MINERALOGIC NOTES ON PUCHERITE, PYRITE, TRICHALCITE, AND WAVELLITE.

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INTRODUCTION.

Minor investigations are constantly being conducted in this laboratory for the necessary purpose of accurately ascertaining the mineralogic identity of materials. These may be specimens submitted for identification by correspondents, they may be new and unlabeled material to be placed upon exhibition or filed with the reference collections, or they may be specimens already incorporated in the collections whose labeling is found to require confirmation or correction. These investigations may be conducted by chemical, optical, or crystallographic methods or a combination of these as the case may require. Almost invariably new facts of importance are developed by these studies, and it is desirable that the results be published, firstly in order to permanently record the evidence upon which the specimen is labeled and secondly because the new data furnished in regard to the properties or occurrence of rare and unusual minerals are of interest and value to mineralogical science in general.

It is a practice previously inaugurated in this department to combine several of these minor researches, even when they are not directly related to each other, into a paper of convenient length for publication in the Museum Proceedings. In the present contribution there are assembled short papers on four different subjects: Pyrite crystals of unusual crystallographic development from Arkansas, Pucherite from a new locality in Brazil in measurable crystals agreeing with those previously recorded on European material and showing one new form, Trichalcite from a new locality in Idaho having optical properties agreeing with those of the mineral from the original locality and showing measurable crystals which add new information regarding the crystallography of this rare arsenate, and Crystallographic and optical properties of wavellite crystals of two specimens from Montgomery County, Ark.

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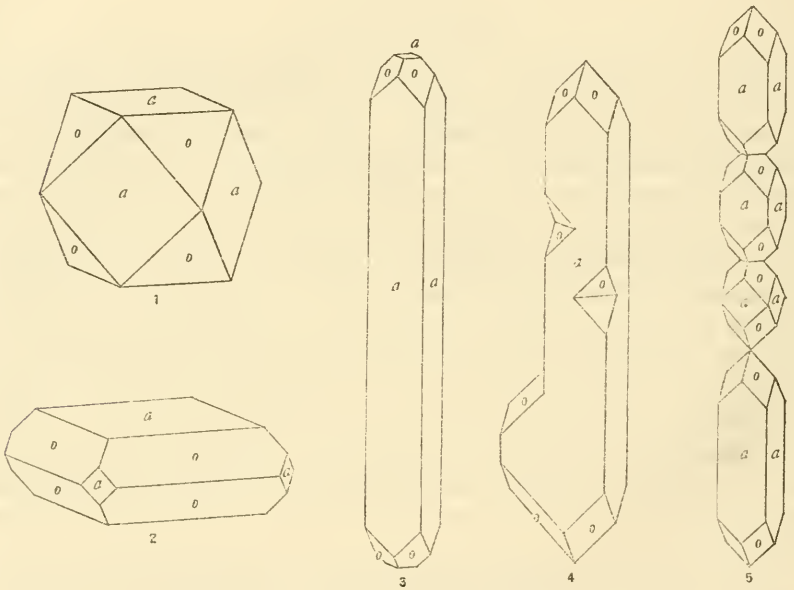
UNUSUAL PYRITE CRYSTALS FROM ARKANSAS.

A specimen recently received for examination from Mr. C. A. McClelland of Stillwater, Ark., contains pyrite crystals of such unusual development as to merit a brief description. The crystals are small, averaging less than a millimeter in diameter, and are attached to the faces of imperfect quartz crystals which line vuggy cavities in white quartz. The quartz forms veins up to 2 inches thick in a black highly graphitic slate. No other minerals are associated with the pyrite. The crystals all show the simple combination of cube *a* (100) and octahedron *o* (111) both prominently developed. Their



FIGS. 1-5.—PYRITE CRYSTALS FROM STILLWATER, ARK.

claim to distinction lies in their unsymmetrical development. Many of the crystals are cuboctahedrons of normal proportions. (Fig. 1.) From this habit they vary to long prismatic with the length 10 to 20 times the diameter as illustrated in Figure 3, the apparently tetragonal prism being formed by the vertical faces of the cube, while the octahedral planes form a terminal pyramid, often truncated at its summit by a minute cube face. The faces are practically perfect and free from striations, although some of the long prisms taper slightly, as indicated by the following angular measurements, which were made on a crystal of the habit illustrated in Figure 3.

Measurements on elongated pyrite crystal from Arkansas.

