ART. XXXIV.—*Mineralogical Notes;* by S. L. PENFIELD and E. S. SPERRY.

1. *Beryl.*

IN connection with the previous communications on the chemistry of beryl from this laboratory,* we thought that it would be of interest to re-examine one of the beryls containing the most alkali to prove if possible the correctness of the assumption which we had made, that the alkalies when present replace the beryllium. For this purpose we selected the cæsium beryl from Norway, Maine, which had been previously analyzed and described in one of our former papers, and subjected it to a very careful chemical analysis by Mr. Sperry, with results which are given below. We also publish the chemical analysis of a transparent yellow beryl, known by some as *golden beryl*, from Litchfield Co., Ct., which is collected and used as gem material. The mineral was perfectly pure and was sent to us by Mr. Geo. F. Kunz, of New York. A third beryl which we have investigated is a transparent glassy variety from Willimantic, Ct., with very unusual crystalline habit, which was brought to our notice by Mr. H. N. Bill, of Willimantic, Ct., who collected it from a narrow vein of coarse granite, at an excavation for a roadway on Oak street, a short distance north of the residence of Mr. Joel Fox. The specimen is irregular in shape, not over $2\frac{1}{2}$ inches in its greatest diameter, it is clear and glassy though much cracked and soiled by infiltrating clay, and with the exception of a small part,

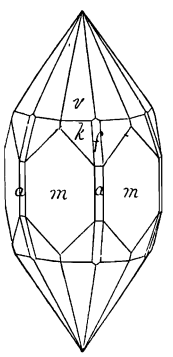
* This Journal, III, xxviii, 25, and III, xxxii, 110.

where it was broken off, is covered with crystalline facets very irregularly distributed, so that the system of crystallization can not readily be told. The most prominent face on the specimen is a prismatic face m measuring nearly one square inch in surface, but with irregular contour and deeply pitted by crystalline depressions scattered irregularly over its surface. At either end of this face and for a distance of one half an inch back, the crystal is terminated by a series of dihexagonal pyramids, or berylloids, in parallel position, there being six of them at one end and four at the other; these run into one another in a most confusing manner, while most of the specimen is covered with such a multitude of beryllloid and prismatic faces, that their relation to each other can only be made out with difficulty, which is further increased by the somewhat curved and dull nature of the faces, so that they give only poor reflections on the goniometer. The forms which were identified are as follows:

m, $10\bar{1}0$, I	p, $10\bar{1}1$, 1	k, $42\bar{6}1$, $6\text{-}\frac{3}{7}$	f, $33\bar{6}1$, 6-2
a, $11\bar{2}0$, i-2	v, $21\bar{3}1$, $3\text{-}\frac{3}{2}$	n, $31\bar{4}1$, $4\text{-}\frac{4}{3}$	

Of these, n and p were identified only once. The common berylloid at the ends of the prism is v with the points rounded off as if they had been dissolved away. Where the beryllloids join the prism, the steeper k faces are common. Fig. 1 represents the arrangement of these faces in a single ideal crystal, while the specimen in hand might be considered as an aggregate of such crystals, with prismatic faces in common terminated by a series of berylloid points. The whole mass has a very much eaten out or etched appearance, and the idea suggests itself that this unusual and curious development, so unlike our ordinary Connecticut beryl, has perhaps resulted from the action of some solvent upon a large mass of beryl. Although the angles obtained in measuring the faces are only approximate, the best of them agree closely with those calculated from Kokscharow's fundamental measurements,* while the determination was further facilitated by the occurrence of the faces in zones. The following angles were measured, and are given in the table, along with the calculated values, the number of times that different faces were measured and the limiting values.

1.



* Materialien zur Mineralogie Russlands, i, 147.

		Measured.	Calculated.	No. of times.	Limit.
$v \wedge v$	$3\bar{1}\bar{2}1 \wedge 21\bar{3}1$	31° 34′	31° 46′	4	30° 57′–31° 34′
$v \wedge v$	$21\bar{3}1 \wedge 12\bar{3}1$	18° 31′	18° 11′	4	18° 31′–19° 51′
$k \wedge k$	$6\bar{2}\bar{4}1 \wedge 42\bar{6}1$	36° 28′	37° 14′	2	35° 8′–36° 28′
$k \wedge k$	$42\bar{6}1 \wedge 24\bar{6}1$	20° 40′	20° 41′	2	20° 2′–20° 41′
$k \wedge f$	$42\bar{6}1 \wedge 33\bar{6}1$	10° 36′	10° 21′	2	9° 32′–10° 36′
$m \wedge v$	$10\bar{1}0 \wedge 3\bar{1}\bar{2}1$	37° 25′	37° 49′	2	37° 16′–37° 25′
$m \wedge n$	$10\bar{1}0 \wedge 4\bar{1}\bar{3}1$	28° 51′	29° 0′	1	
$m \wedge k$	$10\bar{1}0 \wedge 6\bar{2}\bar{4}1$	25° approx.	26° 8′	1	
$m \wedge m$	$10\bar{1}0 \wedge 01\bar{1}0$	59° 49′	60° 3′	1	
$v \wedge k$	$3\bar{1}\bar{2}1 \wedge 6\bar{2}\bar{4}1$	15° approx.	15° 6′	1	

