XV. *On a new Locality of Amblygonite, and on Montebrasite, a new Hydrated Aluminium and Lithium Phosphate. By* M. A. O. Des Cloizeaux, *Member of the Institute of France. Communicated by Professor* W. H. Miller, *Foreign Secretary R.S.*

Received November 27, 1871,—Read February 20, 1873.

Until last year the Amblygonite from the neighbourhood of Penig in Saxony had alone been analyzed—namely, by Berzelius and by Rammelsberg. The beautiful transparent or translucent specimens found in 1862 at Hebron, Maine, U.S.A., had been merely tentatively examined by Prof. Brush, who announced the presence in them of lithia in considerable quantity. Their similarity to the Penig mineral, however, led to their being looked on, without further investigation, as Amblygonite. These specimens, less rare and more transparent than those from Saxony, had enabled me in 1863 to determine their crystalline system and their birefringent optical characters[*].

In 1870 M. Moissenet, mining engineer, sent me a mineral which had been found in considerable quantities in the tin vein of Montebras (Creuse). This mineral, though resembling the Amblygonite of Hebron, appeared to me so far to differ from it in its optical characters and in the composition, deduced from an imperfect analysis made in the laboratory of the École des Mines, as to justify my distinguishing it under the name of Montebrasite[†].

Afterwards, towards the close of 1871, I received from M. Moissenet another specimen coming from Montebras, which presented all the characters of the American Amblygonite, and which consequently was easily distinguished from the Montebrasite, as I showed in my notice read to the Academy on Nov. 27, 1871.

Subsequently to the publication of this note, the analyses made by Pisani (Comptes Rendus des Séances de l'Académie des Sciences, séance du 26 Déc. 1871, tom. lxxiii. p. 1479), by Kobell (Sitzungsberichte der bayerischen Acad. der Wiss., Feb. 3, 1872), and by Rammelsberg (Berichte der deutschen Chem. Gesellsch. Berlin, 26 Feb. 1872, No. 3, p. 78) proved the identity, in point of chemical composition, of the Montebrasite of Montebras and the Amblygonite from near Penig. This identity ought in fact to exist in the Saxon variety, for I have lately satisfied myself that a plate cut from a Penig specimen, in a direction, as nearly as might be, perpendicular to the two principal cleavages, presents the same optical characters as do plates cut from some specimens from Montebras, which will be discussed presently. But this is not the case with

---

[*] Comptes Rendus des Séances de l'Académie des Sciences, tom. lvii. p. 357.

[†] Comptes Rendus des Séances de l'Académie des Sciences. Séances des 31 Juillet et 27 Nov. 1871, tom. lxxiii. pp. 306 & 1247.

respect to the Amblygonite from the State of Maine, nor with that from Montebras, the analysis of which has been made by PISANI; since, as the pyrognostic characters led one to foresee, these differ from the Amblygonites of Saxony and Montebras (which I had previously named Montebrasite) by the absence of soda, by the preponderance of lithia, and by the presence of a notable amount of water, while at the same time the minerals resemble one another in their almost equal proportions of phosphoric acid and of alumina.

If we leave the water out of the question, the soda seems here to play the part which I have attributed to it in certain *pseudodimorphous* bodies, and especially in the sulphate of potash*; except that Amblygonite and Montebrasite belong to the same crystalline system, and their optical characters alone present complete incompatibility, while the crystals of sulphate of potash occur in two nearly resembling but incompatible types, according as they do or do not contain soda.

It results from what has been above stated, that the differences which Amblygonite and Montebrasite present in their physical and chemical characters appear to be sufficiently decided† to compel us to treat these substances as belonging to nearly related but distinct species—the one anhydrous, the other hydrated. We shall retain the name Amblygonite for the sodiolithic species first discovered at Penig by BREITHAUPT, and accordingly the white or violet-tinted lamellar masses abundant at Montebras will be included under it‡; while the hydrated and entirely lithic species, comprising the beautiful laminar specimens and the crystals from Maine, as well as some greenish masses from Montebras, still very rare, will be embraced under the name Montebrasite, which I had at first proposed for the first masses from Montebras, an erroneous analysis of which had been furnished, as before mentioned, by the laboratory at the École des Mines.

In the following pages I shall give a detailed description of the principal crystallographic and optical characters, as well as the analyses of the two species.

I. *Anhydrous Sodiolithic Species—Amblygonite.*

The Amblygonite of Montebras, designated as Montebrasite in my communication to the Academy of Sciences of Nov. 27, 1871, has only been met with in laminar masses, sometimes opaque and of a dull white, sometimes more or less translucid, and in parts even transparent and with a faint tinge of violet. These masses exhibit only two

---

* "Mémoire sur pseudodimorphisme de quelques composés naturels et artificiels," Annales de Chimie et de Physique, 4^{me} sér. tom. i. p. 313.

