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THE PROBABLE IDENTITY OF MAGNIORORITE WITH SUANITE¹MARY E. MROSE AND MICHAEL FLEISCHER, *U. S. Geological Survey, Washington 25, D. C.*

A recent paper by Nefedov (1961) describes a new mineral named magnioborite, of composition $Mg_2B_2O_5$, found in a drill core in a dolomite-calcite skarn rock, for which the locality was not specified. The author was apparently unaware that the monoclinic mineral suanite, of the same composition, had been described by Watanabe (1953) from the dolomite-calcite skarn of the Hol Kol mine in the Suan district, North Korea. Nor does Nefedov cite studies of the system $MgO-B_2O_3$ by Toropov and Konovalov (1940) and by Davis and Knight (1945), in both of which triclinic $Mg_2B_2O_5$ was found as a phase. The crystal structure of suanite had been described by Takéuchi (1952); that of synthetic triclinic $Mg_2B_2O_5$, by Takéuchi (1952) and by Block, Burley, Perloff, and Mason (1959).

A comparison of the reported properties of the monoclinic and triclinic forms of $Mg_2B_2O_5$ is given in Table 1. X-ray powder diffraction data for these two forms are compared in Table 2.

Although magnioborite was considered to be triclinic by Nefedov (1961), his measured optical angles depart from those required by monoclinic symmetry by only 1° in one case and by $2^\circ-3^\circ$ in another, so that the determination of triclinic symmetry for magnioborite cannot be considered conclusive. The indices of refraction, and especially the $2V$, are much closer to those of suanite than they are to those of synthetic triclinic $Mg_2B_2O_5$, as measured by Davis and Knight (1945). We have re-examined the optical properties of both suanite and synthetic triclinic $Mg_2B_2O_5$ and confirm the β indices and $2V$ as reported by Watanabe (1953) and by Davis and Knight (1945) (Table 1).

X-ray powder diffraction patterns of triclinic $Mg_2B_2O_5$ and suanite are distinctive (Fig. 1). The x-ray powder data for magnioborite are tabulated in Table 2 for comparison with those of synthetic triclinic $Mg_2B_2O_5$ and suanite. Although these are not definitely conclusive, it is our opinion that the d -spacing data and their corresponding intensities for magnioborite are more strongly suggestive of identity with suanite than with synthetic triclinic $Mg_2B_2O_5$. This conclusion is based upon the fact that certain strong lines of synthetic triclinic $Mg_2B_2O_5$ (the measured d_{hkl} 's underscored once in Table 2) are absent in both magnioborite and suanite, while, on the other hand, certain lines common to both magnioborite and suanite (the measured d_{hkl} 's underscored twice in Table 2) are either

¹ Publication authorized by the Director, U. S. Geological Survey.

absent in triclinic $Mg_2B_2O_5$ or are of decidedly different intensity. In addition, attention is also called to the fact that Takéuchi (1952) showed that for suanite, those hkl reflections where l is odd (h odd in the present orientation) are generally zero or weak (see Takéuchi's Table 2). Suanite therefore has a strong pseudo-cell with $a=6.155 \text{ \AA}$, $b=3.120$, $c=9.20_3$