The results of the chemical analyses of the three varieties are as follows:

I. Norway, Maine, Sp. Gr. 2·747, No. 409A in Professor Brush's collection.
II. Litchfield Co., Ct., Sp. Gr. 2·716.
III. Willimantic, Ct., Sp. Gr. 2·725, No. 410A in Professor Brush's collection.

	I.	Ratio.	II.	Ratio.	III.	Ratio.
SiO_2	64·12	1·069	65·62	1·093	65·72	1·095
Al_2O_3	17·89	·175	17·86	·175	18·40	·180
Fe_2O_3			·37	·002		
FeO	·16	·002	·18	·002	·26	·004
MnO					·12	·002
BeO	12·13	·485	13·50	·540	13·08	·523
Cs_2O	1·61	·007	·03			
K_2O	·10	·001			·12	·001
Na_2O	1·21	·029	·54	·009	·75	·012
Li_2O	·75	·015	·10	·003	·28	·009
Ign	2·24	·124	2·34	·130	2·06	·114
	100·21		100 54		100·79	

The ratios are as follows:

	SiO_2 :	Al_2O_3 :	RO	:	H_2O.						
I	1·069	·175	·539	:	·124	or	6	:	0·98	: 3·03	: 0·70
II	1·093	·177	·554	:	·130	or	6	:	0·97	: 3·04	: 0·71
III	1·095	·180	·551	:	·114	or	6	:	0·98	: 3·02	: 0·62

In the above ratios, RO includes all the protoxides (Be, Fe, Mn, Cs_2, K_2, Na_2, Li_2)O. In relation to the alkalies, it will be seen that in analysis I, the BeO is fully one per cent lower than in II and III, while by a consideration of the ratios it will be seen that this deficiency is fully made up by the presence of a sufficient quantity of alkalies. This is certainly the necessary proof of the correctness of our assumption that the alkalies in beryl are isomorphous with the BeO. In analysis I, if we neglect the alkalies, the ratio of $SiO_2 : Al_2O_3 : BeO$ becomes 6 : 0·98 : 2·72. In analysis II there is an unusual quantity of Fe_2O_3, which may account for the yellow color of the beryl; however, the results of the FeO and Fe_2O_3 determinations can not be regarded as very exact, owing to the difficulty of decomposing the beryl with hydrofluoric acid, though special care was taken to make the determination as exact as possible. Aside from the above-mentioned peculiarities, the analyses

present no special features which have not been noted in previous papers. The occurrence of alkalies and water, even in our most transparent and purest beryls, is well established. The water must still remain problematical. It has previously been determined as loss on ignition, but we have also made direct determinations by heating the mineral in a Gooch tubulated crucible, collecting the water in a chloride of calcium tube, with special care, and obtained results agreeing with the loss on ignition. If this water is to be included in the formula, we would suggest, as was done in a previous paper,* using the usually accepted formula of beryl, $Be_3Al_2Si_6O_{18}$, plus one-half a molecule of water. This expresses nearly the quantity which is present, while the excess, over 0·50 H_2O in the above ratios, may be accidental or perhaps even basic water, $3H_2O$ being equivalent to Al_2O_3 and H_2O to BeO. That all of the water is basic seems to us improbable, as it is present in too large proportion, and if added in any way to the Al_2O_3 and BeO, it would distort the simple ratio of $SiO_2 : Al_2O_3 : BeO$ to too great an extent. The excess of H_2O over and above one-half a molecule in the three analyses is I, 0·63; II, 0·70; III, 0·42 per cent. Such quantities of accidental water, as we may call it at present, are not uncommon in the analyses of our ordinarily accepted anhydrous minerals.

