STUDIES OF URANIUM MINERALS (I):

PARSONSITE AND RANDITE*

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ABSTRACT

Parsonsite, $Pb_2(UO_2)(PO_4)_2 \cdot 2H_2O$, hitherto known only from the Belgian Congo, is described from the Ruggles pegmatite, New Hampshire, and from Wölsendorf, Bavaria. The New Hampshire material occurs as crusts of microscopic monoclinic crystals. The lath-like crystals are elongated on [001] and flattened on {010} with {001} as the terminal face; $\beta = 99°$. Color citron-yellow; hardness $2\frac{1}{2}$ to 3; specific gravity 5.37; $c_0 = 6.8$Å. Analysis gave: PbO 47.43, UO_3 34.68, P_2O_5 14.46, H_2O 3.43; total 100.00 after deduction of 5.64 per cent quartz. The indices of refraction vary, apparently with the water content; most crystals have $nX \sim 1.870$, $nZ \sim 1.890$, $X \wedge c \sim 19°$. Parsonsite also occurs at Wölsendorf as microscopic yellow crystals identical in habit with the Belgian Congo and New Hampshire material. Biaxial negative, with indices of refraction, somewhat variable, of $nX \sim 1.795$, $nZ \sim 1.815$ and $Z \wedge c \sim 14°$. The *x*-ray powder spacing data are given.

Randite, originally described from Philadelphia, Pennsylvania, by Koenig in 1878 as a carbonate of calcium and uranium is discredited as a mixture consisting principally of calcite and beta-uranotile with some tyuyamunite.

PARSONSITE

In January of 1942, Mr. Philip C. Foster of the Boston Mineral Club submitted a small specimen from the Ruggles pegmatite near Grafton Center, New Hampshire, for identification. A preliminary examination at that time by the late Harry Berman showed the substance to be a uranium mineral but further work was deferred for lack of sufficient material. In January of 1946 a number of large specimens of the same mineral were obtained from a new find made by Mr. H. L. Smith of the Whitehall Company of Keene, New Hampshire, operators of the Ruggles mine. A quantitative analysis by F. A. Gonyer of this material, cited in Table 1, proved it to have the composition $Pb_2(UO_2)(PO_4)_2 \cdot 2H_2O$. This composition is identical with that attributed to parsonsite aside from a slightly higher content of water. The *x*-ray powder pattern, cited in Table 2, was found to be identical with a standard pattern of parsonsite from the files of the U.S. Geological Survey.

Parsonsite was originally described by Schoep from Kasola in the Belgian Congo, where it was found associated with torbernite, kasolite and dewindtite. The mineral occurred as aggregates of microscopic lath-like crystals with the crystal habit and optical orientation shown in Fig. 1. The observed morphological development and the inclined extinction indicates that the crystal symmetry is either monoclinic or triclinic. The

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plane of flattening was taken by Schoep and by Buttgenbach as {010} and the bounding forms, seen only under the microscope, were made {100}, {101} and {001}. The color of the aggregates is chocolate-brown, due to numerous included particles of foreign material, but the mineral itself is colorless to pale rose. Schoep assigned the formula $Pb_2U(PO_4)_2 \cdot H_2O$ to the mineral from the chemical analysis cited in Table 1. The analysis apparently was made on very impure material.

TABLE 1. CHEMICAL ANALYSES OF PARSONSITE

	1	2	3	4
PbO	50.01	49.03	47.43	44.71
UO_3	32.06	31.42	34.68	29.67
P_2O_5	15.91	15.59	14.46	15.08
H_2O	2.02	3.96	3.43	1.56
Rem.				8.25
Total	100.00	100.00	100.00	99.27
S.G.			5.37	6.23

