

ADDITIONAL DATA ON THE PROPERTIES OF BECQUERELITE AND BILLIETITE

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ABSTRACT

The principal properties of becquerelite are restated. Observations made on billietite have led the authors to consider it as a variety of becquerelite.

BECQUERELITE. It may be useful to recall here some data concerning that mineral. One of us has described the properties of becquerelite in the first publication on this species as follows (1), (2): Translucent, brownish yellow mineral, coating pitchblende; easily cleavable; chemical tests give uranium, lead, and water; good crystals are rare; generally pseudo-hexagonal plates parallel to $c(001)$, showing under the microscope a good interference figure and negative acute bisectrix perpendicular to $c(001)$. There is another cleavage parallel to $m(110)$; the angle $m(110):m(\bar{1}\bar{1}0) = 62^\circ$; twinned on plane (110). Thin cleavage plates [$c(001)$] show dichroism in yellow shades. A chemical analysis on 0.3173 gr. of material was made and gave the following results:

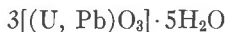
H ₂ O.....	10.02%
PbO.....	5.38
UO ₃	82.73

Later we discovered becquerelite crystals with a prismatic habit and always elongated parallel to the b axis; they did not contain lead. In addition to the perfect cleavage $c(001)$, three other cleavages can be observed on these crystals: $m(110)$, $d(101)$ and $b(010)$.

An analysis of these crystals gave the following (3):

H ₂ O.....	9.91%
UO ₃	90.09

In Fig. 1 are shown several habits of becquerelite crystals as seen with the microscope. The twins (a), (b) and (c) are becquerelite crystals containing lead; no lead was detected in crystals of type (d). Using the cell dimensions and gravity obtained on prismatic crystals, V. Billiet and W. F. de Jong (3) have calculated for becquerelite the formula: $2\text{UO}_3 \cdot 3\text{H}_2\text{O}$. They found 13 molecules in the unit cell which seems unlikely. H. Brasseur (5) recently proposed another formula, namely $3\text{UO}_3 \cdot 5\text{H}_2\text{O}$ with 8 molecules in the unit cell. Assuming this formula to be correct the formula for becquerelite containing lead, becomes



where lead appears to replace a small amount of uranium.

Certain differences were noted in the optical properties of both varieties of the mineral. For instance, the indices of refraction of the lead bearing becquerelite, as determined by Billiet (6) are: $\alpha=1.75$, $\beta=1.87$, $\gamma=1.88$. As previously stated, thin cleavage plates parallel to $c(001)$ are dichroic; moreover the angle of the optic axes, which is $2V=30^{\circ} 35'$ becomes 0° at a temperature of 100° C.; this can be observed on crystals embedded in Canada balsam.

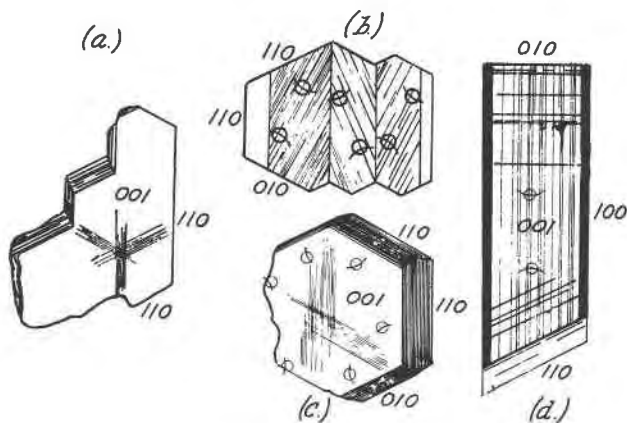


FIG. 1. (a), (b), and (c) are becquerelite twins; (d) is a crystal showing the traces of the cleavages (010), (101), and (110).

The indices of refraction of the becquerelite, $3\text{UO}_3 \cdot 5\text{H}_2\text{O}$, are lower than those mentioned above because of the absence of lead; we found: $\alpha=1.725$, $\beta=1.825$, $\gamma=1.83$; these values are in close agreement with the indices of becquerelite published by the U. S. Geological Survey (7): $\alpha=1.735$; $\beta=1.82$; $\gamma=1.83$. It is to be noted, that the cleavage plates [$c(001)$] of this variety of becquerelite are not dichroic and that the optic angle is not altered by an increase in temperature for crystals embedded in Canada balsam and heated up to 100° C.

BILLIETITE. J. F. Vaes (8) has given the name of billietite to an uranium mineral from the Shinkolobwe mine in Katanga. According to the author, billietite is an hydrated barium uranate; its precise chemical formula has not yet been established as only microchemical tests were made. The presence of barium in the mineral has been confirmed by spectral analysis. Billietite contains no lead. Crystals range from $\frac{1}{2}$ to 2 mm. and closely resemble becquerelite; they are orthorhombic with tabular development, translucent, and amber yellow in color.

