THE IDENTITY OF DAKEITE AND SCHROECKINGERITE

Radim Nováček, *Charles IV University, Praha, Czechoslovakia.*

Schroeckingerite was described in 1873 by A. Schrauf (15) as a new hydrated uranium-calcium carbonate, found at Jáchymov (Joachimstal). According to the original description and all subsequent references which only repeat the data of Schrauf (3, 4, 9, 10, 14, 18), and according to the article by Baron J. v. Schroeckinger (16), schroeckingerite consists of small six-sided scales with a bright yellowish-green color, pearly

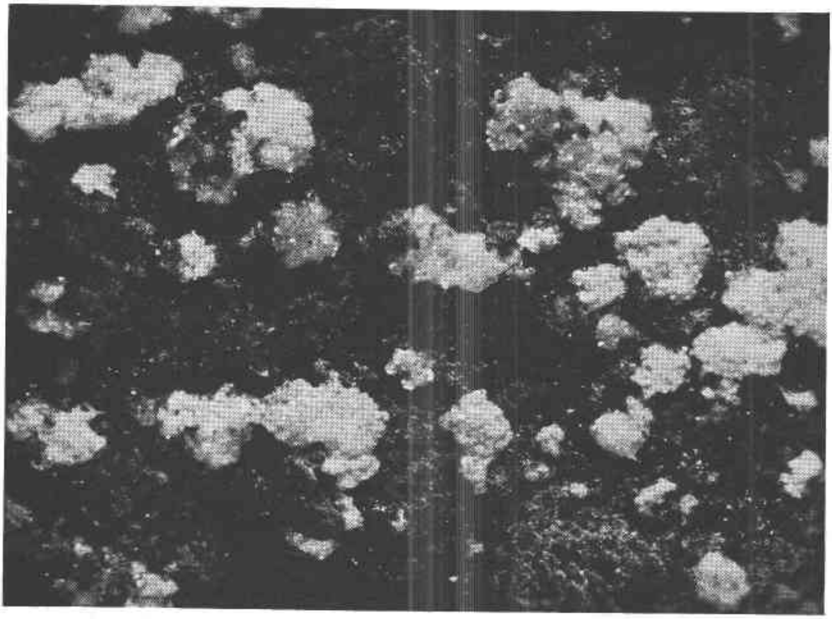

Fig. 1. Schroeckingerite on uraninite from Jáchymov. ×8.

luster, and perfect mica-like cleavage. The scales are about 1 mm. in diameter and form globular and flaky groups on uraninite (Fig. 1). Schrauf describes the six-sided scales as orthorhombic combinations of (001) with (110) and a pinacoid, designated by him as (100); the angle between the pinacoid and the prism is $58\frac{1}{2}°$. The axial plane is perpendicular to the pinacoid. No further data are given.

Schrauf made only a qualitative analysis of the new mineral and found U, CO_2, H_2O, a small quantity of CaO and traces of SO_4''; the loss on ignition (CO_2+H_2O) was given as 36.7%.

Since the original description all the later references to schroeckingerite only repeat the statements of Schrauf. The first new determinations of the optical properties of schroeckingerite are found in Larsen's tables (6, p. 131; 7), determined on specimens from the Roebling collection. The writer adds that "A number of other species labeled 'schroeckingerite' were examined, but they proved to be uranothallite, or some other uranium mineral."

But if we compare Larsen's description (" . . . green-yellow coatings of minute, prismatic crystals . . . " " . . . prismatic crystals with monoclinic symmetry and cleavages (010) very perfect, and (100) perfect. It shows lamellar twinning (100). $X=b$ and $Z\wedge c=41\frac{1}{2}°$") with the original paper of Schrauf, we find that neither the crystal form nor the optical properties agree with the original schroeckingerite. In my paper "Study on some secondary uranium minerals" (11), and in later notes on uranium minerals (12, 13), I have pointed out the similarity of Larsen's data on the supposed schroeckingerite with the optical properties of the new mineral β-uranotile, chemically identical with uranotile or uranophane.*

This statement by Larsen in his tables changes all determinations of "schroeckingerite" published since that date. The schroeckingerite described by Miss E. J. Armstrong (2) from Bedford, N. Y., and probably the mineral from Spruce Pine, Mitchell Co., N. Carolina, labeled as schroeckingerite (Brit. Mus. of Nat. Hist., London, No. 191, B. M. 1929), are β-uranotile. Special data for these minerals and on the β-uranotile from Wölsendorf in Bavaria are given by V. Steinocher and the writer in the following article (17).

