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treme difference in path of about 250,000 waves is about one part in half a million.

It is believed that in some experiments recently published* this degree of accuracy has been attained with a difference of path only one-tenth as large, and exceeded with twice this number. But there is no reason to think that (in some cases at least) the limit of visible interferences will be reached even with two or three hundred thousand waves. This means ultimately an error of something like *one part in twenty millions* in the estimate of a single wave-length.

Thus it appears that it is possible to construct a single instrument of a few pieces of plane glass which can combine the functions of a microscope, a telescope and a spectroscope; and that *for purposes of measurement* may be made to far surpass these instruments in accuracy.

ART. XIX.—*On Lansfordite, Nesquehonite, a new Mineral, and Pseudomorphs of Nesquehonite after Lansfordite;* by F. A. GENTH and S. L. PENFIELD. With Plate IV.

UNDER the name lansfordite one of us† described a new mineral which had been discovered in October, 1887, by Messrs. D. M. Stackhouse and F. J. Keeley in one of the anthracite mines in the neighborhood of Lansford, near Tamaqua, Schuylkill Co., Pa. The specimens collected at that time, which were entirely uniform in appearance, occurred as incrustations and in the form of stalactites showing some crystalline faces. They had throughout their whole mass the appearance of paraffine, a distinct cleavage, probably basal as will be shown later on, and a vitreous luster. The specific gravity was found to be 1·692 (Keeley) and 1·54 (Stackhouse), the former being probably too high owing to a slight decomposition caused by boiling the specimen in water. An analysis by Mr. Keeley gave the following formula: $3MgCO_3 . Mg(OH)_2 . 21H_2O$, corresponding to

	Found.	Calculated.
CO_2	18·90	19·19
MgO	23·18	23·25
H_2O	57·79	57·56
	99·87	100·00

In the month of June, 1888, Mr. Keeley paid a second visit to the locality in order to secure the balance of the lansfordite,

* "On the feasibility of establishing a light-wave as the ultimate standard of length:" Michelson and Morley, this Journal, xxxviii, Sept., 1889.

† Dr. Genth: Zeitschr. Kryst., xiv, 255.

and after a great deal of trouble found the locality and collected every available fragment. Altogether there may have been fifty pieces, the total weight of which did not exceed half a pound. The exact locality is in No. 1 Tunnell at Nesquehoning, four miles from Lansford. All the specimens of the second lot showed a remarkable change. They were not like the first, uniform in appearance, but had suffered partial decomposition, showing at the base of the stalactites and incrustations, where they were attached to the carbonaceous shales, groups of transparent, radiating, prismatic crystals, individuals of which penetrated or were wholly covered by the material of the still unaltered lansfordite. During the period of a few months after collecting the second lot at summer temperature, when the thermometer ranged about 90° F., almost all of the lansfordite specimens suffered a still further decomposition, being converted into an opaque white cryptocrystalline or chalk-like mineral, and this change has been continually going on, so that at the time of writing this article there is not a single specimen of wholly unaltered lansfordite in our possession.

The clear crystals, which we have just mentioned, proved on examination to be a new mineral, having the composition $MgCO_3 . 3H_2O$, to which we have given the name Nesquehonite, after the locality where the mineral was found, the Nesquehoning Mine being one of the best known in Pennsylvania.

In the following pages in addition to the nesquehonite we shall describe a crystallized artificial salt of the same composition. It will also be shown that the altered stalactites are pseudomorphs of nesquehonite after lansfordite and from the crystal faces on the stalactites we have been able to make out the crystallization of the original lansfordite which is at present only known as pseudomorphs. In making the investigation the chemical work was all done by Dr. F. A. Genth in Philadelphia, Pa., and the crystallographic work by S. L. Penfield in New Haven, Ct.

Nesquehonite.

The crystallization of nesquehonite is orthorhombic. The prismatic crystals occur occasionally isolated but usually in radiating groups, showing only one free end which sometimes projects into a cavity but more often penetrates and is covered with the material of the lansfordite. Individual crystals are frequently over 10^{mm} long and 2^{mm} thick, and show at the free end either a basal plane alone or the base in combination with a brachydome. The faces in the prismatic zone are always deeply striated parallel to the vertical axis and consequently the crystals have their vertical edges rounded and are frequently much distorted owing to the prominence of one or more of the verti-

cal faces. On the reflecting goniometer the faces in the prismatic zone frequently yield an unbroken band of reflections of the signal with more prominent parts indicating the position of a unit prism *m*, 110 and a brachypinacoid *b*, 010. No reflections were ever obtained from a macropinacoid and what appears to be that face on many of the crystals is probably a rounding off of the obtuse edge of the prism owing to oscillatory combination of the prismatic faces. No sharp reflections were obtained in this zone from either prisms or brachypinacoids, but by measuring from the most prominent reflections approximate values were obtained for the prismatic angle. The faces at the ends of the few crystals at our disposal yielded better results, the dome faces giving fair reflections of the signal so that the angle could be measured with a good deal of accuracy. The basal plane gave in all cases a double reflection of the signal, the two reflections being just about 1° apart, while the reflection from a simple basal plane, just truncating the brachydome, should be midway between them This vicinal development of the basal plane can be detected on all of the crystals. The cleavage of the mineral is quite perfect parallel to the prism and less perfect parallel to the base. Parallel to the prism the mineral breaks with a splintery, almost fibrous fracture and no success was obtained in developing large flat prismatic surfaces by cleavage; with larger crystals and more material one might obtain cleavage prisms which on the goniometer would give a very correct measurement of the prismatic angle, but in trying to obtain such prisms, splinters were always loosened which were more or less displaced from their proper position and yielded multiple reflections of the signal so that we could not tell from just what reflection to take the reading of the goniometer. The best measurement of the prismatic angle was however obtained from one of these cleavage prisms, and although not as good as one would desire, it is the best that the material at our disposal afforded.

The forms which have been identified on the crystals are:

c, 001, *O*; *b*, 010, *i-∞*; *m*, 110, *I*; and *d*, 011, 1-∞.

The arrangement and development of the faces is shown in fig. 1.

For fundamental angles the following were chosen:

$d \wedge d$, $011 \wedge 0\bar{1}1$ $= 49°\ 6'$
$m \wedge m$, $110 \wedge 1\bar{1}0$ (both cleavage) $= 65\ 36$

from which the following axial relation is calculated:

$$a : b : c = 0{\cdot}645 : 1 : 0{\cdot}4568$$

The following angles were measured independently on six different crystals in addition to the fundamental angles given above:

	$d \wedge d$	$d \wedge b$	$m \wedge m$	$m \wedge m$
Calculated.....	49° 6′	65° 27′	65° 36′	114° 24′
Measured.....	49 6	65 28	66 30	113 30
	48 57	65 8	66	115 5
		65 15	66 4	
		65 10		
		65 51		
		66 0		

The prismatic angles vary considerably from the fundamental values, which would be expected from the nature of the crystals, and consequently the value of the $\breve{a}$ axis 0·645 can only be regarded as approximate.