No.	Form.	Reflections.	Measured.		Calculated.	
			φ	ρ	φ	ρ
			° ′	° ′	° ′	° ′
1	*a* (100)	Very good	0 00	89 16	0 00	90 00
2	*a* (100)	Poor, blurred, two signals	0 28	89. 17	0 00	90 00
3	*a* (100)	Very good	0 00	89 25	0 00	90 00
4	*a* (100)	Good	0 19	89 25	0 00	90 00
5	*a* (001)	Minute, reflection only	.....	0 00	.....	0 00
6	*o* (111)	Excellent	45 00	54 47	45 00	54 44
7	*o* (111)	Good	44 52	54 39	45 00	54 44
8	*o* (111)	Fair	45 10	54 39	45 00	54 44
9	*o* (111)	Good	44 45	54 39	45 00	54 44

In the other direction the crystals are flattened into moderately thin square tables of the habit illustrated in Figure 2. A crystal showing one of the numerous variations of the elongated cuboctahedrons is illustrated in Figure 4. Not uncommonly crystals of moderate elongation are aligned into strings of individuals in parallel position as shown in Figure 5. Occasionally scepter crystals are thus formed by an equidimensional individual being perched atop a long prism.

Variously elongated crystals of pyrite have been described from a number of localities, but crystals of such extreme deviation from normal symmetrical development are by no means common. Whitlock[1] has figured greatly elongated cubes occurring in or with calcite and dolomite, from Rondout, Ulster County, N. Y. One of the illustrated crystals showed small octahedral planes and was thus very similar to those from Arkansas here described. Some of the New York crystals were twinned on the spinel law, giving unusual T and L shaped forms, and the terminal individuals of scepter crystals were oriented in twinned position. No definite twins could be found in the Arkansas specimen, certain pairs simulating twins being found to be only in accidental contact.

The distorted octahedra from French Creek, Pa., described by Penfield,[2] are very different from these elongated individuals.

PUCHERITE FROM MINAS GERAES, BRAZIL.

A specimen (Cat. 94221) which has recently been received by the Museum from Mr. J. E. Carney, jr., through Mr. F. L. Hess, was identified by Mr. Hess as pucherite, the rare bismuth vanadate. Crystallographic measurements confirm Mr. Hess's identification.

[1] Herbert P. Whitlock. Bull. New York State Museum No. 98, p. 6, 1905.

[2] S. L. Penfield. On some curiously developed pyrite crystals from French Creek, Delaware County, Pa. Amer. Journ. Sci., vol. 37, p. 209, 1899.

Pucherite has not heretofore been reported from Brazil and, since the crystal measured shows one form new to the mineral, the results are presented briefly. Crystallized pucherite has previously been known only from Europe, although earthy and pulverulent material has been found in Arizona and California.

The present specimen is from a weathered pegmatite vein in Sao Jose de Bryauba in the Province of Minas Geraes, Brazil. The specimen consists of a mass of pale yellow earthy bismutite which has a faintly woody structure, as though pseudomorphous after some columnar mineral. The exterior of the specimen is partly coated with the crystalline pucherite, while some pucherite is also disseminated through the interior of the bismutite mass. The pucherite is dull dark brownish red in color and forms crusts of imperfect, intergrown, and somewhat bruised crystals. Only one crystal was measured, and very few of those on the specimen are suitable for measurement. The crystal measured had the form shown in orthographic and clinographic projections in Figure 6. The dominant planes are, as shown, the base c(001) and the pyramid e(121), with x(021) and k(122) as smaller faces. The basal pinacoid c(001) gives an excellent signal, which serves to orient the crystal in polar position. The dome x(021) also gives very good signals, while the pyramid e(121) is wavy and striated parallel with its intersection with the base. The pyramid k(122) has not previously been recorded for this species. It occurs as relatively narrow faces giving only moderately good signals. The measurements on the crystal are tabulated below:

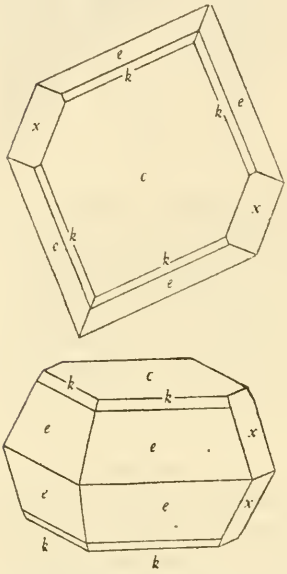


FIG. 6.—ORTHOGRAPHIC AND CLINOGRAPHIC DRAWINGS OF A PUCHERITE CRYSTAL FROM MINAS GERAES, BRAZIL.

