RE-EXAMINATION OF PILINITE AND ITS IDENTIFICATION WITH BAVENITE*

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ABSTRACT

X-ray powder patterns and a new chemical analysis made on pilinite from the type locality have shown it to be the same mineral as bavenite. The strongest lines in the x-ray powder pattern, in order of decreasing intensity are: 3.71, 3.35, 3.22, 3.03, 2.83, 4.85 Å. The new chemical analysis shows 5.5 per cent BeO which was missed in the original analysis. The formula proposed is $(Be,Al)_4Ca_4(SiO_3)_9 \cdot xH_2O$. It is recommended that the name pilinite be dropped.

INTRODUCTION

Pilinite was described as a new mineral by von Lasaulx (1876). The mineral was described as fine feltlike masses of needles, resembling asbestos, occurring with quartz, epidote, and stilbite in cavities in granite at Striegau, Silesia. A chemical analysis gave a formula that corresponded approximately to $2CaO \cdot Al_2O_3 \cdot 5SiO_2 \cdot H_2O$.

The only additional information published about pilinite since the original very brief and incomplete description is a statement in the index of Strunz's Mineralogische Tabellen (2d ed., 1949 and 3d ed., 1957) that pilinite is an asbestiform idocrase.

Examination of the specimen in the U. S. National Museum labeled pilinite from Striegau, Silesia, has shown the mineral to be identical with bavenite. Type specimens were not available for study. However, the material in the Museum is identical in locality, appearance, and association with that described by von Lasaulx, and it seems quite certain that the two are the same.

Bavenite was described as a new mineral from Baveno, Italy, by Artini (1901), but the presence of beryllium was overlooked by him, just as it was 25 years earlier by von Lasaulx. Artini failed to recognize

his mineral as being the same as pilinite. The presence of beryllium in bavenite was reported by Schaller and Fairchild (1932).

CHEMISTRY

A new analysis was made of pilinite from Striegau, Silesia. Except for the separation of beryllium from aluminum and iron, the sample was analyzed by conventional procedures. Beryllium was separated from aluminum and iron by the procedure of Jilek and Kota (1931) in which tartrate is added to prevent the precipitation of aluminum and iron and the beryllium is precipitated by guanidine carbonate. Spectrographic anal-

TABLE 1. ANALYSES OF PILINITE

	1			2
	Per cent	Moles	Mole ratios	Per cent
BeO	5.52	0.221	2.10	
Fe_2O_3	.60	.004		
Al_2O_3	9.62	.094	.94	18.64
CaO	23.44	.418	3.98	19.51
SiO_2	57.04	.950	9.05	55.70
H_2O^+	2.86	1.59	1.51	4.97
H_2O^-	.14			
MgO	.22			
Li_2O				[1.18]
	99.44			100.00

1. Striegau, Silesia, USNM R-7553, Laura L. Reichen, analyst.
2. Original analysis of pilinite, Bettendorf, analyst (von Lasaulx, 1876).

yses of the alumina precipitates made by Harry Bastron of the U. S. Geological Survey indicated that the separation of beryllium from aluminum was satisfactory.

The results of this analysis and of the original analysis made by Bettendorf (von Lasaulx, 1876) are given in Table 1. As the presence of beryllium was not detected in the original analysis, it can be assumed that the figure for alumina includes the beryllia also. Therefore, this incorrect alumina figure should be disregarded in making the comparison of the two analyses. The chemical analyses of bavenite from different localities have been summarized by Fleischer and Switzer (1953). They conclude that the composition of bavenite is well established. The analyses from the four locations cited in their paper are reproduced in Table 2 and the

molecular ratios have been added. The new analysis of pilinite made in the present study shows that it has the same composition as bavenite.

However, in spite of the agreement as to composition, three different formulas have been proposed for bavenite:

$Be_5Al_4Ca_8Si_{18}O_{55} \cdot 2H_2O$ Kutukova (1946), based on 9.89 per cent alumina.

$Be_4Al_2Ca_6Si_{14}O_{41} \cdot 2H_2O$ Rowledge and Hayton (1948), based on 7.00 per cent alumina.

$Be_{2.6}Al_{1.2}Ca_{3.9}Si_{8.8}O_{26} \cdot 1.2H_2O$ Fleischer and Switzer (1953), based on the oxygen content which gives best agreement between calculated and observed sp. gr. Recalculation of Rowledge and Hayton analysis.

TABLE 2. SUMMARY OF BAVENITE ANALYSIS FROM TABLE 1 OF
FLEISCHER AND SWITZER (1953)

	Baveno (1)		Russia (6)		Australia (8)		California (9)	
	Per cent	Moles	Per cent	Moles	Per cent	Moles	Per cent	Moles
SiO_2	56.93	0.948	57.25	0.953	59.13	0.984	57.64	0.960
CaO	24.47	.436	24.35	.434	23.90	.426	23.96	.427
Al_2O_3	10.0*	.098	9.89	.097	7.00	.069	6.46	.063
BeO	5.4*	.216	6.33	.254	7.14	.285	7.66	.306
$BeO+Al_2O_3$		.304		.351		.354		.369
H_2O	2.49	.138	1.90	.105	2.46	.137	3.56	.198

* Fleischer and Switzer (1953) show 5.4 ± 0.5 per cent BeO by spectrographic analysis for a sample from Baveno, Italy. Subtracting this 5.4 per cent BeO from the 15.42 per cent Al_2O_3 shown in their Table 1 for a sample from Baveno leaves 10.02 per cent Al_2O_3.