The optical properties indicate decidedly orthorhombic symmetry. The plane of the optical axes is the base, the brachy-axis being the acute bisectrix and axis of greatest elasticity; the double refraction is therefore negative and is rather strong. From a small plate $1\frac{1}{2} \times 4^{mm}$ cut parallel to the macropinacoid the divergence of the optical axes was measured on a large Fuess axial angle apparatus and found to be:

$2E = 83° 55'$ for red Li flame.
$2E = 84\ 15$ for yellow Na flame.
$2E = 84\ 22$ for green Th flame.

Five reading for yellow varied between 83° 56′ and 84° 37′. As the green and red lights were not so brilliant it was harder to bring the hyperbolæ on the cross-hairs of the instrument and the values can not be regarded as very accurate; they serve, however, to show the small dispersion of the optical axes, which is $\rho < v$. Small cleavage chips of the mineral show under the polarizing microscope with crossed nicols very little change in color on revolving the stage, but in convergent polarized light an optical axis is seen almost in the center of the field. The optical axes are therefore almost at right angles to the prismatic faces. Indices of refraction were not determined. The hardness of the mineral is about 2·5. The crystals readily scratch gypsum but cannot be made to scratch calcite. The specific gravity was determined by just floating the crystals in the Thoulet solution and found to be 1·83. The solution had a slight solvent action on the mineral, carbon dioxide being liberated, bubbles of which attached themselves to the crystals and buoyed them up. The specific gravity had to be taken therefore very carefully after washing the crystals and taking the observation before any appreciable chemical action had set in. A specific gravity determination made in alcohol gave 1·852, agreeing closely with the above.

For the chemical analysis only the best crystals were used, which after drying for three days over sulphuric acid lost only 0·10 per cent and showed a few opaque spots resulting probably from a slight contamination of lansfordite. The analysis yielded:

	I.	II.	III.	IV.	Average.	Ratio.	
CO_2		30·18		30·25	30·22	·687	1·
H_2O and CO_2	70·56		70·52				
MgO	29·44	29·24	29·18	29·04	29·22	·731	1·06
H_2O					40·32	2·240	3·26
					99·76		

The ratio of $CO_2 : MgO : H_2O$ is about 1 : 1 : 3, agreeing with the formula $MgCO_3 . 3H_2O$. The calculated percentage composition of a mineral with the above formula being:

CO_2	31·38
MgO	28·99
H_2O	39·13

which also agrees closely with chemical analysis.

Artificial nesquehonite.

A salt of the composition $MgCO_3 . 3H_2O$ is most readily obtained by dissolving magnesium carbonate in water containing carbon dioxide and allowing the solution to stand till it deposits crystals. The preparation of this salt we find mentioned in Klaproth's Chemisches Wörterbuch, edition of 1808, where it is stated that it crystallizes in transparent six sided prisms, terminated by a six-sided basal plane, but the water of crystallization is not mentioned. In Berzelius' Chemie, edition of 1835, the same method of preparation and description of the salt are given with mention of the three molecules of water of crystallization. In 1855, Marignac* published his results of the crystallographic measurement of the crystals, which he describes as brilliant but deeply striated orthorhombic prisms. He observed *c*, 001, *O*; *b*, 010, *i-ĭ*; *m*, 110, *I* and *d*, 011, 1-$\breve{i}$, the same forms which occur on the natural mineral. His measurements are:

	Marignac.	Nesquehonite, Penfield.
$m \wedge m$ 110 $\wedge$ 1$\bar{1}$0	64°	65° 36′
$d \wedge d$ 011 $\wedge$ 0$\bar{1}$1	47	49 6

We prepared a quantity of the salt, which crystallized in radiating tufts of prismatic crystals. Individual crystals were scarcely over 0·2^{mm} in diameter and about 2·0^{mm} long. Most of them were terminated by a simple basal plane and showed either a rhombic or hexagonal cross section according as *b*, 010, was wanting or present. Sixteen of these little crystals were measured on the reflecting goniometer in hopes of finding one which would give sharp reflections of the signal, but owing to the small size of the crystals and some physical unevenness of the faces the angles admitted of only approximate measurement and showed considerable variation. The prismatic angle varied from 64° 30′ to 68° 45′, most of the

* Mém. de la Soc. de Phys. and D'Hist. Nat. de Genève, xiv, p. 252.

crystals, and among these the best, giving an angle of nearly 66°, which is about that obtained from the natural mineral. One of the largest of the crystals served as a prism for measuring the indices of refraction. The prismatic angle measured 68° 20′; the minimum deviation for yellow light, soda flame, was found to be 46° 40′ for rays vibrating parallel to the vertical axis of the prism and 49° 40′ for rays vibrating parallel to the macro axis. Two of the indices of refraction are therefore $\beta=1{\cdot}501$ and $\gamma=1{\cdot}526$. The relation of the axes of elasticity to the crystallographic is therefore the following $\overline{a=a}$, $b=c$ and $c=b$. The brachy-axis being the acute bisectrix the double refraction is negative the same as in the natural mineral. As a further proof of the identity of the natural and artificial salts we find that the two show exactly the same behavior in convergent polarized light; one of the little crystals lying on a prismatic face shows in convergent polarized light one optical axis almost in the center of the field, the base as the plane of the optical axes and a strong double refraction. Making use of $\beta=1{\cdot}501$ for yellow in the determination of the divergence of the optical axes in the natural mineral $2E=84°\ 15'$, we find $2V=53°\ 5'$, from which we see that the optical axes vary only about 6° from a normal to the prismatic faces. Also having $2V=53°\ 5'$, $\beta=1{\cdot}501$ and $\gamma=1{\cdot}526$ we can calculate $\alpha=1{\cdot}495$.

