound	Structural type	Crystal system and space group	U.C.D. (Å)	M	D_x (D_m)	References	Notes
$BeF_4H_8N_2$ (room temperature)		o'rhombic Pnma	a = 7.49 b = 10.39 } basic cell c = 5.89			[290]	
		Acam	a = 7.49 b = 2×10.39 } true cell c = 2× 5.89			[290]	
$BeF_4H_8N_2$ (< -97°C)		Pn2₁a	$a_f \sim 2a$ $b_f \sim 2b$ } true cell $c_f \sim 2c$ polar axis b			[290]	
		o'rhombic Pnma	a = 5.923 ± 3 b = 10.437 ± 3 c = 7.641 ± 3	4	1.697	[292, 287]	
$Be_2F_5H_4N$		hexagonal	a = 4.68 c = 6.12	1	1.88 (1.8)	[134]	
		o'rhombic	a = 4.68 b = 7.97 c = 6.15	2	1.90	[138]	
		monoclinic P2, Pm or P2/m	a = 4.671 ± 5 b = 6.140 ± 5 c = 7.936 ± 5 β = 90.59° ± 2	2		[287]	11
$Be_2F_8H_8N_2Ni.6H_2O$	tuttonsalt	monoclinic P2₁/a	a = 9.04 b = 12.31 c = 6.04 β = 106°40'	2	1.843	[293, 276]	

$Be_2F_8H_8N_2Ni \cdot 6H_2O$ (cont.)		monoclinic $P2_1/a$	a = 9.199 ± 3 b = 12.522 ± 6 c = 6.151 ± 5 β = 106.546° ± 1		1.824 (1.843)	[274]
$Be_2F_8H_8N_2Pb$	palmierite	trigonal $R\bar{3}m$	a = 5.556 ± 2 c = 21.520 ± 9	3	2.16	[294]
$Be_2F_8H_8N_2Zn \cdot 6H_2O$		monoclinic	a/b = 0.7387 c/b = 0.4909 β = 106,57°		1.859	[276]
		monoclinic $P2_1/a$	a = 9.278 ± 6 b = 12.572 ± 4 c = 6.165 ± 5 β = 106.474° ± 1		1.829 ± 3 (1.932)	[274]
$Be_3F_{12}H_8Mg_2N_2$	langbeinite $K_2Mg_2(SO_4)_3$	cubic $P2_13$	a = 9.968 ± 3	4	1.37	[273]
$Be_3F_{12}H_8Mn_2N_2$	langbeinite	cubic $P2_13$	a = 10.217 ± 3	4	1.50	[273]
$Be_3F_{12}H_8N_2Zn_2$	langbeinite	cubic $P2_13$	a = 10.036 ± 3	4	1.67	[273]
$Be_3F_9H_4NZn$	$BaTi(SiO_3)_3$	hexagonal $P\bar{6}c2$	a = 6.688 ± 3 c = 9.635 ± 3		2.50	[279]
BeF_6HNa_5		monoclinic	a = 11.09 ± 5 b = 4.83 ± 2 c = 17.36 ± 5 β = 71.4°		2.44	[318]
BeF_4KLi	stuffed derivative of tridymite	hexagonal $P6_3$ pseudo space group $P6_3/mmc$	a = 5.070 c = 8.566			[281]
$KLiSO_4$		hexagonal $P6_3$	a = 5.0739 ± 10 c = 8.5674 ± 28	2	2.28	[282]

TABLE XVI (cont.)