† I would further remark, as a distinctive feature of secondary importance, that the Montebrasite (the former Amblygonite) from the United States and that from Montebras present at least three distinct cleavages, parallel to the faces of an oblique-angled parallelepiped; while on none of the specimens of Amblygonite (the former Montebrasite), so many of which have passed through my hands, have I ever been able to detect more than two cleavages.

‡ These are the masses which are designated as Montebrasite in my notice in the 'Comptes Rendus' of 27 Nov. 1871, whereas the greenish specimen from Montebras is described as Amblygonite. I propose this inversion of the names out of respect to the priority of the name Amblygonite.

cleavages, presenting nearly the same degree of facility, but yielding surfaces so uneven and rough that, for measuring their inclination, one has to isolate small portions, as little uneven as possible. But, even with this precaution, one can never obtain sufficiently perfect reflections to afford exact measurements; and it is only by repeating these measurements on a great number of fragments, and by taking the mean of these, that I have succeeded in determining with tolerable exactness the incidence of the two cleavages to be 105° 44′. Close observation shows, furthermore, that the sharpness of the reflected images is generally a little greater on one of the surfaces of cleavage than on the other, which would induce one to suppose that they do not both belong to equivalent crystallographic planes; the difference, however, is so small that one does not notice it at first, still less can it be compared to that which I have pointed out as distinguishing the face *p* (with pearly cleavage) from the face *m* (the vitreous cleavage) of the Montebrasite of Hebron in the State of Maine*.

The insufficiency of the geometrical characters naturally led to the inquiry whether the study of some of its optical properties might not enable me to determine the crystalline type of the mineral; and this investigation, which presents certain special difficulties arising from the small extent of the transparent portions and the presence of numerous twin plates even in the specimens that to all appearance are the most homogeneous, has proved that, without doubt, the laminar masses of Montebras must be referred to the triclinic system.

In order better to compare the points of analogy or of difference which distinguish Amblygonite and Montebrasite (minerals composed of the same constituent elements but in different proportions), I have assumed, in the first of these minerals, that the less perfectly reflecting cleavage took place parallel to the base *p*, and the more perfectly reflecting cleavage parallel to the face to the left, *m*, of an oblique-angled parallelepiped, of which the face to the right *t*, and the relative dimensions are still unknown. The angle *p m* of Amblygonite equals 105° 44′, which differs by only 44′ from the corresponding angle in Montebrasite.

The optical investigation was commenced by the examination of thin plates cut perpendicularly to the two cleavages; and it served to establish that these plates were obviously oblique to the plane of the optic axes. In order to obtain plates as perpendicular as was possible to this plane and to the bisector of the acute angle of the axes, it became necessary to arrange a sort of tentative method by the aid of the polarizing microscope†.

---

* "Sur les propriétés optiques biréfringentes et sur la forme crystalline de l'amblygonite," Comptes Rendus des Séances de l'Acad. tom lvii. p. 357.

† All these tentative sections have been effected by M. H. SOLEIL with his well-known patience and skill. The working of these plates of Amblygonite (formerly Montebrasite) is all the more delicate since the best specimens that I obtained of M. MOISSENET would not allow of plates being cut of a thickness greater than $\frac{3}{4}$ of a millimetre, in order to present the transparency necessary for the subsequent execution of the slight modifications which the polarizing microscope might prove their worked surfaces still to require.

The result of these tentative trials proved that the most perfect plates were those the surfaces of which made nearly equal angles with the two cleavages (affording a mean result of 99° 8′ with *m* and 99° 25′ with *p*). The optic axes are situated in a plane which divides into two very unequal parts the acute angle=74° 16′ of the two cleavages. This direction is entirely different from that which I have found for Montebrasite (formerly Amblygonite) of Hebron and of Montebras, in which the plane of the axes lies in the obtuse angle of 105° formed by the two principal cleavages*.

With regard to the exact orientation of this plane, I have deduced it from that which it presents in the natural macles of which all the plates of Amblygonite of Montebras which I have examined are constituted, and which result from the interposition in the midst of their mass of twin lamellæ that bisect almost exactly, the one set the obtuse angle of 105° 44′, the other the acute angle supplementary to it. These lamellæ, which are often met with on the same specimen, in which they cross one another at an angle of very nearly 90°, are sometimes so thin and so numerous that they convert the whole mass into a network with close meshes, to all appearance rectangular, in which the coloured rings are only visible in the polarizing microscope at a few isolated points. Fortunately this is not always the case, and plates are pretty often found which are referable to one of the four subjoined types, and which offer more or less facility for the study of the optical doubly refracting properties of the substance.