Owing to the ease with which this simple carbonate of magnesia can be produced artificially in crystals and its stability, for the crystals do not lose water in the warm, dry air of a laboratory nor in a desiccator over sulphuric acid, it would seem to be a very natural compound to find in nature; it is, however, probable that its solubility, especially in water containing carbon dioxide, would account for its absence in localities which would seem favorable for its formation. The hydrated carbonates of magnesia which up to this time have been found in nature are basic and are:

Hydromagnesite	$3MgCO_3$, $Mg(OH)_2$, $3H_2O$
Lansfordite	$3MgCO_3$, $Mg(OH)_2$, $21H_2O$
Hydromagnesite	$MgCO_3$, $Mg(OH)_2$, $2HO_2$ or $Mg_2CO_4.3H_2O$

The last of these is a mineral which has recently been described by E. Scacchi* as occurring in dense spherulitic masses from 2 to 15^{mm} diameter in a lava at Pollina, Sicily. The formula written $Mg_2CO_4.3H_2O$ reminds one very much of our mineral but requires 44·94 per cent MgO, while the nesquehonite requires only 28·99 per cent.

* Rendi. della R. Acad. delle. Sci. di Napoli 12, Dic. 1885.

Pseudomorphs of nesquehonite after lansfordite.

Mention has already been made in the first part of this paper and in the original article by Dr. Genth* of the occurrence of lansfordite. On the specimens which were first collected no nesquehonite prisms were visible, but by the time when the second lot was obtained owing to some process a decomposition and recrystallization of the material of the lansfordite had gone on in the mine, resulting in the formation of the nesquehonite crystals. This recrystallization, resulting in the formation of rather large crystals, had in all cases commenced at the base of the stalactites and incrustations, leaving the ends of the stalactites still unaltered lansfordite and no real pseudomorphs were found, while the white cryptocrystalline mineral which was formed afterwards from the lansfordite during a period of warm summer temperature has resulted in the production of perfect pseudomorphs, leaving not only the original stalactite form but also the flat crystal faces at the ends well preserved, the stalactites looking like bits of crayon upon the ends of which flat faces had been worn by writing on a black-board. When the specimens were first sent to New Haven in the spring of 1889, there were among them only two specimens, one a small fragment the other a small stalactite, which still showed the paraffine luster, but when the crystallographic work was commenced in the fall of 1889, these two specimens had also lost their luster and become almost completely changed into the opaque white material. The altered stalactites show on a fractured surface with a strong lens a fine fibrous structure, the fibers either radiating or inter-woven like felt and giving a sort of "schimmer" when held in a strong light. In places it appears dense like chalk or crypto-crystalline. When carefully crushed and mounted in Canada balsam it shows with the microscope throughout a fine fibrous structure, the larger fibers, which happen to lie on a prismatic or cleavage face giving the same optical properties as nesquehonite. This fibrous material has proved on examination to be like nesquehonite in its chemical composition, an analysis giving:

		Ratio.			Calculated. Nesquehonite.	Lansfordite.
CO_2	28·85	0·656	0·93	1·	31·88	19·19
MgO	28·23	0·706	1·00	1·	28·99	23·25
H_2O	42·92	2·384	3·37	3·	39·13	57·56
	100·00					

The analysis and ratio indicate the composition $MgCO_3 \cdot 3H_2O$, the variation from the theoretical being too little CO_2 and too much H_2O resulting probably from a slight admixture of

* Loc. cit.

unaltered lansfordite. For more ready comparison we have given the calculated percentage composition of both nesquehonite and lansfordite.

From the above observations we conclude that the lansfordite is very unstable, losing its water and changing into nesquehonite at a very moderate temperature. Under ordinary conditions this change goes on so rapidly that only microscopic crystals are developed and perfect pseudomorphs are formed. In the mine, where we should expect the temperature conditions to be uniform, the change undoubtedly went on slowly and quite large crystals were formed. We should not expect the summer temperature in the mine to be as high as out of doors, and what agency had been at work in bringing about the change other than rise of temperature we do not know. It is probable that the lansfordite was discovered very soon after its formation and we feel that we were very fortunate in obtaining it before its conversion into nesquehonite.

Crystallization of lansfordite.

Lansfordite is at present only known in pseudomorph crystals; these are, however, so unlike anything which we have ever seen before that they have been subjected to very careful crystallographic study. They are exceedingly interesting as they show a curious combination of stalactitic and crystal growth. The stalactites are mostly round and tapering like ordinary stalactites, but on and near the ends they have perfectly flat crystal faces; these have rounded contours where they join the curved surface of the stalactites and frequently two crystal faces, instead of coming together forming a straight edge, are separated by a curved stalactitic surface. On looking over the material, at first all hopes of measuring the crystals on a reflecting goniometer by direct reflection of light was given up as the faces seemed too dull for that purpose. Two of the crystals were therefore laboriously measured by placing a little Canada balsam on the faces and pressing small bits of thin cover glass upon them before placing them on the goniometer. This method gave rather unsatisfactory results, especially for the smaller faces and was soon abandoned, as it was found that in cleaning up the crystals with alcohol and wiping them with cloth a slight polish was developed on the faces, causing them to give a slight reflection of light, sufficient for an approximate measurement of the angles by using a strong illumination and the low ocular (δ of Websky) on the Fuess reflecting goniometer. It was also soon found that most of the crystal faces were so smooth and perfect that without any polishing they gave, with strong illumination and a low ocular, a fair reflection of light. Altogether there were sent to New Haven

thirteen crystals or parts of stalactites which seemed suitable for measurement and these have been conveniently designated in the following pages by numbers.

No. 1. The best crystal of all was a small one about 5^{mm} in its greatest diameter, which was attached to one of the larger stalactites and readily separated from it leaving an angular cavity, marked with regular lines which are so often seen in breaking apart two crystals which have accidentally grown together. This small crystal gave distinct reflections of the signal and values which can probably be relied on within half a degree. The crystal is triclinic and is shown in fig. 2. The observed forms have been taken as follows: *c*, 001, *O*; *b*, 010, $\dot{\imath}$-$\check{\imath}$; M, 1$\bar{1}$0, *I*; *m*, 110, *I'*; *d*, 021, 2-$\check{\imath}'$; *p*, 1$\bar{1}$1, −1 and *r*, 1$\bar{3}$2, $-\frac{1}{3}$-$\check{3}$. The following measurements were chosen as fundamental.

$c \wedge b$, 001 ∧ 010 = 84° 6′	$b \wedge$ M, 010 ∧ $\bar{1}$10 = 64° 13′
$c \wedge$ M, 001 ∧ $\bar{1}$10 = 96 35	$m \wedge$ M, $\bar{1}$10 ∧ $\bar{1}$10 = 56 57
$b \wedge d$, 010 ∧ 021 = 39° 16′	

from which the following relations are calculated.

a = 95° 22′	
β = 100 15	$\check{a} : \check{b} : \dot{c}$ = 0·5493 : 1 : 0·5655
γ = 92 28	

In addition to the fundamental measurements given above the following were made for the identification of the pyramids.

