GILPINITE, A NEW URANIUM MINERAL FROM COLORADO.[1]

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In seeking for johannite and uranopilite for optical study one of the authors (E. S. L.) found in many of the museums specimens of a crystalline mineral from Gilpin County, Colo. The specimens were labeled johannite in some museums, and uranopilite in others, but a microscopic examination showed that the specimens are all of the same mineral, and a chemical analysis proves that it differs from any known mineral. The name gilpinite is proposed for the species from its occurrence in Gilpin County, Colo. A specimen labeled uranocher (uranopilite) Cornwall, Eng., kindly furnished the authors by Colonel Roebling, of Trenton, N. J., has optical properties that are almost identical with the Colorado mineral, and it no doubt also represents gilpinite.

Physical Properties.—Gilpinite occurs as pale greenish yellow to canary yellow crystal aggregates coating a green copper ore or a black pitchblende, and associated with gypsum. It has a vitreous luster, a hardness of about 2, and a specific gravity above that of methylene iodide, which is 3.32. It is infusible or difficultly fusible but turns black on heating. It is readily soluble in dilute acids.

The optical properties are characteristic. The mineral is in minute, lath-shaped crystals up to 0.3 mm. in length. The axial angle is very near 90° and is somewhat variable and the dispersion of the optic axes is strong to very strong. In part the crystals are optically negative with $\rho > v$, in part optically positive with $\rho < v$. Crystals lying on the flat face show two sets of polysynthetic twin lamellae, nearly at right angles and resembling the albite and pericline twins of plagioclase. The more common set appears to have the twinning and composition plane normal to the laths and parallel to the elongation. The less common set has the twinning and composition plane nearly at right angles to the other set and across the laths. A crystal showing the two sets of twins is represented in Figure 2. The extinction on the flat face, Y to elongation and composition face, is 5° to 8° for yellow light with considerable dispersion for white light. X is apparently normal to this flat face and crystals turned on edge give parallel extinction. The mineral is therefore probably monoclinic, the flat face being (010) and the elongation c. Other faces are probably (101), ($\bar{1}01$) and (001). The chief twinning is on (100), the less common on (001). The optic orientation is

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X=b, $Y \wedge c = 5\frac{1}{2}$-8°. The outline and optic orientation of two crystals lying on face (010) with angles as measured under the microscope are shown in Figures 1 and 2. The indices of refraction were measured by the immersion method with a probable error not exceeding ±0.003; the optical properties vary slightly in the different specimens as is shown by table 1. The optical properties as measured on four specimens of gilpinite are shown in table 1 together with the properties of zippeite and uranopilite, the minerals most resembling gilpinite, for comparison. The four specimens of gilpinite show only a slight difference in their optical properties while the zippeite and the uranopilite are very different altho the habits of the three are sufficiently similar to suggest some relationship.

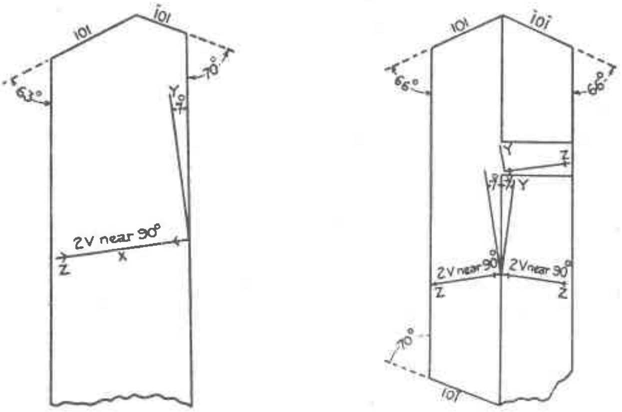

Figure 1—Trace of crystal of gilpinite on (010), showing optical orientation.
2—Trace of crystal of gilpinite on (010), twinned after (100) and (001), and showing optical orientation.

