LAPTEVITE–(Ce) NaFe^{2+}(REE_7Ca$_5$Y$_3$)(SiO$_4$)$_4$(Si$_3$B$_2$PO$_{18}$)(BO$_3$)F$_{11}$ – NEW MINERAL[1] OF THE VICANITE GROUP FROM THE DARAI–PIOZ ALKALINE MASSIF, TAJIKISTAN

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Laptevite-(Ce) is a new mineral of the vicanite group. It was found in a calcite-bafertisite-aegirine-microcline rock in association with stillwellite-(Ce), calcibeborosilite-(Y), fluorite, polylithionite and other minerals at the Darai-Pioz glacier moraine (Tajikistan). Color is dark-brown, in thin plates is transparent. Vitreous luster. It occurs as poorly formed crystals up to 1 cm in size. Mohs' hardness $4.5 - 5$. $D_{meas.} = 4.61(2)$ g/cm^3, $D_{calc.} = 4.619$ g/cm^3. Optically uniaxial negative, $n_o = 1.741(3)$, $n_e = 1.720(3)$. It is partially metamict. Crystal structure has been refined with R = 3.61%. Hexagonal symmetry, space group $R3m$, $a = 10.804(2)$Å; $b = 10.804(2)$Å; $c = 27.726(6)$Å; $V = 2802.7(2)$Å^3, Z = 3. Most intense X-ray powder data lines are as follows [d, (I), (hkl)]: 7.70 (19) (012); 4.41 (29) (202); 3.13 (26) (214); 3.03 (100) (027); 2.982 (85) (125); 2.954 (60) (033); 2.689 (40) (-240); 1.979 (31) (330); 1.770 (21) (-555). IR spectrum (strongest absorption bands, cm^{-1}) 1623, 1437, 1300, 945, 930, 877, 758, 637, 570, 531. Chemical composition (microprobe analysis, wt.%): SiO$_2$ – 15.67, TiO$_2$ – 0.28, ZrO$_2$ – 0.01, ThO$_2$ – 0.38, UO$_2$ – 0.65, FeO – 1.48, CaO – 11.64, MnO – 1.02, SrO – 0.95, Y$_2$O$_3$ – 11.30, La$_2$O$_3$ – 14.51, Ce$_2$O$_3$ – 16.93, Pr$_2$O$_3$ – 2.76, Nd$_2$O$_3$ – 5.16, Sm$_2$O$_3$ – 0.98, Eu$_2$O$_3$ – 0.10, Gd$_2$O$_3$ – 1.56, Tb$_2$O$_3$ – 0.29, Dy$_2$O$_3$ – 1.37, Tm$_2$O$_3$ – 0.17, Yb$_2$O$_3$, – 0.28, B$_2$O$_3$ – 4.98, P$_2$O$_5$ – 1.51, Na$_2$O – 1.05, F – 8.53, –O=F$_2$ – 3.59, total – 100.46. The simplified formula is NaFe^{2+}(REE_7Ca$_5$Y$_3$)(SiO$_4$)$_4$(Si$_3$B$_2$PO$_{18}$)(BO$_3$)F$_{11}$. The mineral is named in honor of Tatyana Mikhaylovna Lapteva (1928 – 2011), the Soviet geologist, petrographer, who made a major contribution to geological study of Central Asia.
3 table, 4 figures, 13 references.
Keywords: laptevite-(Ce), vicanite group, Darai-Pioz alkaline massif.

Laptevite-(Ce) was found in a fenitized rock 1 × 0.8 × 0.4 meter in size, from the Upper Darai-Pioz alkaline massif, which occurs in moraine deposits of the same name glacier (Tajikistan). The Darai-Pioz massif has an isomeric form; it is located on a joint of the Zeravshansky, Alaisky and Turkestansky ridges in the upper part of the Darai-Pioz river. A considerable part of the massif is overlain by a glacier, and primary rock exposures on the massif are hardly accessible. In this regard, mineralogy and petrography of the Upper Darai-Pioz alkaline massif are done on material from moraine deposits. Many publications are devoted to geology and mineralogy of this alkaline massif (Moskvin, 1937; Dusmatov *et al.*, 1963; Dusmatov, 1968; 1971; Semenov *et al.*, 1963; Belakowski, 1991; etc.). The mineralogy of the Upper Darai-Pioz alkaline massif, as well as the majority of alkaline massifs, is extremely variable and unique in many respects. As a rule, almost all alkaline massifs have characteristic geochemically distinct features. One feature of the Upper Darai-Pioz alkaline massif is the large variety of B and *REE* minerals: stillwellite-(Ce), tadzhikite-(Ce), tadzhikite-(Y), kapitsaite-(Y), calcibeborosilite-(Y), byzantievite. Almost all these minerals, except stillwellite-(Ce), were

discovered and described from rocks of this massif.