	Calculated.
$m \wedge p$, 110 ∧ 1$\bar{1}$1 = 59° 36′	58° 56′
$p \wedge r$, 1$\bar{1}$1 ∧ 1$\bar{3}$2 = 21 17	21 41
$c \wedge p$, 001 ∧ 1$\bar{1}$1 = 44 1	44 59

This crystal, which was attached at its lower end, in reality showed none of the M face and only a little of *m* in front, but on top and behind it was quite perfect except for a slight rounding off of the vertical edges between 010, $\bar{1}$10 and $\bar{1}\bar{1}$0 by a stalactitic surface.

The position which we have adopted for our crystal is probably as good as any which could have been chosen for showing the relation of the faces. On the thirteen stalactites which we have examined twenty-four separate forms have been identified whose relations and zones can be well understood from the spherical projection, fig. 3, and which are distributed as follows:

Pinacoids.	Prisms.	Domes.
c, 001, *O*	*m*, 110, *I'*	*d*, 021, 2-$\check{\imath}'$
b, 010, $\dot{\imath}$-$\check{\imath}$	M, 1$\bar{1}$0, *I*	*e*, 0$\bar{2}$1, 2-$\check{\imath}$
	h, 1$\bar{5}$0, $\dot{\imath}$-$\check{5}'$	*f*, $\bar{2}$01, 2-$\check{\imath}$
	k, 3$\bar{1}$0, $\dot{\imath}$-$\bar{3}$	
	l, 1$\bar{7}$0, $\dot{\imath}$-$\bar{7}$	

Pyramids in the four upper octants.

Front right.	Front left.	Back right.	Back left.
P, 111, — 1′	p, $1\bar{1}1$, — 1	y, $\bar{1}11$, 1′	n, $\bar{1}\bar{1}1$, 1
	q, $3\bar{1}2$, — $\frac{3}{2}$-$\bar{3}$	x, $\bar{1}32$, $\frac{3}{2}$-$\breve{3}'$	o, $\bar{1}\bar{1}2$, $\frac{1}{2}$
	r, $1\bar{3}2$, — $\frac{3}{2}$ $\breve{3}$	z, $\bar{3}12$, $\frac{3}{2}$-$\bar{3}'$	ρ, $\bar{1}31$, 3-$\breve{3}$
	s, $1\bar{7}2$, — $\frac{7}{2}$-$\breve{7}$	w, $\bar{5}$ 15 1, 15-$\breve{3}'$	π, $\bar{1}52$, $\frac{5}{2}$-$\breve{5}$
	τ, 12 $\bar{1}\bar{2}$ 21, — $\frac{12}{11}$-$\breve{\frac{2}{3}}$		

As the thirteen crystals which were sent to New Haven offered a great diversity of habit it was found necessary to study and discuss each one separately. In the figures which have been drawn, a mere outline of the stalactite has been given with no attempt at artistic shading. In all of the drawings the flat crystal faces have been lettered and can thus be distinguished from the rounded stalactitic surfaces which are unlettered and show throughout curved contours. After establishing the triclinic character and axial relation of the mineral from the fundamental measurements considerable difficulty was found in orientating some of the more complicated crystals; this was rendered all the more difficult as none of the crystals gave very exact measurements and cleavage, luster or any decided crystalline habit failed entirely, but after becoming familiar with some of the principal zones in a few of the more complicated crystals this difficulty disappeared. It should also be stated here that during the investigation no uncertain reflections were seen which were neglected, all of the reflections were recorded and in every case they could be referred to faces having rational indices and in only two cases τ and w were these indices unusual numbers: The zonal relations were throughout very satisfactory.

No. 2. This is a very simple stalactite about 22^{mm} long and 9 in diameter, terminated at the end by only two crystal faces and with one large prominent face on the side, fig. 4. Reflections were obtained from the faces by sticking glass plates to them and the measured angles, which are not very exact, indicate that the faces are probably c 001, p $1\bar{1}1$ and m 110. The angles are as follows:

		Calculated.
$c \wedge p$,	001 $\wedge$ $1\bar{1}1$ = 42° 30′	44° 59′
$c \wedge m$,	001 $\wedge$ 110 = 77 40	78 12
$p \wedge m$,	$1\bar{1}1$ $\wedge$ 110 = 61	58 56

No. 3 is a stalactite, which is very similar to the previous one, and is terminated by only two faces which are probably c 001 and d 021, giving the measurement $c \wedge d$ = 44° 56′ calculated 44° 50′.

No. 4 is a stalactite about 15^{mm} long and 8 in diameter attached at the base to a mass of radiating prismatic crystals of nesquehonite. At the end it is terminated mostly by a

brachypinacoid b $0\bar{1}0$ and shows in addition **M** $1\bar{1}0$, m $\bar{1}\bar{1}0$, p $1\bar{1}1$ and c 001. A measurement of the two zones **M**, b, m and **M**, p, c was sufficient for a determination of the faces, which when drawn in proper position represent the stalactite as laying on its side. The crystal is represented in fig. 5, where b and m being to the left and behind are not shown. The measured angles are:

		Calculated.	
$M \wedge b$,	$1\bar{1}0 \wedge 0\bar{1}0 = 65° 30'$	$64° 13'$	
$b \wedge m$,	$0\bar{1}0 \wedge \bar{1}\bar{1}0 = 57\ 9$	$58\ 50$	
$c \wedge b$,	$001 \wedge 0\bar{1}0 = 96\ 30$	$95\ 54$	
$M \wedge p$,	$1\bar{1}0 \wedge 1\bar{1}1 = 39° 25'$	$38° 26'$	
$p \wedge c$,	$1\bar{1}1 \wedge 001 = 44\ 30$	$44\ 59$	

The b face not being very perfect accounts for a rather large variation from the theoretical for the first three angles. It was from this crystal that the smaller one was taken, No. 1, which was used for obtaining the fundamental measurements. It was attached at the end of the stalactite, separated readily from it and had no definite crystallographic relation to the larger crystal.

No. 5, is a short stalactite about 10^{mm} long and broad attached at the base to a mass of nesquehonite crystals. Like the previous stalactite the prominent face at the end is a brachypinacoid b $0\bar{1}0$, with which the following forms are associated. **M**, $1\bar{1}0$; l, $1\bar{7}0$; h, $\bar{1}\bar{5}0$; c, 001; e, $0\bar{2}1$; p, $1\bar{1}1$; r, $1\bar{3}2$; s, $1\bar{7}2$; and o, $\bar{1}\bar{1}2$, which were identified by measurements made in the following prominent zones **M**, l, b and h; **M**, p and c; p, r and e; b, s and r; s, e and o and b, e and c. As the faces intersect the negative end of the b axis the figure, No. 6, has been drawn representing the crystal as turned about the vertical axis so that the negative end of $\bar{b}$ is in front and the positive end of $\breve{a}$ to the right. We are thus looking as it were directly at the end of the stalactite. The face b is in two levels separated by a narrow prismatic face h $\bar{1}\bar{5}0$. The angular marking at the lower left hand corner of the drawing represents where a small crystal was detached. The important measurements in the zones mentioned above are as follows.