Chemical Properties.—Gilpinite is readily soluble even in very dilute acids. Material for analysis was carefully picked by hand from a specimen from the U. S. National Museum[2] and this was separated from associated gypsum by methylene iodide. It was not found possible to separate all the pitchblende. A microscopic examination of the material used for the analyses showed, however, only gilpinite and opaque pitchblende.

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[2] Catalog No. 49,090; specimen collected by Dr. W. F. Hillebrand, and transmitted to the Museum by the U. S. Geological Survey in 1890; in the original records labeled simply "uraninite undergoing alteration," the secondary mineral herein named gilpinite not being specially noted.

Only a small amount of material could be thus obtained; the better sample weighed 0.22 gram, and a somewhat less pure one, which seemed sufficiently good for qualitative examination, amounted to 0.07 gram. This latter was heated several times with dilute hydrochloric acid (1 acid to 10 H_2O, by volume) with intervening filtration. The insoluble black portion amounted to 24.00% of the original material. The greenish yellow acid solution upon systematic qualitative analysis gave tests for copper, uranium, iron, sodium, potassium, and sulfuric acid; the absence of calcium and phosphorus was also established. A test solution containing known amounts of these elements in the approximate proportions indicated by the bulk of the precipitates was then subjected to analysis as a check upon the methods to be used in the analysis of the purified material.

Table 1.—Optical Properties of Gilpinite, Zippeite and Uranopilite.

	1. Gilpinite Colorado (U. S. Nat. Mus.)	2. Gilpinite Colorado (Calif. Miner.)	3. Gilpinite Colorado (Am. Mus. Nat. Hist)	4. Gilpinite Cornwall (Col. Roebling)	Zippeite[a]	Uranopilite[a]
Color	Greenish-yellow to canary yellow	As in 1	As in 1	As in 1	Orange-yellow	Orange-yellow to greenish yellow
Pleoc. X	Colorless				Nearly colorless	Pale yellow
Y	Very faint yellow				Pale yellow	Pale yellow
Z	Pale greenish to canary yellow				Deep yellow	Pale yellow
Opt. char.	+ or —	+	—	+	—	+
$2V_{Na}$	near 90°	near 90°	near 90°	near 90°	large	moderate
Disp. of 2V	$\rho < V$ or $\rho > V$ strong to very strong	$\rho < V$ strong	$\rho > V$ strong	$\rho < V$ strong	$\rho < V$? not strong	$\rho < V$ extreme
α	1.577	1.577	1.575	1.575	1.620	1.621
β	1.596	1.597	1.594	1.592	1.680	1.623
γ	1.616	1.616	1.611	1.612	1.720	1.631
Habit	Laths (010)	Laths (010)	Laths (010)	Laths (010)	Laths (010)	Laths (010)
Opt. orient.	X⊥ laths Y∧ elong. 5½°	X⊥ laths Y∧ elong. 5½°	X⊥ laths Y∧ elong. 8°	X⊥ laths Y∧ elong. 5°	X⊥ laths Z∧ elong. 32°	X⊥ laths Y∧ elong. 15°

[a] Unpublished data; measurements by E.S.L.; specimens from Col. Roebling

The purer sample was treated by boiling with several portions of dilute hydrochloric acid (1:10 by vol.), the black residue filtered off, ignited and weighed. The greenish yellow filtrate was heated to boiling and the sulfuric acid precipitated and weighed as barium sulfate. Copper and lead were obtained as sulfides in the acid solution from the barium sulfate precipitate, the precipitated sulfides dissolved in nitric acid, the free nitric acid removed by sulfuric acid and the lead ultimately weighed on a Gooch crucible as $PbSO_4$. Copper was precipitated in the acid solution from the lead precipitate by hydrogen sulfide, the copper weighed as the oxide, dissolved in nitric acid and redetermined electrolytically. After removal of hydrogen sulfide from the copper and lead precipitates, uranium and iron were separated by ammonium hydroxide in hot solution. This precipitate, which was found to carry some barium, was purified, the uranium and iron reprecipitated, the precipitate ignited and weighed, dissolved in hydrochloric acid (sp. gr. 1.12) and the iron chloride extracted with ether (Skey method), the iron and uranium ultimately being weighed as their respective oxides. Excess of barium salts was

TABLE 2.—Analysis of Gilpinite and Related Minerals.