TABLE 1. COMPARISON OF THE PROPERTIES OF THE FORMS OF $Mg_2B_2O_5$

	<i>Suanite</i> Watanabe (1953)	<i>Magnioborite</i> Nefedov (1961)	<i>Synthetic</i> Davis and Knight (1945)
Color	White	Colorless	—
Luster	Silky to pearly	Vitreous	—
Hardness	5½	5-6	—
Spec. grav.			
(obs.)	2.91	2.92 ± 0.02	2.92 ²
(calc.)	2.91 ¹	—	2.90 ²
Habit	Fibrous aggregates	Short prismatic	Platy
System	Monoclinic	Triclinic (from optics and cleavages)	Monoclinic or triclinic
Twinning	Not mentioned	Common, polysyn- thetic	Some observed
Cleavages	One perfect = b	One perfect = b , second at 89°; third imper- fect oblique to others	One perfect; traces of two others at 50° to one another
Sign	Biaxial negative (-)	Biaxial negative (-)	Biaxial negative (-)
α	1.596	1.598	1.589
β	1.639	1.645	1.660
γ	1.670	1.674	1.674
$\gamma - \alpha$	0.074	0.076	0.085
2V	70°	76° ± 2°	approx. 40°
Dispersion	$r > v$, weak	$r > v$, weak	$r > v$, weak ³
Orientation	$X = b$ $Y \wedge \text{perf. cleavage} = 23^\circ$	$X \wedge b = 2^\circ - 3^\circ$ $Y \wedge \text{perf. cleavage} = 68^\circ$ (90° - 22°)	$X \perp \text{perf. cleavage}$
Fusibility	Difficulty fusible	Infusible	Melts 1340°C ± 5°
DTA	Irreversible endother- mal at 630° C.	Reversible endother- mal at 950° - 1020° C. ⁴	—
Associations	In skarn with calcite, kotoite, szaibelyite, spinel, clinohumite, ludwigite, warwickite	In skarn with calcite, dolomite, szaibelyite, ludwigite, warwickite, sulfides	—

¹ Calculated by present authors using single-crystal data for suanite (Table 2).

² Data from Block, Burley, Perloff, and Mason (1959).

³ Determined by present authors on crystals from Sample B30 received through the courtesy of H. M. Davis, Pennsylvania State University.

⁴ See text for discussion.

and $\beta = 104^\circ 20'$; this cell compares very closely to the unit cell of triclinic $\text{Mg}_2\text{B}_2\text{O}_5$ (Table 2). Hence, the presence of x -ray powder spacings in magnioborite that can only be indexed with an hkl index with h odd would indicate that the mineral is suanite. For example, 110 ($d = 3.020 \text{ \AA}$), $\bar{1}11$ ($d = 2.917 \text{ \AA}$), and $\bar{3}11$ ($d = 2.468 \text{ \AA}$) are such lines in magnioborite that can be indexed only on the basis of the suanite cell.

Watanabe (1953) reported that monoclinic suanite, after being heated to 1000°C. , gave the same x -ray powder diffraction pattern as that of tri-

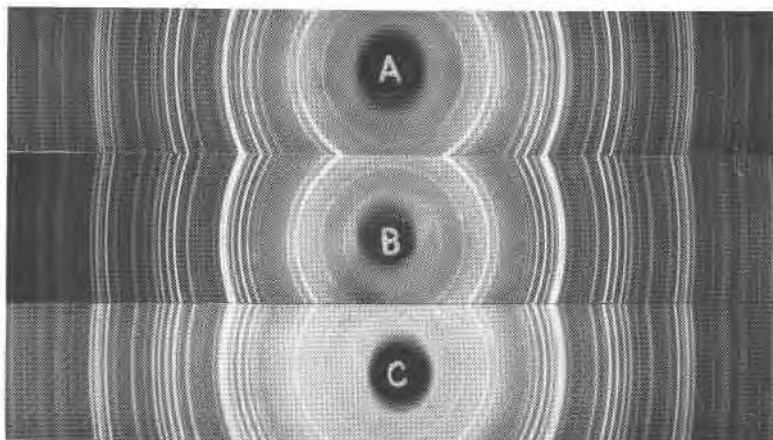


FIG. 1. X -ray powder photographs ($\text{CuK}\alpha$ radiation; camera diameter, 114.59 mm.). (A) Suanite from the Hol Kol mine, Suan district, Korea (USNM 112583; f. 17153). (B) Synthetic triclinic $\text{Mg}_2\text{B}_2\text{O}_5$ (Sample 11; f. 17092). (C) Triclinic $\text{Mg}_2\text{B}_2\text{O}_5$ formed by heating powdered suanite at 1050°C. for 24 hours (f. 17661).

clinic $\text{Mg}_2\text{B}_2\text{O}_5$, which implies that the inversion to the triclinic form is not reversible on cooling. We have confirmed Watanabe's findings. We heated finely powdered suanite (white) in an open silica glass tube in a furnace at 1050°C. for 24 hours and then allowed the heated powder, which had recrystallized into buff-colored aggregates, to cool completely before taking an x -ray pattern. We found that suanite had changed upon heating to 1050°C. to the triclinic phase (Fig. 1C). We noted, also, that prolonged heating of suanite at temperatures below 1000°C. (at 650° and 900°C. , respectively, for 10-day periods) produced no observable change in the suanite pattern. Although Nefedov (1961) mentions that magnioborite was heated above 1000°C. , he does not indicate that x -ray powder patterns were taken of the heat-treated magnioborite for comparison with the untreated mineral.