Up to the present time it is impossible to make a complete quantitative analysis of a positively determined schroeckingerite. The fine specimens of schroeckingerite in the Národní Museum and in the Mineralogical Institute of Charles IV University, Praha, and in the Naturhistorisches Museum of Vienna (Schrauf's original specimens) cannot furnish a sufficient quantity, even for a microchemical quantitative analysis, especially for the determination of carbonic acid.

While I was preparing a specimen of schroeckingerite for an optical examination and for at least a partial analysis, there appeared in this Journal, in 1937, a description of a new mineral dakeite, from Wyoming, by Messrs. Larsen and Gonyer (8). By comparison of the properties of both minerals, I reached the conclusion that the two are identical, as may be seen from the following table:

* In the Abstract of my paper (11), published in *Am. Mineralogist* (1) read *β-uranotile* instead of *α-uranotile*.

	Schroeckingerite	Dakeite
Crystals:	hexagonal, micaceous plates	micaceous plates
Cleavage:	basal perfect	basal perfect
Color:	yellow to green-yellow	green-yellow
Pleochroism:	$X(\alpha)$ = colorless, or very pale yellow	X = very pale yellow
	$Y(\beta)$ and $Z(\gamma)$ = pale greenish-yellow	Y and Z = pale greenish-yellow
$X(\alpha)$ for Na-light:	1.496	1.489 ± 0.002
$Y(\beta)$, $Z(\gamma)$ for Na-light:	1.539–1.545	1.542 ± 0.001
Optically:	negative	negative
$2V$ (for Na-light):	0°–25° (rarely to 40°)	5° (Larsen); 5°–15° (Nováček)
Dispersion:	not perceptible	not perceptible
Luminescence in ultraviolet light:	bright yellowish-green	bright yellowish-green
Specific gravity:	2.515	2.51

Also from the chemical point of view both minerals are in agreement as shown in the following table:

(I) Dakeite analyzed by Mr. Gonyer.

(II) My partial analysis of schroeckingerite from Jáchymov (4 mg. and 2 mg. of material).**

(III) Theoretical values for the composition $3CaO \cdot Na_2O \cdot UO_3 \cdot 3CO_2 \cdot SO_3 \cdot 10\, H_2O$ as it is interpreted by Larsen and Gonyer (8).

	I Dakeite	II Schroeckingerite	III Theoret. composition
CaO	18.31%	19.1%	18.9%
Na_2O	7.31	not determined	6.9
UO_3	30.27	32.4	30.3
CO_2	13.71	not determined	14.8
SO_3	9.61	9.1	8.9
H_2O	19.95	20.2	20.2
Insoluble	1.06	0.4	—
	100.22	—	100.0
Loss on ignition (Nováček)	34.67%	36.04%	
Loss on ignition (Schrauf)	—	36.7%	

** The methods of analysis are described in greater detail in my paper, 1936 (11, p. 3–5): uranium was determined in acetate solution as oxychinolate, calcium as oxalate and the sulphate as barium sulphate. The dehydration was carried out in a platinum micro-crucible after it had been shown that the partially dried mineral is not hygroscopic; the dehydration was continued in an electric furnace until a temperature of 345°C. was reached.

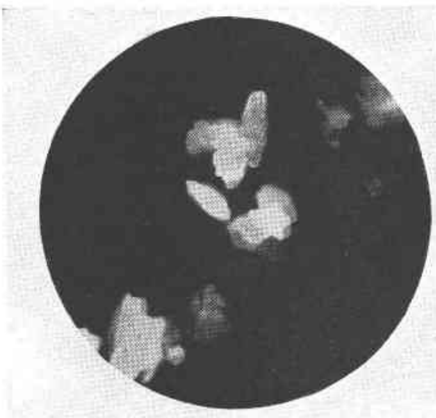

FIG. 2. Schroeckingerite from Jáchymov. Photomicrograph of six-sided crystals and their cross sections. ×47. Crossed nicols.

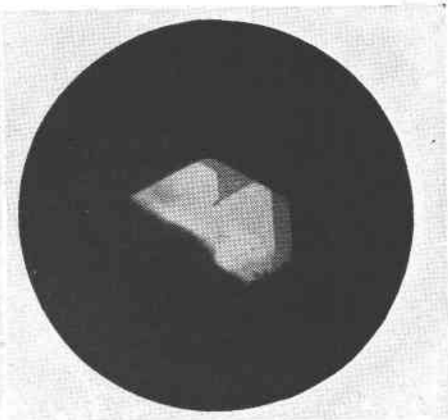

FIG. 3. Schroeckingerite from Jáchymov. Photomicrograph of a fragment of a six-sided scale parallelly intergrown with smaller scales. Minute black inclusions visible. ×87. Crossed nicols.

