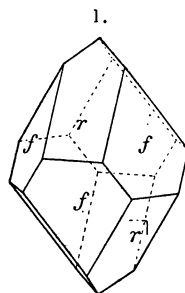


ART. XXXVI.—*On the Chemical Composition of Hamlinite and its Occurrence with Bertrandite at Oxford County, Maine*; by S. L. PENFIELD.

In the summer of 1890, Mr. W. E. Hidden and the author published a short description of a rhombohedral phosphate occurring with the rare minerals herderite and bertrandite at Stoneham, Maine. Only a single specimen, showing a few minute crystals, was ever found at the locality, and the investigation was therefore incomplete, being confined to determinations of the crystallization and physical properties and the identification of phosphorus, aluminium, fluorine and water, while from its association it was supposed that it would also contain beryllium.

The mineral was named *hamlinite* in honor of Augustus C. Hamlin of Bangor, Maine, who has always taken a keen interest in collecting and studying the minerals of his State and especially the beautiful tourmalines from Mt. Mica and vicinity. As stated in the original article, the incomplete description was published for the purpose of calling attention to a mineral which would probably prove to be interesting, and also in hopes that others would be led to look for the mineral and find it. This hope has not been in vain, for Mr. Lazard Cahn of New York had the good fortune to discover among a suite of minerals from Oxford County, Maine, some specimens showing rhombohedral crystals of a mineral, unknown to him, which he gave to the author, suggesting that they might prove to be the rare mineral hamlinite. It is hoped that additional information may be obtained concerning the exact locality at which the mineral is found, so that a supply of specimens may become available for distribution. The mineral was readily identified as hamlinite by its rhombohedral crystallization, basal cleavage, positive double refraction, and blowpipe reactions.

The crystals are implanted upon feldspar and muscovite and are associated, like the ones from Stoneham, with apatite, herderite and rarely bertrandite. The crystals present two prominent habits: One a combination of the rhombohedrons $r, 10\bar{1}1$ and $f, 02\bar{2}1$, developed as shown in the accompanying figure. On these crystals there are occasionally small basal planes and slight horizontal striations on the rhombohedral faces near their juncture with the base. The other habit is essentially a combination of the hexagonal prism of the first order, $10\bar{1}0$, with the base, but, owing to a vicinal



development and rounding, the prismatic faces have a tendency toward a steep rhombohedron, and the basal planes are marked by triangular prominences.

The crystals attain at times a diameter of 3 to 4^{mm}, but are not well adapted for measurement owing to the vicinal character of the faces. The following measurements can claim to be only approximations, since there were usually several reflections of the signal of the goniometer from each face, and it was impossible to tell upon which one the cross-hair of the telescope should be placed. The calculated angles are those derived from measurements of the hamlinite from Stoneham, $c=1.135$, but the crystals from that locality showed a vicinal development of their faces, and the values can not, therefore, be considered as very exact.

	Measured.	Calculated.
$r \wedge r$, $10\bar{1}1 \wedge \bar{1}101 =$	$88^\circ 41'$	$87^\circ 2'$
$f \wedge f$, $02\bar{2}1 \wedge 2021 =$	$109 \quad 11$	$108 \quad 2$
$r \wedge f$, $10\bar{1}1 \wedge 02\bar{2}1 =$	$54 \quad 44$ and $54^\circ 47'$	$54 \quad 1$

It was found to be practically impossible to select by hand-picking a sufficient quantity of the pure hamlinite crystals for an analysis, and, therefore, a number of specimens upon which the crystals were observed were pulverized, and the hamlinite separated from the other minerals by means of the heavy liquids. Apatite, however, could not be thus separated, but, owing to the fact that hamlinite is almost insoluble in boiling dilute hydrochloric acid, it was possible by treatment with successive portions of acid until the solution gave no test for calcium to remove the apatite completely. All possible precautions were taken to make the separation and purification of the mineral as complete as possible, and the mineral, when examined with the microscope, showed no visible impurity. The specific gravity of the hamlinite varied considerably, that portion which was taken for the chemical analysis being between 3.159 and 3.283, while some of the mineral was still a trifle higher and some a little lower.

A qualitative analysis indicated the presence of aluminium, strontium, barium, phosphorus, fluorine and water, and the absence of calcium and beryllium. In the quantitative analyses the strontium and barium were weighed together as sulphates and subsequently separated as recommended by Fresenius,* by a double precipitation of the barium as chromate. The fluorine was weighed as calcium fluoride, and the latter was tested and found to be pure by conversion into sulphate. Water was determined in two ways; first by fusing with dry sodium carbonate and weighing the water directly,† second by loss on

* Zeitsch. für anal. Chemie, xxix, p. 413, 1890.

