

TABLE 3

The Chemical Composition and the Physical and Optical Properties of Uramphite and Synthetic Uranyl and Ammonium Phosphate

Substance examined	Content, %				Specific gravity	Fluorescence	Index of refraction
	NH ₄	U	P	H ₂ O			
Uramphite	4.6	57.0	6.92	11.0	3.7	Medium yellowish green (autunite type)	N _x = 1.564 N _y = N _z = 1.585
Synthetic phosphate	5.09	54.45	6.56	12.35		Ditto	N _e = 1.564 N _o = 1.585
Theoretical composition of hydrous uranyl and ammonium phosphate, NH ₄ (UO ₂)(PO ₄)·3H ₂ O	4.12	54.45	7.09	12.0			

The Debyeograms for uramphite and the synthetic phosphate are shown in Figure 4. The photograph was taken by K.F. Kudimovaia on a URS-70 apparatus, with an RKU camera having a diameter of 86 mm, and with Cu-radiation and a Ni-filter. The thickness of the sample was 0.6 mm. The voltage was 35 kv at 25 ma. The exposure time was three hours.

The values of the x-ray constants for uramphite and the synthetic phosphate are given in Table 2.

Data on the chemical composition and on the physical and optical properties of natural and synthetic phosphates are shown for comparison in Table 3.

All these data show that uramphite is completely similar to the hydrous uranyl and ammonium phosphate synthesized by E.I. Sheludikovaia. The agreement of interplanar distances between the natural and synthetic phosphates indicates the identity of the structures of the two forms. This structure corresponds to the double salt of orthophosphoric acid, in which ammonium takes the place of one cation.

These facts, together with the results of the chemical analysis, indicate the following formula for the mineral:



The name of the mineral, uramphite, is derived from its composition ("ur" from uranium, "am" from ammonium, and "ph" from phosphate).

The discovery of this mineral is evidence of solutions rich in the NH₄ ion circulating in the zone of oxidation of uranium-coal deposits; the NH₄ came from the decay of organic material in the coal. This circumstance is grounds for believing it possible to find minerals of similar composition in other deposits of uranium in caustic organic deposits.

URSILITE - A NEW SILICATE OF URANIUM

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A distinctive silicate of uranium has been found along joints in quartz porphyries (Figures 1 and 2); it occurs with kaolinite, calcite, and rarely with uranophane, sklodowskite, and kasolite, and it is distinguished from all known silicates by a number of properties.* It generally forms lemon-yellow earthy or nodular incrustations, rarely radiating spherulites, and it is distinctly fluorescent in greenish yellow under ultraviolet light.

TABLE 1

Optical Properties of Uranium Silicates

Mineral	N _z	N _y	N _x	Optical sign	N _z -N _x
Calcium ursilite	1.556		1.548	(-)	0.008
Magnesium ursilite	1.550		1.543	(-)	0.007
Sklodowskite	1.646	1.635	1.611	(-)	0.035
Uranophane	1.657	1.615			0.046
	1.670	1.665	1.642	(-)	0.023
	1.672	1.667	1.649		0.028
β-Uranotile	1.689	1.682	1.668	(-)	0.021
Cuprosklodowskite	1.664	1.664	1.654	(-)	0.010
	1.667	1.667	1.665		0.002
Kasolite	1.895		1.890	(+)	0.005
Soddyite	1.950	1.910	1.869	(+)	0.081
		1.662	1.645		
	1.597		1.582		0.015
Gastunite	2.582		1.561		0.021
	1.70		1.670		0.030

Two varieties of this mineral have been identified: calcium ursilite and magnesium ursilite.

The mineral is brittle and has a hardness of 3; the specific gravity, determined by a picnometer, is 3.034 for calcium ursilite and 3.254 for magnesium ursilite; it is easily soluble in acids (especially when warm), turning the solution green and yielding silica gel. During heating, the water is driven off and the mineral becomes black. It gives a definite uranium reaction.

Under the microscope the new uranium silicate is seen to be weakly pleochroic, N_x - pale green, N_z - green; the extinction is parallel and the sign of elongation is positive. Interference colors are gray in thin-sections of normal thickness. The indices of refraction are very near each other. Table 1 shows a comparison of calcium ursilite and magnesium ursilite with other uranium silicates described in the literature [1, 2].

*It is named for its composition.