Nefedov states that no change was noted in the indices of refraction or optical figure of magnioborite heated above 1000°C. or before the blow-

TABLE 2. X-RAY POWDER DATA FOR TRICLINIC AND MONOCLINIC FORMS OF $Mg_2B_2O_5$

Triclinic $Mg_2B_2O_5$ $P\bar{1}(C_2^1)$; $a=6.187 \text{ \AA}$, $b=3.119$, $c=9.219$, $\alpha=90^\circ 24'$, $\beta=104^\circ 19'$, $\gamma=92^\circ 08'$						Magnioborite		Monoclinic $Mg_2B_2O_5 = \text{Sunite}$ $P2_1/a(C_2^2)$; $a=12.31 \pm 0.01 \text{ \AA}$, $b=3.120$ ± 0.005 , $c=9.205 \pm 0.010$, $\beta=104^\circ 20' \pm 05''$							
Synthetic Takéuchi (1952)		Synthetic Davis (pers. comm., 1961)		Synthetic Present Study		Locality not given Nefedov (1961)		Sun district, Korea Present Study				Hol Kol mine Sun dist., Korea Takéuchi (1952)			
Measured ³		Measured ⁴		Calculated ⁵		Measured ⁶		Measured ⁷		Measured ⁸		Calculated ⁹		Measured ¹⁰	
d_{hkl}	I	d_{hkl}	I	hkl	d_{hkl}	d_{hkl}	I	I	d_{hkl}	I	d_{hkl}	hkl	I	d_{hkl}	I
—	—	—	—	001	8.93	8.93	5	—	—	3	8.91	8.92	001	—	—
—	—	—	—	100	5.99	5.98	13	3	6.0	6	5.96	5.96	200	—	—
—	—	—	—	$\bar{1}01$	5.67	—	—	4	5.0 ¹¹	—	—	5.64	201	—	—
—	—	—	—	101	4.49	—	—	—	—	—	—	—	—	—	—
4.385	m	4.48	5	002	4.47	4.47	71	7	4.50	25	4.47	4.47	201	m—	4.470
—	—	—	—	—	—	—	—	—	—	—	—	4.46	002	—	—
3.981	s	4.11	3	$\bar{1}02$	4.100	4.101	21	4	4.13	11	4.091	4.090	$\bar{2}02$	s	4.081
—	—	—	—	102	3.219	3.214	11	1	3.25	2	3.214	3.211	202	s	3.239
3.159	s	3.13	3	010	3.116	3.120	18	—	—	—	—	—	—	—	—
—	—	3.07	2	$\bar{2}01$	3.078	3.074	2	—	—	—	—	3.065	$\bar{4}01$	—	—
—	—	—	—	200	2.995	—	—	5	3.02	3	3.020	3.018	110	—	—
—	—	2.99	3	003	2.977	2.983	3	—	—	18	2.983	2.982	400	—	—
—	—	—	—	$\bar{1}03$	2.976	—	—	—	—	—	—	2.973	003	—	—
—	—	—	—	—	—	—	—	—	—	—	—	2.970	$\bar{2}03$	—	—
—	—	—	—	—	—	—	—	—	—	—	—	2.945	011	—	—
—	—	2.86	8	011	2.927	—	—	1	2.931	3	2.917	2.915	$\bar{1}11$	—	—
—	—	2.83	23	$\bar{2}02$	2.833	2.829	80	9	2.834	50	2.823	2.822	$\bar{4}02$	s	2.822
—	—	—	—	$\bar{1}10$	2.811	—	—	—	—	—	—	2.806	111	—	—
—	—	—	—	$\bar{1}11$	2.763	—	—	—	—	5	2.765	2.764	210	—	—
—	—	—	—	110	2.720	—	—	4	2.741	9	2.732	2.731	$\bar{2}11$	—	—
2.740	s	2.71	3	$11\bar{1}$	2.700	2.705	25	—	—	—	—	—	—	—	—

¹ Single-crystal data of Block, Burley, Perloff, and Mason (1959), reoriented to conform to the setting of sunite.