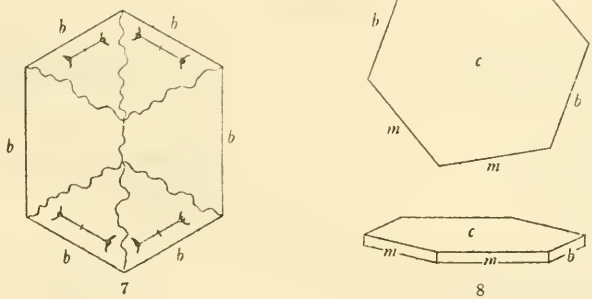
Forms and angles on pucherite from Brazil.

Letter.	Miller.	Symbol.	Measured.		Calculated.	
			φ	ρ	φ	ρ
			° ′	° ′	° ′	° ′
c	(001)	0	.....	0 00	.....	0 00
x	(021)	02	0 00	66 49	0 00	66 49
e	(121)	12	43 14	72 40	43 11	72 40
k	(122)	$\frac{1}{2}1$	43 34	58 49	43 11	58 01

TRICHALCITE FROM SHOSHONE COUNTY, IDAHO.

Some years ago the writer had occasion to visit the property of the Liberal King claim near the Lookout Mountain mine on the high mountain east of the Forks of Pine Creek in the Pine Creek district, Shoshone County, Idaho. The following account is abstracted from notes made at that time:

The upper tunnel of this property has developed a vein 6 to 8 feet wide, striking N. 80° W. and dipping 80° southwest. This vein consists of porous quartz inclosing much wall rock. Disseminated in moderate amount through this quartz are sulphides, mainly pyrite with less chalcopyrite and arsenopyrite and occasionally a little galena and sphalerite. The porosity of the quartz seems to be an original condition and not due to the solution or removal of any primary constituent of the vein. Some coarse-grained galena was seen in a lens of quartz on the hanging wall side of the main vein. Percolating waters have largely decomposed the surfaces of the chalcopyrite and pyrite masses, depositing a sooty black secondary sulphide or oxide of copper. More intense oxidation has colored the porous quartz by the formation of brilliant yellow, blue, and green coatings of secondary minerals. On the hanging wall of the quartz vein there is a pronounced fissure having a thoroughly



FIGS. 7–8.—7, OPTICAL AND CRYSTALLOGRAPHIC STRUCTURE OF TWINNED CRYSTAL OF TRICHALCITE. 8, ORTHOGRAPHIC AND CLINOGRAPHIC DRAWINGS OF SIMPLE TABULAR CRYSTAL OF TRICHALITE.

crushed gouge, which is made up entirely of country rock with no drag quartz. Distributed along this fissure are streaks of fine-grained brown sphalerite or finely intergrown sphalerite and galena up to several inches wide.

On the dump of this tunnel there was, at that time, a large pile of the quartzose vein material, which was very highly colored with the secondary minerals mentioned above. These had the appearance of arsenates, and specimens collected at that time gave qualitative reactions for arsenic. The bulk of the coatings was exceedingly small, however, and, as no facilities for detailed investigation were available, the specimens became lost without their minerals being definitely identified.

Recently a typical specimen of this material from the Liberal King claim has been forwarded to the National Museum by the United States Geological Survey as a part of the collection of Mr.

Edward L. Jones, jr., illustrating his work in this district.[3] The opportunity was thus offered for determining the mineralogical identity of the secondary arsenates which form the brilliant coatings.

The ore consists, as has been detailed above, of porous white quartz containing disseminated sulphides, including pyrite, chalcopyrite, and arsenopyrite, the latter in steel gray orthorhombic crystals. There is also some black sphalerite and perhaps a little enargite in the ore. The pyrite is partly coated by the black mineral, probably sooty chalcocite, and the quartz is brilliantly colored by thin films of a blue-green mineral with lesser amounts of a yellow-green to yellow mineral and an emerald-green crystalline one.

The most abundant of these, the blue-green mineral, has a vitreous to pearly luster and resembles tyrolite. It gave qualitative chemical reactions for copper and arsenic. At the request of the writer Mr. A. Rodolfo Martinez very kindly worked out the optical properties of this mineral, and by reference to Larsen's tables[4] it was found to agree with the rare arsenate trichalcite, as shown by the following comparison:

Comparison of optical properties of trichalcite.

Pine Creek, Idaho (Martinez).	Turginsk, Urals (Larsen).
Color pale bluish-green.	Color pale bluish-green.
Nonpleochroic.	Nonpleochroic.
Biaxial.	Biaxial.
Sign negative (−).	Sign negative (−).
2V large.	2V large.
$\alpha =$ ———.	$\alpha = 1.67 \pm 0.01$.
$\beta = 1.688$.	$\beta = 1.686 \pm 0.003$.
$\gamma =$ ———.	$\gamma = 1.698 \pm 0.003$.
Birefringence medium low.	Birefringence 0.028
X normal to plates.	X normal to plates.