		Calculated.	
$M \wedge l$,	$1\bar{1}0 \wedge 1\bar{7}0 = 49° 15'$	$49° 16'$	
$M \wedge b$,	$1\bar{1}0 \wedge 0\bar{1}1 = 63\ 30$	$64\ 13$	
$l \wedge h$,	$1\bar{7}0 \wedge 1\bar{5}0 = 33\ 30$	$34\ 16$	
$M \wedge p$,	$1\bar{1}0 \wedge 1\bar{1}1 = 39$	$38\ 26$	
$p \wedge c$,	$1\bar{1}1 \wedge 001 = 44\ 5$	$44\ 59$	
$p \wedge r$,	$1\bar{1}0 \wedge 1\bar{3}2 = 21\ 30$	$21\ 41$	
$r \wedge e$,	$1\bar{3}2 \wedge 0\bar{2}1 = 23\ 52$	$24\ 36$	
$b \wedge s$,	$0\bar{1}0 \wedge 1\bar{7}2 = 33° 34'$	$33° 24'$	
$s \wedge r$,	$1\bar{7}2 \wedge 1\bar{3}2 = 26\ 36$	$26\ 14$	
$s \wedge e$,	$1\bar{7}2 \wedge 0\bar{2}1 = 18\ 25$	$19\ 2$	
$e \wedge o$,	$0\bar{2}1 \wedge \bar{1}\bar{1}2 = 42\ 26$	$42\ 14$	
$b \wedge e$,	$0\bar{1}0 \wedge 0\bar{2}1 = 45$	$44\ 32$	
$e \wedge c$,	$0\bar{2}1 \wedge 001 = 51\ 30$	$51\ 22$	

On this crystal we find for the first and only time l and s. l gives a faint but distinct reflection and gives a measurement on **M** very close to the calculated; s is very surely determined both by its zones and the angles which do not vary much from the calculated. The prism h $\bar{1}\bar{5}0$ gave a poor reflection, as b,

$0\bar{1}0$ also reflected poorly the angle of h on l was taken for the identification of h. The angle varies 46′ from the theoretical but considering the poor reflection of the signal and that this same form was identified on two other crystals we feel very sure that we have given to h the proper indices. A second faint reflection was obtained from a face 3° from h and corresponding nearly to $\bar{1}60$ but the measurement is not very exact and the form does not occur on any other crystals, so that we do not feel warranted in numbering this among our list of planes.

No. 6 is like an incrustation or very short stalactite covering the ends of a cluster of radiating nesquehonite crystals. The incrustation is terminated by a very prominent brachypinacoid b, 010, measuring 9 by 7^{mm} with which the following forms are associated, m, 110; M, $\bar{1}10$; h, 150; d, 021; e, $02\bar{1}$; c, 001; p, $1\bar{1}1$ and $\bar{1}1\bar{1}$ and r, $\bar{1}3\bar{2}$; figure 7 represents the arrangement of the faces on this crystal. The large b face is in three levels separated by narrow m, p and d faces. At the back of the crystal we find a zone of three small faces p, r and e indicated by dotted lines, as e is reduced almost to a line, in one projection it does not show on any of the figures except the basal projections. As we usually have on these stalactites only the faces corresponding to one end or corner of a crystal it is seldom that we have two parallel faces as the pyramid p $1\bar{1}1$ and $\bar{1}1\bar{1}$ in this example. In the following table will be found the angles which were measured in the prominent zones for the identification of the faces.

		Calculated.				Calculated.
$b \wedge$ M, $010 \wedge \bar{1}10 = 64°$		64° 13′	$p \wedge c$, $1\bar{1}1 \wedge 001 = 44°$	15′	44° 59′
$b \wedge m$, $010 \wedge 110 = 59$	30′	58 50	M $\wedge p$, $\bar{1}10 \wedge 1\bar{1}1 = 39$	4	38 26
$m \wedge h$, $110 \wedge 150 = 38$	15	39 31	$p \wedge r$, $1\bar{1}1 \wedge \bar{1}3\bar{2} = 21$	43	21 41
$b \wedge d$, $010 \wedge 021 = 39$	30	39 16	$r \wedge e$, $\bar{1}3\bar{2} \wedge 02\bar{1} = 24$		24 35
$d \wedge c$, $021 \wedge 001 = 44$	30	44 50			

No. 7 is a small fragment of a stalactite about 11^{mm} in its greatest diameter. The faces which are present are represented in about their natural development in fig. 8. Crystal faces are present only in the front, lower and right hand part of the crystal. The following forms were present: c, $00\bar{1}$; b, 010; m, 110; k, $3\bar{1}0$; M, $1\bar{1}0$ and $\bar{1}10$; g, $3\bar{1}2$; z, $\bar{1}\bar{2}3$; y, $1\bar{1}\bar{1}$; x, $1\bar{3}\bar{2}$; n, $11\bar{1}$; o, $11\bar{2}$, e, $02\bar{1}$ and p, $\bar{1}1\bar{1}$. The prominent zones which were measured for the identified of the faces are as follows: b, m, k and M; m, z, y and x; m, n and o; z, k and M, q and p and c. The measured angles are as follows:

		Calculated.				Calculated.
$b \wedge m$, $010 \wedge 110 = 64°$		64° 13′	$m \wedge n$, $110 \wedge 11\bar{1} = 45°$	27′	44° 37′
$m \wedge k$, $110 \wedge 3\bar{1}0 = 37$	32′	38 2	$m \wedge o$, $110 \wedge 11\bar{2} = 68$	45	68 5
$k \wedge$ M, $3\bar{1}0 \wedge 1\bar{1}0 = 19$	17	18 55	$k \wedge z$, $3\bar{1}0 \wedge 3\bar{1}2 = 37$		35 29
$m \wedge z$, $110 \wedge 3\bar{1}\bar{2} = 55$	40	53 22	$k \wedge q$, $3\bar{1}0 \wedge 3\bar{1}2 = 30$	23	29 59
$z \wedge y$, $3\bar{1}\bar{2} \wedge 1\bar{1}\bar{1} = 19$	45	20 8	M $\wedge p$, $\bar{1}10 \wedge \bar{1}1\bar{1} = 39$	15	38 26
$y \wedge x$, $1\bar{1}\bar{1} \wedge 1\bar{3}\bar{2} = 24$		25 6	$p \wedge c$, $\bar{1}1\bar{1} \wedge 00\bar{1} = 44$	37	44 59

The zones and the approximate measurement of the angles fully determine the forms on this crystal. The dome *e*, which is relatively quite a large face, is reduced almost to a line in our projection.

