Vol. 9 No. 3 Journal of Wuhan University of Technology *Sept.* 1994

A NEW MINERAL—FLUORBRITHOLITE-(CE)

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(Received: 1992-11-25)

Abstract: *The new mineral fluorbritholite-(Ce) occurs in nepheline syenite, marble xenoliths, sodalite syenite xenoliths and pegmatite dikes at Mont St. Hilaire, Quebec. It is associated mainly with analcine, microcline, aegirine, zircon, biotite, pyrophanite, astrophyllite, ancylite, natrolite, monazite etc.*

The mineral is hexagonal, $P6_3/m$, with a 9.517(5) Å, *c* 6.983(4) Å, *c/a* 0.7337, *v* 547.7(8) Å^3, *Z* = 2. *The strongest X-ray powder diffraction lines and their relative intensities (visual) are:* 2.851(100), 2.821(30), 2.753(30), 1.970(20), 1.969(30) *(for MSH-3).*

Fluorbritholite-(Ce) crystal is shown prismatic. Its colour is pale yellow, tan, reddish-brown. Streak colourless to pale brown; Lustre adamantine; Opaque to translucent; Hardness 5; *Brittle; Cleavage* {0001} *distinct; Fracture even to conchoidal; Density* 4.66(1) *(meas) or* 4.66 *g/cm*^{3} *(calc.); Non-fluorscent. Optically uniaxial (-),* ω 1.792(5), ε 1.786(5) *in* Na *light; Nonpleochroic.*

Electron microprobe analyses correspond to $(Ce_{1.69}La_{1.02}Na_{0.82}Nd_{0.44}Sr_{0.30}Ca_{0.17}Mn_{0.17}Y_{0.09}Pr_{0.06}Th_{0.05}Fe_{0.01})\sum_{4.32}(Si_{2.32}P_{0.61})\sum_{2.93}O_{11.81}F_{1.19}$, *the ideal struetural formula is* $(PEE,Ca)_5(Si,P)_3O_{12}F$.

Britholite-(Ce) and britholite-(Y) should be renamed respectively, hydroxylbritholite-(Ce) and hydroxylbritholite(Y) to be suggested in discussion section.

Key words: *new mineral*; *fluorbritholite-(Ce)*; *britholite*; *nepheline syenite*; *hexagonal*; *Mont St. Hilaire*; *Quebec*

1 Introduction

The new mineral fluorbritholite-Ce) $\cdot (REE,Ca)_5(Si,P)_3O_{12}F$, formerly was known as UK22 (Chao & Baker 1979)collected in summer of 1977 from Mont St. Hilaire, Quebec. The mineral was studied with cooperating by Gu Jiexiang and Tang Saren in China and George Y. Chao in Canada in the last two years. The mineral and name are approved by the comission on New Minerals and Mineral names of International Minernlogical Association in October 1991. The type specimes are deposited at the National Museum of Canada. The mineral is named for the composition and relationship to britholite.

2 Occurrence

The mineral occurs at Mont St. Hilaire, Quebec, in nepheline syenite, marble xenoliths, sodalite syenite xenoliths and pegmatite dikes. Fluorbritholite-(Ce) was found in the vugs. There are a large number of REE-bearing minerals with association. The main associted minerals are: analcime, microcline, aegirine, zircon, biotite, pyrophanite, astrophyllite, ancylite, natrolite, monazite(in vuges); fluorite, pectolite calcite, aegirine, carbonate-apatite, biotite, gotzenite (in marble xenoliths); lovozerite, lueshite, ussingite, eudialyte steenstrupine, gmelinite, phillipsite, chabazite, sodalite, analcime, serandite, albite, clinoamphibole, and many other rare and unidentified minerals. The mineral formed in the late magmatic and metasomatic stages.

3 Physical and Optical Properties

Fluorbritholite-(Ce) crystal generally displays as aggregates and patches of fine tan needles in radiating or subparallel groups. The single crystal is shown prismatic shape (—0.5mm), also nearly eqant (fig. 1). The colour is commonly pale yellow, tan, reddish-brown. The streak is colourless to pale brown. The lustre is adamantine, opaque to translucent. The hardneess is about 5 on the Mohs scale and brittle. The mineral has distinct {0001} cleavage. Fracture is even to conchoidal. The density of the mineral measured by Berman balance is 4.66(1)g/cm^3 and density calculated is 4.66g/cm^3. The mineral does not fluoresce under short-wave and long-wave ultraviolet light. Some specimens are partially metamict.

Fluorbritholite-(Ce) is optically pale yellow, nonpleochroic, transparent, parallel ex-

tinction and interference color of first order grey. The mineral is uniaxial(−) with ω 1.792 (5), ε 1.786(5) (measured in sodium light).

