

ART. XLIII.—*On the Mineral Locality in Fairfield County, Connecticut, with the description of two additional new species*; by GEORGE J. BRUSH and EDWARD S. DANA. Second paper.

IN the preceding volume of this Journal (July and August, 1878), we published an account of the discovery of a new mineral locality at Branchville, Fairfield County, Connecticut, and gave descriptions of five new minerals, all manganesian phosphates, occurring there. During the autumn following we pushed forward our explorations at the locality with as much vigor as possible, and with tolerable success. We were fortunate in finding a new and independent deposit of the phosphates, and obtained from it a considerable quantity of eosphorite, lithiophilite and a little triploidite, and with them some other species of interest, among which we may mention a series of uranium compounds. The detailed description of these discoveries we shall defer until a third paper, which we hope to publish in another number. In the present paper we propose to give the descriptions of the two additional new species we have identified; one of these we mentioned in our last paper under the name of *fairfieldite*. We add also the results of a new analysis of reddingite, and some further facts in regard to lithiophilite. Both of the new species came from the original material, removed by Mr. Fallow, when the locality was first opened. We have not, as yet, succeeded in finding additional quantities of them. It may not be improper to add that with the return of warm weather we have commenced anew the exploration of the locality in a more thorough manner than before, and we hope to meet with some success.

6. FAIRFIELDITE.

General physical characters.—Fairfieldite occurs usually in massive crystalline aggregates; also rarely in distinct crystals. The structure is foliated to lamellar, some varieties closely resembling selenite; also occasionally in radiating masses consisting of curved foliated or fibrous aggregations; these radiated forms are not unlike stilbite.

The hardness is 3.5, and the specific gravity 3.15. The luster is pearly to sub-adamantine; on the surface of perfect cleavage (*b*) it is highly brilliant. The color is white to pale straw yellow; the streak is white. Transparent. Brittle.

Two rather distinct varieties have been observed: the first (A) occurs filling cavities in the reddingite, and covering the distinct crystals of this mineral. It is uniformly clear and transparent, and is highly lustrous, showing entire absence of even

incipient alteration. It is generally foliated to lamellar, although sometimes of a somewhat radiated structure. The second variety (B) occurs in masses of considerable size interpenetrated rather irregularly with quartz, and quite uniformly run through with thin seams and lines of a black manganesian mineral of not very clearly defined character. This mineral is granular in texture, lustrous, is difficultly fusible, and consists for the most part of the hydrated oxides of manganese and iron; but contains also phosphoric acid and traces of lime.

This second variety of fairfieldite is often friable to the touch and lacks something of the brilliant luster of the first variety. It also shows greater difference of structure, passing from the distinct crystals to the massive and radiated form. The identity of these two kinds is shown by the analyses given below. Fairfieldite also occurs in small particles in fillowite (described beyond), and in masses of some size immediately associated with esophorite, triploidite, and dickinsonite.

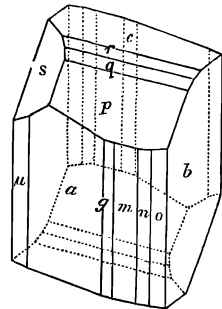
Crystalline form.—Indistinct crystals of fairfieldite occur occasionally in cavities in the massive mineral. They are usually composite in character, made up of many individual crystals, interpenetrating each other, and in only an approximately parallel position. On the most favorable crystals the form could be clearly made out, but exact measurements were quite impossible; this is the more to be regretted as the number of variable elements is so large. The cleavage parallel to b (010) is highly perfect; that parallel to a (100) somewhat less so.

The crystals belong to the *Triclinic System*, and the general habit is shown in the adjoining figure. The following supplement angles were accepted as the basis of the calculations.

$a \wedge c$	$100 \wedge 001 = 88^\circ$
$a \wedge b$	$100 \wedge 010 = 102^\circ$
$a \wedge p$	$100 \wedge 111 = 56^\circ 30'$
$c \wedge p$	$001 \wedge 111 = 33^\circ$
$b \wedge p_i$	$010 \wedge 111 = 78^\circ 30'$

From these angles, the lengths and mutual inclinations of the axes were calculated, as follows:—

c (vert.)	\bar{b}	\bar{a}
·7065	3·5757	1·0000 or
·1976	1·0000	·2797
Also α ($c \wedge \bar{b}$)	β ($c \wedge \bar{a}$)	γ ($\bar{b} \wedge \bar{a}$)
$102^\circ 9'$	$94^\circ 33'$	$77^\circ 20'$