No. 8 is one of the most perfect of the stalactites; it is short, 10^{mm} long and 6^{mm} in diameter. At the base the white material of the altered lansfordite spreads out very much and covers a group of nesquehonite prisms which are attached to a piece of carbonaceous shale. The planes which are present are very symmetrically grouped, reminding one of a monoclinic crystal, and are as follows: *b*, 010; *c*, 001; M $1\bar{1}0$ and $\bar{1}10$; *d*, 021; *e*, $0\bar{2}1$; *x*, $\bar{1}23$; *y*, $\bar{1}11$; *p*, $1\bar{1}1$ and *r*, $1\bar{3}2$. The arrangement of the faces in about their natural development is shown in fig. 9, while fig. 10, which is a projection on a plane at right angles to the vertical axis, will give a somewhat better idea of the symmetrical arrangement of the faces. The large basal plane *c* is in two levels, and to the left there is a cleft in the stalactite which is also bounded by crystal faces, not shown in the drawing. The faces of the crystal were quite devoid of luster before rubbing and polishing with a soft cloth, by which treatment the edges were somewhat rounded and the angles of the faces slightly changed; however, the faces can be fully determined by the zones and the approximate measurements. The angles measured in the prominent zones are as follows:

		Calculated.				Calculated.	
b ∧ M, 010 ∧ $\bar{1}10$	64°	64° 13′		*d* ∧ *x*, 021 ∧ $\bar{1}32$	21° 10′	20° 20′	
b ∧ *d*, 010 ∧ 021	39 30	39 16		*x* ∧ *y*, $\bar{1}32$ ∧ $\bar{1}11$	24 40	22 50	
d ∧ *c*, 021 ∧ 001	45 10	44 50		*r* ∧ *c*, $1\bar{3}2$ ∧ 001	41 25	43 24	
c ∧ *e*, 001 ∧ $0\bar{2}1$	49	51 22		*c* ∧ *x*, 001 ∧ $\bar{1}32$	44 50	43 52	
p ∧ *r*, $1\bar{1}1$ ∧ $1\bar{3}2$	19 54	21 41		M ∧ *y*, 110 ∧ $\bar{1}11$	43 30	44 10	
r ∧ *e*, $1\bar{3}2$ ∧ $0\bar{2}1$	25 24	24 36		*y* ∧ *c*, $\bar{1}11$ ∧ 001	53 30	52 25	

Nos. 9 and 10 are two crystals which had grown together into a single stalactite about 25^{mm} long by 8^{mm} diameter, and readily separated lengthwise with the stalactite. At the junction of the two crystals at the lower end there was a deep reentrant angle, reminding one of a twin crystal but there seemed to be no crystallographic relation between the two halves, and we probably have to do simply with the growth of two crystals into one stalactite. This much must be said, however, that the axis of the stalactite corresponds closely to the vertical axis of the crystals, and the faces on the two crystals for the most part intersect the negative end of the vertical axis. One of these crystals is represented in fig 11. The rounded surface of the stalactite is behind, while in front there is an angular marking indicating the surface by which the two crystals were united and at the lower end a group of crystal faces, which are as follows: *b*, 010; *c*, 001; *h*, 150; *m*, 110; *d*, 021; *e*, $02\bar{1}$; *r*, $\bar{1}2\bar{2}$ and *p*, $\bar{1}1\bar{1}$. The angles were measured in the

following zones: *b*, *h* and *m*; *p*, *r*, *e* and *m* and *d*, *b*, *e* and *c*; and are as follows:

		Calculated.			Calculated.
$b \wedge m$, $010 \wedge 1\bar{1}0$	56° 47′	58° 50′	$d \wedge b$, $021 \wedge 010$	38° 55′	39° 16′
$h \wedge m$, $150 \wedge 1\bar{1}0$	39 11	39 31	$b \wedge e$, $010 \wedge 02\bar{1}$	45	44 32
$p \wedge r$, $\bar{1}1\bar{1} \wedge \bar{1}3\bar{2}$	21 31	21 41	$e \wedge c$, $02\bar{1} \wedge 00\bar{1}$	50 50	51 22
$r \wedge e$, $\bar{1}3\bar{2} \wedge 02\bar{1}$	24 9	24 36			

The other half of this stalactite is shown in fig. 12, where the rounded stalactitic surface is in front, while the small group of crystal faces, which are mostly in the back, are indicated by dotted lines. The forms which were identified are as follows: M, $1\bar{1}0$; *m*, 110; *c*, $00\bar{1}$; *b*, $0\bar{1}0$; *d*, $0\bar{2}\bar{1}$; *e*, $02\bar{1}$; *p*, $\bar{1}1\bar{1}$; *r*, $\bar{1}3\bar{2}$ and *x*, $1\bar{3}\bar{2}$, and were measured in the following zones: *b*, M and *m*, *p*, *r* and *e*; *b*, *d*, *c* and *e*; and *r*, *c* and *x*, the angles being as follows:

		Calculated.			Calculated.
$b \wedge$ M, $0\bar{1}0 \wedge 1\bar{1}0$	64° 10′	64° 13′	$b \wedge d$, $0\bar{1}0 \wedge 0\bar{2}\bar{1}$	39° 5′	39° 16′
M $\wedge m$, $1\bar{1}0 \wedge 110$	57 15	56 57	$d \wedge c$, $0\bar{2}\bar{1} \wedge 00\bar{1}$	44 50	44 50
$p \wedge r$, $\bar{1}1\bar{1} \wedge \bar{1}3\bar{2}$	21 30	21 41	$c \wedge e$, $00\bar{1} \wedge 02\bar{1}$	51 5	51 22
$r \wedge e$, $\bar{1}3\bar{2} \wedge 02\bar{1}$	24 25	24 36	$r \wedge c$, $\bar{1}2\bar{2} \wedge 00\bar{1}$	44 5	43 24
			$c \wedge x$, $00\bar{1} \wedge 1\bar{1}\bar{2}$	42	43 52

