

OXIDATION PRODUCTS OF PITCHBLENDE FROM BEAR LAKE

CHARLES PALACHE AND HARRY BERMAN, *Harvard University*.

The uranium-silver ores of Great Bear Lake have been described by Spence and Kidd¹ who devoted their chief attention to the place and mode of occurrence of the veins and to the primary ore minerals. The large collection of material collected by Spence in 1931 contained a number of specimens in which the ore was brilliantly colored by a variety of oxidation coatings. The best of these were selected and sent to the Harvard Mineralogical Laboratory for possible identification. It proved on examination of the specimens that the coating films and tiny veins containing the oxidation products were so thin that very little material of any one kind could be obtained. However, some results were obtained which are presented here as a preliminary report. More and better material for description may be obtained during the mining season of 1932 in which case it is hoped that a more conclusive examination may be made.

The specimens are for the most part fragments of the botryoidal pitchblende said to come from vein No. 2 (?). Quartz and barite are present in most of them and they are traversed by a network of thin veinlets which when broken open show crystalline coatings. Surfaces are also veneered with mamillary coatings of bright orange, yellow, red and green color but these substances proved generally to be colloids which could not be definitely determined. The minerals containing uranium which were found were:—

- (a) Mineral X, an oxide of uranium closely related to becquerelite but possibly a new species.
- (b) Uranophane.
- (c) Zippeite.
- (d) A crystalline mineral Y.
- (e) Colloidal substances.

(a) MINERAL X

This mineral occurs on most of the specimens but never in large amount. The largest crystal was under a millimeter in diameter

¹ Spence, Hugh S., Radium and Silver at Great Bear Lake: *Mining and Metallurgy*, March, 1932. Kidd, D. R., A Pitchblende Silver Deposit, Great Bear Lake, Canada: *Econ. Geol.* 27, 145, 1932.

and generally the crystals were too small to be readily seen as individuals even with a lens. The crystals are thin plates which often stand edgewise in drusy coatings on the walls of small vugs in the veinlets. Barite and quartz accompany mineral X, and the other oxidation products of the uraninite when present seem to be later. The crystals of mineral X are shining plates with a perfect cleavage, taken as basal pinacoid. The plates are in subparallel groups but in some of the smallest crystals which could be handled the deviation from parallelism was slight so that fairly reliable crystal measurements could be made. The color is lemon yellow to yellowish brown. Hardness about 3. Cleavage basal, very perfect. The optical properties are given in tabular form below together with those of becquerelite and schoepite.

TABLE OF OPTICAL PROPERTIES

	Mineral X*	Becquerelite*	Schoepite
Color	Yellow	Brown to yellow	Yellow
H	3+	2-3	
Opt. Char.	(-), 2V med. large	(-), 2V = 30° ±	(-), 2V = 90° ±
Disp.	ρ > ν, strong	ρ > ν	ρ > ν
Pleoch.	{ X = colorless Y & Z = yellow	{ X = colorless Y & Z = yellow	{ X = colorless Y & Z = yellow
α	1.785	1.735	1.690
β	1.810	1.820	1.714
γ	1.820	1.830	1.735
Orient.	X = c, Y = b	X = c, Y = b	X = c, Y = b
Cleavage	(001), perfect	(001), perfect	(001), perfect

* Optics by H. Berman

CRYSTAL FORM. Mineral X is orthorhombic and pseudotetragonal. The habit is tabular parallel to the base with elongation of the tablet in the direction of the *b* axis. Eight crystals were measured but only three gave readings at all consistent, and the only form used for calculating the axial ratio was a pyramid which is taken as the unit pyramid.

$$\begin{array}{l}
 (111) \quad \phi \quad \rho \\
 \quad \quad 63^{\circ}54' \quad 67^{\circ}07' \\
 p_0 = 2.12 (8) \quad a = 0.49 (0) \\
 q_0 = 1.04 (2) \quad c = 1.04 (2) \\
 \text{Forms:—} (001), (010), (100), (120), (111), (011), (021).
 \end{array}$$

	Calculated		Observed				No. of Obs.
	ϕ	ρ	ϕ		ρ		
120	45°35'	90°00'	44°49'	45°19'	90°		3
011	0	46°11'			45°21'	45°22'	2
021	0	64°22'			65°11'	65°45'	2
111	63°54'	67°07'	63°05'	64°18'	66°51'	67°32'	6

The form relations of mineral X, schoepite and becquerelite are shown in tabular form below. The choice of elements is based on schoepite, for which Mr. Berman determined the unit cell by means of rotation x -ray photographs. His result agreed with that of Walker,² not that of Ungemach,³ who doubled the a axis of Walker to simplify symbols.