TABLE 2

Chemical Composition of the New Uranium Silicates

Oxide	Sample No. 203a			Sample No. 203c			Sample No. 203b			Sample No. 103a			Uranophane	Sklodovskite
	Wt.%	Mole- cular ratio	Oxide ratio	Wt.%	Molecular ratio	Oxide ratio	Wt.%	Mole- cular ratio	Oxide ratio	Wt.%	Mole- cular ratio	Oxide ratio	Wt.%	Wt.%
SiO ₂	26.90	0.448	2.55	26.67	0.444	2.55	26.92	0.449	2.53	26.80	0.448	2.55	14.02	14.28
Al ₂ O ₃	0.24			0.27			0.14							
Fe ₂ O ₃	0.13			6.67	0.119	0.9	6.31	0.113	1	0.79	0.014		6.55	
CaO	5.75	1.103	0.72	1.55	0.038		2.49	0.062		6.72	0.168	1		4.76
MgO	0.95	0.024					None			None				
K ₂ O	None						None			None				
Na ₂ O	None			49.80	0.174	1	50.40	0.175	1	50.32	0.175	1.087	66.80	68.10
UO ₃	50.57	0.166	1	8.3	0.799	4.5	14.7	0.817	4.7	14.9	0.828	5.74	12.62	12.86
H ₂ O ⁻	8.83		5	5.83										
H ₂ O ⁺	6.90	0.875												
Total	100.33			99.12			100.96			99.53			10.000	100.00
Formula	1.5(CaO)2(UO ₃)5(SiO ₂)·10H ₂ O			2(CaO)2(UO ₃)5(SiO ₂)·9H ₂ O			2(CaO)2(UO ₃)5(SiO ₂)·9H ₂ O			2(MgO)2(UO ₃)5(SiO ₂)·9H ₂ O			(CaO)→ →2(UO ₃)→ →2(SiO ₂)→ →2(SiO ₂)· ·6H ₂ O	

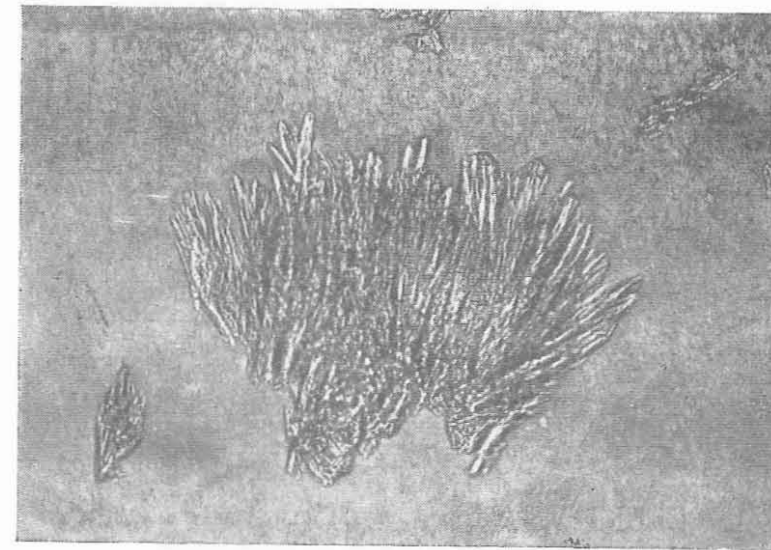
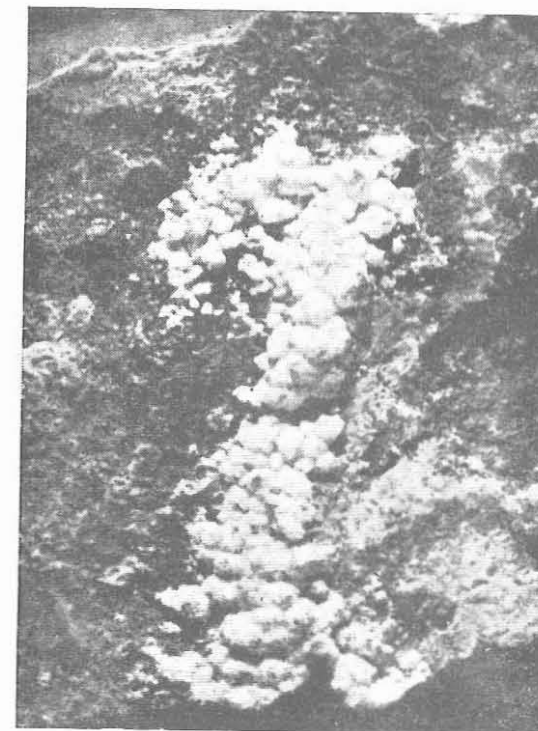


Fig. 1. An immersion of calcium ursilite (x 30).



a



b

Fig. 2. Segregations of calcium ursilite (a) and magnesium ursilite (b) (x 5).