Fig 1 (p. 579) represents those plates which are divided into slices, triangular or trapezial in section (1, 3, 5, 7, 9, &c.), which are more or less homogeneous, by a series of bands which are generally narrow (2, 4, 6, 8, &c.), parallel to one another, and very nearly parallel to the bisector-plane of the acute angle of 74° 16′; in these bands we may recognize, by the fibrous aspect which they exhibit even under illumination by ordinary light, a number of excessively thin lamellæ. Thus, while in the sectional figures indicated by an odd number the disposition and dispersion of the coloured rings can be studied in the polarizing microscope, it is only in some narrow regions of the bands indicated by the even numbers that one can examine them. This examination suffices, however, to show that whenever the section has been so successfully made as that the plane of the optic axes is as nearly normal as possible to the worked surface in the case of the slices with the odd numbers, it still remains in a very slight degree oblique to the plane in the case of those with the even numbers. In the latter case the orientation of this plane is only to be explained by the existence of lamellæ parallel to the edge *p m* which have undergone a revolution of 180° round an axis within a few minutes of being perpendicular to that edge. A great number of observations were made with an apparatus in which the two Nicols were crossed, on the maximum extinction of the light in the bands successively even and odd; and these gave the result, that the plane of the optic axes in the bands of the former order formed, with that in the latter case, a mean angle of 58° 22′.

---

* It will be seen further on that the Montebrasite which I have lately found among the specimens from Montebras presents the same optical characters as that from Hebron in the State of Maine.

The presence of the numerous lamellæ of which I have spoken ought, one would suppose, to be evidenced on the cleavages *p* and *m* by fine striæ parallel to their mutual intersection; of these, however, I have never been able to find the smallest trace in the midst of the irregularities which the surfaces of these cleavage-planes present. This is no doubt due to the lamellæ, which are so thin as not even to produce the phenomena of the colours of thin plates, not permitting of our distinguishing from *p* and *m* their faces in the turned position $\rotatebox{90}{$m$}$ and $\rotatebox{90}{$p$}$, the inclination of which on the former planes has the calculated angle $p\ \rotatebox{90}{$m$}=179° 56'$ and $m\ \rotatebox{90}{$p$}=180° 4'$, a difference alike unappreciable to the eye and to direct measurements*.

Figures 2 and 4 present plates compounded of two great divisions twinned round an axis perpendicular to a surface of assemblage which is contained in the obtuse angle $p\ m=105° 44'$, and gave to direct measurement a mean angle of 52° 2′ with *p*, and consequently an angle of 53° 42′ with *m*. The two figures only differ in other respects from one another in the relative dimensions of their constituent portions; and these dimensions may vary to any extent, according to the spot where the plane of assemblage may meet the cleavages *p* and *m*. Each of these portions is furrowed by fibrous bands, which are sometimes reduced to mere threads and present an orientation like that of fig. 1, and by lamellæ, generally very thin, which are parallel to the plane of assemblage.

The tessellated pattern, often very complex, which is produced by the two systems of lamellæ is perfectly visible in polarized light with parallel rays; and one can even obtain by photography† magnified images in which the threads situated in the obtuse angle may be recognized as being in general more blended and less undulated than are those situated in the acute angle. The mutual inclination of the lamellæ which belong to the two systems has been approximately estimated at 89° 12′ and 90° 48′ upon plates cut nearly normal to the plane of the optic axes. By combining with the angle of 58° 22′ found on the twins of the type No. 1 this number 89° 12′, an inclination of 123° 14′ may be deduced for that between the plane of the optic axes belonging to one region of the plate and that belonging to the other region of it. (The measures that were made with plates similar to those of figs. 2 and 4 vary between 122° 42′ and 123° 31′.) As for the adjustment of the two regions of the section with regard to the plane of the optic axes and to their bisector, when this has been made as accurate as possible with regard to the one it is slightly inaccurate with regard to the other, exactly as is the case with the twins similar to those in fig. 1.

On the laminar masses from which I obtained the plates of the types 2 and 4 I have

---

* The same fact may be observed in crystals of calcite and of aragonite traversed by twin lamellæ, where the trace of these ceases to be visible upon the faces at which they come out, when they present more than a certain degree of thinness.