4 X-ray Crystallography

Table 1 X-ray powder diffraction data for fluorbritholite-(Ce) Mont Saint-Hilaire, Quebec

	MSH-1			*MSH*−2			*MSH*-3		
hkl	$D_{calc.}$	$D_{meas.}$	*I*	$D_{calc.}$	$D_{meas.}$	*I*	$D_{calc.}$	$D_{meas.}$	*I*
200	4.130	4.11	20	4.121	4.11[illegible]	10	4.130	4.170	20
111	3.942	3.950	10	3.939	3.921	10	3.941	3.930	10
002	3.504	3.494	20	3.492	3.483	10	3.499	3.492	20
102	3.225	3.219	20	3.215	3.205	10	3.222	3.223	20
210	3.118	3.118	20	3.115	3.116	10	3.122	3.115	20
211	2.852	2.845	100	2.845	2.839	100	2.851	2.840	100
112	2.824	2.822	40	—	—	—	2.821	2.818	30
300	2.753	2.747	30	2.747	2.741	10	2.753	2.748	30
310	2.919	2.287	10	2.286	2.284	5	2.291	2.293	10
113	2.098	2.099	10	2.091	2.093	5	2.096	2.097	10
400	2.065	2.063	5	—	—	—	—	—	—
222	1.971	1.970	30	1.966	1.965	10	1.970	1.970	20
312	1.917	1.916	15	1.913	1.911	5	1.917	1.917	10
320	—	—	—	—	—	—	1.895	1.894	5
213	1.870	1.870	40	1.865	1.864	10	1.869	1.868	30
321	1.829	1.829	20	1.825	1.827	10	1.829	1.826	20
410	1.820	1.820	20	1.799	1.799	10	1.802	1.803	20
402	1.779	1.779	20	1.775	1.775	10	1.778	1.778	20
004	1.752	1.751	20	1.746	1.747	10	1.750	1.751	20
331	1.550	1.551	10	1.547	1.549	5	1.550	1.550	10
214	1.528	1.528	10	1.523	1.524	5	1.526	1.527	10
502	1.494	1.497	10	—	—	—	1.494	1.496	10
304	1.478	1.480	10	1.473	1.473	5	1.477	1.475	10
332	1.448	1.450	10	—	—	—	1.477	1.479	10

114.6 mm Gandolfi camera, CuKa radiation (λ=1.5418 Å), visual intensities. MSH-1 was heat treated at 800℃ for 3 hrs to improve crystallinity

Precession and 4-circle method are used for single crystal studies. the result indicats that fluorbritholite-(Ce) is hexagonal, with a 9.517(5), c 6.983(4) Å. c/a 0.7337, v 547.7(8) Å^3, Z=2. The systematic extinction observed are consistent with space group $P6_3/m$. The cell parameters are refined by least-squares method using powder diffraction data

obtained from photographs taken with CuKα radiation and a 114.6mm Gandolfi camera. The X ray powder diffraction data of fluorbritholite-(Ce)are given in Table 1. The unit cell, density and optical data are shown in table 2.

Table 2. Gladstone-Dale calculations

	MSH-1	*MSH*-2	*MSH*-3
a(Å)	9.537(5)	9.517(5)	9.937(6)
c	6.999(4)	6.983(4)	7.006(5)
D_{calc} (g/cm³)	4.727	4.65	5.000
$D_{meas.}$	—	4.66(1)	—
ε	1.789(5)	1.786(5)	1.790(5)
ω	1.785(5)	1.792(5)	1.794(5)
K_p(1)	0.165	0.159	0.158
K_c	0.164	0.166	0.158

(1)Calculated using $D_{calc.}$

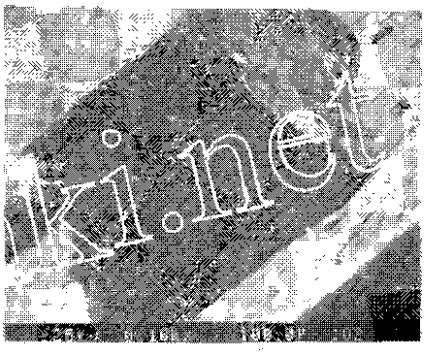

Fig. 1. Scanning ellectron photomicrograph of fluorbritholite-(Ce)

5 Chemical Composition

Three chemical analyses were carried out by means of an electron microprobe using the following standards: REE2(Nd, Sm), REE3 (Ce, La, Pr, Y, Ca, Si, Al), hornblende(Fe, Mg, Na), ilmenite(Mn), celestine(Sr), thorite(Th), brannerite (U), apatite (P) and biotite (F). The three sets of data are given in Table 3. The empirical formulas (based on O+F=13) are:

MSH−1: $(Ca_{1.95}Ce_{1.35}La_{0.76}Nd_{0.31}Pr_{0.17}Y_{0.19}Th_{0.05}Sr_{0.08}Sm_{0.03})_{\sum 4.73}(Si_{0.68}P_{0.32})_{\sum 2.99}O_{12.02}F_{0.98}$.