The observed planes are as follows:—

<i>c</i>	<i>O</i>	001	<i>s</i>	$\bar{4}\bar{4}$	$\bar{1}\bar{1}$
<i>b</i>	$i\bar{1}$	010	<i>g</i>	$i\bar{3}'$	320
<i>a</i>	$i\bar{1}$	100	<i>m</i>	<i>I'</i>	110
<i>p</i>	$-1'$	111	<i>n</i>	$i\bar{3}'$	230
<i>q</i>	$\bar{1}'$	112	<i>o</i>	$i\bar{2}'$	120
<i>r</i>	$\bar{1}'$	113	μ	<i>I</i>	$\bar{1}\bar{1}\bar{0}$

The following list includes the principal angles (supplement) for the different planes, calculated from the axial values given above.

	Calculated.	Measured.
$c \wedge a$	$001 \wedge 100 = 88^\circ$	*88°
$c \wedge b$	$001 \wedge 010 = 78^\circ 33'$	79°
$c \wedge m$	$100 \wedge 110 = 84^\circ 39'$	
$c \wedge p$	$001 \wedge 111 = 33^\circ$	*33°
$c \wedge q$	$001 \wedge 112 = 18^\circ 31'$	19°
$c \wedge r$	$001 \wedge 113 = 12^\circ 43'$	13°
$c \wedge s$	$001 \wedge \bar{1}\bar{1}\bar{1} = 53^\circ 34'$	
$a \wedge b$	$100 \wedge 110 = 102^\circ$	*102°
$a \wedge g$	$100 \wedge 320 = 10^\circ 57'$	10°
$a \wedge m$	$100 \wedge 110 = 16^\circ 31'$	16° 30'
$a \wedge n$	$100 \wedge 230 = 24^\circ 40'$	25°
$a \wedge o$	$100 \wedge 120 = 32^\circ 20'$	32°
$a \wedge \mu$	$100 \wedge \bar{1}\bar{1}\bar{0} = 14^\circ 45'$	16°
$a \wedge p$	$100 \wedge 111 = 56^\circ 30'$	*56° 30'
$a \wedge q$	$100 \wedge 112 = 70^\circ 15'$	
$a \wedge r$	$100 \wedge 113 = 75^\circ 48'$	
$a \wedge s$	$100 \wedge \bar{1}\bar{1}\bar{1} = 51^\circ 17'$	
$b \wedge \mu$	$010 \wedge \bar{1}\bar{1}\bar{0} = 116^\circ 45'$	
$b \wedge g$	$010 \wedge 320 = 91^\circ 3'$	
$b \wedge m$	$010 \wedge 110 = 85^\circ 29'$	
$b \wedge n$	$010 \wedge 230 = 77^\circ 20'$	
$b \wedge o$	$010 \wedge 120 = 69^\circ 40'$	
$b \wedge p$	$010 \wedge 111 = 78^\circ 30'$	*78° 30'
$b \wedge q$	$010 \wedge 112 = 78^\circ 2'$	78°
$b \wedge r$	$010 \wedge 113 = 78^\circ 4'$	
$b \wedge s$	$010 \wedge \bar{1}\bar{1}\bar{1} = 121^\circ 16'$	120° 30'
$m \wedge p$	$110 \wedge 111 = 51^\circ 39'$	
$m \wedge q$	$110 \wedge 112 = 66^\circ 8'$	
$m \wedge r$	$110 \wedge 113 = 71^\circ 56'$	

In one case an apparent penetration-twin was observed, the two crystals crossing one another so that the planes *b* and *a* of the one were parallel respectively to the planes *a* and *b* of the other. If this coincidence were perfect (exact measurement was out of the question) and the crystal were really a twin the

twinning-plane must make with a (100) an angle of either 51° (toward 010) or 39° (toward $0\bar{1}0$). This condition is equally well satisfied by the plane 270 ($100 \wedge 270 = 51^\circ 4'$), or by $\bar{2}70$ ($100 \wedge \bar{2}70 = 39^\circ 3'$). As this supposed twinning-plane has so complex a relation to the other planes of the crystal, it is probable that this coincidence is only accidental.

Optical properties.—Minute fragments of fairfieldite parallel to the two cleavage planes were examined in the stauroscope, with the following results:—The planes of light-vibration intersect the cleavage plane a (100) in lines which make angles of 40° and 50° respectively with the edge $a|b$. One optical axis was visible on the edge of the field in converging light, obviously lying in the vibration-plane making an angle of 50° with the obtuse edge named, and toward that edge.