† I am indebted to M. Cornu for images of these obtained by means of a small solar microscope in the laboratory of the École Polytechnique.

occasionally observed indications of the line in which the plane of assemblage meets the cleavages in the form of a slight ridge (see that of fig. 2), or of striations which are only visible in a bright light, and which correspond to the groove drawn to the right on the plane on the back of the section of fig. 4: the reentering angle *md* was found to be 181° to 182°; by calculation it should be 181° 40′. When the lamellæ parallel to the plane of assemblage of figs. 2 and 4* are grouped in bands of a certain width, their arrangement is that represented in fig. 3.

Though the determination of the crystallographic data for Amblygonite must necessarily be incomplete until at least a third face has been discovered not lying in the same zone with the two principal cleavages, I have given in the following Table a *résumé* of the measured and of the calculated incidences, the correctness of which may be looked upon as fairly satisfactory. For brevity, I indicate by S the surface which has been worked perpendicularly to the plane of the optic axes and to the bisector of their acute angle, by H the twin plane lying in the obtuse angle of the two cleavages, and by L the plane of the laminæ lying in their acute angle. At the point in which the three edges $\frac{m}{S}$, $\frac{S}{p}$, $\frac{p}{m}$ (figs. 1, 2, and 3) meet one another the plane angles are:—

Plane angle of m = 97° 17′ 20″.
„ „ p = 96 55 3.
„ „ S = 104 34 49.

		Calculated.		Observed.
		° ′		° ′
m : S		......	....	99 8 mean.
p : S		......	....	99 25 „
p : m		......	....	105 44 „
p : H (fig. 4)		......	....	52 2 „
m : H (fig. 2)	=	126 16 53 44	....	„ „
p : d (fig. 4)	=	104 4	....	104 32 „
m : u (fig. 2)	=	107 28	....	„
m : d (figs. 2 and 3)	=	178 20 salient	....	„
m : d (fig. 4)	=	181 40 reentering	....	181 to 182°
S superior : H (figs. 2, 3, and 4)	=	89 36	....	„
S inferior : H (figs. 2 and 4)	=	90 24	....	„

---

* The twin plane contained in the angle of 105° 44′ may be conceived as being parallel to an hypothetical face c', which would truncate the posterior edge to the right of the parallelepiped, of which we only as yet know the planes p and m, with an inclination upon p of 127° 58′. According to M. BREITHAUPT, there should be a different cleavage corresponding to a similar face on the specimen of Amblygonite from Penig. In my note of date 1863, I had thought I could make use of the inclination of this cleavage upon m for the calculation of the height of the primitive form of Montebrasite (at that time supposed to be Amblygonite) from Hebron. As will be seen further on, Mr. DANA has established the presence of a face c' for the large crystals of Montebrasite found at Hebron; but the inclinations appear very different from those which M. BREITHAUPT obtained on the Amblygonite from Penig.

		Calculated.		Observed.
		° ′ ″		
edge $\frac{p}{m}$: edge $\frac{S}{H}$	=	101 39 33		
p : L (fig. 1)	=	37 6		
m: L (fig. 1)	=	37 10		
p : $\rotatebox{90}{$m$}$ (fig. 1)	=	179 56 salient.		
m : $\rotatebox{90}{$p$}$ or d : $\rotatebox{90}{$m$}$ (figs. 1 and 4)	=	180 4 reentering.		
S : L superior	=	101 39 50		
S : L inferior	=	78 20 10		
L: H	=	89 8 90 52		
edge $\frac{S}{L}$: edge $\frac{S}{H}$ (figs. 1 and 2)	=	.... 90 48	....	89° 12′
edge $\frac{S}{L}$: edge $\frac{p}{m}$	=	89 46 90 14	....	„ „

Fig. 1.

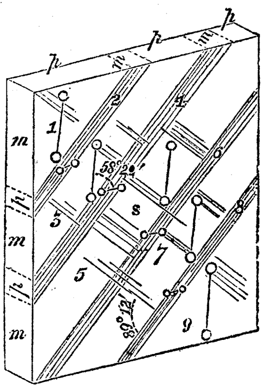


Fig. 2.

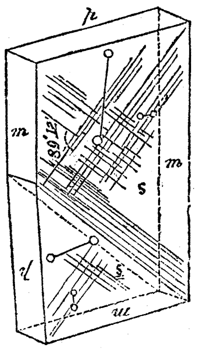


Fig. 3.

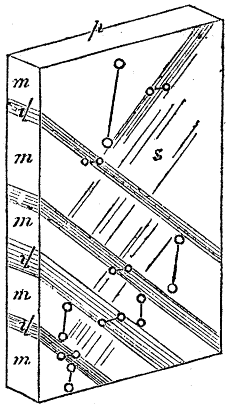
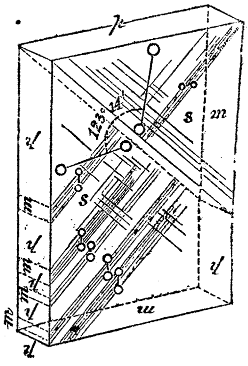


Fig. 4.