² Single-crystal data obtained in the present study from a crystal of sunite from the Sun district, Korea (USNM 112583). Quartz-calibrated Buerger precession camera. Zr-filtered Mo radiation ($\lambda=0.7107 \text{ \AA}$). Film measurements corrected for horizontal and vertical film shrinkage.

³ Calculated by the present authors from the Q_{obs} values of Takéuchi, using the formula $Q=4 \sin^2 \theta/\lambda^2$. Camera radius, 28.65 mm. $CoK\alpha$ ($\lambda=1.79 \text{ \AA}$).

⁴ Data obtained for Sample B30, using a recording x-ray spectrometer. Radiation not specified.

⁵ Interplanar spacings calculated by present authors from data of Block, Burley, Perloff, and Mason (1959). All calculated spacings listed for $d_{hkl} \geq 2.000$.

⁶ Powder diffraction data for synthetic $Mg_2B_2O_5$ (Sample 11) prepared by E. Levin, National Bureau of Standards, and kindly supplied for use in the present study by A. Perloff, National Bureau of Standards. Film no. 17092. Film corrected for expansion. Camera diameter, 114.59 mm. Ni-filtered Cu radiation ($\lambda=1.5418 \text{ \AA}$). Lower limit 2θ measurable 7.0° (12.6 \AA). D = diffuse. B = broad.

⁷ Unfiltered Fe radiation (λ not specified). Camera diameter, 57.3 mm. D = diffuse. NaCl used for internal standard. All β values indicated in the original paper have been omitted in this paper.

⁸ Powder diffraction data for sunite from the Sun district, Korea (USNM 112583). Film no. 17153. Film shrinkage negligible. Camera diameter, 114.59 mm. Ni-filtered Cu radiation ($\lambda=1.5418 \text{ \AA}$). Lower limit 2θ measurable 7.0° (12.6 \AA).

⁹ Interplanar spacings calculated from single-crystal data of the present authors. All calculated spacings listed for $d_{hkl} \geq 2.000$.

¹⁰ Calculated by the present authors from the Q_{obs} values of Takéuchi, using the formula $Q=4 \sin^2 \theta/\lambda^2$. Camera radius, 28.65 mm. $CoK\alpha$ ($\lambda=1.79 \text{ \AA}$).

¹¹ β of $d=4.50 \text{ \AA}$.

TABLE 2—(continued)