The cleavage plane parallel to b (100) is intersected by the vibration planes in lines making angles of 10° and 80° respectively with the edge $b|a$. In this case also an optical axis (the second) is distinctly visible on the outer limit of the field. This serves to fix approximately the position of the bisectrix. As the cleavage fragments examined were less than $\frac{1}{2}$ mm. in size, any further examination was impossible.

Chemical Composition.—The two varieties of fairfieldite have been analyzed by Mr. S. L. Penfield, with the following results:

	A.	B.
P ₂ O ₅	38.39	39.62
FeO	5.62	7.00
MnO	15.55	12.40
CaO	28.85	30.76
Na ₂ O	0.73	0.30
K ₂ O	0.13	---
H ₂ O	9.98	9.67
Quartz	1.31	0.55
	100.56	100.30

The ratios of the oxides calculated from these analyses are as follows:—

	A.		B.	
P ₂ O ₅	.270	1	.279	1
FeO	.078		.097	
MnO	.219		.175	
CaO	.515	3.06	.549	2.96
Na ₂ O	.012		.005	
K ₂ O	.001		---	
H ₂ O	.554	2.05	.537	1.93

The ratio P₂O₅ : RO : H₂O = 1 : 3 : 2 answers to the formula R₃P₂O₈ + 2 aq. If here R = Ca : Mn + Fe = 2 : 1 and the ratio of Mn : Fe be also 2 : 1. The formula requires:—

P ₂ O ₅	39.30
FeO	6.64
MnO	13.10
CaO	30.99
H ₂ O	9.97
	100.00

The fact that the second variety was friable and somewhat deficient in luster suggested an incipient alteration, but the analysis did not confirm this idea. The larger amount of lime afforded in the analysis of this kind is possibly due to admixture of a little apatite, which is often observed with it, and the larger proportion of iron may be due to the fact that this variety could not be entirely freed from the black oxide interpenetrating it.

Pyrognostics.—In the closed tube fairfieldite gives off neutral water, and the assay turns first yellow, then dark brown, and becomes magnetic. In the forceps glows, blackens and fuses quietly at about 4.5 to a dark yellowish-brown mass, coloring the flame pale green, with faint reddish-yellow streaks on the upper edge. Soluble in the fluxes giving reactions for iron and manganese. Fairfieldite is soluble in nitric and hydrochloric acids.

Fairfieldite is named from the county in which the locality occurs.

7. FILLOWITE.

General physical characters.—Fillowite occurs in granular crystalline masses. By fracture the crystalline grains can be usually separated with ease; they show in most cases merely striated planes of contact, having no crystallographic significance; occasionally, however, isolated but brilliant crystalline planes are observed and rarely a nearly complete crystal. The masses are not infrequently penetrated by distinct prismatic crystals of triploidite; and sometimes they enclose particles of fairfieldite. The outer surfaces are very often coated with a silvery-white radiated mineral, but in so sparing quantities that we have been thus far unable to determine definitely its character. Reddingite is very commonly associated with fillowite, and in many cases it is not easy to distinguish the two minerals.

The hardness is 4.5, and the specific gravity in two trials 3.41 and 3.45. The luster is sub-resinous to greasy. The color generally wax-yellow, also yellowish to reddish-brown with a red or green tinge, and rarely almost colorless. Streak white. Transparent to translucent; fracture uneven; brittle.

Crystalline form.—The crystals of fillowite, whose occurrence has already been mentioned, have a marked rhombohedral

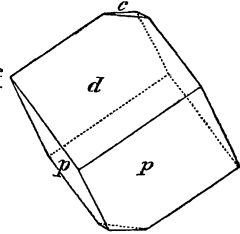
aspect. As shown in the figure the three planes, whose several inclinations are almost identical, have their common solid angle replaced by a nearly equilateral triangle. The measurements, however, point to a monoclinic form, and that this is the true explanation is proved by the optical examination. The cleavage is basal, nearly perfect.