MSH−2: $(Ca_{1.77}Ce_{1.55}La_{0.96}Nd_{0.21}Na_{0.21}Mn_{0.15}Sr_{0.09}Pr_{0.08}Th_{0.05}Y_{0.02}Sm_{0.01})_{\sum 4.99}(Si_{0.17}P_{0.79})_{\sum 2.78}O_{11.96}F_{1.04}$.

MSH−3: $(Ce_{1.68}La_{1.02}Na_{0.82}Nd_{0.41}Sr_{0.30})Ca_{0.29}Mn_{0.17}Y_{0.02}Th_{0.03}Fe_{0.01})_{\sum 4.92}(Si_{2.32}P_{0.61})_{\sum 2.93}O_{11.81}Y_{0.09}Th_{0.02}Fe_{0.01}\sum_{4.92}(Si_{2.32}P_{0.61})_{\sum 2.93}O_{11.81}F_{1.19}$.

The simplified formula is $(REE,Ca)_5(Si,P)_3O_{12}F$ (the substitution are too numerous to calculate the theoretcal composition). $1-(K_p/K_c)=0.027$. The compatibility with empirical chemical is excellent. Fluorbritholite-(Ce) is gelatinizes in HCl and H_2SO_4, both 1:1.

6 Discussions

The F-analogue of britholite-(Ce) from Mont St. Hilaire is not new as it has been noted from many other localities. We are proposing a new name fluorbritholite-(Ce), so that it

Table 3. Composition of fluorbritholite-(Ce)

	MSH-1	MSH-2	MSH-3
Ce_2O_3 wt%	29.17	28.70	33.14
La_2O_3	15.80	20.21	19.78
Pr_2O_3	3.52	1.69	1.20
Nd_2O_3	8.83	4.62	8.78
Sm_2O_3	0.67	0.25	—
Y_2O_3	1.26	0.36	1.27
FeO	—	—	0.10
CaO	13.96	12.87	1.92
SrO	0.45	1.18	3.74
MgO	0.02	—	—
MnO	—	1.39	148
Na_2O	0.01	0.85	3.04
ThO_2	1.74	1.84	1.09
U_3O_8	0.30	0.11	0.31
SiO_2	20.61	16.92	16.59
Al_2O_3	—	—	0.08
P_2O_5	2.84	7.25	5.21
F	2.38	2.58	2.70
F=O	−1.00	−1.09	−1.14
Total	100.56	99.73	99.20
Number of ions on the basis of 13(O+F)			
Ce	1.39	1.35	1.69
La	0.76	0.96	1.02
Pr	0.17	0.08	0.06
Nd	0.31	0.21	0.44
Sm	0.03	0.01	—
Y	0.09	0.02	0.09
Fe	—	—	0.01
Ca	1.95	1.77	0.29
Sr	0.03	0.09	0.30
Mn	—	0.15	0.17
Na	—	0.21	0.82
Th	0.05	0.05	0.03
U	0.01	—	2.32
Si	2.68	2.17	0.01
Al	—	—	0.61
P	0.31	0.79	1.19
F	0.98	1.04	

standards; REE2(Nd, Sm), REE3(Ce, La, Pr, Y, Ca, Si, Al), hornblende (Fe, Mg, Na), ilmenite (Mn), ce-

lestite(Sr), thorite(Th), brannerite(U), apatite(P), biotite(F).

may be distinguished from the OH-rich members, following the accepted practice as for the apatite and apophyllite groups of minerals. The type material of britholite-(Ce) from Greenland contains more OH than F (OH : F = 1.98 : 1). Another mineral from the Urals has an OH : F ratio of 7.45 : 1.

We suggest that britholite-(Ce) should be renamed hydroxylbritholite-(Ce), also britholite-(Y) should be renamed hydroxylbritholite-(Y). The chemical formula of britholite-(Ce) should be officially $(Ce.Ca.Na)_5(SiO_4.PO_4)_3(OH,F)$.

Table 3 shows that there are high-(Ca) (*MSH*-1 and *MSH*-2) and low-Ca(*MSH*-3) varies from Mont St. Hilaire. The structural significance of the difference in Ca contents is not yet clear and, therefore, no attempt is made to distinguish them.

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