For becquerelite we have doubled the c axis as given by Schoep and Ungemach.

TABLE OF CRYSTAL ELEMENTS

	a	c	ρ_0	q_0
Schoepite	.4262	.875	2.054	.875
Mineral X	.490	1.04 (2)	2.12 (8)	1.04 (2)
Becquerelite	.5591	1.210	2.164	1.210

It will be observed that the mineral X is exactly intermediate in form between the other two closely related minerals.

CHEMICAL COMPOSITION. It was impossible to obtain satisfactory material for an analysis. A small sample of .12 grams not wholly pure was analyzed by Mr. Gonyer as shown below in Column 1. These figures are compared with the analyses of schoepite and becquerelite. It is evident that none of these analyses are satisfactory. They were probably made on small amounts of insufficiently purified material. The lead, always present, has been ignored in the accepted formula. In the case of mineral X there is somewhat more lead but in another sample, smaller but very pure, which was analyzed qualitatively, lead was absent. If so the lead in the analysis is to be ignored and mineral X receives the same formula as schoepite and becquerelite.

² *American Mineralogist*, 8, 67, 1923.

³ *Ann. Soc. geol. Belg., Congo Belge*, 52, Fasc II, c79, 1929.

TABLE OF CHEMICAL ANALYSES

	1	2	3	4	5	6	7
H ₂ O	8.29	8.73	5.82	10.02	11.24	11.27	11.18
UO ₃	76.10 (U ₃ O ₈)	81.63	86.51	82.73	84.99	79.01	88.82
PbO	9.16	9.64	5.25	5.38	.97	4.56	
insol	4.10				3.71	2.76	
Fe ₂ O ₃			0.54		.49	1.32	
SiO ₂			0.83				
SO ₃			1.01				
TeO ₃						1.09	
	97.65	100.00	99.96	98.13	101.40	100.01	100.00

1. Mineral X analyzed by Gonyer.
2. Mineral X recalculated to 100%, omitting insoluble and converting U₃O₈ to UO₃.
3. Becquerelite: A. Schoep, analyst. *Bull. de la Soc. Min. Fr.*, vol. 47, 1924, pp. 147-157.
4. Becquerelite " "
5. Schoepite " "
6. Schoepite " "
7. Calculated for UO₃ · 2H₂O.

(b) URANOPHANE

This mineral occurs as a green to yellowish green crust, made up of minute needles, too small for accurate microscopic work. The indices and orientation, however, suggest a mineral closely related to uranophane. Qualitative chemical tests show an abundance of silica and the other elements of uranophane, as well as some copper, the green color being probably in part due to this latter constituent. From the specimens at hand it seems improbable that a satisfactory sample for analysis can be obtained, since the crusts are very thin and intimately mixed with other uranium compounds.

(c) ZIPPEITE

This material was found on only one specimen in clearly defined tufts, which yielded a good check optically, with zippeite. Another specimen showed the same material as a very thin crust. Apparently the zippeite has been formed after mineral X since it is found on that material. Only enough material for an optical examination was available.

(d) MINERAL Y

Mineral Y is a red uranium compound which forms tiny crystal-line tufts. The crystals are not large enough for measurement on the goniometer; the refractive indices are higher than 2.06. Ap-

parently this substance is a lead uranium compound, or an anhydrous uranium alteration product. No definite information has been obtained mainly because of the scarcity of the material. It is probably near curite.

(e) COLLOIDAL SUBSTANCES

A number of colloidal, or very finely crystalline uranium compounds have been found in the veins in which the above described minerals occur. The yellowish isotropic material seems to grade into the finely crystalline mineral X, and no doubt has a similar composition. Some of the waxy crusts are green or brown, or red. These are probably hydrous uranium compounds, with copper, perhaps, in the case of the green material.