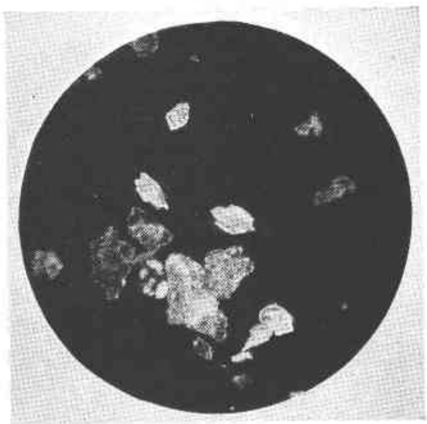

FIG. 4. Photomicrograph of dakeite from Wyoming. ×47. Crossed nicols. The scales do not have the six-sided outline like schroeckingerite.

It is evident that also chemically there is no doubt about the identity of both minerals, especially since sodium has been found present in the schroeckingerite from Jáchymov. The dehydration curves for schroeckingerite and dakeite are exactly parallel (Fig. 5). The smaller content of water in dakeite (I stated it as 18.95% at 345°C. whereas Mr. Gonyer has determined it as 19.95%, and the theoretical value is 20.2%) may be explained by the fact that a considerable part of the H_2O is expelled at a very low temperature, as is shown in the diagram.

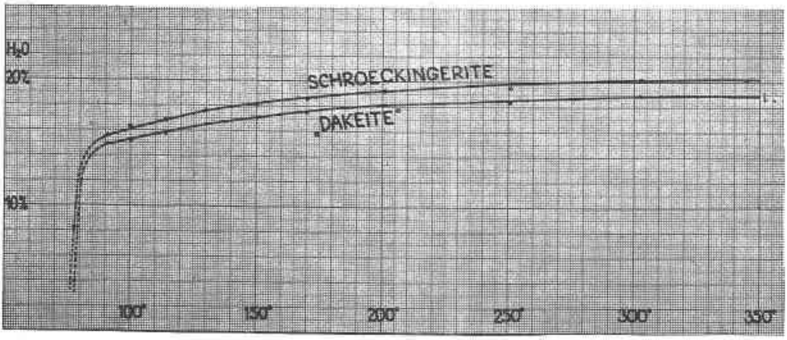

FIG. 5. Dehydration diagram of schroeckingerite from Jáchymov and dakeite from Wyoming. Except for the small difference in the total amount of water, the complete conformity of both curves is evident.

The higher content of uranium in the mineral from Jáchymov is caused by the presence of small dark inclusions of uraninite (?); it was impossible to eliminate them entirely from the analyzed mineral.

It is interesting to note that Schrauf (like Mr. Larsen originally with dakeite, cf. 5) did not indicate the presence of sodium. The extraordinary sensitivity of the flame test for sodium accounts for this omission. Less easily explained are Schrauf's data on the small amount of calcium and on "hardly provable traces" of sulphate. I have been able to demonstrate on the original schroeckingerite material of Schrauf (Wien, Naturhist. Mus., sample Aa 6740) that both the reactions for Ca and SO_4'' are quite distinct when the microchemical test is employed.

The statement of Schrauf that the angle (100):(110) is $58\frac{1}{2}°$, may be an error of observation, quite possible on scales of micaceous character like those of schroeckingerite. I have not been able to find distinct differences from 60° on the six-sided scales. There exists the possibility that schroeckingerite (or dakeite) is hexagonal and that the observed biaxial character (axial angle $2V=25°$, in a few cases even 40° in schroeckingerite, 5° in dakeite, after Larsen) is an anomaly; I have observed greater values, up to 10–15°, on dakeite from the University's collection.

According to the kind communication of Doctor A. Scholz (Regensburg) who has studied schroeckingerite from the collections of the University Mineralogical Department at Bonn and from the Naturwissenschaftlicher Verein of Nurnberg, labeled "zippeite," he found several small euhedral crystals, on which he was able to determine differences of about 2° from the value of 60°. The locality of one sample was Jáchymov, of the other Johanngeorgenstadt.

