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FLUOCERITE AND ASSOCIATED MINERALS FROM THE BLACK CLOUD PEGMATITE, TELLER COUNTY, COLORADO*

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The Black Cloud pegmatite, which is exposed 800 feet north of U. S. Highway 24, 2.3 miles west of Divide in Teller County, Colorado, was studied in June 1957 and June 1958. Laboratory studies were completed between September 1958 and May 1959. Both field and laboratory work were supported by a grant from the Michigan Memorial-Phoenix Project Fund, Project 150. This study is part of a continuing investigation of the pegmatites of the South Platte–Pikes Peak area of Colorado, to which field work during the last three summers has been devoted (Heinrich, 1958), and represents an extension of a previous reconnaissance study of rare-earth pegmatites in Colorado (Heinrich, 1948).

The lensoid pegmatite, well exposed in two large open cuts, trends N. 40° W. with generally steeply dipping to vertical contacts with Pikes Peak granite. It is nearly 350 feet long, and at its bulbous northwestern nose it is 110 feet thick. The sharply defined internal structure includes:

1. Wall zone (quartz, oligoclase, microcline) as much as 25 feet thick, fine grained, with much graphic quartz-oligoclase rock.
2. Intermediate zone, 50–75 feet thick, masses of pink microcline with interspersed pods of white to gray quartz and scattered small beryl crystals.
3. Core of milky quartz, as much as 50 feet thick, studded with primary vugs 1–6 inches across enclosing clear, milky or smoky quartz crystals.

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4. Irregular replacement lenses and pods, 2–6 feet long, localized chiefly along contacts between quartz and microcline masses in the intermediate zone.
5. Fracture-controlled concentrations of biotite in books as large as 2 feet across.

The replacement bodies (0.1–0.5% of the pegmatite volume) are of two types: fluoritic (more common) and albitic. They contain nearly all the unusual minerals.

The accessory mineral assemblage is characterized by fluorides, phosphates, multiple oxides, and silicates of both Ce- and Y-group minerals (Table 1). Those occurring almost exclusively in the fluoritic pods are

TABLE 1. ACCESSORY MINERALS OF THE BLACK CLOUD PEGMATITE

Fluorides	Fluorite, fluocerite
Phosphates	Monazite, xenotime
Multiple oxides	Samarskite, yttrotantalite, fergusonite
Silicates	Allanite, gadolinite, thorite, beryl, bertrandite

xenotime, monazite, fluocerite, gadolinite, and thorite. Samarskite is confined to albitic pods. The other accessory species occur in both types, as does purple fluorite (Type III). Glassy green (Type I) and porcelanoid gray-tan (Type II) fluorites occur in fluorite-rich pods only. The bulk of the monazite and xenotime occurs as microscopic inclusions in Type II fluorite (Col. A, Table 3). The occurrence of yttrotantalite is the second authenticated for the United States; it was found as small grains in microcline.

Fluocerite, which has been reported previously in the United States only from Cheyenne Mountain, El Paso County, Colorado (Allen and Comstock, 1880; Hillebrand, 1899), occurs in very modest amounts in the pegmatite. It was found only on the dump in pieces 2 to 8 inches long. These specimens, which are aggregates of fluocerite, monazite, usually with some feldspar and several other minerals, have an extraordinary high specific gravity and are markedly radioactive. They are dark olive brown in color with a dull waxy luster. They show a characteristic texture consisting of ovoids of medium brown fluocerite as much as 0.8×1.0 inches in section, surrounded by a fine-grained rim which varies in color from darker brown to black to red (Fig. 1). The red marginal mineral is monazite. The other interstitial species has not been certainly identified (Unknown Mineral No. 1).

Optical properties of the fluocerite are as follows: uniaxial negative, indices of refraction $\omega = 1.615$, $\epsilon = 1.607$. The specific gravity is 5.80, by means of the Berman microbalance. This value is low owing to inclusions, chiefly monazite.

In thin section the mineral shows narrow multilamellar twinning,

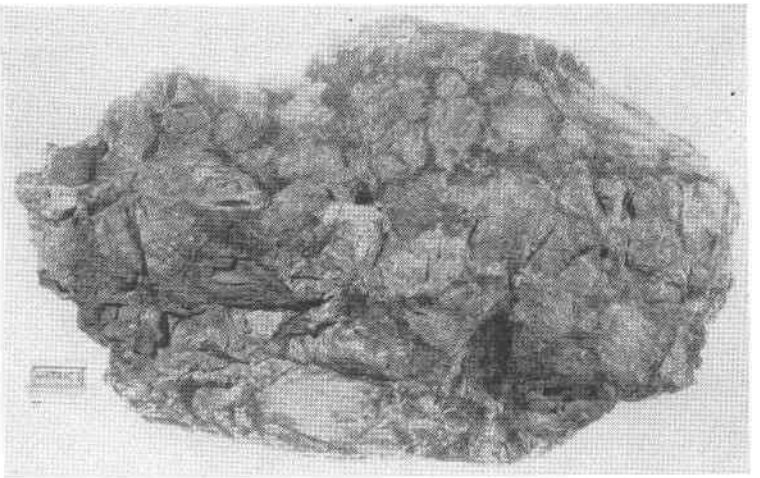

FIG. 1. Largest mass of fluocerite (9×14 cm.) found at Black Cloud pegmatite, Teller County, Colo. Irregular to rounded areas are fluocerite; dark interstitial material is chiefly unidentified RE silicate; darker brown areas in lower left are monazite.