The plane of the optic axes makes an angle of $\left\{\begin{array}{l}12° 29' \text{ with } m\\ 67° 13' \text{ with } p\end{array}\right.$. In the twins fig. 1 the plane of the axes of 1, 3, 5, 7, 9 meets that of 2, 4, 6, 8 at an angle of 58° 22′ (which is the mean of several observations). In the twins figs. 2 and 4 the plane of the axes of one region intersects that of the other region at an angle of 123° 14′, by observation 122° 42′ to 123° 31′. The bisector of the acute angle of the axes is *negative*, and it is very little removed from coincidence with the twin plane H, and makes respectively angles of 11° 39′ 58″ with the edge $\frac{p}{m}$, 53° 26′ 31″ with the edge $\frac{p}{S}$, and 51° 8′ 18″ with the edge $\frac{m}{S}$. The mean index was measured on a prism of 59° 23′, the refracting edge of which is almost exactly normal to the plane of the optic axes; I have found $\beta=1{\cdot}594$ (the yellow sodium ray).

The apparent separation of the axes admits of the two corresponding systems of coloured rings being both visible in air. This separation, though sufficiently constant in the different regions in the same plate, being about 86°, is, however, as low as about

71° in some specimens. By operating in air and in oil[*] on two plates tolerably perpendicular to the plane of the optic axes and to their acute bisectors, I obtained at 20° C. for the first plate:—

$$\left.\begin{array}{l}2\,E = 86^{\circ}\,23'\\ 2\,H = 55\ 18,\ \text{whence}\ 2\,E = 86^{\circ}\,28'\end{array}\right\}\ \text{Red ray.}$$

$$\left.\begin{array}{l}2\,E = 86\ 21\\ 2\,H = 55\ \ 8,\ \text{whence}\ 2\,E = 86\ 19\end{array}\right\}\ \text{Yellow ray (soda).}$$

For the second plate:—

$$\left.\begin{array}{l}2\,E = 70^{\circ}\,54'\\ 2\,H = 46\ 20,\quad \text{whence}\ 2\,E = 71^{\circ}\ \ 0'\end{array}\right\}\ \text{Red ray.}$$

$$\left.\begin{array}{l}2\,E = 70\ 32\\ 2\,H = 45\ 59\ 30'',\ \text{whence}\ 2\,E = 70\ 32\end{array}\right\}\ \text{Yellow ray.}$$

It is evident from these numbers that the actual dispersion of the axes is feeble, presenting $\varrho > v$[†]. We come to the same conclusion by observing in air and in oil the fringes of the hyperbolas which traverse the two systems of coloured rings at an angle of 45° to the plane of polarization, and which present a reddish yellow on the *inside* and blue on the *outside.* A careful scrutiny further reveals that these fringes seem to have a slightly more decided colour in the one system than in the other, but in both the rings present to all appearance the same form. In the plane of polarization, the transverse bars of the central ring in each system are bordered by colours, the distribution of which in contrary directions indicates very distinctly a twisted dispersion ("dispersion tournante"): these colours appear furthermore to be slightly more definite round one of the bars than round the other; but so slight a difference would not authorize us to admit the existence of a small amount of inclined dispersion, the combination of which with the twisted dispersion ("dispersion tournante") would suffice to characterize a substance belonging to the triclinic system, unless the plates of Amblygonite from Montebras (formerly Montebrasite) possessed perfect homogeneity[‡]. The

---

[*] The oil I used was very viscous, and had the indices $n_r = 1{\cdot}476$; $n_i = 1{\cdot}478$.

[†] In Montebrasite (formerly Amblygonite), State of Maine, one has, on the contrary, $\varrho < v$ on either side of the acute bisector; so that this opposite character in the proper dispersion of the optic axes would suffice to distinguish Amblygonite from Montebrasite, since it forms a distinctive character of the highest importance in crystallized substances, and seems to be the most constant of all their properties as optically birefringent substances. In fact there is no example of a single well-defined species of a natural or artificial product presenting in different specimens optic axes with opposite dispersions, provided that these axes are situated in the same plane; and this is true whatever may be the variations in their physical and chemical characters. It is only when the axes pass from one plane into a second perpendicular to it, as happens in orthose, heulandite, and other minerals, that any change takes place in the relative positions of the axes corresponding to the red rays with regard to the axes which correspond to the blue.