The angles (supplement) accepted as the basis for calculation, are as follows:—

$$\begin{array}{lll} c \wedge p & 001 \wedge \bar{1}11 & = 58^\circ 40' \\ c \wedge d & 001 \wedge 201 & = 58^\circ 31' \\ p \wedge p & \bar{1}11 \wedge \bar{1}\bar{1}\bar{1} & = 95^\circ 23' \end{array}$$

Calculated from these the elements of the crystal are:—

<i>c</i> (vert.)	<i>b</i>	<i>a</i>	β
·8201	·5779	1·0000 or	89° 51'
1·4190	1·000	1·7303	



The position taken for the crystal is that which exhibits most strikingly its close approximation to the rhombohedral form. If it were desired to make the plane *d* the unit orthodome $\bar{1}01$, then the plane *p* would have the symbols $\bar{1}11$ and $\bar{1}\bar{1}\bar{1}$, and the elements of the crystal would be:— $\beta=73^\circ 11'$; *c* (vert.)=1·1422, *b*=0·578, *a*=1·000.

The observed planes have already been given; they are:—

$$c \quad 001 \quad 0. \qquad d \quad 201 \quad -2-i. \qquad p \quad \bar{1}11 \quad 1.$$

The calculated angles and those measured (on two crystals) are:—

	Calculated.	(1) Measured.	(2)
<i>c</i> \wedge <i>d</i>	$001 \wedge 201 = 58^\circ 31'$	*58° 31'	
<i>c</i> \wedge <i>p</i>	$\left\{ \begin{array}{l} 001 \wedge \bar{1}11 \\ 001 \wedge \bar{1}\bar{1}\bar{1} \end{array} \right. = \left\{ \begin{array}{l} 58^\circ 40' \\ 58^\circ 37' \end{array} \right.$	$\left\{ \begin{array}{l} *58^\circ 40' \\ 58^\circ 37' \end{array} \right.$	
<i>p</i> \wedge <i>p</i>	$\bar{1}11 \wedge \bar{1}\bar{1}\bar{1} = 95^\circ 23'$	*95° 23'	95° 25'
<i>p</i> \wedge <i>d</i>	$\left\{ \begin{array}{l} \bar{1}11 \wedge 201 \\ \bar{1}\bar{1}\bar{1} \wedge 201 \end{array} \right. = \left\{ \begin{array}{l} 95^\circ 20' \\ 95^\circ 20' \end{array} \right.$	$\left\{ \begin{array}{l} 95^\circ 20' \\ 95^\circ 16' \end{array} \right.$	$\left\{ \begin{array}{l} 95^\circ 15' \\ 95^\circ 18' \end{array} \right.$

Optical properties.—It was found possible to examine small cleavage fragments of fillowite according to the usual methods, and the results served to settle the question of the system, which the measured angles might have left undecided. One vibration-plane intersects the basal plane (cleavage) parallel to the edge *c* | *d* and the other is normal to it. Moreover the two optic axes are visible when the Rosenbusch microscope is employed; it was impossible to decide, however, in which plane they lay, since the only sections transparent enough for this examination were destitute of the other crystalline planes.

Chemical properties.—The analyses of fillowite by Mr. S. L. Penfield afforded the following results:—

	I.	II.	Mean.	Ratios.	
P ₂ O ₅	39·06	39·15	39·10	·275	2·75 1
FeO	9·48	9·18	9·33	·129	} 8·51 3·09
MnO	39·48	39·36	39·42	·555	
CaO	undet.	4·08	4·08	·073	
Na ₂ O	5·65	5·84	5·74	·092	
Li ₂ O	·07	·04	·06	·002	
H ₂ O	1·75	1·56	1·66	·092	·92 0·33
Quartz	0·86	0·90	0·88		
			100·11	100·27	

The ratio P₂O₅:RO:H₂O = 1:3: $\frac{1}{3}$, corresponds to the formula 3R₂P₂O₅+H₂O. If in this formula R = Mn:Fe:Ca:Na₂ = 6:1:1:1 the calculated percentages are:—

P ₂ O ₅	40·19
FeO	6·80
MnO	40·19
CaO	5·28
Na ₂ O	5·84
H ₂ O	1·70
	100·00

The very small amount of water present suggests the question as to whether it is really an original constituent of the mineral. This question we have been unable to decide positively; we can only add that of a large number of specimens examined, all, even the most transparent, showed its presence. Moreover, if the water be not essential, the composition of the mineral would be somewhat analogous to triphylite, containing sodium instead of lithium, and the want of correspondence in crystalline form does not favor this idea.

Pyrognostics.—In the closed tube fillowite yields a small amount of water which reacts neutral. B.B. in the forceps colors the flame momentarily pale green, then intensely yellow and fuses with intumescence to a black feebly magnetic globule. Fusibility 1·5. With the fluxes reacts for iron and manganese. Soluble in nitric and hydrochloric acids.