2. *Phenacite.*

Having proved that alkalies are almost always present in beryl, replacing the BeO, we decided to analyze a phenacite, with especial reference to the detection and estimation of any alkalies that might be present. The material, which was furnished to us by Mr. Geo. F. Kunz, of New York, was the flat rhombohedral variety from Topaz Butte, near Florissant, Pike's Peak region, Colorado. All of the material was clear and colorless and had a specific gravity between 2·966 and 2·957, determined by means of the heavy solution. The analyses are

	Sperry.	Penfield.	Mean.	Calculated for Be_2SiO_4.
SiO_2	54·46	54·42	54·44	54·47
BeO	45·57	45·60	45·58	45·53
Na_2O	0·21		0·21	
Li_2O	trace			
Ign.	0·26		·26	
			100·49	

The atomic weights Be=9·08 and O=15·96 were used in calculating the above values, while for Be=9·4 and O=16·, the values are SiO_2=54·15 and 45·85. Special care was taken in the determination of the alkalies, the solutions coming in con-

* This Journal, III, xxxii, 110.

tact with glass only during the necessary filtrations. The slight trace is calculated as Na_2O, although it contained traces of lithia, as shown by the spectroscope.

Crystals from Mt. Antero, Colorado.—In a previous paper* one of us published a description of these crystals from a few specimens which belonged to the Rev. R. T. Cross, of Denver. During the summer of 1887, Mr. W. B. Smith, of Denver, Colorado, secured a large number of crystals, through a mineral collector, which are now quite largely distributed through mineral cabinets. The difficulty in securing the specimens is their occurrence at an altitude of over 12,000 feet, at a locality which is only accessible during a short period in the summer, after the snow has disappeared. The crystals are attached to quartz, transparent beryl (aquamarine, sometimes with good terminations), and Baveno twins of orthoclase, and are associated with muscovite and octahedral fluorite. All of the specimens which we have seen in the collections of Messrs.

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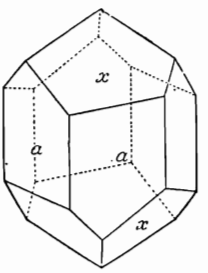

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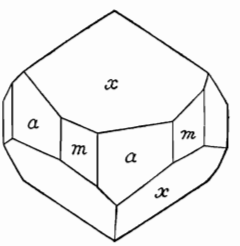

C. S. Bement, Geo. J. Brush, W. B. Smith, the Yale University cabinet and the U. S. National Museum show two prominent developments. One of these, according to our own observations and those of Mr. W. B. Smith, who has seen the greatest number and variety of specimens from this locality, always occurs among those crystals which are attached to quartz or beryl and is represented in its simplest form in fig. 2, which shows the combination of a ($11\bar{2}0$, i-2) and x ($\bar{1}3\bar{2}2$, $-r\ \frac{1}{4}\ (\frac{3}{2}\text{-}\frac{3}{2})$), giving a very interesting form, owing to the unusual combination of a prism of the second with a rhombohedron of the third order; sometimes there are associated, with these, small faces of m ($10\bar{1}0$, I), s ($21\bar{3}1, +r\ \frac{1}{4}\ (3\text{-}\frac{3}{2})$) r ($10\bar{1}1, +1$), and d ($01\bar{1}2, -\frac{1}{2}$) as represented in figs. 4 and 5 of the previous communication.† The second habit, which is found among those crystals which are attached to orthoclase, has two prisms well developed and is short prismatic, fig. 3,

* This Journal, III, xxxiii, 132. † Loc. cit.

frequently much shorter than represented in the illustration. Many of the crystals are of considerable size, measuring over one-half inch in diameter and one inch in length. The *x* faces on the larger crystals are always dull and rough and the prismatic faces vertically striated.

3. *Monazite from Alexander Co., N. C.*

Crystals of this mineral, from a locality about three miles east of the Emerald and Hiddenite Mine, were first brought to notice and described by Mr. Wm. E. Hidden,* who sent us several grams of very pure transparent crystals for chemical examination. It seemed especially desirable to have an analysis of such a pure, crystallized variety, owing to the fact that most analyses of monazite show a greater or less percentage of ThO_2, and the conflicting views relative to its relation to the mineral; i. e., that it belongs in the composition of the mineral, although the oxide ThO_2 has no chemical relation to the Ce_2O_3, La_2O_3 and Di_2O_3, or that it is present together with SiO_2 and H_2O as an impurity of thorite, $ThSiO_4$, H_2O. This latter view was advanced by one of us in a former paper,† being substantiated by analytical results and microscopic examination, but the former view is still held by many and is especially advocated by C. W. Blomstrand, who has recently published a detailed paper‡ on the subject.