Compound	Structural type	Crystal system and space group	U.C.D. (Å)	M	D_x (D_m)	References	Notes
$BeF_4K_2NiO_4S \cdot 6H_2O$						[276]	
$Be_2F_8K_2Ni \cdot 6H_2O$		monoclinic P2$_1$/a	a = 8.949 ± 2 b = 12.023 ± 2 c = 6.086 ± 2 β = 104.397° ± 1	2	2.174 ± 2	[274]	
$Be_2F_8K_2Pb$	$PbK_2(SO_4)_2$	trigonal R$\bar{3}$m	a = 5.455 ± 2 c = 20.500 ± 9	3	2.58	[294]	
$Be_2F_8K_2KPbRb$	$PbK_2(SO_4)_2$	trigonal R$\bar{3}$m	a = 5.498 ± 2 c = 20.857 ± 9	3	2.76	[294]	
$Be_2F_8K_2Sr$	$PbK_2(SO_4)_2$	trigonal R$\bar{3}$m	a = 5.424 ± 2 c = 20.429 ± 9	3	1.93	[294]	
$Be_2F_8K_2Zn \cdot 6H_2O$		monoclinic P2$_1$/a	a = 8.937 ± 8 b = 12.076 ± 5 c = 6.133 ± 3 β = 103.925° ± 1		2.181 ± 3	[274]	
Be_3F_9KMg	$BaTi(SiO_3)_3$	hexagonal P$\bar{6}$c2	a = 6.547 ± 3 c = 9.564 ± 3		2.43	[277]	
$Be_3F_{12}K_2Mg_2$	$K_2Mg_2(SO_4)_3$	cubic P2$_1$3	a = 9.875 ± 3	4	1.59	[278]	
Be_3F_9KMn	$BaTi(SiO_3)_3$	hexagonal P$\bar{6}$c2	a = 6.661 ± 3 c = 9.761 ± 4		2.57	[277]	
$Be_3F_{12}K_2Mn_2$	$K_2Mg_2(SO_4)_3$	cubic P2$_1$3	a = 10.102 ± 3	4	1.72	[278]	
Be_3F_9KNi	$BaTi(SiO_3)_3$	hexagonal P$\bar{6}$c2	a = 6.566 ± 2 c = 9.575 ± 3		2.73	[277]	
$Be_3F_{12}K_2Ni_2$	$K_2Mg_2(SO_4)_3$	cubic P2$_1$3	a = 9.888 ± 3	4	1.86	[278]	

Formula	Mineral	System / Space group	Lattice parameters	Z	Density	Ref.
Be_3F_9KZn		hexagonal $P\bar{6}c2$	a = 6.583 ± 2 c = 9.623 ± 3		2.76	[277]
$Be_3F_{12}K_2Zn_2$		cubic $P2_13$	a = 9.932 ± 2	4	1.89	[278]
$BeF_4Li_2 \cdot H_2O$		monoclinic $P2_1$	a = 5.45 b = 4.82 c = 8.80 β = 107.5°			[145]
BeF_4LiNa	olivine	o'rhombic Pnma	a = 4.64 ± 2 b = 10.72 ± 4 c = 6.20 ± 2	4	2.48 (2.431)	[295, 117]
	willemite	trigonal $R3$ or $R\bar{3}$	a = 13.30 ± 2 c = 8.97 ± 2			[130]
BeF_4LiRb		hexagonal $P6_3$ or $P6_322$	a = 5.185 c = 8.751			[281]
	KLiSO₄	hexagonal $P6_3$	a = 5.1845 ± 6 c = 8.7485 ± 14	2	2.89	[282]
BeF_4LiTl	LiKSO₄	hexagonal $P6_3$	a = 5.2236 ± 5 c = 8.7621 ± 16	2	4.75	[282]
Be_2F_6LiNa	diopside	monoclinic $P2_1/c$	a = 9.71 b = 8.89 c = 5.24 β = 105°50'	4		[130, 133]
$Be_2F_7LiNa_2$	hardystonite	tetragonal $P\bar{4}2_1m$	a = 7.5 ± 2 c = 5.03 ± 2	2	2.4 (2.414)	[296]
		tetragonal	a = 7.63 ± 4 c = 4.84 ± 2		2.40	[298]

TABLE XVI (cont.)