The leucocratic rock in which laptevite-(Ce) was found, consists of calcite, bafertisite, aegirine and microcline, has uneven granular texture, from fine- to coarse-grained, often with a spotty texture. This texture is caused by the uneven distribution of accu-mulations of microcline, aegirine, calcite, bafertisite, quartz, calcibeborosilite-(Y), stillwellite-(Ce) and laptevite-(Ce). Microcline consists of coarse idiomorphic grains 1 − 6 cm in size; the color is grayish to yellow-white. Aegirine forms prismatic, often deformed, black crystals up to 3 cm long. Quartz forms icy, translucent, light gray, coarse-grained agregates, 2 − 3 cm in size. One characteristic feature of this association is the presence of relatively large plates of brown-red bafertisite; tetragonal, poorly formed calcibeborosilite-(Y) crystals to 2 cm of a dark gray color and aquant grains of light pink stillwellite-(Ce), to 3 cm, without visible faces. Minor minerals are fluorite, polylithionite and albite. Most often, laptevite-(Ce) grows together with bafertisite, calcibeborosilite-(Y) and stillwellite-(Ce).

Physical properties

Laptevite-(Ce) occurs as poorly formed crystals to 1 cm (Fig. 1), commonly with metamict cores. It is brown, with yellowy-brown cores. In thin splinters, it is transparent. The luster is vitreous, often greasy, fracture is uneven, cleavage is absent. The Mohs hardness is 4 − 4.5. Microhardness VHN = 453 (ave. on 15 measurements, the range is VHN = 443 to 485); measurements were made at the PMT-3, calibrated on NaCl at loading of 50 g. The measured density is 4.61(2) g/cm^3, it was determined by equilibration in aqueous solution of Clerici liquid. The calculated density is 4.619 g/cm^3. Refractive indices of laptevite-(Ce) measured by the immersion method (at 589 nm) are as follows: $n_o = 1.741(3)$, $n_e = 1.720(3)$, mineral is optically negative, uniaxial. Laptevite-(Ce) is water-insoluble, dissolves poorly in HCl (1:1) at room temperature. The infrared spectrum was measured on an Avatar IR-Fourier spectrometer of Thermo Nicolet with a KBr microtablet (Fig. 2). The strongest absorption bands of laptevite-(Ce) are as follows (cm^{-1}): 1623, 1437, 1300, 945, 930, 877sh, 758, 637, 570, 531.

Chemical composition

The chemical composition of laptevite-(Ce) was determined in two laboratories: at Fersman Mineralogical Museum RAS, Moscow and at the Geological Sciences Department, University of Manitoba, Winnipeg, Canada, by EMPA with both wave dispersive and energy dispersive spectrometers (WDS and EDS). Eight grains of a laptevite-(Ce) were studied and 42 analyses were determined for them. In A.E. Fersman Mineralogical Museum analyses were obtained with a JCXA-733 of JEOL electron microprobe using (Si-Li) EDS and INCA analysis system at 20 kV accelerating voltage, 2 nA probe current and 1 µm probe diameter. The following standards were used: microcline USNM143966 (Si), anorthite USNM 137041 (Ca), ilmenite USMN 96189 (Ti, Fe), Mn (Mn), SrTiO$_3$ (Sr), YPO$_4$ (Y), LaPO$_4$ (La, P), CePO$_4$ (Ce), PrPO$_4$ (Pr), NdPO$_4$ (Nd), SmPO$_4$ (Sm), EuPO$_4$ (Eu), GdPO$_4$ (Gd), TbPO$_4$ (Tb), DyPO$_4$ (Dy), TmPO$_4$ (Tm), YbPO$_4$ (Yb), omphacite USNM 110607 (Na), MgF$_2$ (F). At the University of Manitoba, analyses were done using a Cameca SX-100 electron microprobe, equipped with WDS at 15 kV accelerating voltage, 20 nA probe current and 5 µm probe diameter. The following standards