The chemical analysis was made with great care by both of us, according to the method described in the previous paper. The specific gravity, taken with precision on a chemical balance, was found to be 5·203. The analysis yielded

	Sperry.		Penfield.		Mean.
P_2O_5	29·57	28·95	29·19	29·57	29·32
Mixed oxides	71·91	72·37	72·25		72·18
SiO_2	·24		·47		·32
Ignition	·17				·17

The determination of ThO_2 and CeO_2 in the mixed oxides and calculation of CeO_2 to Ce_2O_3 gave as the complete analysis:

			Ratio.
P_2O_5	29·32		·207
Ce_2O_3	37·26	÷ 328	·210
$(La, Di)_2O_3$	31·60		
ThO_2	1·48		·005
SiO_2	·32		·005
Ign.	·17		
	100·15		

The amount of thoria is very slight, really not greater than the SiO_2 as can be seen by the ratio $ThO_2 : SiO_2 = 1 : 1$, al-

* This Journal, III, xxxii, 207.

† This Journal, III, xxiv, 250.

‡ Geol. För. Förh., ix, p. 160, 1887.

though owing to its very high atomic weight it is represented by a much greater percentage in the analysis. The identity of the thoria was proved by making an atomic weight determination on ·0276 grams of the oxide and by converting it into sulphate which gave 228 instead of 232, an agreement as close as could be expected from the small quantities used. The joint molecular weight of the (Ce, La, Di)$_2$O$_3$ was found to be 328. The amount of ThO$_2$ is here too small to warrant any generalizations as to whether it is present as a silicate, which is certainly substantiated by our analysis, or whether it belongs to the phosphate. Regarding the ThO$_2$ and SiO$_2$ as present in the form of thorite, the P$_2$O$_5$ and (Ce, La, Di)$_2$O$_3$ are present in the proportion of a normal phosphate, as shown by the ratio, ·207 : ·210 = 1 : 1. ThO$_2$ can not be regarded as an essential constituent of monazite, as it is present in varying proportions, though almost always present in the different varieties.

4. *Sussexite from Mine Hill, Franklin, N. J.*

This rare mineral was first described by Professor Geo. J. Brush,* who determined its formula to be HRBO$_3$, where R = Mn and Mg. A new analysis of this mineral was to be desired, especially for the more accurate determination of the boric acid, which was made by the method proposed by Professor F. A. Gooch.† The material for analysis was taken from the original specimens in the collection of Professor Brush, the purest fibers being selected, which had a specific gravity of 3·123, taken very carefully on a chemical balance, after boiling in water to expel the air.

The analysis by Penfield yielded

		Ratio.		
B_2O_3	33·31	·476		1·00
MnO	38·08	·536	·974	2·05
ZnO	3·24	·040		
MgO	15·92	·398		
H_2O	8·53	·472		·99
Loss by drying at 250° C.	·90			
	99·98			

The air-dry powder lost 0·34 per cent by drying at 100° C. and 0·90 per cent at 250° C. Regarding this water as hygroscopic, the ratio of $Be_2O_3 : RO : H_2O = 1 : 2 : 1$ very closely, which fully substantiates the formula of Prof. Brush, H(Mn, Mg, Zn)BO$_3$.

5. *Twin Crystals of Quartz with inclined Axes.*

Two twin crystals were recently purchased by Professor Geo. J. Brush, in London, labeled from Madagascar. As such crystals are very exceptional, we thought that a notice of them

* This Journal, II, xlvi, 240. † Am. Chem. Journal, ix, p. 23.

would not be without interest to the readers of the Journal. Crystals from Japan, with exactly the same habit, have been described and figured by G. vom Rath.* The two crystals in the cabinet of Professor Brush, which are each about one inch in greatest diameter, are very much flattened parallel to a prismatic face and have a pyramid of the second order, $1\bar{2}12$, 1-2 as twinning plane. The forms are those of the ordinary quartz combination, m ($10\bar{1}0$, I), r ($10\bar{1}1$, 1) and z ($01\bar{1}1$, -1) and are developed as shown in fig. 4. The m faces are strongly striated horizontally. The crystals seem to have been attached only at that part where the r and z faces make a small re-entrant angle, at the lower part of the twin. The crystals showed no decided pyro-electric phenomena.

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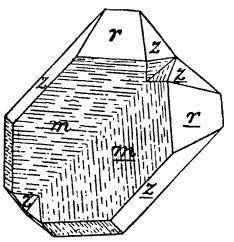

6. *Oligoclase from Bakersville, N. C., with abnormal optical properties.*†

The material which forms the subject of this investigation was sent to us by Mr. Norman Spang, of Etna, Pa., and later another fragment from undoubtedly the same locality was sent to New Haven by Mr. Geo. F. Kunz, of New York.