Compound	Structural type	Crystal system and space group	U.C.D. (Å)	M	D_x (D_m)	References	Notes
$Be_2F_8LiNa_3$		monoclinic	a = 6.52 ± 2 b = 9.62 ± 4 c = 12.26 ± 6 β = 126°8'	4	2.63	[299]	
Be_3F_9MgRb	$BaTi(SiO_3)_3$	hexagonal $P\bar{6}c2$	a = 6.647 ± 3 c = 9.602 ± 3		2.78	[279]	
Be_3F_9MnRb	$BaTi(SiO_3)_3$	hexagonal $P\bar{6}c2$	a = 6.784 ± 3 c = 9.855 ± 3		2.86	[279]	
$Be_3F_{12}Mn_2Tl_2$	langbeinite	cubic $P2_13$	a = 10.255 ± 3	4	2.87	[273]	
$Be_3F_{10}Na_4 \cdot 2H_2O$		orthombic	a = 6.46 b = 14.98 c = 10.27	4		[305]	
$BeF_{15}NaTh_3$		tetragonal	a = 11.82 c = 10.29			[301]	
$BeF_{15}NaU_3$	$BeF_{15}NaTh_3$	tetragonal	a = 11.61 c = 10.12			[301]	
$BeF_4(Na_{0.38}Rb_{0.62})$	glaserite	trigonal $P\bar{3}m1$	a = 5.74 c = 7.49			[300]	
$BeF_4Ni \cdot 6H_2O$		monoclinic Cc or C2/c	a = 9.915 ± 6 b = 7.200 ± 5 c = 24.08 ± 2 β = 98.469° ± 1	8	1.970 ± 5	[275]	
		monoclinic	a = 9.886 ± 5 b = 7.184 ± 5 c = 24.07 ± 2 β = 98.88° ± 2		1.974 ± 6	[283]	

Formula	Structure type	System / Space group	Lattice parameters	Z	Density	Ref
$Be_2F_8NiRb_2$		monoclinic $P2_1/a$	$a = 9.115 \pm 2$ $b = 12.299 \pm 1$ $c = 6.189 \pm 2$ $\beta = 105.50° \pm 7$		2.524 ± 3	[280]
$Be_2F_8NiRb_2 \cdot 6H_2O$		monoclinic $P2_1/a$	$a = 9.096 \pm 4$ $b = 12.254 \pm 6$ $c = 6.206 \pm 4$ $\beta = 104.922° \pm 1$		2.524 ± 4 (2.413)	[274]
$Be_2F_8NiTl_2 \cdot 6H_2O$		monoclinic $P2_1/a$	$a = 9.122 \pm 3$ $b = 12.326 \pm 6$ $c = 6.197 \pm 4$ $\beta = 105.579° \pm 1$		3.690 ± 4	[274]
Be_3F_9NiRb	$BaTi(SiO_3)_3$	hexagonal $P\bar{6}c2$	$a = 6.669 \pm 3$ $c = 9.624 \pm 3$		3.07	[279]
$Be_2F_8PbRb_2$		trigonal $R\bar{3}m$	$a = 5.558 \pm 2$ $c = 21.357 \pm 9$	3	2.88	[294]
$Be_2F_8PbTl_2$		trigonal $R\bar{3}m$	$a = 5.577 \pm 2$ $c = 21.894 \pm 9$	3	4.00	[294]
$Be_2F_8Rb_2Zn$		monoclinic $P2_1/a$	$a = 9.149 \pm 2$ $b = 12.321 \pm 1$ $c = 6.202 \pm 2$ $\beta = 105.22° \pm 7$	2	2.534 ± 3	[280]
$Be_2F_8Rb_2Zn \cdot 6H_2O$		monoclinic $P2_1/a$	$a = 9.147 \pm 4$ $b = 12.337 \pm 4$ $c = 6.191 \pm 4$ $\beta = 105.068° \pm 1$		2.534 ± 4 (2.549)	[274]
Be_3F_9RbZn	$BaTi(SiO_3)_3$	hexagonal $P\bar{6}c2$	$a = 6.686 \pm 3$ $c = 9.658 \pm 3$		3.09	[279]
$Be_2F_8Tl_2Zn \cdot 6H_2O$		monoclinic $P2_1/a$	$a = 9.189 \pm 3$ $b = 12.337 \pm 3$ $c = 6.223 \pm 2$ $\beta = 105.225° \pm 1$		3.646 ± 3	[274]

TABLE XVI (cont.)