No. 11 is a small stalactite 18^{mm} long by 7^{mm} diameter, which when it was first sent to New Haven in the spring of 1889, still showed the paraffine luster of the unaltered lansfordite; when it was measured in the following fall it was only partially altered to nesquehonite, but had become almost completely changed by the first of December. The faces did not give good reflections of light, but as the angles which were measured on this partially altered crystal do not vary widely from the calculated, which were obtained from the measurement of a completely altered crystal, we conclude that in the change of composition the angles of the lansfordite have not been very materially changed. The faces which were identified are as follows: *b*, 010; *c*, $10\bar{1}$; *m*, 100; M, $1\bar{1}0$; *p*, $\bar{1}1\bar{1}$; *d*, $0\bar{2}\bar{1}$; and P, $\bar{1}\bar{1}\bar{1}$, *x*, $1\bar{3}\bar{2}$, and are arranged as shown in fig. 13. The angles were measured in the following zones: *b*, *m* and M; *m*, *c* and P; and *m*, *x* and *d*, and are as follows:

		Calculated.			Calculated.
$b \wedge m$, $010 \wedge 1\bar{1}0$	59° 15′	58° 50′	$m \wedge c$, $1\bar{1}0 \wedge 00\bar{1}$	103° 30′	101° 48′
$m \wedge$ M, $110 \wedge 1\bar{1}0$	58	56 57	$c \wedge$ P, $00\bar{1} \wedge \bar{1}\bar{1}\bar{1}$	44 30	43 15
$d \wedge x$, $0\bar{2}\bar{1} \wedge 1\bar{3}\bar{2}$	19	20 20	$c \wedge p$, $00\bar{1} \wedge \bar{1}1\bar{1}$	44 30	44 59

This is the only crystal on which the pyramid P, 111 was identified, and here it occurs only as a very small face which is not represented in the drawing. It is interesting to find on the mineral all of the four possible faces making up the triclinic unit pyramid. On this crystal we notice that the decomposition or change from lansfordite to nesquehonite proceeds along certain planes which are parallel to the base. It is probable that these planes indicate the direction of cleavage of the

lansfordite. On breaking across the stalactite near the base where it seemed wholly altered to nesquehonite, it parted with nearly a plane surface parallel to *c*, 001.

No. 12 is a small end of a stalactite about 8mm in diameter. Like the previous one it showed at the time the measurements were made a little of the paraffine luster of the unaltered lansfordite. The crystal is highly modified and shows the following forms: *b*, 010; *c*, 001; *d*, 021; *e*, $0\bar{2}1$; M, $\bar{1}10$; *x*, $\bar{1}32$; *y*, $\bar{1}11$; *n*, $\bar{1}\bar{1}1$; *o*, $\bar{1}\bar{1}2$; *q*, $3\bar{1}2$; *p*, $1\bar{1}1$; *r*, $1\bar{3}2$; *π*, $\bar{1}\bar{5}2$; *ρ*, $\bar{1}31$ and *w*, $\bar{5}151$. These are represented in about their natural size in fig. 14, which is a projection upon a plane at right angles to the vertical axis and which in this case is better than an ordinary projection for showing the relation of the faces. The prominent zones which were measured are: *b*, *d*, *c* and *e*; *d*, *x* and *y*; *c*, *o* and *n*; *c*, *y* and M; *q*, *p*, *r*, *e*, *π* and *ρ*, and *r*, *c*, *x* and *w*, the angles being:

		Calculated.				Calculated.	
b ∧ *d*, 010 ∧ 021	39° 25′	39°	16′	*q* ∧ *p*, $3\bar{1}2 \wedge \bar{1}11$	15° 20′	15°	3′
d ∧ *c*, 021 ∧ 001	44 57	44	50	*p* ∧ *r*, $1\bar{1}1 \wedge 1\bar{3}2$	21 38	21	41
c ∧ *e*, 001 ∧ $0\bar{2}1$	53 35	51	22	*e* ∧ *r*, $0\bar{2}1 \wedge 1\bar{3}2$	23 51	24	36
d ∧ *x*, 021 ∧ $\bar{1}32$	35 20	20	20	*e* ∧ *π*, $0\bar{2}1 \wedge \bar{1}\bar{5}2$	18 21	20	2
x ∧ *y*, $\bar{1}32 \wedge \bar{1}11$	24 15	22	50	*e* ∧ *ρ*, $0\bar{2}1 \wedge \bar{1}31$	32 36	33	42
c ∧ *o*, 001 ∧ $\bar{1}\bar{1}2$	33 30	33	43	*π* ∧ *ρ*, $\bar{1}\bar{5}2 \wedge \bar{1}31$	14 15	13	34
c ∧ *n*, 001 ∧ $\bar{1}\bar{1}1$	56 38	57	11	*r* ∧ *c*, $1\bar{3}2 \wedge 001$	45 44	43	25
c ∧ *y*, 001 ∧ $\bar{1}11$	52 40	52	25	*c* ∧ *x*, 001 ∧ $\bar{1}32$	44	43	52
y ∧ M, $\bar{1}11 \wedge \bar{1}10$	44 40	44	10	*x* ∧ *w*, $\bar{1}32 \wedge \bar{5}151$	35 16	35	22

In this crystal we notice for the first time two new pyramids *π* and *ρ* in the zone *p*, *r*, *e* which has been so prominent in most all of the crystals, we also notice for the first and only time the very steep pyramid *w* in the zone *r*, *c*, *x*.

No. 13 is a fragment about 19mm by 11mm wide, with some rounded surfaces, which was broken from a much larger piece of incrustation; except for the rounded surfaces the incrustation did not have anything of a stalactitic habit. The fragment which was measured separated readily from the rest of the incrustation, leaving angular markings which indicate the juncture of independent and distinct crystals. It was more highly modified than the remaining parts of the incrustation and showed the following forms, *b*, both 010 and $0\bar{1}0$; *c*, 001; M, $\bar{1}10$; *k*, $\bar{3}10$; *m*, $\bar{1}\bar{1}0$; *d*, 021; *e*, $0\bar{2}1$; *o*, $\bar{1}\bar{1}2$; *n*, $\bar{1}\bar{1}1$; *x*, $\bar{1}32$; *y*, $\bar{1}11$; *z*, $\bar{3}12$; *f*, $\bar{2}01$; *p*, $1\bar{1}1$; *τ*, 10 $\bar{1}\bar{2}$ 11, *r*, $1\bar{3}2$, *π* $1\bar{5}2$ and *ρ*, $\bar{1}31$. The arrangement of the faces is shown in about their natural size and developement in fig. 15, which is a projection upon a plane at right angles to the vertical axis. The prominent zones which were measured are *b*, M, *k* and *m*; *c*, *o* and *n*; *d*, *x*, *y*, *z*, *f* and *m*; *b*, *d*, *c*, *e* and *b′*; and *p*, *τ*, *r*, *e*, *π* and *ρ* the angles being—

