NEW DATA ON SCHROECKINGERITE[1]

Howard W. Jaffe,[2] Alexander M. Sherwood,[3] and Maurice J. Peterson[4]

Abstract

Schroeckingerite (dakeite) contains fluorine in a sufficient quantity to be calculated as an essential part of the formula. The previous value given for Na_2O is high, as is evidenced by a new analysis supported by comparative spectrograms. The mineral from the Wyoming type locality occurs in a partly indurated arkose, as well as in gypsite.

Introduction

Schroeckingerite, described as a hydrated carbonate and sulfate of calcium, sodium and uranium, is known only from two localities—Jachymov (Joachimstal), Czechoslovakia, and near Wamsutter, Wyoming. Due in part to its unusually complex composition and restricted occurrence, schroeckingerite has had a turbulent mineralogical history. It was first described from Jachymov by Schrauf[5] as a hydrated uranium-calcium carbonate on the basis of a qualitative analysis. The presence of sodium and sulfate was subsequently recognized by Novácek,[6] who studied the Jachymov material and by Larsen and Gonyer[7] who described the Wyoming occurrence. The name dakeite was assigned to the Wyoming material, which at the time was believed to be a new mineral. Novácek showed that dakeite was identical with schroeckingerite and the former name has since been discredited. It is the purpose of this paper to show that the chemical composition of schroeckingerite is even more complex than was recognized by previous investigators.

Chemistry of Schroeckingerite

During a routine visual spectroscopic examination of a prospector's sample of schroeckingerite submitted to this laboratory, it was observed

[1] Published by permission of the Director, Bureau of Mines, U. S. Department of the Interior.

[2] Petrographer, Metallurgical Division, College Park Branch, Bureau of Mines, College Park, Maryland.

[3] Chemist, Metallurgical Division, College Park Branch, Bureau of Mines, College Park, Maryland.

[4] Spectrographer, Metallurgical Division, College Park Branch, Bureau of Mines, College Park, Maryland.

[5] Schrauf, A., Schröckingerit, ein neues Mineral von Joachimsthal: *Min. Mitt*, Heft **II**, 137–138 (1873).

[6] Novácek, R., The identity of dakeite and schroeckingerite; *Am. Mineral.*, **24**, No. 5, 317–323 (1939).

[7] Larsen, E. S., Jr., and Gonyer, F. A., Dakeite, a new uranium mineral from Wyoming: *Am. Mineral.*, **22**, No. 5, 561–563 (1937).

that the mineral contained fluorine. Consequently, a sample of schroeckingerite from the Wyoming type locality described by Larsen and Gonyer and by Dake[8] was obtained from the U. S. National Museum. All the data for schroeckingerite given in this paper were determined on the museum sample. Visual spectroscopic analysis of carefully picked ma-

TABLE 1. ANALYSIS OF SCHROECKINGERITE FROM WYOMING

Analysis		Molecular Ratios		Theoretical Composition
CaO	18.14	0.3245	6× .0541	18.91
Na_2O	3.63	.0587	1× .0587	3.49
UO_3	31.44	.1091	2× .0546	32.21
CO_2	14.20	.3227	6× .0538	14.86
SO_3	9.17	.1146	2× .0573	9.02
F	2.15	.1131	2× .0565	2.14
H_2O	20.15	1.1200	20× .0560	20.27
R_2O_3	0.95	—	—	—
SiO_2	0.08	—	—	—
	99.91			100.90
	.90 Deduct 0=2F			−0=2F .90
	99.01			100.00

TABLE 2. ANALYSES OF SCHROECKINGERITE

	I	II	III
CaO	18.14	18.31	19.1
Na_2O	3.63	7.31	Not determined
UO_3	31.44	30.27	32.4
CO_2	14.20	13.71	Not determined
SO_3	9.17	9.61	9.1
F	2.15	—	—
H_2O	20.15	19.95	20.2
Insol.	—	1.05	0.4
R_2O_3	0.95	—	—
SiO_2	0.08	—	—
	99.91	100.22	—
Deduct 0=2F	.90		
	99.01		

[8] Dake, H. C., The dakeite locality—Wyoming, *The Mineralogist*, **6**, No. 3, 7–8 (1938).

terial showed fluorine to be a constituent of the museum sample as well as the prospector's sample. Fluorine was not detected spectroscopically in samples of the barren host rock. As a result of these preliminary studies, a larger sample was selected for a complete chemical analysis. The sample was carefully examined with both the binocular and petrographic microscopes and found to be essentially free of impurities. A complete analysis made by the Metallurgical Division staff is given in Table 1, with the molecular ratios and theoretical composition.