Compound	Structural type	Crystal system and space group	U.C.D. (Å)	M	D_x (D_m)	References	Notes
Be_3F_9TlZn	$BaTi(SiO_3)_3$	hexagonal $P\bar{6}c2$	a = 6.698 ± 3 c = 9.641 ± 3		3.95	[279]	
$BeF_4Zn \cdot 6H_2O$		monoclinic Cc or C2/c	a = 9.949 ± 5 b = 7.128 ± 5 c = 24.14 ± 2 β = 99.030° ± 1	8	2.031 ± 5	[275]	
		monoclinic	a = 9.947 ± 5 b = 7.182 ± 5 c = 24.10 ± 2 β = 99.16° ± 2		2.021 ± 6	[283]	
$BeCl_2 \cdot 4.5H_2O$		monoclinic $P2_1/c$ Pc or P2/c	a = 12.96 b = 13.19 c = 15.80 β = 75°30' ± 10' } sub-cell			[302]	
			a = 6.48 b = 13.19 c = 7.90 β = 75°30' ± 10'			[302]	

FIG. 27. Unit cell dimensions of the solid solution series of $(NH_4)_2Cu(SO_4)_{2-x}(BeF_4)_x \cdot 6H_2O$ [284].

NOTES TO TABLE XVI

1. The new analysis of pilinite [169] shows that it has the same composition as bavenite and it is suggested that the name 'pilinite' be dropped.

2. The formula is: $Be_5 Mg_{3.8} Al_{15.6} Fe_{0.8} O_{33.4}$. The formula given in Table XVI is an idealized one.

3. The detailed formula is:
$Be_{3.06}(Sc_{1.26} Fe_{0.17}^{3+} Al_{0.03} Fe_{0.31}^{2+} Mn_{0.12})(Si_{5.93} Be_{0.07})O_{18} \cdot 0.87 H_2O$

4. $NH_4 BePO_4 - NH_4 BeAsO_4$: solutions are formed in all proportions.

5. $Be_3 (PO_4)_2 - Be_3 (AsO_4)_2$ solid solutions.

6. Atomic parameters are: B in (1a) 000
   Be in (2d) 1/3 2/3 z, 2/3 1/3 $\bar{z}$, z = 0.894
   O_{II} in (2d) 1/3 2/3 z, 2/3 1/3 $\bar{z}$, z = 0.587
   O_I in (3e) 000, 0x0, $\bar{x}$ $\bar{x}$ 0, x = 0.312.

7. Long needles which are extremely hygroscopic [217].

8. The two minerals eudidymite and epididymite have the same chemical composition.

9. Powder diagrams reported without indexing.

10. Tedenac and Cot [287] claim that the compound $NH_4 BeF_3$ is not monoclinic as stated in Ref. [131].

11. The diagram could not be indexed by Tedenac and Cot [287] as hexagonal [134] or orthorhombic [138].

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IV. DIFFUSION

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The experimental methods for the determination of diffusion rates and their evaluation as well as the relationships between the various diffusion coefficients have been discussed at some length by the present author in the Atomic Energy Review Special Issue on Niobium [1], to which the reader is referred. Here, only the results of measurements of diffusion rates in beryllium (Table XVII) and diffusion rates in beryllium oxyde (Table XVIII) are listed. In these tables, the following letters are used in column 3 to indicate the experimental methods:

    B. Determination of the radioisotope distribution by sectioning.
    E. Determination of the concentration gradient by X-ray analysis, followed by a Matano evaluation.
    H. Heterogeneous isotopic exchange between a solid sample and a gas.
    I. Beryllium powder: rate of fission gas release from irradiated powder, assuming spherical particles.
    J. Hahn emanation technique.
    K. Proton activation of ^{18}O followed by autoradiography.