Fig. 1. A brown crystal of laptevite-(Ce) with bafertisite in calcite with microcline. Slanting light. Width of a view field is 5 cm.
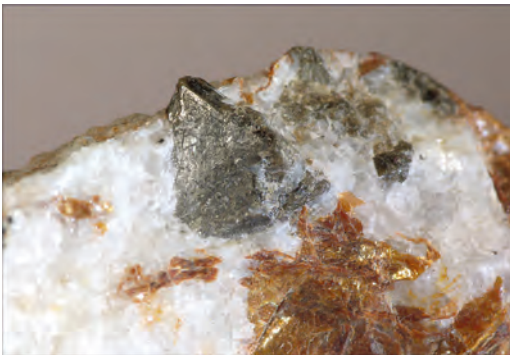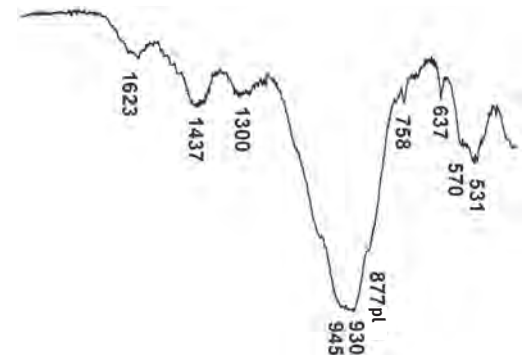
Fig. 2. IR spectrum of a laptevite-(Ce), obtained at the Avatar IR-Fourier spectrometer of Thermo Nicolet from a tablet with KBr.

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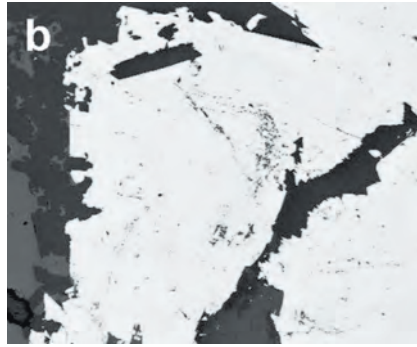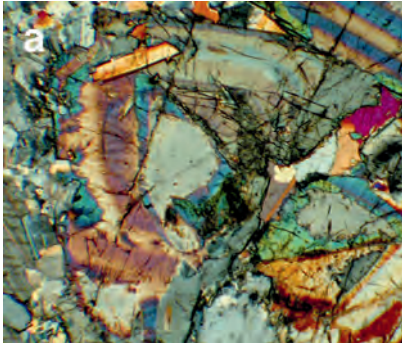
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Fig. 3. Accretion of zoned laptevite-(Ce) crystals with albite and calcite:
a — the transparent polished section in transmitted light (nicols are crossed);
b — the same fragment in the back-scattered electrons contrast mode on average atomic number (BSE). Width of a vision field is 2.6 mm.

Table 1. **Chemical composition of laptevite-(Ce) (wt.%)**

Component	1		2
	Average	Range	
SiO$_2$	15.67	14.54 − 15.98	15.58
TiO$_2$	0.28	0.18 − 0.53	0.30
ZrO$_2$	0.01	0.00 − 0.05	0.10
ThO$_2$	0.38	0.17 − 0.56	0.43
UO$_2$	0.65	0.44 − 0.71	0.70
FeO	1.48	1.31 − 1.66	1.59
CaO	11.64	11.12 − 12.01	11.83
MnO	1.02	0.82 − 1.07	0.84
SrO	0.95	0.81 − 1.60	1.46
Y$_2$O$_3$	11.30	11.07 − 11.73	11.21
La$_2$O$_3$	14.51	13.20 − 15.01	13.86
Ce$_2$O$_3$	16.93	16.20 − 17.92	17.58
Pr$_2$O$_3$	2.76	2.43 − 3.97	2.90
Nd$_2$O$_3$	5.16	4.37 − 5.58	5.10
Sm$_2$O$_3$	0.98	0.77 − 1.26	1.03
Eu$_3$O$_3$	0.10	0.04 − 0.34	0.16
Gd$_2$O$_3$	1.56	1.19 − 1.69	1.40
Tb$_2$O$_3$	0.29	0.16 − 0.25	0.21
Dy$_2$O$_3$	1.37	1.24 − 1.67	1.47
Tm$_2$O$_3$	0.17	0.09 − 0.26	0.13
Yb$_2$O$_3$	0.28	0.20 − 0.39	0.35
B$_2$O$_3$	4.98	3.79 − 5.40	4.71
P$_2$O$_5$	1.51	1.35 − 1.58	1.47
Na$_2$O	1.05	0.86 − 1.26	0.98
F	8.53	8.05 − 9.47	8.44
Total	103.56		103.83
− O = F$_2$	− 3.59		− 3.55
Total	99.97		100.28