	1	1a	1b		2	3	4
Gangue	19.64						
H_2O–	1.50						
		1.66	767	4x192	5.59	17.69	15.23
H_2O+	10.08	12.15					
SO_3	12.44	15.45	193	1x193	20.02	13.06	17.36
UO_3	45.67	56.72	198	1x198	67.72	67.86	62.04
CuO	4.67	5.80	73		5.99	.....	5.21
FeO	3.84[a]	4.77	66	1x182	0.20	.....	.....
PbO	0.67	0.82	4	182	.....	.....	.....
Na_2O	1.55	1.93	31		.....	.....	.....
K_2O	0.56	0.70	8		.....	.....	.....
CaO	.....	.....	....		.....	0.61	.....
Fe O_3	.....	.....	....		.....	0.17	.....
	100.62	100.00	$RO.UO_3.SO_3.$ $4H_2O.$ R=Cu,Fe,Na_2.		CuO. $3UO_3.$ $3SO_3.$ $4H_2O$	$3UO_3.$ $2SO_3.$ $12H_2O$	CuO. $3UO_3.$ $3SO_3.$ $12H_2O$

[a] A little Fe_2O_3 is present but the material available was insufficient for separation of the two states of iron.

1. Gilpinite from Gilpin County, Colo.; analysis by G. V. B.
1a. Analysis 1, free from gangue, computed to 100%. The gangue carried 0.80% H_2O– and 1.50% H_2O+.
1b. Molecular ratios of 1a.
2. Johannite—quoted from Dana.
3. Zippeite—quoted from Dana.
4. Zippeite—quoted from Dana.

removed from the ammoniacal filtrate by ammonium carbonate reagent, the ammonium salts volatilized, and the sodium and potassium weighed as the combined chlorides; the respective elements were determined indirectly by solution of their chlorides and weighing the chlorine present as silver chloride. H_2O- and + were determined in a separate sample by heating at 105° and 200°

All precipitates and filtrates were carefully worked over for impurities or traces which might have escaped detection. Water, gangue, uranium, and sulfuric acid were determined in duplicate samples. Since barium was found to contaminate the combined iron and uranium precipitate thrown down by ammonia, the excess barium chloride was removed in the duplicate prior to the precipitation of these elements. There was a tendency for small amounts of uranium to resist precipitation by ammonia, even when precipitated by very slight excess of carbonate-free ammonium hydroxide in hot solutions.

The results of the analyses are given in Table 2, together with analyses of related minerals for comparison. Chemically gilpinite is somewhat similar to analysis 4 of zippeite, but the difference is considerable and the optical properties of gilpinite and zippeite are very different, as has been shown in Table 1. If the two analyses of zippeite were made on homogeneous material they must represent two distinct minerals.

Conclusion.—The whole group of the secondary uranium minerals including sulfates, carbonates,[3] phosphates, etc., is in need of entire revision. Some of the so-called species may thus be eliminated, a number of new species established, and our knowledge of the species and their relations made much more comprehensive. To accomplish this it will be necessary to study the minerals chemically, optically, and, where possible, crystallographically. The homogeneity of the material analyzed must be established by a careful optical study as most of the minerals are intimately mixed with gypsum and other impurities. The great need is for complete data, and all the properties should be measured on matetial identical with that analyzed.

The methods commonly used to determine the secondary uranium minerals are evidently inadequate; microscopic examination by one of the authors (E. S. L.) of about a hundred specimens of such minerals from the best museums of the country has shown that over one third were incorrectly labeled. The optical properties of these minerals are characteristic and with few exceptions the minerals can be quickly and accurately identified by a microscopic examination. This can be made on a few tiny crystals—very much less material than is required for the simplest qualitative tests. Unfortunately, many of the optical data are not tied to accurate chemical analyses.

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[3] An article on certain of these will appear in the July number of this magazine.