Triclinic Mg ₂ B ₂ O ₅ P1(C ₂); a = 6.18; Å, b = 3.11, c = 9.21, α = 90°24', β = 104°19', γ = 92°08'				Magnioborite		Monoclinic Mg ₂ B ₂ O ₅ = Suanite P2 ₁ /a(C ₂); a = 12.31 ± 0.01 Å, b = 3.120 ± 0.005, c = 9.20 ₅ ± 0.010, β = 104°20' ± 05''									
Synthetic Takéuchi (1952)		Synthetic Davis (pers. comm., 1961)		Synthetic Present Study		Locality not given Nefedov (1961)		Suan district, Korea Present Study		Hol Kol mine Suan dist., Korea Takéuchi (1952)					
Measured ³		Measured ⁴		Calculated ⁵		Measured ⁶		Measured ⁷		Measured ⁸		Calculated ⁹		Measured ¹⁰	
d _{hkl}	I	d _{hkl}	I	hkl	d _{hkl}	d _{hkl}	I	I	d _{hkl}	I	d _{hkl}	hkl	I	d _{hkl}	
—	—	2.64	1	201	2.649	2.643	15	3	2.656	15	2.637	2.638	401	—	—
2.584	s	2.58	100	111	2.607	2.600	90	—	—	—	—	2.559	211	—	—
—	—	—	—	012	2.576	2.580	5	10	2.577	100	2.557	2.556	012	vs	2.563
2.531	vs	2.54	5	012	2.536	2.536	60	—	—	—	—	2.556	112	—	—
—	—	—	—	111	2.515	—	—	—	—	—	—	—	—	—	—
—	—	—	—	112	2.496	—	—	—	—	—	—	2.481	212	—	—
—	—	—	—	112	2.467	—	—	3D	2.476	8	2.468	2.465	311	m	2.464
—	—	—	—	—	—	—	—	—	—	—	—	2.455	310	—	—
—	—	—	—	103	2.436	—	—	—	—	—	—	2.431	203	—	—
2.381	vw	2.44	1	203	2.434	2.433	11	2	2.430	8	2.430	2.430	112	—	—
—	—	2.37	1	—	—	—	—	—	—	—	—	2.427	403	—	—
—	—	2.32	1	—	—	—	—	—	—	—	—	2.304	312	—	—
2.265	m—	2.29	1	104	2.286	2.288	9	4	2.288	5	2.281	2.282	204	w	2.318
—	—	2.28	1	112	2.277	—	—	—	—	—	—	2.279	311	—	—
—	—	—	—	202	2.244	—	—	—	—	—	—	2.237	212	—	—
—	—	2.23	2	004	2.233	2.235	11	—	—	—	—	2.236	402	—	—
—	—	—	—	211	2.230	—	—	5	2.223	3	2.227	2.230	004	w	2.220
—	—	—	—	210	2.204	—	—	—	—	2	2.187	2.187	113	—	—
—	—	—	—	112	2.202	—	—	—	—	—	—	2.186	411	—	—
—	—	—	—	013	2.171	—	—	—	—	—	—	2.156	410	—	—
—	—	—	—	113	2.156	—	—	—	—	—	—	2.152	013	—	—
2.167	m—	2.18	3	211	2.152	2.151	2	6	2.156	13	2.151	2.151	213	w	2.144
—	—	—	—	113	2.149	—	—	—	—	—	—	—	—	—	—
—	—	2.14	1	013	2.135	2.132	30	—	—	—	—	—	—	—	—
—	—	—	—	212	2.126	—	—	—	—	—	—	—	—	—	—
—	—	—	—	210	2.117	2.116	2	3	2.113	2	2.100	2.093	412	—	—
—	—	2.07	1	212	2.068	—	—	—	—	—	—	—	—	—	—
—	—	—	—	301	2.060	—	—	—	—	—	—	2.055	113	—	—
—	—	—	—	211	2.060	—	—	—	—	—	—	2.053	313	—	—
—	—	2.05	2	204	2.050	2.052	11	4	2.060	11	2.051	2.051	601	—	—
—	—	—	—	—	—	—	—	—	—	—	—	2.023	312	—	—
2.026	s	2.01	16	302	2.019	2.015	100	9	2.011	60	2.010	2.015	411	vs	2.006
—	—	—	—	—	—	—	—	—	—	—	—	2.010	602	—	—

TABLE 2—(continued)