Note. 1 − the average and variation limits of 42 microprobe analyses for 8 grains are executed by means of JCXA-733 equipped with INCA EDS (U = 20 kV, I = 2 nA, probe diameter at 1 μm), 10 analyses has performed with Cameca SX-100 equipped with WD (U = 15 kV, I = 20 nA, 5 μm probe diameter), B$_2$O$_3$ determined by the ICP OES method (3 analyses); analysts A.A. Agakhanov, L.A. Pautov, Panseok Yang.
2 − the analysis of grain, on which crystal structure of a mineral was solved (from the same sample); performed with Cameca SX-100 equipped with WD (U = 15 kV, I = 20 on, probe diameter at 5 μm), (Uvarova et al., 2013).

were used: titanite (Ti), zircon (Zr), ThO$_2$ (Th), UO$_2$ (U), pyrope (Fe), spessartine (Mn), strontianite (Sr), YPO$_4$ (Y), LaPO$_4$ (La, P), CePO$_4$ (Ce), PrPO$_4$ (Pr), NdPO$_4$ (Nd), SmPO$_4$ (Sm), EuPO$_4$ (Eu), GdPO$_4$ (Gd), TbPO$_4$ (Tb), DyPO$_4$ (Dy), TmPO$_4$ (Tm), YbPO$_4$ (Yb), datolite (B), jadeite (Na), fluorite (F), diopside (Si, Ca).

For the determination of Li, Be, B and *REE*, three analyses by ICP-OES were made. In order to do this, a grain of laptevite-(Ce), previously checked by EDS, was digested in polypropylene bottles in 40% HF with addition of HNO$_3$ and were evaporated to wet salts. After which, HNO$_3$ was repeatedly added to sample and evaporated to a solid residue for full removal of all fluorides. Further, the residue was dissolved in HNO$_3$, and then diluted to 2% HNO$_3$. The resultind solution was analyzed with a VISTA Pro instrument of Varian. Concentrations of Be and Li, measured by the ICP-OES method in the new mineral does not exceed trace amounts. The data for B and *REE* by ICP-OES method are correlate well with those, obtained by EPMA.

Crystals of laptevite-(Ce) are often cracked and include intergrowths of other phases (Figs. 3, 4). They also show zonality, generally connected with isomorphous substitutions of La, Ce and Y (Fig. 4).

The average composition from electron microprobe and ICP-OES methods (Table 1, an. 1) was recalculated (on a base of total anions (O + F) = 48 apfu), giving the empirical formula (Na$_{0.88}$$REE_{0.12}$)$_{Σ1.00}$(Fe$_{0.54}Mn_{0.37}Ti_{0.09}$)$_{Σ1.00}$($REE_{6.79}Ca_{5.40}Y_{2.60}Sr_{0.24}U_{0.06}Th_{0.04}$)$_{Σ15.13}$(SiO$_4$)$_4$(Si$_{2.78}B_{2.68}P_{0.55}O_{17.33}F_{0.67}$(B$_{1.05}O_3$)F$_{11}$, at this REE = Ce$_{2.68}La_{2.32}Nd_{0.80}Pr_{0.44}Gd_{0.22}Dy_{0.19}Sm_{0.15}Yb_{0.04}Tb_{0.04}Tm_{0.02}Eu_{0.01}$.