The mineral is remarkable for its purity, both pieces being as transparent as plate glass, the only things to mar the transparency being little bunches or tufts of minute crystals with radiated structure which are scattered sparingly and irregularly through the feldspar; these show no distinct form and cannot be referred to any definite species. The feldspar cleavages are well shown; one of them, the basal (001), is very perfect and easily obtained; the second, the brachypinacoid (010), is much less perfect, the mineral breaking with a conchoidal fracture so that it is hard to obtain a flat cleavage surface; there is also a tendency to break with an irregular conchoidal fracture parallel to the macropinacoid (100). The angle between the two cleavages, 001 and 010, was measured on two fragments which were carefully selected, but the results are not very satisfactory owing to the poor (010) cleavage. The best of these measurements is $001 \wedge 010 = 88° 2'$ (supplement), the second gave $88° 45'$, but the reflections were poorer. If placed in position on the basal plane, the crystal would have an inclination of about 2° to the left. An interesting point in connection with this feldspar is that there is not a trace of twinning structure to be

* Pogg. Annalen, clv, 49.

† An account of this feldspar was given by Mr. G. F. Kunz, with an analysis by Prof. F. W. Clarke, in the September number, p. 222.

found on either fragment, a cleavage piece showing one square inch of surface on the basal plane, being perfectly flat and free from striations. The specific gravity is 2·651.

The following analysis was made by Mr. Sperry:

		Ratio.	Anorthite.	Albite.
SiO_2	62·60	1·043	·160 (2)	·883 (6·00)
Al_2O_3	23·52	·228	·080 (1)	·148 (1·00)
Fe_2O_3	·08			
CaO	4·47	·080	·080 (1)	
Na_2O	8·62	·139		·145 (·99)
K_2O	·56	·006		
Ign.	·10			
	99·95			

Disregarding the trace of Fe_2O_3 and H_2O, and calculating the SiO_2 and Al_2O_3 which would unite with the CaO to form anorthite (ratio $SiO_2 : Al_2O_3 : CaO = 2 : 1 : 1$), we find that the remaining constituents are in the right proportion to form albite (ratio $SiO_2 : Al_2O_3 : Na_2O = 6 : 1 : 1$). The ratio of anorthite molecule to albite molecule is 1 : 3·6, the per cent being:

Anorthite	$Ca_2Al_4Si_4O_{16}$=22·32
Albite	$Na_2Al_2Si_6O_{16}$=77·45

The above chemical results are sufficient to classify this mineral as oligoclase.

The most interesting and important thing in connection with this mineral is that its optical properties are very far from those of oligoclase. Sections parallel to the basal plane do not show the extinction of oligoclase +1°, but the very large angle +39° to 40°. The positive nature of this angle was determined very carefully on the two fragments whose cleavage angles were measured. The extinctions were measured with a Fuess microscope, and in the two sections varied from 38° 30′ to 40°. Sections parallel to the brachypinacoid did not show any change from light to dark in ordinary polarized light when the sections were turned, but in convergent light showed an optic axis, as nearly as one could tell, exactly in the center of the field. When the cleavage lines are parallel to the principal planes of the polarizer and analyzer, the dark bar running through the axis is almost parallel to the cleavage lines. A similar section of oligoclase should show an extinction of +5°, and in convergent light a bisectrix almost in the center of the field.

We regret that we cannot give any facts regarding the mode of occurrence and associations of this interesting feldspar, but must leave that for others who may be so fortunate as to study this mineral in the field. A study of the crystals, if any are to be found, is also to be desired.

7. *Barium Feldspar from Blue Hill, Delaware Co., Pa.; the* CASSINITE *of Dr. I. Lea.**

Professor F. A. Genth† was the first to show that this was in any way an interesting and distinct variety by his analysis, which showed that the feldspar contained nearly four per cent of BaO; his results, however, yielded no definite formula, and could not be correctly interpreted without an optical examination.