Triclinic Mg ₃ B ₂ O ₃ P $\bar{1}$ (C ₂ ^v); a = 6.187 Å, b = 3.118, c = 9.219, $\alpha = 90^\circ 24'$, $\beta = 104^\circ 19'$, $\gamma = 92^\circ 08'$				Magnioborite		Monoclinic Mg ₃ B ₂ O ₃ = Suanite P2 ₁ /a(C _{2h}); a = 12.31 ± 0.01 Å, b = 3.120 ± 0.005, c = 9.208 ± 0.010, $\beta = 104^\circ 20' \pm 05''$							
Synthetic Takéuchi (1952)		Synthetic Davis (pers. comm., 1961)		Synthetic Present Study		Locality not given Nefedov (1961)		Suan district, Korea Present Study		Hol Kol mine Suan dist., Korea Takéuchi (1952)			
Measured ³		Measured ⁴		Calculated ⁵		Measured ⁷		Measured ⁸		Calculated ⁹		Measured ¹⁰	
d _{hkl}	I	d _{hkl}	I	hkl	d _{hkl}	d _{hkl}	I	I	d _{hkl}	d _{hkl}	hkl	I	d _{hkl}
—	—	—	—		1,976	2		1	1,978	—	—	—	—
1.941	vs	1.949	5		1.948	35		8	1.927	30	1.916	m	1.919
1.901	m—	1.892	2		1.888	42		3	1.890	5	1.884	—	—
1.862	s	1.848	4		1.845	13		5	1.849	11	1.843	m	1.831
—	—	1.821	1		—	—		4	1.822	8	1.817	—	—
—	—	1.787	1		1.784	13		2D	1.788	3	1.783	—	—
—	—	—	—		—	—		—	—	1	1.761	—	—
—	—	—	—		1.719	6		—	—	<1	1.730	—	—
1.722	yw	1.707	2		1.707	13		6	1.715	11	1.710	mw	1.717
—	—	1.670	1		1.670	4		3	1.676 ¹²	3	1.675	mw	1.690
—	—	—	—		—	—		—	—	<1	1.660	—	—
—	—	1.645	1		1.641	4		2	1.653	2	1.645	—	—
—	—	—	—		1.618	4		—	—	<1	1.626	—	—
1.615	vw	1.608	1		1.605	13		2	1.610	6	1.604	—	—
—	—	1.593	1		—	—		5	1.588	8	1.585	m—	1.596
1.573	m+	1.561	3		1.558	35		7	1.564	21	1.562	m+	1.566
—	—	—	—		—	—		—	—	<1	1.549	—	—
1.534	m+	1.537	1		1.533	13		3	1.537	8	1.531	—	—
1.523	m+	1.514	3		1.514	25		6	1.518	11	1.514	m	1.509
1.496	vw	1.488	7		1.489	21		7	1.503	11	1.498	m	1.504
—	—	—	—		—	—		3	1.476	5	1.472	—	—
—	—	—	—		1.453	2D		2D	1.451	<1	1.451	—	—
—	—	—	—		1.408	4		4	1.429	3	1.426	w	1.429
—	—	—	—		1.383	3		3	1.393	<1	1.388	—	—
1.382	m—	1.368	1		1.365	9		6	1.370	8	1.366	w	1.365
1.349	m—	—	—		1.349	4		4	1.346	2	1.344	w	1.351
1.324	w+	—	—		1.320	2D		3	1.316	2	1.314	—	—
1.302	w+	—	—		1.307	6		3	1.302	<1	1.302	—	—
—	—	—	—		1.295	7		7	1.293	5	1.288	w+	1.296
1.276	vw	—	—		1.277	2		—	—	—	—	—	—
—	—	—	—		1.274	3		—	—	—	—	—	—
1.265	vw	—	—		1.251	6		2	1.245	1	1.244	w	1.241

¹² In the original paper indicated as a β line.

TABLE 2—(continued)