We have named this the *seventh* new manganesian phosphate from this locality, after Mr. A. N. Fillow, of Branchville, Conn., our obligations to whom we have already mentioned in our former paper.

REDDINGITE.

In our preceding paper we described the new mineral reddingite, and showed that in the habit of its octahedral crystals and in their angles it was closely homeomorphous with scorodite and strengite. In composition, however, it was shown that there was a variation, as follows:—

Scorodite	$\text{FeAs}_2\text{O}_8 + 4\text{aq.}$
Strengite	$\text{FeP}_2\text{O}_8 + 4\text{aq.}$
Reddingite	$\text{Mn}_3\text{P}_2\text{O}_8 + 2\text{aq.}$

It is thus seen that reddingite differs from the other species in that the metal is in the protoxide condition, and again since there are only three equivalents of water present. In order to establish beyond all question that this difference was a real one, we have had a second analysis made. The material was selected from another specimen, and as before, was obtained free from all impurities except quartz.

The analyses, made by Mr. Horace L. Wells, are given below (A) as also that by him (B) published in our preceding paper:—

	I.	II.	A Excluding Quartz.	B
P_2O_5	33.58	----	35.16	34.52
FeO	7.54	----	7.89	5.43
MnO	41.28	----	43.22	46.29
CaO	0.67	----	.71	0.78
Na_2O	trace	----	----	0.31
H_2O	11.72	11.72	12.27	13.08
Quartz	4.46	4.39		
	<hr/>		<hr/>	<hr/>
	99.25		99.25	100.41

The new analysis leads to the formula $\text{Mn}_3\text{P}_2\text{O}_8 + 3\text{aq.}$, or the same as that obtained before. The only marked difference between the two results is one which we have found to characterize all the species of the locality, that is, a little variation in the relative amounts of iron and manganese. That the manganese is really in the protoxide condition cannot be questioned for a moment.

Recapitulation.

It seems of some interest to place together the seven new species which the locality has afforded us. We shall hope, at some future time, to offer some remarks in regard to their mutual relations; we can only say here that there is in the facts observed nothing to suggest that any one of the species is a secondary mineral or a product of alteration; all seem to be original minerals of the vein. We have found single hand-specimens which exhibit all of the first four minerals together.

- | | | |
|--|----|--|
| 1. EOSPHORITE. | | Orthorhombic. |
| $\text{R}_2\text{AlP}_2\text{O}_{10}, 4\text{H}_2\text{O}$, | or | $\text{AlP}_2\text{O}_8 + 2\text{H}_2\text{Mn}(\text{Fe})\text{O}_2 + 2\text{aq.}$ |
| 2. TRIPLOIDITE. | | Monoclinic. |
| $\text{R}_4\text{P}_2\text{O}_9, \text{H}_2\text{O}$ | or | $\text{Mn}_3(\text{Fe}_3)\text{P}_2\text{O}_8 + \text{Mn}(\text{Fe})(\text{OH})_2$ |
| 3. DICKINSONITE. | | Monoclinic. |
| $4(\text{R}_2\text{P}_2\text{O}_9), 3\text{H}_2\text{O}$ | or | $4(\text{Mn, Fe, Ca, Na}_2)_3\text{P}_2\text{O}_8 + 3\text{aq.}$ |

4. LITHIOPHILITE.		Orthorhombic.
LiMnPO_4	or	$\text{Li}_3\text{PO}_4 + \text{Mn}_3\text{P}_2\text{O}_8$.
5. REDDINGITE.		Orthorhombic.
$\text{R}_3\text{P}_2\text{O}_7, 3\text{H}_2\text{O}$	or	$\text{Mn}_3(\text{Fe}_3)\text{P}_2\text{O}_8 + 3\text{aq.}$
6. FAIRFIELDITE.		Triclinic.
$\text{R}_3\text{P}_2\text{O}_8, 2\text{H}_2\text{O}$	or	$\text{Ca}_3(\text{Mn}_3, \text{Fe}_3)\text{P}_2\text{O}_8 + 2\text{aq.}$
7. FILLOWITE.		Monoclinic.
$3(\text{R}_3\text{P}_2\text{O}_8), \text{H}_2\text{O}$	or	$3(\text{Mn, Fe, Ca, Na}_2)_3\text{P}_2\text{O}_8 + \text{aq.}$

Altered Lithiophilite.