The analysis reported in this paper (I) and those of Gonyer (II) and Novácek (III) are offered for comparison in Table 2. These represent the only quantitative analyses of schroeckingerite that have been published to date.

The significant differences between analyses (I) and (II) are the absence of fluorine in the latter and a discrepancy in the percentage given for soda. The value 3.63 given in (I) is the average of two determinations which gave 3.57 and 3.69 per cent Na_2O, respectively.

Gonyer's analysis (II) shows approximately twice the quantity of soda found by the writers (I) and Novácek's analysis (III) unfortunately does not include a soda determination.

To confirm the chemical values of 3.63 per cent Na_2O and 2.15 per cent F in schroeckingerite reported in analysis (I), four synthetic standard samples were prepared. A base mixture of 47.0 per cent U_3O_8 and 53.0 per cent $CaCO_3$ was used to approximate the composition of schroeckingerite. Additions of Na_2SO_4 to the base mixture were made to obtain samples containing 3.6 per cent and 7.3 per cent Na_2O, respectively. Likewise, additions of CaF_2 were made to the U_3O_8-$CaCO_3$ mixture to obtain samples containing 2.0 per cent and 5.0 per cent fluorine. All samples were prepared by hand mixing and grinding with a boron carbide mortar and pestle.

Fifteen milligrams of each of the standard samples and the schroeckingerite were carefully weighed on a microbalance, transferred to a 3/16″ diameter graphite electrode and arced in a 250-volt direct current arc. Spectrograms were recorded by means of a 3-meter grating-type spectrograph. The standard samples containing 3.6 per cent and 7.3 per cent Na_2O and schroeckingerite were spectrographed on one plate. A separate plate was used to spectrograph the fluorine standards and schroeckingerite.

Figure 1 shows the sodium doublets at 5889.97 and 5895.93 and 5688.0 and 5682.8 Å. The Na lines in the spectrogram of schroeckingerite are quite similar to the 3.6 per cent Na_2O standard. Conversely, the Na lines in the 7.3 per cent Na_2O standard are of much greater intensity than those in the schroeckingerite spectrogram.

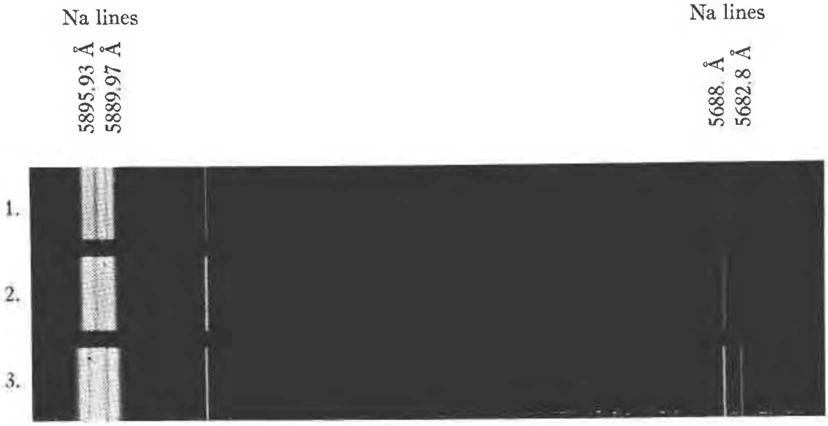

FIG. 1. Spectrograms of (1) schroeckingerite, (2) synthetic mixture of U_3O_8 and $CaCO_3$ containing 3.6 per cent Na_2O and (3) the synthetic mixture with 7.3 per cent Na_2O.

Figure 2 shows the CaF band, with its head at 5291Å for schroeckingerite and the two standard samples containing 2.0 per cent and 5.0 per