The simplified formula of laptevite-(Ce) is NaFe^{2+}(REE_7Ca$_5$Y$_3$)(SiO$_4$)$_4$(Si$_3$B$_2$PO$_{18}$)(BO$_3$)F$_{11}$. The analysis of a grain fragment, from which crystal structure of a mineral was studied, is also given in table 1 (an. 2). The compatibility in-
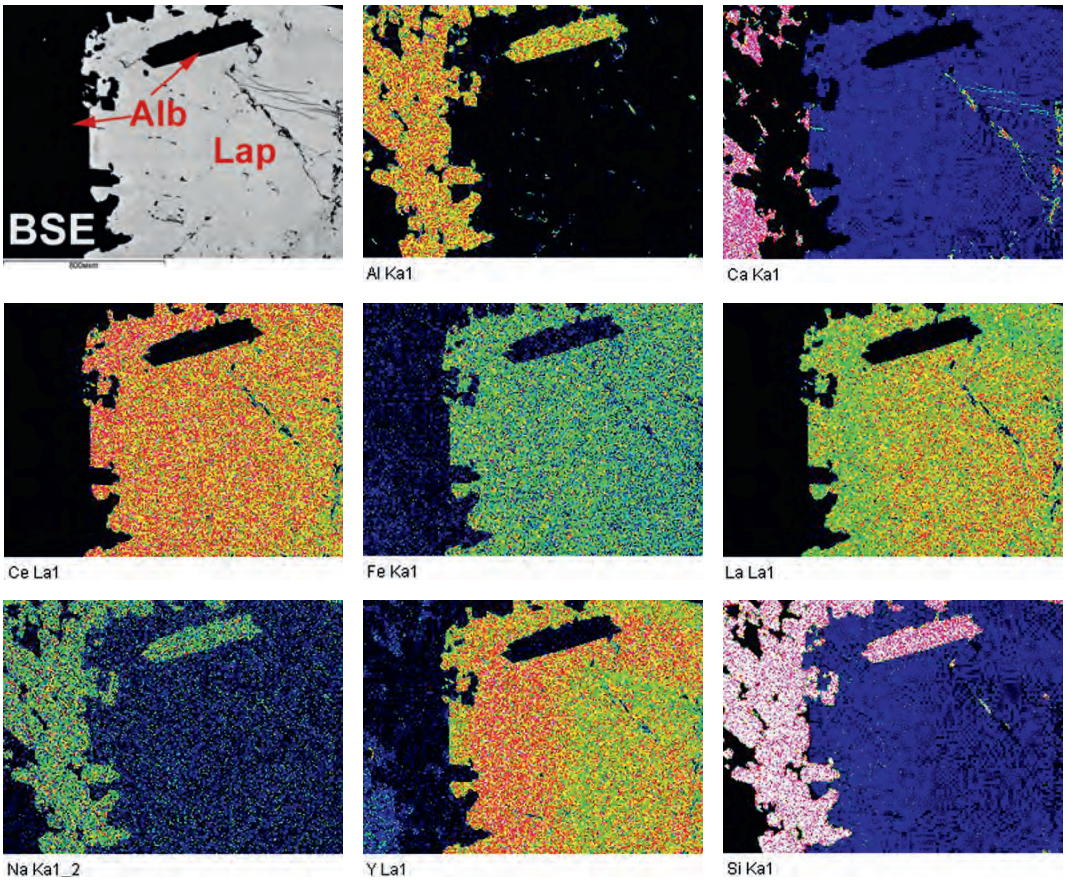
Fig. 4. A fragment of laptevite-(Ce) crystal (Lap); intergrowth with albite (Alb). BSE image mode and X-ray maps of distribution of the specified elements.

dex $(1 - K_p/K_c) = 0.004$, that corresponds to its highest degree (superior).

X–ray data

At the initial stage of this investigation, X-ray powder data of this phase were measured. After this, grains for single crystal work were selected, but they appeared metamict. Further fractions of the mineral were extracted from five samples and attempts to measure X-ray powder data were made, but those fractions also were metamict. This problem was solved by heating the mineral. The fragments of crystals, selected for tempering contained yellow-brown, more transparent cores and dark cracked rims. The compositions of both zones in the extracted crystal fragments were checked using EDS. Tempering was done in a tubular furnace at 800°C in a stream of argon. The central parts of the laptevite-(Ce) crystals turned into a white porcellanous X-ray-amorphous substance, and the external rim of the crystals remained without visible changes and gave X-ray powder data identical to those obtained at the beginning of the investigation for non-heated material. All further measurements were obtained on the heated material.