† This Journal, xlviii, p. 37, 1894.

ignition, using a weighed quantity of lime to retain the fluorine.* The air-dry powder lost only 0.16 per cent by heating to 100°, and the water was not expelled until the mineral was heated nearly to redness, thus indicating the presence of hydroxyl.

The results of the analysis are as follows:

					Average.	Ratio.	
P ₂ O ₅ ----			28.92		28.92	.204	1.00
Al ₂ O ₃ ---	32.29	32.30			32.30	.316	1.55
Fe ₂ O ₃ ---		.90			.90		
SrO ----	18.33	18.53			18.43	.178	} .204 1.00
BaO ----	4.10	3.89			4.00	.026	
H ₂ O ----			11.93	12.07	12.00	÷9=	} 1.333 1.435 7.03
F-----	1.93				1.93	.102	
SiO ₂ ----	.96				.96		
K ₂ O ----		.34			.34		
Na ₂ O ---		.40			.40		
					100.18		
Oxygen equivalent of fluorine,					.81		
					99.37		

The ratio of P₂O₅:Al₂O₃:(Sr+Ba)O:(OH+F) is very nearly 1:1.5:1:7, which gives the formula Al₃Sr(OH)₇P₂O₇, or better [Al(OH)₂]₃[SrOH]P₂O₇, where strontium is partially replaced by barium and hydroxyl by fluorine.

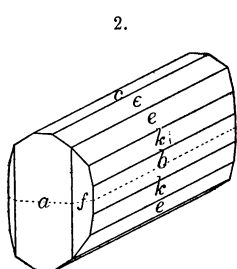
By the method of preparing the mineral for analysis traces of adhering feldspar and mica could not be wholly avoided, and, although the small quantities of Fe₂O₃ and alkalis may belong partly to the hamlinite and partly to impurities, these have been neglected in making the calculations. If the alkalis together with their equivalent of Al₂O₃ (1.06 per cent), the Fe₂O₃ and the SiO₂, in all 3.62 per cent, are deducted from the analysis and the remainder calculated to one hundred per cent, the results are as given below, where they are compared with the theoretical composition, where Sr:Ba = 7:1 and OH:F = 13:1.

	Found.	Calculated.
P ₂ O ₅ -----	30.20	30.31
Al ₂ O ₃ -----	32.67	32.65
SrO -----	19.25	19.29
BaO-----	4.18	4.08
H ₂ O-----	12.53	12.48
F-----	2.01	2.04
	100.84	100.85
O=F-----	.84	.85

* This Journal, xxxii, p. 109, 1886.

In its chemical composition hamlinite holds a unique position among minerals, as strontium and barium have never before been observed as essential constituents of a phosphate and this is the first time that a pyrophosphate has been recorded.

Note concerning Bertrandite Crystals from Oxford County, Maine.



Associated with the hamlinite just described there was one specimen showing prismatic crystals averaging about 2^{mm} in length and 1^{mm} in diameter, which proved to be the rare mineral bertrandite. The habit is shown in the accompanying figure and the forms are as follows:

$$\begin{array}{llll} a, 100 & c, 001 & \epsilon, 011 & k, 0\cdot12\cdot1 \\ b, 010 & f, 130 & e, 031 & \end{array}$$

The crystals are in reality twins, two hemimorphic individuals being united by their basal planes, and occasionally the line of twinning may be traced horizontally across the *a*, *f* and *b* faces. The specific gravity was found to be 2·571. The measured angles are given below, together with the calculated values derived from the axial ratio $a : b : c = 0\cdot56885 : 1 : 0\cdot5973$.

	Measured.	Calculated.		Measured.	Calculated.
$f \wedge f, 130 \wedge 130 =$	$119^{\circ} 20'$	$119^{\circ} 16'$	$c \wedge e, 001 \wedge 031 =$	$60^{\circ} 50'$	$60^{\circ} 50'$
$c \wedge \epsilon, 001 \wedge 011 =$	30 50	30 51	$c \wedge k, 001 \wedge 0\cdot12\cdot1 =$	82 20	82 4

In closing the author desires to express his thanks to Mr. Cahn for calling his attention to this new occurrence of hamlinite and bertrandite.

Laboratory of Mineralogy and Petrography,
Sheffield Scientific School, May, 1897.