[‡] Under the same circumstances Montebrasite of Hebron and Montebras presents a *horizontal* dispersion in combination with a well-marked *inclined* dispersion. The phenomena to which those different kinds of dispersion give rise in the coloured rings are described and figured in my "Mémoire sur l'emploi du microscope polarisant," in the 'Annales des Mines' for 1864, tom. vi. 6th series.

doubly oblique form of this mineral can, in fact, only be established in an incontestable manner by the obliquity of the cleavages *p* and *m* on the plane perpendicular to that in which the optic axes lie, because this obliquity is absolutely incompatible with a clinorhombic form, in which the plane of symmetry would be perpendicular to the plane of the optic axes and to the bisector of their acute angle, in which, furthermore, the twisted dispersion would be very strong.

Heat changes the angle of separation of the optic axes by diminishing it in a sensible degree. A plate only slightly oblique to their plane gave in air for the red rays

$$2E=86° 26' \text{ at } 14°C; \ 82° 16' \text{ at } 120° C.$$

Between these two temperatures one of the axes moved about $2\frac{1}{3}$ times faster than the other, the first having advanced towards the bisector by 2° 56′, while the second had only moved 1° 14′; the bisector, therefore, had moved from its initial position, and had been displaced by 0° 51′ towards the same side as the axis which had made the least progress*.

When I published my first notice, "Sur les propriétés optiques biréfringentes et sur la forme crystalline de l'amblygonite," Comptes Rendus des Séances de l'Académie des Sciences, tom. lvii. p. 357, I had only been able to place under the polarizing microscope a very small plate parallel to the more difficult cleavage *m* of the Penig variety; consequently I was only able to examine the optical phenomena in this case in a very incomplete manner. Having lately again examined a plate nearly perpendicular to the edge of the intersection of the two unequal cleavages *p* and *m*, I could perceive that around the *negative* acute bisector the plane of the optic axes is in the acute angle $p\,m=74° 16'$, that the dispersion proper to the axes indicates $\varrho > v$, and that there is also a very observable *twisted* dispersion combined with a slight *inclined* dispersion. In oil the separation of the optic axes is about $2\,H=56° 30'$ (in white light). These characters belong to Amblygonite (formerly Montebrasite) of Montebras. The only difference that the specimens from Penig present, as compared with those from Montebras, is that their physical constitution is more homogeneous, and that they are not traversed, as the latter are, by twin plates.

Amblygonite melts easily in a simple alcoholic flame, without decrepitation and with a slight bubbling, into an opaline white blebby glass. Before the blowpipe it communicates to the flame a reddish-yellow coloration, owing to the soda and lithia which it contains. This coloration enables one immediately to distinguish it from Montebrasite, which contains only lithia, and consequently only yields a flame of a rich carmine tint.

The composition of Amblygonite is established by the following analyses:—

---

* A plate of Montebrasite from Hebron heated to about 100° exhibits no change in the appearance of its coloured rings.

	Amblygonite of Montebras.			Amblygonite of Penig.
	Pisani.	Kobell.	Rammelsberg.	Rammelsberg.
Fluorine	8·20	9·00	10·06	9·44
Phosphoric acid	46·15	45·91	48·55	48·00
Alumina	36·32	35·50	36·36	36·26
Lithia	8·10	6·70	7·96	6·68
Soda	2·58	5·30	0·93	3·29
Potash	....	....	0·40	0·43
Lime	....	0·50	....	....
Oxide of manganese	0·40	....	....	....
Loss on ignition	1·10	0·70	....	....
Silica mixture	....	0·60	....	....
	102·85	104·21	104·26	104·10
Density	3·09 to 3·10	....	....	3·11

II. *The Hydrated Lithic Species—Montebrasite.*

I received quite recently (November 1871) from M. Moissenet a new specimen obtained from the mine of Montebras, from the midst of the masses which I had at first called Montebrasite (now Amblygonite), and distinguishable by its possessing an unwonted transparency rare in that substance. A cursory examination sufficed to show that I had not to deal in it with the old Montebrasite (*i. e.* Amblygonite), but rather with the mineral supposed to be Amblygonite, although then not analyzed, and of which the finest specimens, which presented the form of laminar masses or of coarse crystals *, had been found hitherto at Hebron, State of Maine, U.S.A.

The new specimen from Montebras is of a pale green colour in its more transparent parts, and presents the three principal cleavages *p*, *m*, *t* which I have recognized in the masses from Hebron, and of which the first is easily obtained, and yields an unbroken surface with a somewhat pearly lustre, while the second, less easily obtained, results in broken surfaces vitreous in lustre ; and the third is a still more difficult cleavage, and is recognizable by small reflecting surfaces scattered among rough surfaces of fracture.