Inspection of the molecular ratios in Table 2 shows that the mole fractions of SiO_2 (0.948–0.984) and of CaO (0.426–0.436) are nearly the same for each sample. Furthermore, by comparing the sum of the mole fractions of BeO plus Al_2O_3 (0.304–0.369) instead of the weight per cents of BeO (5.4–7.66) or Al_2O_3 (6.46–10.0) we see a possibility of a relationship between beryllium and aluminum instead of only poor analytical checks. That beryllium and aluminum proxy for one another is a reasonable assumption because beryllium is known to occur in tetrahedral coordination and aluminum can occur in either tetrahedral or octahedral coordination. The atomic ratios in Table 3, therefore, have been calculated on the assumption that beryllium and aluminum proxy for each other (from the analyses given in Table 2 and pilinite copied from Table 1). We suggest $(Be,Al)_4Ca_4(SiO_3)_9 \cdot xH_2O$ as a formula which fits the chemical analyses of all these samples of bavenite.

TABLE 3. ATOMIC RATIOS OF COMPONENTS OF PILINITE FROM STRIEGAU
AND BAVENITE FROM VARIOUS LOCATIONS

Sample	Location	Ca	Be	Al	Si	O	H_2O	Sp. gr.
Pilinite	Striegau	3.98	2.10	1.88	9.05	27	1.51	2.73
Bavenite	Australia	3.98	2.66	1.28	9.20	27	1.15	2.71
Bavenite	California	4.06	2.91	1.20	9.14	27	1.88	
Bavenite	Baveno	4.15	2.06	1.87	9.03	27	1.31	2.72
Bavenite	Russia	4.00	2.30	1.78	9.04	27	.98	2.73

One argument in favor of this formula is that the $1:3$ silicon to oxygen ratio is consistent with the grouping $(SiO_3)_n^{-2n}$ known to exist in fibrous and asbestos-like material. The $9:26$ ratio suggested by Fleischer and Switzer is not known to exist.

The measured specific gravity of pilinite from Striegau is 2.73 (measured by means of an Adams-Johnston fused silica pycnometer). If one assumes the unit cell of Claringbull (1940) and four formula weights per unit cell, the calculated specific gravity is 2.81. The unit cell of Claringbull, determined on bavenite from Muotta Nera, Switzerland, is $a = 19.34$, $b = 23.06$, and $c = 4.95$ kX. The fact that the calculated specific gravity (2.79) for the formula of Fleischer and Switzer agrees closely with the observed specific gravity (2.73) seems fortuitous, because it is well known that specific gravities on fibrous material can be low.

OPTICAL PROPERTIES

Pilinite occurs in fibers or platy fibers that reach a maximum length of 2 mm., but a breadth of not more than 0.02 mm. The elongation of the fibers is negative. The indices of refraction are in close agreement with published values for bavenite, and are as follows:

$$\begin{matrix} n(Na) \\ \alpha = 1.586 \\ \beta \text{ near } \gamma = 1.590 \end{matrix} \pm 0.002$$

X-RAY POWDER DATA

X-ray powder data for bavenite and pilinite are given in Table 4. No correction was made for film shrinkage.

CONCLUSION

Pilinite and bavenite are identical. Therefore, one name should be dropped. The name pilinite has priority by 25 years, and according to strict rules of nomenclature bavenite should be relegated to the syn-

TABLE 4. *X*-RAY POWDER DATA FOR BAVENITE AND PILINITE

Cu/Ni radiation; $\lambda = 1.5418$ Å

Camera diameter 114.59 mm., 2θ cut-off 6°

Bavenite Baveno, Italy USNM C-3478		Pilinite Striegau, Silesia USNM R-7553		Bavenite (Continued)		Pilinite (Continued)	
I	d (Å)	I	d (Å)	I	d (Å)	I	d (Å)
3	11.79	5	11.63	1	2.80	2	2.79
1	9.94	1	9.83	1	2.75	2	2.73
3	7.56	5	7.44	1	2.67	1	2.65
4	5.04	5	4.98	6	2.56	7	2.56
3	4.87	6	4.85	3	2.49	5	2.48
		1	4.82	3	2.42	5	2.42
1	4.48					2	2.37
1	4.35	1	4.35	2	2.33	4	2.32
5	4.19	4	4.21	2	2.29	4	2.29
4	3.87	3	3.85	2	2.25	4	2.26
10	3.74	10	3.71			3	2.23
		1	3.59	1	2.16	1	2.16
2	3.41	1	3.40	3	2.11	5	2.09
9	3.35	9	3.35	3	2.08	5	2.08
8	3.24	8	3.22	3	1.98	6	1.97
7	3.13	8	3.12	4	1.95	6	1.95
7	3.05	7	3.03	2	1.88	4	1.87
5	2.85	6	2.83	2	1.83	4	1.82

onymy. However, Dana (1892, p. xliii) states that the law of priority may be set aside, "When a name has been lost sight of and has found no one to assert its claim for a period of more than fifty years; especially if the later name adopted for the species has become intimately incorporated with the structure of the science. . . ." We suggest, therefore, that the name pilinite be dropped and bavenite retained.

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