Triclinic Mg ₂ B ₂ O ₅ $P\bar{1}(C_2^1)$; $a=6.187 \text{ \AA}$, $b=3.119$, $c=9.219$, $\alpha=90^\circ 24'$, $\beta=104^\circ 19'$, $\gamma=92^\circ 08'$				Monoclinic Mg ₂ B ₂ O ₅ =Suanite $P2_1/a(C_{2h}^2)$; $a=12.31 \pm 0.01 \text{ \AA}$, $b=3.120$ ± 0.005 , $c=9.205 \pm 0.010$, $\beta=104^\circ 20' \pm 05''$									
Synthetic Takéuchi (1952)		Synthetic Davis (pers. comm., 1961)		Synthetic Present Study		Magnioborite Locality not given Nefedov (1961)		Suan district, Korea Present Study		Hol Kol mine Suan dist., Korea Takéuchi (1952)			
Measured ³		Measured ⁴		Calculated ⁵		Measured ⁷		Measured ⁸		Calculated ⁹		Measured ¹⁰	
d_{hkl}	I	d_{hkl}	I	hkl	d_{hkl}	d_{hkl}	I	I	d_{hkl}	d_{hkl}	hkl	I	d_{hkl}
1.242	vw	—	—		1.232	3	6	1.234	5	1.233		w+	1.231
—	—	—	—		1.216	11	5	1.216	8	1.214		—	—
—	—	—	—		—	—	—	—	<1	1.203		—	—
1.192	m	—	—		1.189	2	2	1.191	<1	1.192		—	—
—	—	—	—		1.181	1	3	1.181	1	1.180		—	—
—	—	—	—		—	—	3	1.168	1	1.166		—	—
1.155	vw	—	—		1.150	3	4	1.150	<1	1.148		w	1.154
—	—	—	—		1.136	2	—	—	2	1.133		—	—
—	—	—	—		1.115	4	8	1.120	3	1.118		—	—
—	—	—	—		1.100	3	7	1.096	2	1.103		—	—
—	—	—	—		1.087	1	2D	1.080	<1	1.080		—	—
—	—	—	—		1.071	2	2D	1.066	<1	1.069		—	—
—	—	—	—		—	—	2D	1.057	<1	1.059		—	—
—	—	—	—		—	—	4	1.050	2	1.051		—	—
—	—	—	—		—	—	3	1.029	<1	1.030		—	—
—	—	—	—		1.019	3B	1	1.024	2	1.024		—	—
—	—	—	—		—	—	—	—	2	1.013		—	—
—	—	—	—		—	—	—	—	<1	1.005		w+	1.000
0.9919	m	—	—		0.9962	2B	—	—	2	0.9948		—	—
—	—	—	—		0.9776	2B	—	—	2	0.9877		—	—
—	—	—	—		0.9681	2	—	—	2	0.9675		—	—
—	—	—	—		0.9615	1	—	—	—	—		—	—
—	—	—	—		0.9544	1B	—	—	2	0.9562		—	—

Plus additional weak lines with $I \leq 2$.Plus additional weak lines with $I \leq 2$.

pipe. Optical examination of triclinic Mg₂B₂O₅ which we obtained after heating powdered suanite at 1050° C. for 24 hours indicated an appreciable change only in the β index and in the 2V. If Nefedov's magnioborite is suanite, he could have been misled into believing that no optical change had taken place upon heating magnioborite above 1000° C. unless he carefully checked the grains of the heat-treated magnioborite for the β index and the 2V.

According to the published data, differential thermal analysis should be decisive. Watanabe reported that suanite gives an endothermal peak at 630° C., perhaps corresponding to the inversion of monoclinic to triclinic $Mg_2B_2O_5$. He also gave a DTA curve for szaibelyite, $Mg(BO_2)(OH)$, for comparison; this gave a larger endothermal break than suanite at 670° C.; Shabynin (1955) gave a similar curve with a large endothermal break at 690° C. for szaibelyite.

If Watanabe (1953) is correct, monoclinic $Mg_2B_2O_5$ should give an endothermal break at 630° C. and triclinic $Mg_2B_2O_5$ should give no break near this temperature. The test fails for magnioborite, because Nefedov unfortunately does not give his DTA curve. He states,

"Magnioborite containing up to 10 per cent admixture of szaibelyite and dolomite was subjected to thermal analysis. On the heating curve, besides endothermal effects associated with the dehydration of szaibelyite and the dissociation of dolomite, occurring in the interval from 600° to 880° C., there was recorded an endothermal effect at temperatures 950° to 1020° C. Repeated experiments of heating more coarse-grained powders of magnioborite, also with admixtures of szaibelyite and dolomite, were carried out at temperatures up to 1030° C. The heating was stopped after the endothermal effect at 950° to 1020° C. On cooling the sample to 960° C., an exothermic effect was noted at 960° C., equal in intensity to the endothermal effect at the same temperature during the heating of the sample. Further cooling gave no thermal reactions."

If Nefedov's (1961) magnioborite is suanite, the DTA curve should show endothermal breaks at 630° C. and at 670° to 690° C. (szaibelyite); if it is triclinic $Mg_2B_2O_5$, the 630° C. break should be missing.