---

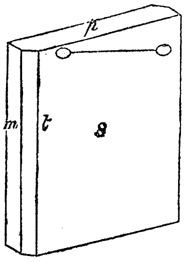
* In the 5th edition of his 'System of Mineralogy,' p. 545, Mr. Dana has figured a large crystal of Montebrasite of Hebron, the forms of which, referred to the oblique-angled parallelepiped produced by the three principal cleavages *p*, *m*, *t*, and which I adopted in 1863 as the primitive form of amblygonite, now Montebrasite, seem as if they ought to be expressed by the simple symbols m, t, g^1, g^4, $x=(f^{\frac{1}{2}}\, c^{\frac{1}{4}}\, g^1)$. Unfortunately the measure indicated by Mr. Dana could only be approximately made in consequence of the inequalities of the surface of the crystal, and would not justify our using them as means of determining with exactitude the dimensions of the primitive solid.

Thus if we take for the fundamental data the numbers $m\,t=135°\ 30'$, $p\,m=105°$, $p\,t$ forwards $=88°\ 30'$ (exact measures taken on planes of cleavage), $t\,g'$ adjac.$=73°\ 20'$, $m\,c'$ adjac.$=131°\ 50'$ (approximate measures obtained on the crystals), we obtain for the forms g^4 and $x=(c^{\frac{1}{2}}\, f^{\frac{1}{4}} g^1)$, by calculation, incidences so far divergent from those obtained by observation, namely a difference of from 3° to 4°, that it would be better to wait for fresh observations made upon more perfect crystals. Agreement between the results of calculation and direct measurement is only to be obtained by having recourse to symbols for which the expressions are so complicated as to be altogether unusual in the triclinic system.

Some good measurements, made on very smooth surfaces of the two former cleavages, yielded exactly the angle $p\ m=105°$. For the other incidences I obtained the approximate values $m\ t=135°$ to $136°$, $p\ t=89°$ to $89° 15'$.

The transparency that suitably chosen fragments acquire when cut into thin plates has led me to modify a little the orientation of the plane of the optic axes and of their bisectors which I found upon the Hebron specimen. By means of artificial twins formed of two plates, each of which has been worked perpendicular to the two cleavages p and m, and which were united by their faces p, I have been enabled to satisfy myself that the plane of the optic axes situated in the obtuse angle $p\ m=105°$ traverses the edge $\frac{p}{m}$, but that it is not quite normal to m, as I had at first supposed, since it gives mean angles of about 82° with m and 23° with p. By the employment of a similar process with an artificial macle made from the fragments from Hebron, I have obtained numbers that are almost identical with those just given.

Fig. 5.



The bisector of the acute angle of the optic axes is negative, and does not seem to be exactly parallel to the edge $\frac{p}{m}$; but its exact direction in the plane which contains both it and the optic axes cannot be determined with great exactitude on account of the difficulty of obtaining plates which are exactly perpendicular to it, and more particularly on account of the great separation of the axes even in oil*.

This separation, which prevents the centre of the coloured rings being ever seen in air, is essentially variable, in consequence of the irregularity of the interlacing laminæ in the interior, the existence of which is evidenced in particular on the surfaces of the nacreous cleavages by a waviness or by slight reentering angles visible in a bright light. I have found upon some of the plates for the acute angle of the optic axes for red in oil between 14° and 20° C.,

$$2H_{a.r}=95° 48'; \ 99° 39'; \ 101°; \ 102°; \ 102° 38'.$$

The obtuse angle containing the positive bisector gave measurements

$$2H_{o.r}=102° 50'; \ 104° 21'; \ 106° 10'.$$

---

* In the neighbourhood of the bisector of the obtuse angle of the optic axes difficulties of the same kind present themselves. It is, in fact, established by the simultaneous maximum extinction of the light in both parts of a twin formed of two plates parallel to m, of which the faces p are brought together in opposite positions, that the plane of the axes is parallel to the edge $\frac{p}{m}$, which should be a little oblique to the *positive* bisector, inasmuch as the coloured rings seen in oil through the faces m do not seem to be at the same distance from the normal to these faces. The position of the bisector itself could not, however, be precisely determined; for even when plates inclined at about 7° or 8° upon m, as nearly as possible perpendicular to the plane of the axes, were used, it was scarcely possible to measure with any exactitude in oil the angle that each of them makes with a normal common to the plates and to the edge $\frac{p}{m}$. Some experiments led to the conclusion that this normal made with the positive bisector an angle of about 4° to 5°.