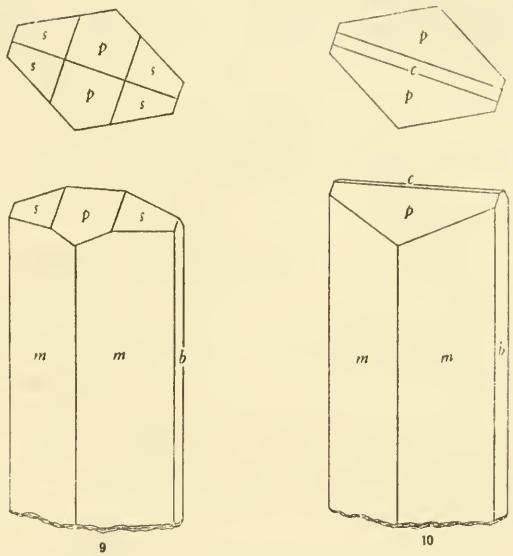
There is no other known mineral containing copper and arsenic acid which approaches these properties and, while it is regrettable that the mineral is not available in quantity sufficient for analysis, its identity can be considered as established by these data.

Upon examination of the specimen under a binocular microscope it was found that the mineral was in thin tabular crystals of hexagonal aspect, and although these were very minute it was found possible to measure two of them on the 2-circle goniometer. The basal pinacoid gave good signals, but the very narrow prismatic planes were more or less curved and irregular, yielding only approximate measurements, accurate perhaps to 1°. These indicated 60° angles for the prismatic zone, the mineral thus simulating hexagonal crystallographic

[3] Edward L. Jones, jr., A reconnaissance of the Pine Creek district, Idaho. U. S. Geol. Survey Bull. 710(*a*), pp. 1–36, 1919.

[4] Esper S. Larsen, jr., Microscopic determination of the nonopaque minerals. U. S. Geol. Survey Bull. 679, pp. 144 and 263, 1921.

symmetry. Examination in polarized light of the measured crystals shows these to be twins, as shown in Figure 7, made up of biaxial orthorhombic sectors. The sectors have interlocking boundaries. Each sector has a well-defined cleavage parallel to its free edge, and the extinction is parallel to this edge. Each sector gives in convergent light a perfectly centered biaxial interference figure. The several apparently prismatic planes of the pseudo-hexagonal tablet thus are evidently pinacoids of the several orthorhombic units which go to make up the twinned group. This may indicate that the orthorhombic form is an inversion product which is pseudomorphous after an original hexagonal form, but it is more probable that it is merely characteristic of trichalcite to form repeated twins, with the twinning plane the unit prism (110), which are pseudohexagonal. This is characteristic of a great many orthorhombic minerals whose prismatic angle approaches the hexagonal angle, as, for example, aragonite, witherite, cerrussite, chalcocite, etc. Figure 8 is drawn to show, in orthographic and clinographic projections, a crystal which, while having the same tabular habit, is untwinned.



FIGS. 9-10.—ORTHOGRAPHIC AND CLINOGRAPHIC DRAWINGS OF WAVELLITE CRYSTALS FROM ARKANSAS.

Trichalcite has previously been known only from the original locality in the Urals, the Idaho occurrence thus giving a second locality for this rare arsenate. The associated arsenates in the Idaho specimen have not been identified. These include a yellow-green material resembling scorodite and a green mineral resembling clinoclasite.

WAVELLITE CRYSTALS FROM ARKANSAS.

A specimen in the Museum collection (Cat. 45211) which shows minute white to brownish-white acicular crystals implanted singly and in groups over surfaces of gray-green variscite was labeled "natrolite on variscite." The specimen was received from Mr. Charles F. Brown and bore this label when received. The unusual association of a zeolite with a phosphate had not previously been noted, and this

led to a preliminary optical examination which showed that the acicular crystals were not natrolite but were more probably tavistockite or wavellite. More detailed optical measurements made by Dr. E. S. Larsen indicated that, in all probability, the mineral was wavellite. The properties are as follows: Biaxial, positive (+), 2V medium large, ($\pm 60°$). Dispersion $\rho > v$ so small as to be doubtful. $Z = c$. No principal optical directions perpendicular to the prism faces. Refractive indices $\alpha = 1.525 \pm 0.003$, $\beta = 1.534 \pm 0.003$, $\gamma = 1.545 \pm 0.003$. Birefringence 0.020 ± 0.003. There are apparently three good cleavages normal to the principal optical directions.