The reversible break at 950° to 1020° C. is very puzzling but a possible explanation is afforded by the work of Davis and Knight (1945) on the system $MgO-B_2O_3$. Nefedov gives an analysis by I. A. Stolyarova of material containing szaibelyite and dolomite, apparently similar in composition to the material he studied by differential thermal analysis. This contained B_2O_3 43.40, MgO 52.04, FeO 1.37, MnO 0.22, CaO 1.25, Fe_2O_3 0.98, insol. 0.70, total 99.96 per cent. If one neglects the iron, manganese, and calcium, the ratio MgO/B_2O_3 is 2.07. The thermal behavior is inexplicable for this composition, but fits quite well into what should be observed for material between $2MgO \cdot B_2O_3$ and $MgO \cdot B_2O_3$ in composition, which Davis and Knight (1945) found to give a sharp endothermal break at 988° C., the temperature at which the synthetic compound MgB_2O_4 melts incongruently. The szaibelyite present has the same MgO/B_2O_3 ratio (2:1) as magnioborite.

Nefedov (1961) also states, "The beginning of melting of the sample of the mineral was recorded at 1080° C.; nevertheless it is entirely possible that it is lowered by the admixture of szaibelyite and that the fusion temperature of pure magnioborite is higher. This assumption is based on the

fact that transparent fragments of magnioborite placed on a platinum wire do not fuse after long heating before the blowpipe." Even allowing for the effects of the iron and manganese present, the temperature of melting observed is hard to explain for the composition $Mg_2B_2O_5$, which Davis and Knight (1945) found to melt congruently at $1340^\circ C.$, or for compositions which are richer in MgO , but it does check with the behavior of mixtures lying between $Mg_2B_2O_5$ and MgB_2O_4 , which Davis and Knight found to form two liquids at $1142^\circ C.$ It is likely that material like this loses B_2O_3 when heated to high temperatures, which would change the composition in the reverse direction.

In summary, the data given by Nefedov (1961) are insufficient to permit a definite decision as to whether magnioborite is identical with suanite (monoclinic $Mg_2B_2O_5$) or is the naturally occurring triclinic dimorph of $Mg_2B_2O_5$. A sample of magnioborite was not available to us for direct x -ray comparison with suanite and triclinic $Mg_2B_2O_5$. We believe, however, that the x -ray evidence and especially the values of $2V$ and of the β index indicate that magnioborite is probably suanite. Therefore, because the burden of proof is on the person describing such material, we feel that new evidence must be given before magnioborite can be accepted as a valid species.

After our work was completed, a comparison of the properties of suanite and magnioborite by Shabynin (1961) led him to state that magnioborite is identical with suanite and "is excluded as a new mineral." Apparently he, too, was unaware of the existence of the synthetic triclinic dimorph of $Mg_2B_2O_5$ and had not taken its properties into consideration for comparison with those of magnioborite.

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SOME UNUSUAL MINERALS FROM THE "MOTTLED ZONE"
COMPLEX, ISRAEL

Y. K. BENTOR, *Geological Survey of Israel and Hebrew University, Jerusalem* AND S. GROSS AND L. HELLER, *Geological Survey of Israel.*

In most parts of Israel a chalky-shaly rock sequence, the Ghareb and Takiye formations is found overlying flint beds of Campanian age. In subsurface sections this sedimentary rock sequence is generally highly bituminous and may contain 25 per cent or more organic matter. In a number of widely separate areas, however, such as the Hatrurim region and the Beersheba Valley in the northern Negev, near Ramleh in the coastal plain and at Maaleh Adumim in the Jordanian part of the Judean Desert, a peculiar rock complex, the so-called "Mottled Zone," appears instead of this normal sequence. The "Mottled Zone," which reaches a maximum thickness of 220 m, comprises a large number of rock types such as limestone, chalk, marl, shale as well as gypseous, ferruginous and phosphatic rocks, all distinguished by a pronounced but highly irregular coloration. These various rock types occur without any apparent regularity and pass into each other without distinct boundaries. No bedding can be observed, but a schist-like structure is fairly common. This rock sequence contains an abundance of trace elements, among which Ag, V, Ni and Cr are prominent. Chromium, in the form of green chromium silicates in particular is found in many veins up to 1 m thick and may make up 6 per cent of the vein material.

One of the most widespread rock types of the "Mottled Zone" is a very hard, dense, splintery, brown, violet or black rock. Microscopic examination shows it to be composed mainly of calcite and spurrite,¹ approxi-

¹ Spurrite has also been found in these rocks by E. Sass and tobermorite by C. Milton (private communication).