pyramidal in orientation, making an angle of 45° with the trace of the perfect (0001) cleavage. Numerous inclusions of various types are present: 1) small specks or irregular blebs of monazite; 2) rounded grains of a high relief, turbid, golden brown isotropic species which, from the radial cracks that surround them, is strongly radioactive; and 3) aggregates of pinpoint flakes of a brilliant crimson mineral which shows very slight pleochroism, has low birefringence and moderate relief. The centers of the fluocerite ovoids are usually markedly altered to a yellowish brown, very fine-grained constituent, whose formation appears to have been controlled somewhat by the basal cleavage. It is apparently isotropic, and its segregation may have resulted from the selective replacement of cores of originally zoned fluocerite crystals.

The abundant associated monazite occurs as small blebs and marginal rims that extend thin veinlets into the fluocerite, especially along the cleavage.

Most of the other interstitial material is an exceedingly fine-grained aggregate, brownish to grayish brown in color, which shows very low birefringence and appears to have undergone extensive structural damage as the result of metamictization (Unknown Mineral No. 1). Some of this substance appears to be granular, some of it pseudomorphous after a bladed species. Most of it is barely translucent in thin section and has a mean index of refraction, $n = 1.81$. Spectroscopic analysis indicates it is probably a silicate principally of Al, Fe, Ca, La and Nd. We have not

TABLE 2. *X*-RAY DATA FOR FLUOCERITE

A		*B*	
d	I/I_1	*d*	*I*
3.629	.7	3.64	m
3.536	.6	3.55	m
3.186	1.0	3.19	vs
2.534	.3	2.54	vw
2.046	.8	2.05	s
1.997	.8	2.00	vs
1.813	.2	1.815	vw
1.780	.7	1.782	m
1.720	.5	1.723	w
1.614	.2		
1.592	.1		
1.429	.4	1.427	w
1.357	.4	1.36	w
1.342	.3	1.343	w
1.317	.4	1.32	w
1.268	.1		
1.256	.1		
1.209	.1		
1.180	.2		
1.170	.4	1.175	w
1.144	.1		
1.121	.4	1.127	vw
1.076	.1		
1.041	.4	1.045	vw
(and others)			

Col. A. (Ce, La)F_3 (synthetic). ASTM II—1152.
Col. B. Fluocerite, Black Cloud pegmatite, Colo.

TABLE 3. ANALYSES BY *X*-RAY FLUORESCENCE

	A	*B*		*A*	*B*
Ca	30.3	0.5	Gd	0.21	0.1
Y	1.8	0.2	Dy	0.13	
La	0.3	10.8	Er	0.08	
Ce	0.8	19.0	Fe	0.3	
Pr	0.25	1.1	Th	0.022	0.3
Nd	0.7	3.6	Sr	0.014	
Sm	0.1	0.3	Mo	0.5	

A. Type II fluorite, Black Cloud pegmatite, Colo., containing abundant microscopic inclusions of xenotime and monazite.
B. Fluocerite, Black Cloud pegmatite, Colo., containing about 8% quartz as inclusions.

been able to match its x-ray pattern with that of any other species available to us.

Other minerals commonly associated with the fluocerite are small grains of altered gadolinite, small grains and crystals of metamict thorite, and a rare unidentified colorless species of moderate birefringence, biaxial character, with a mean index of refraction near 1.54. Relict in sections rich in fluocerite are corroded grains of quartz, plagioclase, and microcline-perthite.

The identity of the fluocerite was checked by means of an x-ray powder photograph (Table 2); its composition is given in Table 3, Column B.

Most of the rare-earth pegmatites of the South Platte–Lake George area are enriched in Y-group rare earths. The nearest neighbor to the Black Cloud, the Teller pegmatite near Lake George (Glass *et al.*, 1958), as well as most of the other pegmatities of the district, are characterized by Y-earth accessory mineral assemblages. The Black Cloud deposit appears to be unique for the area in having an accessory mineral group of both Y- and Ce-group elements.

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DETRITAL EUXENITE AND ASSOCIATED MINERALS, SAND BASIN, GRANITE COUNTY, MONTANA*

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The presence of metamict multiple oxide and silicate minerals ("radioactive blacks") in many stream placers in west-central Idaho has long been established (e.g. Shannon, 1922), and in 1952–1954 the geology of these deposits was studied in detail (Mackin and Schmidt, 1956; summarized in Heinrich, 1958). The radioactive placer minerals have been derived chiefly from the quartz monzonitic facies of the Idaho batholith, in which they occur locally as accessory species. "Segregations" of quartz

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