X-ray powder data of a laptevite-(Ce) (Table 2) were recorded on the DRON-2 instrument with a graphite monochromator (Cu$K\alpha$ radiation). Quartz was used as the internal standard. The powder data are well indexed in hexagonal cell, space group $R3m$: $a = 10.779(2)$, $c = 27.864(4)$Å, $V = 2803.6(3)$Å^3, $Z = 3$. Unit cell parameters and powder data of laptevite-(Ce) are very close to those of the vicanite group minerals (Table 3). The structure of laptevite-(Ce) was refined on 924 independent reflections to an R-factor = 3.87%. A mineral hexagonal, space group $R3m$, $Z = 3$. Cell dimensions are as follows: $a = 10.804(2)$, $c = 27.726(6)$Å, $V = 2802.6(2)$Å^3 (Bruker P4

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Table 2. **X-ray powder diffraction data for laptevite-(Ce)**

observed I	observed d, Å	calculated I	calculated d, Å	hkl
5	9.24	7	9.216	0 0 3
19	7.70	17	7.755	0 1 2; 1 -1 2; -1 0 2
2	5.38	3	5.394	1 1 0; -2 1 0
6	4.73	4	4.767	0 1 5; 1 -1 5
29	4.41	38	4.428	2 0 2; -2 2 2; 0 -2 2
4	3.62	7	3.650	1 0 7; -1 1 7
13	3.59	5	3.579	2 0 5; 0 2 5; -2 2 5
7	3.53	7	3.513	-1 -1 6
4	3.48	2	3.508	2 1 1
6	3.41	3	3.427	-1 3 2
5	3.20	3	3.249	0 1 8
26	3.13	37	3.149	2 1 4; 3 -1 4; -2 3 4
19	3.11	14	3.123	-3 3 0; 0 3 0; 3 0 0
4	3.08	11	3.081	0 0 9; 0 2 7
100	3.03	100	3.023	-2 0 7; 2 -2 7
85	2.982	41	2.980	1 2 5; -1 3 5; 3 -2 5
60	2.954	51	2.955	0 3 3; 3 0 3; -3 3 3
10	2.750	15	2.782	2 0 8
40	2.689	38	2.701	-2 4 0; -4 2 0; 2 2 0
13	2.610h	10	2.638	2 1 7
		2	2.593	2 2 3
6	2.553	8	2.550	3 1 2
3	2.430	4	2.431	3 -4 4
8	2.202h	5	2.216	4 0 4
		13	2.191	0 3 9; 3 0 9
11	2.171	9	2.172	3 -4 7; -4 1 7; -3 -1 7
15	2.154	9	2.155	4 -4 5; 0 4 5; -4 0 5
3	2.142	2	2.140	3 2 1
13	2.117	10	2.121	2 3 2; -2 5 2; 5 -3 2
2	2.079	4	2.080	0 -1 13; 1 0 13; -1 1 13
11	2.049	11	2.050	3 2 4; -2 -3 4; 2 -5 4
13	2.030	12	2.031	-2 -2 9; 2 2 9; -2 4 9
10	2.012	6	2.012	4 0 7; -4 4 7; 0 -4 7
8	2.003	17	2.002	2 3 5; 3 -5 5; -5 2 5
14	1.990	16	1.994	4 1 3; -1 5 3; 5 -1 3
3	1.942	6	1.940	-4 0 8; 0 4 8; 4 -4 8
4	1.885	5	1.887	-5 3 7; -3 5 7; 3 2 7
8	1.869	6	1.868	1 4 6; 4 1 6
18	1.845	23	1.855	0 3 12
13	1.822	16	1.824	-5 2 8; 3 -5 8; 2 3 8
31	1.797	19	1.801	3 3 0; -3 6 0; -6 3 0
21	1.770	15	1.773	-5 5 5; 5 0 5; 0 -5 5
5	1.700	8	1.698	3 2 10
7	1.683	3	1.685	-6 4 5; 4 2 5
3	1.622	3	1.624	0 2 16
8	1.598	4	1.590	0 3 15
5	1.548	4	1.548	5 1 7
8	1.540	5	1.539	2 0 17; 0 0 18
6	1.529	6	1.529	1 4 12
7	1.514	4	1.513	3 2 13; 1 5 8; 0 4 14
2	1.500	3	1.501	-7 4 4
5	1.491	2	1.491	2 4 10; -7 5 3
14	1.477	9	1.479	5 2 3
2	1.424	2	1.425	2 -7 3; 7 -5 6