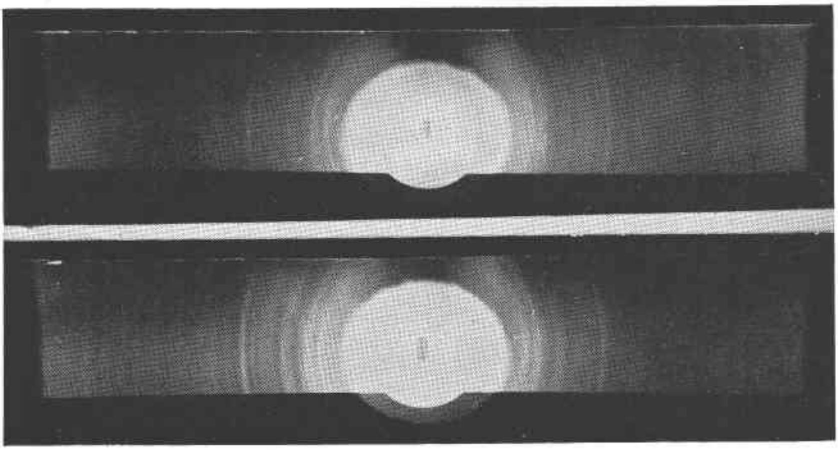

FIG. 6 *a*. (above) Debye-Scherrer diagram of schroeckingerite from Jáchymov.
6 *b*. (below) Debye-Scherrer diagram of dakeite from Wyoming.

The Laue-diagrams made by Professor F. Ulrich and Mr. V. Schön on the schroeckingerite from Jáchymov are not sufficiently distinct to permit definite conclusions. The imperfect quality of the Laue-diagrams is caused by smaller scales of schroeckingerite, parallelly intergrown on practically every large individual crystal. The Debye-Scherrer-diagrams of schroeckingerite (Fig. 6 *a*) and dakeite (Fig. 6 *b*) confirm fully the identity of both minerals.

All the data given above prove satisfactorily that the schroeckingerite from Jáchymov (Joachimstal), described though incompletely by Schrauf, and the dakeite from Wyoming, described by Messrs. Larsen and Gonyer, are identical. The priority of the name schroeckingerite is apparent.

REFERENCES

1. *Am. Mineral.*, **20**, 813, (1935).
2. ARMSTRONG, E. J., Schroeckingerite from Bedford, New York: *Am. Mineral.*, **20**, 62–63, (1935).
3. DOELTER, C., *Handbuch der Mineralchemie*, **I**, 546–547.
4. HINTZE, C., *Handbuch der Mineralogie*, **I**, 3510–3511.

5. LARSEN, E. S., Jr., *Mineralogist*, **5**, (2), 7–8 (1937).
6. LARSEN, E. S., The Microscopic Determination of the Nonopaque Minerals: *U. S. Geol. Survey, Bull.* **679**, Washington 1921.
7. LARSEN, E. S., AND BERMAN, H., The Microscopic Determination of the Nonopaque Minerals: *U. S. Geol. Survey, Bull.* **848**, Washington 1934.
8. LARSEN, E. S., JR. AND GONYER, F. A., Dakeite, a new uranium mineral from Wyoming: *Am. Mineral.*, **22**, 561–563, (1937). DAKE, H. C., The dakeite locality—Wyoming: *Mineralogist*, **6** (3) 7–8 and 23–26 (1938).
9. *Lotos*, **24**, 70–71, (1874), (Prag).
10. *Neues Jahrb. f. Mineralogie*, **646**, (1873).
11. NOVÁČEK, R., Study on some secondary uranium minerals: *Věstník Král. čes. spol. nauk II. tř.* (1935), Praha (1936); *Am. Mineral.*, **20**, 813; *Mineral. Abstracts*, **VI**, 148–149; *Neues Jahrb. f. Min.*, **I**, 141–143; *Bull. Soc. min. Franc.*, **58**, 324–328, (1935).
12. NOVÁČEK, R., Revise druhotných uranových nerostů z Jáchymova: *Čas. Nár. Musea*, **CIX**, 100–107, (1936); *Mineral. Abstracts*, **VI**, 345.
13. NOVÁČEK, R., Vtoričnye uranovye mineraly iz Jachimova: *Ac. Sci. SSSR*, 783–788, (1936).
14. *Oester. Zeits. f. Berg- und Hüttenwesen*, **21**, 305, (1873).
15. SCHRAUF, A., Schröckingerit, ein neues Mineral von Joachimsthal: *Tscherm. Miner. Mittheilungen*, 137–138, (**1873**).
16. v. SCHRÖCKINGER, J., Ueber neue Anbrüche von Silbererzen in Joachimsthal und einige neue Mineralvorkommen in Oesterreich: *Verh. d. k. k. geol. Reichsanstalt Wien*, 66–68, (**1875**).
17. STEINOCHER, V. AND NOVÁČEK, R., On β-uranotile: *Am. Mineral.*, **24**, 324–338, (1939).
18. *Vesmír*, **1874** (III), 83, Praha.