In some specimens the *interior* or real angle of the axes is 90°, and in oil is equal to 102° round each of the two bisectors. In other specimens an interchange seems to occur between the bisector of the acute and that of the obtuse angle, their respective signs remaining otherwise the same; thus in two plates taken from the same fragment,

$$2H_r = \begin{array}{l}108^\circ\ 24'\\ 97^\circ\ \ 5'\end{array}\left\{\begin{array}{l}\text{the angle containing the \textit{negative} bisector.}\\ \text{,, \qquad ,, \qquad \textit{positive} \qquad ,,}\end{array}\right.$$

These different variations in the separation of the optic axes are of course associated with greater or less irregularities in the form of the coloured rings, and of the hyperbolas which traverse them; but the one invariable feature is seen in the different kinds of dispersion which I have already remarked on in the specimens from Hebron. Direct measurement indicates $\varrho < v$ to be the *proper* dispersion of the axes containing the negative bisector. This dispersion, strongly marked in one of the systems of rings of which the hyperbola examined at 45° to the plane of polarization is bordered by bright blue in the inside and by red on the outside, is on the contrary very weak in the other system, in which the borders of the hyperbola present, both on the outside and in the inside, blue tints that are hardly distinguishable.

Examined in the plane of polarization, the transverse bars of the central ring of the two systems give evidence of the existence of *horizontal* dispersion by the symmetrical arrangement of their borders; while these borders, on the other hand, exhibit colours that are distinctly more decided in the one system than in the other, but the difference is the inverse of that which is seen in the position 45° to the plane of polarization.

The characters which have been described thus show that in Montebrasite (formerly Amblygonite) of Montebras, as in that from Hebron, there coexists with the horizontal a well-marked inclined dispersion, a combination peculiar to crystals of the triclinic system. About the positive bisector the inclined dispersion is united to the twisted dispersion.

Montebrasite from Montebras, and that from Hebron, contain only lithia; hence they communicate a colour of a brilliant carmine-red to the flame of the blowpipe, in which they melt with great readiness into a white enamel with a distinct decrepitation. In a closed tube they disengage a water which corrodes the glass. Their loss under the action of the heat is observably greater than that of Amblygonite, while on the other hand their density is lower. M. Pisani has found for the composition of the laminated specimens from Hebron and of the green variety from Montebras:—

	Hebron.	Montebras.
Fluorine	5·22	3·80
Phosphoric acid	46·65	47·15
Alumina	36·00	36·90
Lithia	9·75	9·84
Water	4·20	4·75
	101·82	102·44
Specific gravity	3·03 (Pisani) 2·999 (Damour)	3·01 (Pisani) 2·977 (Damour)

Note upon Wavellite of Montebras.

Wavellite, in the form of thin coatings, presenting a mammillated and fibrous structure, forms a layer over almost all the fissures that occur in the Amblygonite of Montebras; and sometimes even the latter is seen to lose its laminar structure, to become white and opaque, and to pass insensibly into the former mineral. When the coatings are somewhat thick and contain cavities, radiated spherules are found in them, which are composed of long thin needles with brilliant terminations. These needles exhibit a vertical prism that is deeply grooved but cannot be measured; its acute edges are truncated by the diagonal face g^1, and surmounted by a rhomboidal octahedron, two culminating edges of which are replaced by minute faces of the bevel a^1. Professor MILLER, in his 'Elementary Introduction to Mineralogy,' has figured two solids of a similar kind, $b^{\frac{1}{2}}$ and e_3, both of which are situated in the zone g^1 a^1, like the terminal octahedron of the needles of Montebras; but their angles of incidence do not at all agree with those that I have succeeded in measuring with some exactitude. Moreover, by adopting the fundamental crystallographic data of Professor MILLER, the symbol of the new form will be $e_{\frac{8}{3}}$, and the calculated angles, as compared with those resulting from direct measurement, are:—

	Calculated.	Observed.
g^1 $e_{\frac{8}{3}}$	$=123^\circ$ 32′	123° ′ to 123° 25′.
g^1 $e_{\frac{8}{3}}$ upon $e_{\frac{8}{3}}$	$=$ 56 28	56 20 to 57 30.
$e_{\frac{8}{3}}$ $e_{\frac{8}{3}}$ upon a^1	$=$112 56	113 52 mean.
$e^1_{\frac{8}{3}}$ a^1	$=$146 8	147 approximate.
$e_{\frac{8}{3}}$ $e_{\frac{8}{3}}$ upon g^1	$=$120 22	121 mean.

Most of the known analyses of Wavellite indicate the presence in it of a small quantity of fluorine, sometimes as much as two per cent. M. PISANI has ascertained that the variety from Montebras, formed in the midst of other fluoriferous phosphates of alumina, contains:—

Fluorine	2·27
Phosphoric acid	34·30
Alumina	38·25
Water	26·60
	101·42
Specific gravity	2·33