Note. DRON-2 diffractometer; Cu anode, graphite mono-chromator, counter speed is 1°/min, quartz used as internal standard. Analyst A.A. Agakhanov.

diffractometer with the CCD detector, Mo$K\alpha$ radiation) (Uvarova *et al.*, 2013).

The structure of the new mineral has the main features of minerals of the vicanite group (Ballirano *et al.*, 2002; Bioiocchi *et al.*, 2004; Raade *et al.*, 2007; 2008; Uvarova *et al.*, 2013). Basic elements of the structure are as follows: layers A (z ~ 0), B (z ~ 0.13) and C (z ~ 0.23), linked into a complex heteropolyhedral framework. There are four tetrahedral sites (*T*1-*T*4) occupied by Si, B, P and coordinated by O, a triangular *T*5 position occupied by B and coordinated by O and F, an octahedral *M*6 position = (Fe²⁺, Mn, Ti), coordinated by O

Table 3. **Comparative characteristic of minerals: laptevite-(Ce), vicanite-(Ce), okanoganite-(Y), hundholmenite-(Y) and proshchenkoite-(Y)**

Mineral characteristics	laptevite-(Ce)	vicanite-(Ce)	okanoganite-(Y)	hundholmenite-(Y)	proshchenkoite-(Y)
Formula	$Na(Fe^{2+},Mn^{2+})$ $(REE_7Ca_5Y_3)_{15}$ $(SiO_4)_4(Si_3B_2PO_{18})$ $(BO_3)F_{11}$	$(Ca,REE,Th)_{15}Fe^{3+}$ $[SiO_4]_3[Si_3B_3O_{18}]$ $[BO_3](As^{5+}O_4)$ $(As^{3+}O_3)_x(NaF_3)_{1-x}F_7$ $(H_2O)_{0.2}$, x=0.4	$(Na,Ca)_3(Y,Ce)_{12}$ $B_2Si_6O_{27}F_{14}$	$(Y,REE,Ca,Na)_{15}$ $(Al,Fe^{3+})Ca_xAs^{3+}_{1-x}$ $(Si,As^{5+})Si_6B_3$ $(O,F)_{48}$	$(Y,REE,Ca,Na,Mn)_{15}$ $(Fe^{2+},Mn)Ca(P,Si)$ $Si_6B_3O_{34}F_{14}$
Space group	$R3m$	$R3m$	$R3m$	$R3m$	$R3m$
a, Å c Z	10.804(2) 27.726(6) 3	10.8112(2) 27.3296(12) 3	10.7108(5) 27.0398(11) 3	10.675(6) 27.02(2) 3	10.7527(7) 27.4002(18) 3
X-ray powder intensive lines, $D_{meas.}(I)$	7.70 (19) 4.41 (29) 3.13 (26) 3.03 (100) 2.982 (85) 2.954 (60) 2.689 (40) 1.979 (31) 1.770 (21)	7.70 (50) 4.42 (50) 3.13 (50) 2.993 (100) 2.950 (70) 2.698 (50) 1.839 (50) 1.802(50)	4.38(41) 3.11(48) 2.970(100) 2.939(95) 2.926(50) 2.676(32) 1.978(35) 1.822(32) 1.784(43)	4.38 (33) 3.114 (43) 2.972 (100) 2.947 (76) 2.924 (66) 2.681 (36) 1.978 (37)	4.441 (36) 3.144 (77) 3.028 (45) 2.968 (100) 1.782 (32) 1.713 (32)
Color	brown, yellowy-brown	flavovirent	reddish-brown, light pink	pale grayish-brown to the grayish-brown	
Luster	vitreous	vitreous		vitreous, diamond	
$D_{meas.}$, g/cm³	4.61(2)	> 4.2	4.35(4)	> 4.2	4.72
$D_{calc.}$, g/cm³	4.619	4.73	4.96	5.206	4.955
Mohs hardness	4.5−5	5−6	4	5−6	near 5
Optical properties (sign)	uniaxial (−)	uniaxial (−)	uniaxial (−)	uniaxial (−)	uniaxial (−)
n_o	1.741(3)	1.757(2)	1.753(2)	1.7578(5)	1.734(2)
n_e	1.720(3)	1.722(2)	1.740(2)	1.7487(5)	1.728(2)
	Our data	Maras *et al.*, 1995; Ballirano *et al.*, 1991	Boggs, 1980	Raade *et al.*, 2008	Raade *et al.*, 2008