In our former paper we called attention to the large amount of black oxidized material rich in lithia which was associated in the first deposit with eosphorite, triploidite and dickinsonite. We stated also, that the occurrence of this black substance induced us to make the deeper exploration which resulted in the discovery of lithiophilite. We have now made a more critical examination of this black mineral, and have found on breaking it up into very small fragments occasional kernels or nuclei, often no larger than a pea, of unaltered lithiophilite. By far the greater part of the black masses, however, have proved to be oxidized to the core. The black material varies considerably in its structure; some specimens retain with great distinctness the cleavage of the original lithiophilite; other fragments break with a conchoidal fracture, while still other specimens form porous, crumbly, loosely aggregated masses. The color of the mineral also varies; it is generally grayish-black to pitch-black; occasionally, however, it has a purple to violet color, the latter being due apparently to a different state of oxidation of the manganese and iron. That this is the case seems to be proved by the fact that the black variety can be made to assume a purple hue by dipping it in hydrochloric acid; the mass so treated becomes at once colored purple externally, and is not to be distinguished from a specimen of the naturally occurring purple mineral. The luster varies from sub-resinous to dull. Hardness 3-4. Specific gravity 3.26-3.40. It is not to be expected that in such an alteration product the chemical composition should be constant. We have had two characteristic specimens analyzed and give the results below. The first was of the cleavable variety, having a nucleus of unaltered lithiophilite, and was analyzed by Mr. F. P. Dewey, in the Sheffield Laboratory, $G. = 3.39-3.40$.

	I.	II.	Mean.	Atomic Ratios
P ₂ O ₅	40.79	40.53	40.66	.286
Fe ₂ O ₃	12.55	12.57	12.56	.079
Al ₂ O ₃	0.10	0.09	0.10	.001
MnO	35.83	35.66	35.74	} = $\frac{25.27}{\text{Mn}_2\text{O}_3}$ } .160 } = $\frac{11.66}{\text{MnO}}$ } .164
O in excess	1.20	1.18	1.19	
CaO	0.13	0.23	0.18	.003
MgO	<i>tr.</i>	<i>tr.</i>	<i>tr.</i>	
Li ₂ O	5.71	5.61	5.66	.188
Na ₂ O	0.44	0.53	0.49	.008
H ₂ O	3.11	3.03	3.07	.170
	<hr/> 99.86	<hr/> 99.43	<hr/> 99.65	

Another specimen of the more compact dull variety analyzed by H. L. Wells, afforded the following results:—G. = 3.26–3.27.

	I.	II.	Mean.	Atomic ratio.	
P ₂ O ₅	40.25	40.51	40.38	.284	1
Fe ₂ O ₃	16.04	15.74	15.89	.099	
MnO	32.07	31.99	32.03	} = $\frac{14.71}{\text{Mn}_2\text{O}_3}$ } .191 } = $\frac{18.80}{\text{MnO}}$ } .265	
O in excess	1.47	1.50	1.48		
CaO	.74	.70	.72	.010	} .339 2.88
Li ₂ O	4.69	4.96	4.83	.161	
K ₂ O	0.25	0.28	0.26	.003	
Na ₂ O	<i>tr.</i>	<i>tr.</i>	<i>tr.</i>		
H ₂ O	3.32	3.41	3.37	.187	
Residue	0.90	0.90	.90	.187	
	<hr/> 99.86	<hr/> 99.86	<hr/> 99.86		

This last variety approaches the composition of a normal phosphate, but as before remarked it is not to be expected that such products of alteration should be homogeneous or prove to be definite mineral species. In general the above analyses show a marked correspondence with the analogous product of the alteration of the Norwich triphillite as analyzed by Craw and Mallet. The Branchville black material is, however, richer in manganese and in lithia, and fortunately we find it enveloping unaltered lithiophilite so that there can be no question as to the character of the original mineral.

In order to avoid any misunderstanding we may repeat here a remark already made, that we have observed also a variety of other black decomposition products bearing no relation to the above. One of them contains the oxides of iron and manganese simply being derived from the alteration of the carbonate (rhodochrosite); others have been derived respectively from the decomposition of eosphorite, triploidite and reddingite. The last named has often the characteristic octahedral form of the original mineral.

We would express here our sincere thanks to the three gentlemen, Messrs. Penfield, Wells and Dewey, who have assisted us in the chemical part of this investigation.