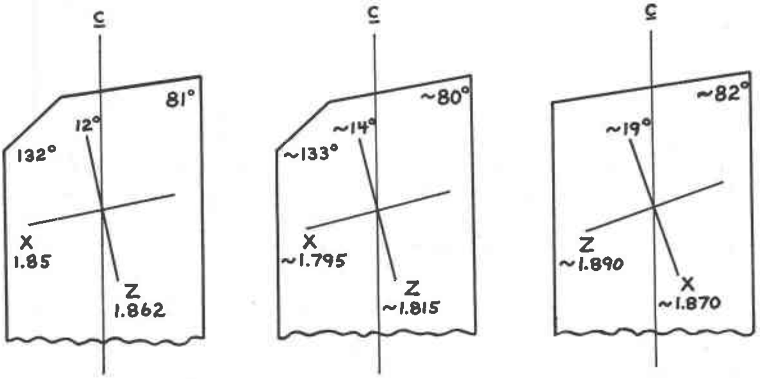
1. $Pb_2(UO_2)(PO_4)_2 \cdot H_2O$.
2. $Pb_2(UO_2)(PO_4)_2 \cdot 2H_2O$.
3. Parsonsite. Ruggles mine, New Hampshire. F. A. Gonyer analyst, April, 1947. Recalculated to 100 after deduction of 5.64 per cent insoluble.
4. Parsonsite. Kasola, Belgian Congo. Schoep analyst (1923). Rem. is CaO 0.63, CuO 0.25, Al_2O_3 1.23, TeO_3 3.01, MoO_3 0.43, CO_2 1.19; insol. 1.51. Original total given as 99.47. Analysis on impure material.

TABLE 2. X-RAY POWDER SPACING DATA FOR PARSONSITE

Copper radiation, nickel filter (in Å)

d	*I*	*d*	*I*	*d*	*I*
4.13	8	2.42	1	1.87	2
3.90	1	2.33	1	1.83	4
3.38	9	2.29	2	1.77	4
3.22	10	2.24	2	1.71	4
3.14	3	2.21	2	1.64	7
2.97	1	2.18	2	1.61	2
2.89	2	2.10	6	1.57	2
2.77	3	2.02	2	1.53	1
2.69	1	1.96	2	1.50	1
2.61	2	1.93	1	1.42	3
2.52	1	1.90	1	1.39	2
				1.36	3

Parsonsite from New Hampshire. Parsonsite occurs at the Ruggles pegmatite near Grafton Center, Grafton County, New Hampshire, as crusts of microscopic spicular or lath-like crystals. The mineral occurs sparingly along fracture surfaces in massive feldspar and quartz in the near vicinity of the uraninite and gummite masses for which the locality is known. The parsonsite is associated with autunite and phosphuranylite and all of these have ultimately been derived from the alteration of the primary uraninite. The color of the mineral is pale citron-yellow, and the luster is adamantine. The hardness is $2\frac{1}{2}$ to 3, and the specific gravity, measured on a relatively compact aggregate, is 5.37. This value is much lower than the value 6.23 reported by Schoep for the material from the Belgian Congo. The latter value seems high for a substance of the present composition in comparison with the specific gravities of lead-uranium minerals such as dewindtite, renardite, and fourmarierite. It is not fluorescent in short- or long-wave ultraviolet light. Under the microscope, the crystals are seen to have a habit very similar to those from the Belgian Congo, although the optical properties are somewhat divergent therefrom. The crystals ordinarily are bounded only by {010}, {100} and {001}, with $\beta \sim 100°$; minute faces of {*hk*0} and {*hkl*} were noted in a few instances. The indices of refraction vary both within the same crystal and between different crystals. Most crystals have transparent and relatively perfect terminations and grade along the elongation toward the point of attachment into translucent material with much lower indices of refraction and with rough external faces. The terminal



1. Belgian Congo 2. Wölsendorf 3. New Hampshire

FIG. 1

parts of the majority of the crystals have the optical orientation shown in Fig. 1 with nX about 1.870 and nZ about 1.890. Other crystals have comparable birefringence but with lower values for nZ ranging down to about 1.86. A few crystals were noted with nX over 1.88. The indices of the Belgian Congo crystals were originally given by Schoep as over 1.99, with the optical orientation shown in Fig. 1, but Billiet later reported the values $nX=1.85$ and $nZ=1.862$. The optical orientation of most of the crystals from New Hampshire, as shown in Fig. 1, has the positions of X and Z opposite to those of the Belgian Congo material, but other crystals conformed to the latter orientation. The extinction angle between Z (or X) and c varied from about 6° to 23°, as measured on crystals clearly resting on $\{010\}$, and always was in the obtuse angle of β. The crystals are pale yellow in transmitted light and are not perceptibly pleochroic. No clear correlation could be found between the variation in extinction angle and either the optical orientation or the indices of refraction. The variation in the indices of refraction, found also in the parsonsite from Wölsendorf described beyond, presumably is connected with variation in the water content of the mineral at ordinary temperatures, as is characteristic of torbernite and some other hydrated oxysalts of uranium. The water content of the New Hampshire mineral as found by analysis is between $1H_2O$ and $2H_2O$ in the derived formula. The formula with $2H_2O$ is regarded as the more probable. The analysis was made by conventional procedures on a sample weighing only about 0.4 gram that contained about 6 per cent of admixed quartz and hence may be somewhat in error.