atoms, and six positions with coordination from 7 to 10: $M1$-$M5$ positions occupied by Ca and *REE*, and $M7$ occupied by Na and *REE*. $M1$-$M6$ positions are coordinated generally by oxygen, to a lesser extent by F.

In the **A layer**, T1 and T4 tetrahedra are linked into a complex anion, which is characteristical for vicanite minerals group; it's composition is $(Si_3B_2PO_{18})^{-17}$ in laptevite-(Ce), unlike other minerals of group where the composition of this anion is $(Si_3B_3O_{18})^{-15}$. Other units of the A layer are M6 clusters, formed by octahedra, which are connected with SiO-tetrahedra (T1, T2) and the polyhedron $^{[9]}M(1) = (REE, Ca)$.

The **B layer** in laptevite-(Ce) consists of isolated Si-O T3 tetrahedra ($B_{0.84}\square_{0.16}$), triangles and also $^{[10]}M2 = (REE, Ca)$ and $^{[8]}M4 = (Ca, REE, U, Th)$ polyhedrons. The BO_3-triangular groups are present only in one mineral of the

group − vicanite-(Ce). In other minerals, this position is vacant.

The **C layer** is formed by M3 polyhedra = (Ca, Sr, *REE*), M5 = (Y, *REE*) and M7 = (Na, *REE*). Tetrahedra and polyhedral of all layers, connect with each other and create a single frame work. The formula of laptevite-(Ce) is (recalculation on O + F = 48 apfu): $(Fe_{0.58}Mn_{0.31}Ti_{0.10}Zr_{0.02})_{\Sigma1.01}[(Ce_{2.80}La_{2.22}Nd_{0.79}$ $Pr_{0.46}Dy_{0.21}Gd_{0.20}Sm_{0.15}Yb_{0.05}Tb_{0.03}Eu_{0.02}$ $Tm_{0.02})_{\Sigma6.95}Ca_{5.52}Y_{2.60}Na_{0.83}Sr_{0.37}U_{0.07}Th_{0.04}]_{\Sigma16.38}$ $Si_{6.78}B_{3.54}P_{0.54}O_{36.39}F_{11.61}$, and the ideal formula is $NaFe^{2+}(REE_7Ca_5Y_3)(SiO_4)_4(Si_3B_2PO_{18})(BO_3)F_{11}$.

The populations of the majority of the 14 sites in the structures of laptevite-(Ce) and the other minerals of the vicanite group are identical. Therefore it is hard to say, which of a minerals of the group has the greatest similarity to laptevite-(Ce) (Uvarova *et al.*, 2013). Structurally laptevite-(Ce) is closest to

Laptevite-(Ce) NaFe^{2+}(REE_7Ca$_5$Y$_3$)(SiO$_4$)$_4$(Si$_3$B$_2$PO$_{18}$)(BO$_3$)F$_{11}$ —
new mineral of the vicanite group from the Darai-Pioz alkaline massif, Tajikistan

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vicanite-(Ce), due to presence of BO$_3$-triangles, which are absent in other minerals of the group, although between vicanite-(Ce) and laptevite-(Ce), the major differences in composition are as follows in vicanite-(Ce): the M5 polyhedron is occupied by thorium, theT3 tetrahedron by arsenic, and the anion position, occupied in laptevite-(Ce) by fluorine, in general is vacant (Ballirano *et al.*, 2002).

The holotype sample of laptevite-(Ce) is stored in the Fersman Mineralogical Museum (Moscow, Russian Federation), registration number 4195/1.

Acknowledgments

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