Our investigations were made on very good cleavage specimens in the Yale University cabinet. A section parallel to the base (001) shows that the mineral is a mixture, composed chiefly of a monoclinic feldspar with interpositions of a plagioclase (albite) with fine striations and small extinction angle. The albite appears as streaks running through the section parallel to the ortho-axis *b;* these streaks have nearly a uniform width of about 0·05^{mm}, a varying length of usually less than 1^{mm}, and taper off slightly toward the ends, which are rounded. They are distributed quite evenly through the section, with usually a clear space of 0·5^{mm} between the streaks. In the section parallel to the clinopinacoid (010), the streaks are much more conspicuous. The plagioclase has an extinction of +18°, which would indicate that it is nearly pure albite; the monoclinic feldspar has an extinction of +6° like orthoclase, it also shows in convergent light an obtuse bisectrix. The difference in the extinction angles makes the albite streaks more conspicuous than in the basal section, the streaks being parallel to the vertical axis *c;* they have the same width as in the basal section, 0·05^{mm}, but usually a greater length, the longest being 2^{mm}; they are also more tapering. The albite is therefore interposed in thin plates parallel to the orthopinacoid, with the cleavage continuous in the two minerals. From the frequency and thickness of the albite streaks it seems as though it would make up not more than one-tenth of the total bulk of the feldspar. In the clinopinacoid section it is also seen that the material in which the albite is imbedded is not homogeneous but is streaked by a series of very narrow bands parallel to the vertical axis, *c;* these are very evenly distributed through the orthoclase and show the same extinction as the albite. It is probable that these microscopic interpositions, parallel to the larger ones, are also albite and they give in polarized light, when one of the minerals is dark, a curious vein-like, striated appearance to the section. Each of the larger streaks of albite is surrounded for a distance of about 0·01^{mm} with a zone of pure feldspar, which contains none of these minute streaks of albite; this makes the contrast between the wider streaks of albite and the mono-

* Proc. Acad. Nat. Sci. Philad., 1866, 110. † Report Min. Penn., 1876, 224.

clinic feldspar all the more marked in polarized light, for if the albite is dark it will be surrounded by a border of homogeneous light material, the whole being imbedded in a gray streaked ground-mass which has the optical effect of an orthoclase, because the microscopic albite interpositions are subordinate to the monoclinic feldspar.

We hoped that at least a partial separation of the albite and the monoclinic feldspar could be made by means of the heavy solutions, but in this we were disappointed; the cleavage being continuous in the two minerals prevents a good mechanical separation by powdering, and the difference in specific gravity was too slight to yield good results. All of the powder had nearly a uniform specific gravity. That which was taken for analysis sank in the Thoulet solution of sp. gr. 2·642, leaving about half of the powder floating. The following analysis, which was made by Mr. Sperry, showed traces of Mn, Mg and Sr, but they were too minute to be determined. The mean of three analyses by Professor Genth is also given for comparison:

	Genth.	Sperry.	Ratio.		Anorthite.	Albite.	BaK feldspar.
SiO_2	62·60	62·95	1·049		·010 (2)	·384 (6)	·655
Al_2O_3	19·97	19·82	·192		·005 (1)	·066 (1)	·121
Fe_2O_3	·12	·17					
CaO	·19	·25	·005		·005 (1)		
Na_2O	4·31	4·01	·064	·186		·064 (1)	
BaO	3·71	3·95	·026				·117
K_2O	8·95	8·57	·091				
Ign.	·19	·11					
	100·04	99·83					

In the above the ratio of $Al_2O_3 : RO = ·192 : ·186$, almost 1:1. Regarding the small amount of CaO as belonging to anorthite, and uniting it with the albite to form a plagioclase, we can divide our analysis into two parts which will probably represent the mixture very closely:

Na,Ca feldspar, Albite.		K, Ba feldspar, Monoclinic.		K, Ba feldspar, Calculated to 100.	Ratio.	$K_2Al_2Si_6O_{16}$.	Ba feldspar.
SiO_2	23·64	SiO_2	39·31	61·12	1·019	·852 (6)	·167 (4)
Al_2O_3	7·33	Al_2O_3	12·49	19·42	·188	·147 (1)	·041 (1)
CaO	·25	BaO	3·95	6·14	·040		·040 (1)
Na_2O	4·01	K_2O	8·57	13·32	·142	·142 (1)	
	35·23		64·32	100·00			

In the 64·32 per cent of the monoclinic K, Ba feldspar the ratio of $SiO_2 : Al_2O_3 : RO = 5·60 : 1·03 : 1$, which gives no simple formula if we regard it as a homogeneous mineral. If, however, we regard it as composed of a potash feldspar $K_2Al_2Si_6O_{16}$ and a barium feldspar, deducting the ratio of $K_2Al_2Si_6O_{16}$ we have left $SiO_2 : Al_2O_3 : BaO = ·167 : ·041 : ·040$, almost exactly 4:1:1.