Chemical analyses, made by V.D. Sidel'nikova and O.V. Krutetskaia, have shown that all the analyzed varieties have a uniform content of uranium and silicon (Table 2). The quantity of water in the mineral ranges from 15.73 wt. % in sample No. 203a to 14.7 wt. % in sample No. 203b. The calcium and magnesium contents in the analyzed samples are inconstant, except that with a decrease in the calcium content the magnesium content increases.

From these analyses it is seen that there is a transition from almost pure calcium hydrous uranium silicate to a variety of almost pure magnesium hydrous uranium silicate. The total molecular quantity of calcium and

magnesium is almost the same in the two analyses and is approximately the same as the molecular ratio of uranium. In sample No. 203a the molecular quantity of UO_2 is somewhat lower. Whether this is due to errors in analysis or to a greater insufficiency of cations than in samples No. 203b and No. 203c, it is difficult to say at present. We are inclined to explain the presence of magnesium in the analyses of samples No. 203b and No. 203c by the occurrence of magnesium ursilite, which has similar properties to calcium ursilite. Thus, on the basis of this data, two varieties may be distinguished at the present time: hydrous calcium uranium silicate (sample Nos. 203a, 203b, 203c), calcium ursilite; and hydrous magnesium uranium silicate (sample No. 103a), magnesium ursilite.

TABLE 3
X-Ray Data

Iron tube - 2R = 57.9, d = 0.6, manganese filter, voltage - 35 kv			
Sample No. 203a (calcium ursilite)		Sample No. 103 (magnesium ursilite)	
I_1/I_2	θ	I_1/I_2	θ
8	5.04	10	4.98
9	4.56	8	4.58
10	3.37	8	3.37
2	3.18		
10	3.02	10	3.06
7	2.63		
7	2.51		
4	2.40	6	2.42
6	2.28	9	2.30
7	2.22	5	2.20
5	2.10	9	2.07
2	2.02		
6	1.979	6	1.981
6	1.859		
9	1.828		
6	1.790	6	1.798
2	1.723		
3	1.590		
8	1.562		
4	1.527		
1	1.480		
2	1.419		
8	1.378		
8	1.345		
2	1.253		
4	1.212		
2	1.294		
	1.178		
9	1.158		
9	1.120		
3	1.101		
3	1.092		
8	1.075		
8	1.054		
7	1.038		

In contrast to uranophane and sklodowskite, the new uranium silicate has a considerably higher content of silicon and a somewhat lower content of uranium and water (Table 2).

The x-ray powder patterns of the varieties of the new silicate described in this paper are identical.

Table 3 shows the interplanar distance for calcium ursilite and magnesium ursilite, calculated by N.I. Organova without a standard having a correction for absorption.

The x-ray powder pattern for sample No. 103 (magnesium ursilite) was weak; it was possible to compute only ten lines, but these all coincided with the lines for calcium ursilite (sample No. 203a) and it is hence clear that structures of the two varieties are identical.

Comparison with the Debyeograms of uranophane and sklodowskite show that several values of interplanar distance for uranophane coincide with lines for the new silicate, but the intensities are completely different.

The optical properties of the new uranium silicate are quite different from other known silicates (see Table 1); only gastunite (variety type 1a in Table 1), described by H. Haberlandt, and A. Schiener [3], has a refractive index near that of calcium ursilite. It is yellow, forms nodular segregations, and, like the uranium silicate described in this paper, gives a distinct greenish yellow fluorescence with ultraviolet light.

Spectral analyses of gastunite (no chemical analyses were given) show it to contain, as principal constituents, uranium, calcium, and silicon (in one sample it contains lead and thorium as well). H. Haberlandt and A. Schiener, giving no calculation data, indicate that the x-ray powder pattern of gastunite cannot be identified with others. They distinguish three varieties of the mineral on the basis of refractive indices: gastunite proper, variety 1a, and variety 1b.

Variety 1a is most similar to calcium ursilite, according to the value for N_x . But because of the different values for N_z , it is impossible to consider the two minerals identical. H. Haberlandt and A. Schiener have presented no other data on gastunite.

Thus, the above data leads to the conclusion that the uranium silicate described in this paper is different from gastunite, although the two have a number of features in common. Ursilite more nearly resembles gastunite than it does other uranium silicates: uranophane, sklodowskite, cuprosklodowskite, soddyite, and kasolite.

LITERATURE CITED

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*In Russian.