An effort was made to obtain crystallographic data by the x-ray rotation and Weissenberg methods, but the crystals were too small to yield satisfactory data. The identity period along the direction of elongation, or c-axis, was found to be 6.8 ± 0.1 Å. The Weissenberg resolution of the 0-layer about this axis was very faint, but the observed reflections were consistent with the plane symmetry C_{2l}. This fact and the inclined extinction against this axis indicate that the symmetry of the mineral is monoclinic with the elongation along c. The 0-layer photograph as projected gave a rectangular net with 10.21 Å and 6.77 Å as the dimensions of the smallest direct cell. One of these dimensions is b_0 or a submultiple thereof and the other is $a_0 \sin(\beta - 90°)$ or a submultiple thereof, but their separate identity is not known. Efforts to obtain a 1-layer photograph about this axis or photographs about the b-axis were unsuccessful.

Parsonsite from Wölsendorf, Bavaria. A second new occurrence of parsonsite was found on a specimen in the Wölsendorf suite of the Harvard collection. This specimen comprised a mass of purplish black fluorite together with rusty-appearing quartz crystals and yellow plates of uranocircite. The parsonsite, identified by its *x*-ray powder photograph, formed yellow, tufted aggregates of microscopic lath-like crystals deposited upon the uranocircite. The crystals were much smaller than those from New Hampshire and it did not prove possible to obtain physical or morphological data. Under the microscope the crystals had the habit shown in Fig. 1. The indices of refraction varied considerably but always were below those of the material from the Belgian Congo and from New Hampshire. Much of the material had the optical orientation shown in the drawing with nX about 1.795 and nZ about 1.815 and with $Z \wedge c$ mostly between 8° and 20° in the obtuse angle. A few crystals had nZ considerably below 1.81, with nX undetermined, and others had nZ about 1.825. Several crystals were noted with the reversed optical orientation previously found in the New Hampshire material. The extinction angle between Z (or X) and c ranged from a few degrees up to 36°. The crystals were colorless to faint yellow in transmitted light and did not show perceptible pleochroism. The optical sign was negative, and the dispersion strong.

The occurrence of parsonsite at Wölsendorf has been mentioned without description by Schoep and Scholz.

RANDITE

The name randite was given by Koenig in 1878 to a supposed hydrous carbonate of calcium and uranium found as canary-yellow coatings on granite pegmatite and hornblende gneiss at Frankford near Philadelphia, Pennsylvania. The original material came from Barber's quarry. Similar yellow coatings have been found on the Weissahickon gneiss at several nearby quarries associated with torbernite, autunite, and yellowish-green fluorescent hyalite. The original analysis, on 47 milligrams of material, was later shown by Rand to have been made on a mixture of calcite and an unidentified acicular mineral to which the name randite was then restricted. A partial analysis by Rand of the acicular crystals remaining after the calcite had been dissolved away by acetic acid gave CaO 16.71 and "U_2O_3" 46.71 per cent. A number of specimens of randite were available for examination including one specimen from the Academy of Natural Sciences of Philadelphia labelled as a gift from Mr. Rand. The writer is indebted to Mr. Samuel G. Gordon for opportunity to examine this specimen. Optical and *x*-ray study revealed that the yellow crusts were gross mixtures of calcite, kaolin, beta-urantile in minute acicular crystals, and tyuyamunite as thin dense crusts. The beta-urantile is predominant on the specimens and doubtless is the acicular mineral mentioned by Rand. Rand's partial analysis is considerably higher in CaO than either beta-uranotile or tyuyamunite, perhaps due to residual calcite. Whatever the explanation of this discrepancy, it appears that the name randite has been applied to a mixture of known species and hence is to be discredited.

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