Our knowledge of the barium feldspars is confined to analyses of the mineral from a few localities. For the sake of comparison we quote the following:

I. Binnenthal, Switzerland, analysis by Stockar-Escher.*
II. Jakobsberg, Sweden, analysis by L. J. Igelström.†
III. Unknown locality, analysis by Pisani.‡

	I.	Ratio.	II.	Ratio.	III.	Ratio.
SiO_2	52·67	·878	53·53	·892	55·10	·917
Al_2O_3	21·12	·205	23·33	·226	23·20	·225
Fe_2O_3					·45	·003
CaO	·46	·008			1·83	·033
MgO	·04	·001	3·23	·081	·56	·014
BaO	15·05	·098	7·30	·047	7·30	·048
Na_2O	2·14	·034			7·45	·120
K_2O	7·82	·083	11·71	1·25	·83	·009
Ign.	·58				3·72	
	99·88		99·10		100·44	

The ratios in the three analyses are as follows:

	SiO_2	Al_2O_3	RO
I.	·878 :	·205 :	224 = 4 : 0·93 : 1·02
II.	·892 :	·226 :	253 = 4 : 1·01 : 1·13
III.	·917 :	·225 :	224 = 4 : 0·98 : 0·98

All of these analyses have a ratio of $SiO_2 : Al_2O_3 : RO = 4 : 1 : 1$ and a formula $RAl_2Si_4O_{12}$; but one thing is very noticeable, that in all, the RO is very variable. In I, which is that of the purest hyalophane, the ratio of $BaO + (Ca, Mg)O : K_2O + Na_2O = 1 : 1$, and some have proposed that the feldspar is a mixture of $K_2Al_2Si_6O_{16}$ and a Ba feldspar like anorthite, $BaAl_2Si_2O_8$, similar to Tschermak's theory for the plagioclase feldspars. If, however, II and III are to be referred to hyalophane, we cannot accept this last hypothesis, but must accept for the formula of the species $RAl_2Si_4O_{12}$, R = Ba, Ca, Mg, K_2, Na_2.

Going back to our own analysis, it seems best to regard the feldspar as a mixture of 35·23 per cent of albite, 51·15 per cent of orthoclase and 13·17 per cent of hyalophane, $BaAl_2Si_4O_{12}$. The two latter are monoclinic, and have either grown together as isomorphous mixtures or, if in any other way, the optical properties are such that the relation to the two minerals can not be told. It must be noted also that in making this supposition it is necessary to regard the hyalophane as a pure barium feldspar; we see, however, no other way to interpret our analysis. If we regard our barium feldspar as united with potash to form a hyalophane like that from the Binnenthal, then the excess of potash cannot be united with Al_2O_3 and SiO_2 to form

* Kenngott, Uebersicht der Min. Forsch., 1856–57, p. 107.
† Bull. Soc. Min. de France, vi, 139.
‡ Bull. Soc. Min. de France, i, 84.

any simple compound, while the supposition which we have made gives ratios which are very simple and exact.

8. *A very pure magnesia mica, phlogopite, from Edwards, St. Lawrence Co., N. Y.*

Our attention was first called to this mineral by Mr. C. D. Nims of Philadelphia, N. Y., who had obtained it from the talc mines in Edwards. Later one of us,* while making a mineralogical excursion in St. Lawrence Co. under the auspices of the U. S. Geological Survey during the summer of 1887, visited the locality and was generously supplied with material by Mr. T. J. Hooper, superintendent of the Anthony Mine of the Adirondack Pulp Co.

The mineral occurs filling a narrow seam or vein associated with tremolite and the pure white talc which is extensively mined in that region. It occurs in large plates, without regular crystalline outline except an occasional hexagonal marking, which are more or less bent and intergrown. The cleavage is not quite as good as in most micas, being more like that of ripidolite; the folia are elastic when very thin but thicker folia, over $0{\cdot}1^{mm}$, crack and break quite readily in three directions parallel to the fracture figure. Thin plates of the mica appear perfectly clear and colorless; plates 2^{mm} thick and over have a very delicate sea-green color, thick pieces being exceedingly light colored and transparent, for a mica, in the direction of the vertical axis. The six-rayed fracture figure (*Schlagfigur*, German) and the pressure figure with rays at right angles to it are obtained by driving a steel point into the plates or pressing with a steel rod with rounded end against thin plates on an elastic support. The optical properties are not constant, even in the same plate. In convergent polarized light many pieces give a uniaxial interference figure, but usually the dark cross opens into hyperbolæ always showing a small optic axial angle; this was not measured because it was so variable. The plane of the optic axes is the plane of symmetry, parallel to one of the rays of the fracture figure, making it a mica of the second kind. The double refraction is negative.

Before the chemical analysis or any tests were made the nature of this mineral was questionable, such minerals as brucite, a highly crystallized variety of talc or a light colored ripidolite, suggested themselves rather than mica.

The specific gravity of the mineral was taken very carefully on the chemical balance, after boiling, to expel any air from between the folia, giving 2·793 and 2·791. The following analysis is by Mr. Sperry:

* Penfield.