Vaes gives the following symbols to the observed forms: (010); (110); (101); (011) and (111); the value of the angle (101): $(\bar{1}01)$ is $61\frac{1}{2}^{\circ}$. There

is a perfect cleavage parallel to (010); twins were noted parallel to (111) and (101). The acute bisectrix is perpendicular to (010); $2V = \pm 36^\circ$; $r > v$; dispersion strong; the axial plane is parallel to (001). Vaes found that the refractive indices are very near to those of becquerelite but does not mention their values. Dichroism is apparent in cleavage plates parallel to (010) in various shades of yellow; $Z = a$; $Y = c$; $X = b$.

New observations. We have found flat, tabular pseudo-hexagonal crystals of billietite (Fig. 2) associated with soddyite and coating a fragment

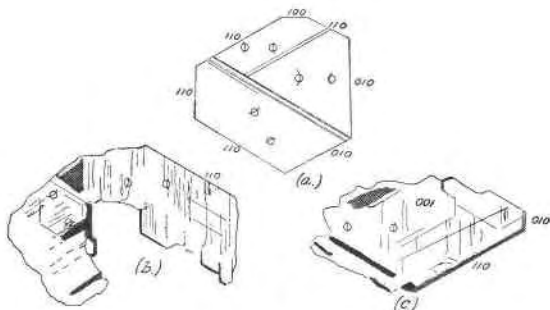


FIG. 2. Twinned crystals of billietite lying on perfect cleavage plane (001). (a) is very regular and does not show any other cleavage; (b) and (c) show distinctly the traces of two different cleavages (110) and (010).

of uranium ore consisting of soddyite and curite. In order to emphasize the strong crystallographic similarity of billietite and becquerelite, we think it advisable to interchange the axes b and c of billietite. We are giving, below, the indices of the forms in the new orientation, opposite to those proposed by Vaes.

FORMS OF BILLIETITE CRYSTALS

J. F. Vaes	New position (Schoep & Stradiot)
(010)	c (001)
(101)	m (110)
(011)	d (101)
(110)	e (011)
(111)	p (111)

The indices of the perfect cleavage plate becomes $c(001)$; $61\frac{1}{2}^\circ$ is the angle between $m(110)$ and $m(\bar{1}\bar{1}0)$; the plane of the optical axes is parallel to $a(100)$, and the acute bisectrix is perpendicular to $c(001)$. We have measured the indices of refraction using appropriate solutions of phosphorus in methylene iodide, and we find: $\alpha = 1.73$; $\beta = 1.82$; $\gamma = 1.83$.

All the data on billietite and becquerelite are grouped in the following table.

	Becquerelite	Becquerelite	Billietite
Chemical composition	$3[(U, Pb)O_3]5H_2O$	$3UO_3 \cdot 5H_2O$	UO_3, Ba, H_2O
Crystal system	orthorhombic	orthorhombic	orthorhombic
Twinning	(110)	not observed	(110) and (111)
Cleavages	$c(001), m(110), d(101), b(010)$	$c(001), m(110), d(101), b(010)$	$c(001), n(110), b(010)$
Color	amber yellow translucent	amber yellow translucent	amber yellow translucent
Pleochroism	in yellow shades $X = \text{colorless}$ $Y = \text{yellow}$ $Z = \text{deep yellow}$	in yellow shades $X = \text{colorless}$ $Y = Z = \text{yellow}$	in yellow shades $X = \text{colorless}$ $Y = \text{yellow}$ $Z = \text{deep yellow}$
Optic. Orient.	$X = c, Y = a, Z = b$	$X = c, Y = a, Z = b$	$X = c, Y = a, Z = b$
Acute bissect.	perpend. to $c(001)$	perpend. to $c(001)$	perpend. to $c(001)$
Axial plane	parallel to $a(100)$	parallel to $a(100)$	parallel to $a(100)$
2V	$\pm 30^\circ$	$\pm 30^\circ$	$\pm 36^\circ$
Indexes of refraction	$\alpha = 1.75$ $\beta = 1.87$ $\gamma = 1.88$	$\alpha = 1.725$ $\beta = 1.82$ $\gamma = 1.83$	$\alpha = 1.73$ $\beta = 1.82$ $\gamma = 1.83$

CONCLUSION

Apart from the presence of barium, there is scarcely any difference between billietite and the becquerelite that does not contain lead; there is more difference between the two types of becquerelite. It seems very likely, therefore, that billietite is merely a variety of becquerelite containing some barium substituting for uranium. The problem can not be considered solved until analyses and *x*-ray study are made. This is one more example showing that new names for minerals should not be proposed on the basis of incomplete data.

On first inspection there seemed to be a relationship between the pseudo-hexagonal tabular habit of becquerelite and the presence of Pb or Ba in the molecule; it is a fact that we never found pseudo-hexagonal tabular becquerelite crystals that did not give a reaction for Pb or Ba;

but it must be said that some prismatic crystals of becquerelite have the same indices of refraction as plumbobecquerelite.

The presence of Pb or Ba in the becquerelite molecule is perhaps to be explained as resulting from the replacement of U^{+6} by Pb^{+2} or by Ba^{+2} ; the ionic radii of those elements have nearly the same value; but we do not understand why such replacements do not occur in other uranium hydroxides, for instance in schoepite and in paraschoepite.

A cleavage parallel to (101) has not yet been observed on billietite, perhaps because of the insufficient number of crystals examined.

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