In order that no question might remain regarding the identity of the material, such as could be spared without serious injury to the specimen was scraped off and examined chemically. Only 0.036 gram of pure material was available. This gave a loss on ignition of 30.09 per cent ($= H_2O + F$). The ignited mineral was fused with a large excess of sodium carbonate and the fusion leached with boiling water. The residue of insoluble material consisted of 0.0022 gram of Fe_2O_3, possibly largely derived from reagents. It contained no lime. The filtrate gave abundant reactions for alumina and phosphoric acid.

Although the crystals were very minute, averaging perhaps $\frac{1}{2}$ mm. in length and one-fifth to one-tenth this in diameter, it was found possible, after several trials, to secure one which gave satisfactory measurements on the 2-circle goniometer. Since, as pointed out by Wherry,[5] the axial ratios of wavellite are probably variable and are not accurately known beyond the third decimal place, the angles measured were used to calculate axial values for the best crystal measured from the Arkansas specimen. The measurements gave as follows:

Form.	Measurements.		Difference.		Average.	
	φ	ρ	φ	ρ	φ	ρ
	° ′	° ′	° ′	° ′	° ′	° ′
p (101)	89 55	36 10	0 08	0 00	89 59	36 10
	90 03	36 10				
	gives $p_o = 0.7310$					
s (111)	60 26	40 06	0 25	0 17	60 28½	40 10
	60 15	40 18				
	60 33	40 14				
	60 40	40 01				
	gives $p_o = 0.7344$					

The values for p_o derived from the two forms are not in satisfactory agreement; and since the faces of neither form gave conspicuously

[5] Edgar T. Wherry. Notes on mimetite, thaumasite, and wavellite. Proc. U. S. Nat. Mus., vol. 54, pp. 373-381, 1918.

superior measurements, it is necessary to take the mean value for p_o, namely 0.7327. With this value assumed, the forms $s(111)$ and $m(110)$ yield for q_o the values 0.4161 and 0.4112, respectively. Again, it is necessary to adopt the average of two values, and the axial values obtained for the crystal are as follows:

$p_o = 0.7327$ $\quad a = 0.5645$
$q_o = .4136$ $\quad c = .4136$

The above value for the a axis is practically identical with that of Wherry for the Pennsylvania material ($a = 0.5640$), while the c axis is somewhat greater than Wherry's ($c = 0.4040$). The present examination merely adds another observation to the four or five already available.

In habit the crystals of the Arkansas specimen are not unusual, as shown in Figure 9, the forms being $b(010)$, $m(110)$, $p(101)$, and $s(111)$, all prominently developed. There is a tendency for the crystals to aggregate in almost parallel position or in sheaves. The prismatic faces are slightly striated vertically. The angles measured on the only really satisfactory crystal examined are below compared with the angles calculated from the above derived values for the axes:

Calculated and measured angles of wavellite.

Letter.	Miller.	Symbol.	Measured.		Calculated.	
			φ	ρ	φ	ρ
			° ′	° ′	° ′	° ′
b	(010)	$\infty 0$	0 06	90 00	0 00	90 00
b	(010)	$\infty 0$	0 06	90 00	0 00	90 00
m	(110)	∞	60 47	90 00	60 33	90 00
m	(110)	∞	60 46	90 00	60 33	90 00
m	(110)	∞	61 04	90 00	60 33	90 00
m	(110)	∞	60 53	90 00	60 33	90 00
p	(101)	10	89 55	36 10	90 00	36 14
p	(101)	10	90 03	36 10	90 00	36 14
s	(111)	1	60 26	40 06	60 33	40 05
s	(111)	1	60 15	40 18	60 33	40 05
s	(111)	1	60 33	40 14	60 33	40 05
s	(111)	1	60 40	40 01	60 33	40 05

In an endeavor to obtain further crystallographic data on the Arkansas wavellite a number of specimens of this material were examined. The best specimen from this locality in the Museum collections (Cat. 45866) consists of spherulitic aggregates of divergent crystals, which are transparent and of a beautiful sea-green color. Although in the body of the spherical group the crystals are deformed

by crowding, their terminations diverge sufficiently to permit idiomorphic development. Several trials, however, showed that these are totally unsuited for goniometric measurement, the prismatic planes being exceedingly wavy, while the broad faces of the dome $p(101)$ and the narrow faces of the basal pinacoid $c(001)$, while transparent, are etched to complete dullness and give only the faintest reflection and no signal whatever. Only qualitative measurements were obtained, and these indicate the forms present to be $b(010)$, $m(110)$, $p(101)$, and $c(001)$. The aspect is chisel-shaped, as shown in the drawing, Figure 10.