		Calculated.				Calculated.	
$b \wedge M$,	$010 \wedge \bar{1}10 = 63°\ 50'$		$64°\ 13'$	$b \wedge d$,	$010 \wedge 021 = 39°\ 30'$		$39°\ 16'$
$M \wedge k$,	$\bar{1}10 \wedge \bar{3}10 = 20$	20	18 55	$d \wedge c$,	$021 \wedge 001 = 44$	45	44 50
$m \wedge M$,	$\bar{1}10 \wedge 1\bar{1}0 = 56$	30	56 57	$c \wedge e$,	$001 \wedge 0\bar{2}1 = 51$	25	51 22
$d \wedge x$,	$021 \wedge 132 = 21$	40	20 20	$e \wedge b'$,	$0\bar{2}1 \wedge 0\bar{1}0 = 44$	25	44 32
$x \wedge y$,	$\bar{1}32 \wedge \bar{1}11 = 24$		22 50	$p \wedge e$,	$1\bar{1}1 \wedge 0\bar{2}1 = 46$		46 16
$y \wedge z$,	$\bar{1}11 \wedge \bar{3}12 = 20$	0	20 8	$\tau \wedge e$,	$101\bar{2}11 \wedge 0\bar{2}1 = 43$		42 49
$y \wedge f$,	$\bar{1}11 \wedge \bar{2}01 = 33$	10	32 59	$r \wedge e$,	$1\bar{3}2 \wedge 0\bar{2}1 = 24$	15	24 36
$f \wedge m$,	$\bar{2}01 \wedge \bar{1}10 = 41$	15	41 31	$e \wedge \pi$,	$0\bar{2}1 \wedge \bar{1}\bar{5}2 = 20$		20 8
$c \wedge o$,	$001 \wedge \bar{1}\bar{1}2 = 32$		33 43	$e \wedge \rho$,	$0\bar{2}1 \wedge \bar{1}\bar{3}1 = 32$	30	33 42
$c \wedge n$,	$001 \wedge \bar{1}\bar{1}1 = 56$	45	57 11				

At one edge of our crystal, near the top and middle in fig. 15, we notice a little indentation where three small faces *f*, *z* and *y* form zone, a few millimeters to the right we again find *z* and *y* but separated from the former by a curved stalactitic surface and also by the pyramids *n* and *o*. The small face *f* is very perfect and is here observed for the first time. It has a very simple symbol $\bar{2}01$, $2\text{-}\bar{1}$ and is readily determined by its angles with the faces *m* and *y* in the zone. Another feature of this crystal is the highly developed zone *p*, *r*, *e*, where we notice for a second time the pyramids π and ρ. The pyramid *p* is present only as a very small face but gave a distinct reflection, the pyramid *r* however, which is only a few degrees removed it is a face of considerable size. The symbol $10\ \bar{1}\bar{2}\ 11$ is an unnatural one and may be regarded as questionable; it would not have been accepted if it had not been that the reflection from it was followed by a distinct reflection making the proper angle for the pyramid *p*. The pyramid *n* is in two levels separated by the zone of small faces *f*, *z*, *y*; to the right of this zone, see fig. 15, we notice both *o* and *n*, to the left only *n*.

Recapitulation.

The measurements which have thus far been given were obtained from thirteen crystals; from the material which was sent to New Haven a few other fragmentary ones could have been measured but they did not seem to offer anything new or of special interest. Owing to the curious combination of stalactite and crystal there is no decided crystallographic habit which can be mentioned as characteristic of our mineral nor in those specimens which are decidedly stalactitic is there any definite relation between the axis of the stalactite and the crystallographic axes for in figures 11, 12 and 13 the faces which terminate the stalactite mostly intersect the end of the vertical axis and in fig. 4 its positive end; in figs. 5 and 6 they intersect the negative end of the macro axis and in fig. 7 its positive end.

In criticising the crystallographic results it must be borne in mind that none of the crystal were well suited for measure-

ment, as they were without exception pseudomorphs and the faces had lost to a greater or less extent the high polish and luster of ordinary crystal faces. Many of the measurements were therefore made from very indistinct reflections, being mere "schimmer" measurements and in such cases the angles vary at times more than one degree from the calculated. Among all the measurements the agreement between the measured and calculated angles is very satisfactory, considering the nature of the material, while the zonal relation of the faces, as observed on the goniometer, was throughout very perfect. From the following statement a good idea of the frequency of the faces can be obtained: leaving out of consideration two stalactites, No. 2, terminated by only three faces, and No. 3, by only two, we find that the faces, *c*, 001, *b*, 010 and *p*, $1\bar{1}1$ were identified on all of the remaining eleven crystals; M, $1\bar{1}0$ on ten; *m*, 110 on nine; *e*, $0\bar{2}1$ and *r*, $1\bar{3}2$ on eight; *d*, 021 on seven; *x*, $\bar{1}32$ on six; *y*, $\bar{1}11$ and *o*, $\bar{1}\bar{1}2$ on four; *n*, $\bar{1}\bar{1}1$ and *h*, 150 on three; *k*, $3\bar{1}0$, *q*, $3\bar{1}2$, *z*, $\bar{3}12$, *π*, $\bar{1}\bar{5}2$ and *ρ*, $\bar{1}\bar{3}1$ on two and *l*, $1\bar{7}0$, *s*, $1\bar{7}2$, *f*, $\bar{2}01$, P, 111, *τ*, 10, $\bar{1}\bar{2}$, 11 and *w*, $\bar{5}$, 151 on only one crystal. Owing to the pseudomorphous nature of the mineral we cannot give any statement of the optical properties of the lansfordite. The cleavage of the lansfordite, which Dr. Genth mentioned in the original article as being very good is probably basal, which we infer from the fact that the partially altered crystal No. 11 broke near its base, where it was wholy altered, parallel to the basal plane and lower down where the mineral was only partially altered the decomposition seemed to be advancing along planes, probably cleavage, parallel to the base.

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Art. XX.— *Weber's Law of Thermal Radiation*; by William Ferrel.

1. In a previous paper on the Law of Thermal Radiation,* which will be referred to in what follows as paper A, the laws of Dulong and Petit and of Stefan were examined, and it was shown from comparisons with the results of experiment that neither of these laws holds generally for all temperatures of the radiating body, but that either, and especially the latter, holds through a considerable range of the ordinary temperatures of experiment and observation, and that for higher or lower temperatures, a change in the values of the constants is

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