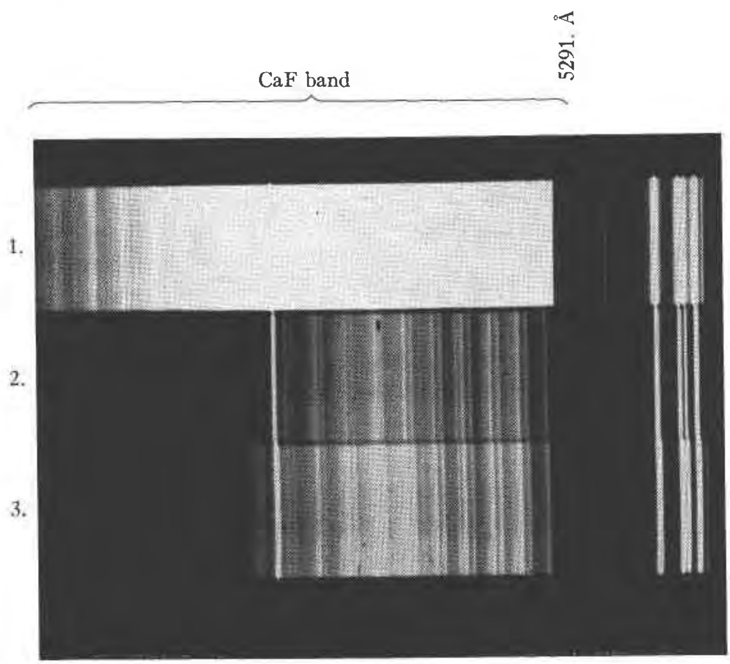

FIG. 2. Spectrograms of (1) a synthetic mixture of U_3O_8 and $CaCO_3$ containing 5.0 per cent fluorine, (2) schroeckingerite and (3) the synthetic mixture containing 2.0 per cent fluorine.

cent fluorine. Comparison of the intensities shows that the CaF band for schroeckingerite agrees with that of the 2.0 per cent standard.

Based on the analysis made in this laboratory, the composition of schroeckingerite may be written as: $Ca_3Na[UO_2(CO_3)_3(SO_4)F]\cdot 10H_2O$.

Petrography

The physical and optical properties of schroeckingerite recorded by the writers are essentially those published by Larsen[7] for "dakeite." The mineral is greenish yellow and occurs in micaceous, pseudohexagonal plates showing a perfect basal cleavage. It fluoresces a vivid yellow-green under the ultraviolet lamp. Before the Geiger-Mueller counter, it shows only faint radioactivity. The following optical properties were recorded:

	n
X (colorless to very pale yellow)	1.489 ± 0.002
Y (pale greenish yellow)	1.541 ± 0.002
Z (pale greenish yellow)	1.541 ± 0.002
2V=near 5° (−)	

Novácek and others have pointed out that schroeckingerite may be hexagonal, uniaxial and the small separation of the isogyres is due to strain. Numerous interference figures examined by the writers all showed a slight separation of the isogyres. As individual grains do not show any marked wavy extinction it is assumed that the mineral is biaxial.

Larsen notes that the mineral occurs as rounded to elongated pisolites, up to a centimeter in diameter in gypsite. He reports that "the gypsite is made up mostly of small crystals of gypsum with a little sand and the dakeite." The locality is further described by Dake,[8] who reports that the "dakeite" occurs in a gypsite bed having an average thickness of three feet. The bed is overlain by a "disintegrated granite" and underlain by "loosely consolidated sandstones and volcanic ash."

The samples obtained from the U. S. National Museum indicate that the schroeckingerite is not confined to the gypsite alone but also occurs in the "disintegrated granite" of Dake. A composite of several samples of the host rock examined in this laboratory showed a rather heterogeneous mineral assemblage and a surprisingly low gypsum content. The principal constituents, aside from schroeckingerite, included albite-oligoclase, microcline, quartz, and kaolinite. Accessory minerals represented included chlorite, epidote, hornblende, muscovite, gypsum, and rutile. A composite of several samples from which the schroeckingerite was removed analyzed only 0.02 per cent S, indicating a very low gypsum content. The host rock examined here is best classified as a partly indurated arkose.

An x-ray powder diffraction pattern of schroeckingerite obtained by H. F. Carl with an automatic recording x-ray diffraction spectrometer is given in Table 3.

TABLE 3. X-RAY POWDER DIFFRACTION PATTERN OF SCHROECKINGERITE FROM WYOMING

I/I_0	d_{hkl}	I/I_0	d_{hkl}
5	14.5	1	3.32
1+	8.3	1	3.24
10	7.2	1 broad	3.1
1+	5.62	6	2.88
1+	5.45	1	2.78
1	5.32	<1	2.71
6	4.81	<1	2.63
1	4.26	1+	2.40
1+	4.18	<1 broad	2.30
1	4.06	<1	2.12
1	3.61	3	2.05
1	3.37	1+	1.80

I/I_0 = relative intensity.
d_{hkl} = interplanar spacing.

ACKNOWLEDGMENTS

This investigation was conducted under the immediate supervision of Alton Gabriel, to whom the writers are indebted for valuable criticism and advice.

The writers wish to thank E. P. Henderson and James Benn, both of the U. S. National Museum, for furnishing the samples of schroeckingerite, Morris Slavin of the Metallurgical Division for helpful suggestions, and R. D. Dwiggins, formerly of the Metallurgical Division, for participation in the analytical work.