	I.	II.	Mean.	Ratio.
SiO_2	44·82	44·81	44·81	·747
Al_2O_3	10·84	10·90	10·87	·106
FeO	·35	·28	·31	·004
MgO	28·91	28·89	28·90	·722
K_2O	8·33	8·47	8·40	·089
Na_2O	·33	·46	·38	·006
Li_2O	·09	·07	·08	·003
H_2O	5·44	5·41	5·42	·301
Loss at 100°	·98	·94	·96	·053
			100·13	

The analysis shows that the mineral is essentially a phlogopite but no relation between the constituents can be detected which can be expressed by a simple formula. Comparing it with other analyses, especially the recent ones given in Tschermak's article "Die Glimmergruppe"* we notice that it has about the same percentage of SiO_2, MgO and K_2O, less Al_2O_3 and Fe_2O_3, the latter we expect from its unusually light color, more H_2O and no fluorine, which is a little surprising as all previous analyses have shown from 0·8 to over 4·0 per cent of F.

If we seek out in our analysis the molecules which Tschermak regards as characteristic for the micas,

$$K = Si_6Al_6K_6O_{24} \text{ ratio of } SiO_2 : Al_2O_3 : K_2O = 2 : 1 : 1$$
$$\text{and } M = Si_6Mg_{12}O_{24} \text{ ratio of } SiO_2 : MgO = 1 : 2$$

we find that they are present in the following proportion together with a residue.

K.		Ratio.		M.		Ratio.		Residue.		Ratio.	
SiO_2	12·72	·212	(2)	SiO_2	21·77	·363	(1)	SiO_2	10·32	·172	(1)
Al_2O_3	10·87	·106	(1)	FeO	·31	·004	(2)	H_2O	5·28	·293	(2)
K_2O	8·40	·089	(1)	MgO	28·90	·722	(2)	loss at 100°	·96	·053	(2)
Na_2O	·38	·006	(1)		50·98				16·56		
Li_2O	·08	·003	(1)								
H_2O	·14	·008	(1)								
	32·59										

We find that there is 32·59 per cent of the K molecule in which the protoxide is almost wholly K_2O, a little Na_2O, Li_2O and H_2O being required to make the ratio 2 : 1 : 1. The M molecule is a very pure magnesia silicate while the 16·56 per cent of residue is a very pure ortho silicic acid H_4SiO_4, or if desired $Si_6H_{24}O_{24}$ with the ratio of $SiO_2 : H_2O = ·172 : ·346 = 1 : 2·01$. It is necessary here to include the H_2O which was lost at 100° C., the analysis being made on air-dry powder. The phlogopites contain more acid than the ordinary micas which are made up of mixtures of the K and M molecules.

* Zeitschr. Kryst., iii, 143.

Tschermak regards this excess of acid as comprised in the molecule $S = Si_{10}H_8O_{24}$ or the fluorine compound $Si_{10}O_8F_{24}$. The ortho-silicate which we find in this analysis, however, H_4SiO_4, seems a more natural compound to be associated with the other ortho-silicate molecules K and M.

If we do not follow Professor Tschermak in discussing the results of our analysis, as we have done above, we can detect a certain relation between the constituents. By taking one-seventh of the SiO_2 in the above ratio as unity we obtain

SiO_2	:	Al_2O_3	:	(Mg, Fe)O	:	(K, Na, Li)$_2$O	:	H_2O
7	:	0·99	:	6·80	:	0·92	:	3·31
nearly 7	:	1·	:	7	:	1	:	3

and if the excess of the H_2O above 3·00 is regarded as replacing MgO and K_2O, the ratio would be almost exactly whole numbers. This ratio and the composition of the mineral may be expressed by the somewhat elaborate formula $H_6K_2Mg_7Al_2Si_7O_{28}$. The acid radical Si_7O_{28} shows that the mineral is an orthosilicate, while the following percentage composition calculated from the above formula shows how closely it corresponds to the results of the analysis:

	SiO_2	Al_2O_3	MgO	K_2O	H_2O
Theory	44·16	10·83	29·44	9·89	5·68 = 100·00
Analysis...	44·81	10·87	29·06	9·25	6·38 = 100·37

The above analysis is like the original in our article except that the FeO has been calculated to an equivalent of MgO and the Na_2O and Li_2O to an equivalent of K_2O. Although it will not do to make any general statement regarding the chemical composition of phlogopite from one single analysis we offer the above results as a contribution to the chemistry of the micas, feeling assured that they are derived from exceptionally pure material.

In closing, we wish to express our thanks to those persons who have assisted us in our work by furnishing the material for carrying on these investigations, and whose names have been mentioned in our article.

Mineralogical Laboratory, Sheffield Scientific School,
July 19th, 1888.