

LOVDARITE, A NEW HYDROUS ALKALI-BERYLLIUM SILICATE^{1,2}

Yu. P. Men'shikov, A. P. Denisov (deceased), Ye. I. Uspenskaya and E. A. Lipatova

Geological Institute, Kola Branch, USSR Academy of Sciences, Apatity
(Presented by Academician F. V. Chukhrov, October 6, 1972)

Lovdarite was discovered by Yu. P. Men'shikov in the Yubileynaya stratiform pegmatoid deposit, exposed between lujavrite (at the bottom) and fayaite (at the top) of the third eruptive phase of an alkalic intrusion [1] on Mount Karnasurt in the Lovozero pluton. Its name means "a gift from Lovozero". This deposit is zoned and has a complex structure.

Lovdarite forms massive white or yellow rims, ranging in width from 1 to 2 cm, on chkalovite grains and crystals, which are as large as 5 x 10 cm and are embedded in natrolite (Fig. 1). It completely replaces small grains of chkalovite. Aggregates of lovdarite are compact and porcelaneous or have a fibrous-radial texture and, in places, are friable. On walls of small sporadic cavities in compact lovdarite and chkalovite there are druses of transparent, colorless prisms of lovdarite. They are 1 to

2 mm long and exhibit a vitreous luster; the cleavage is distinct along (100), (010) and (001) and weak along (110), where it makes an angle of 45° with the first two cleavage directions. Crystals are brittle. The hardness of the lovdarite aggregates is 5 to 6. The specific gravity is 2.33 ± 0.01 . The mineral can be readily melted with the blowpipe to transparent, colorless glass. It is insoluble in 4 percent HCl, 6 percent HNO₃ and 5 percent H₂SO₄ at 20°.

Lovdarite is optically biaxial; $2V = 90^\circ$; the main zone is positive. The extinction is straight relative to the elongation of crystals; $\gamma_c = 1.518 \pm 0.002$, $\beta_m = 1.516 \pm 0.002$, $\alpha_r = 1.513 \pm 0.002$, $\gamma_c - \alpha_r = 0.005$ (determined by L. M. Fedorova).

The crystal system is orthorhombic; the space group is $D_2^3 = P_{21212}$. The unit-cell parameters are: $a_0 = 38.789 \pm 0.004 \text{ \AA}$, $b_0 = 6.776 \pm 0.006 \text{ \AA}$, $c_0 = 7.012 \pm 0.007 \text{ \AA}$, $v = 1843 \text{ \AA}^3$, $z = 4$, $\rho_x = 2.32$. The powder pattern of lovdarite is given in Table 1.

The chemical analysis (Table 2) was done on 2-g portions of pure material. The BeO content of different varieties ranges from 6 to 7 percent (analyst K. G. Lokhonya). The Na/K

¹Translated from: Lovdarit—novyy vodnyy berillo-silikat shchelochey. Doklady Akademii Nauk SSSR, 1973, Vol. 213, No. 2, pp. 429-432.

²Mineral approved by the Commission for New Minerals, All-Union Mineralogical Society, USSR Academy of Sciences, on August 15, 1972.

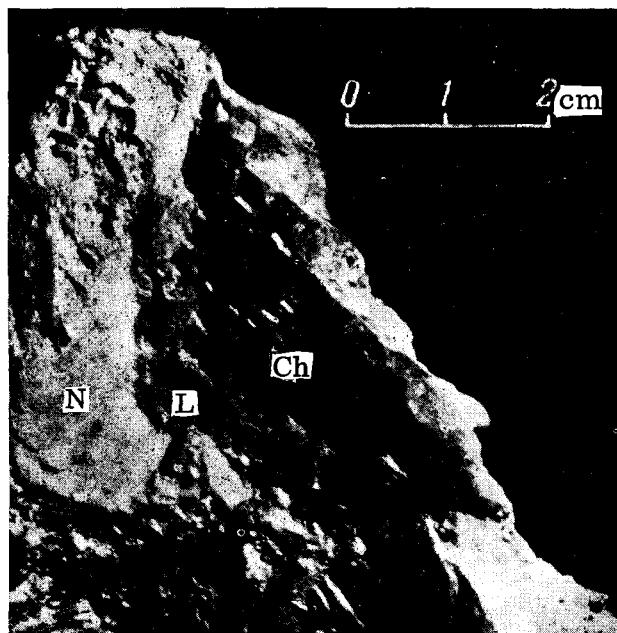


Fig. 1. Lovdarite (L) forming rims on a crystal of chkalovite (Ch) embedded in natrolite (N).

Table 1
Interplanar Spacings of Lovdarite

Se- quence	<i>l</i>	<i>d</i> , Å	<i>hkl</i>	Se- quence	<i>l</i>	<i>d</i> , Å	<i>hkl</i>
1	1	(10.7)	400β	45	5	1.785	21.1.0, 13.1.3
2	3	9.7	400	46	2	1.757	004, 104, 923
3	3	(7.2)	110β, 210β	47	4	1.731	404, 21.1.1, 10.2.3
4	6	6.56	110, 210	48	3	1.707	10.3.2, 014
5	2	6.12	310	49	3	1.690	240, 314, 20.2.0
6	2	5.80	401	50	3	1.6717	440, 17.2.2, 11.3.2
7	3	(5.47)	510β, 111β	51	3	1.6573	540, 15.3.1
8	9	4.96	510, 111	52	1	1.6050	17.3.0, 433
9	0.5	4.68	610	53	1	1.5955	641, 23.1.1, 533
10	0.5	4.36	411, 701	54	1	1.5719	14.3.2, 24.1.0
11	0.5	4.11	511	55	1	1.5640	22.2.0, 733, 024
12	0.5	3.87	10.0.0	56	1	1.5400	424, 941
13	1	3.685	711, 901	57	1	1.5270	042, 11.4.0, 142
14	2	(3.618)	320β	58	4	1.5047	724, 12.1.4
15	4	3.518	002	59	4	1.4912	26.0.0, 824, 11.4.1
16	5p	(3.449)	11.1.0β, 012β	60	3	1.4765	13.4.0, 11.3.3
17	2 _{diff}	3.326	220	61	1	1.4630	20.1.3, 17.3.2
18	10	3.288	320	62	1	1.4524	21.0.3, 12.3.3
19	2	3.182	420, 502	63	3	1.4184	15.4.0, 21.1.3, 14.4.1
20	10	3.136	11.1.0, 012	64	3	1.4030	005, 105
21	3	3.072	212	65	3	1.3861	16.4.0, 505, 034
22	1	3.015	620, 221	66	3	1.3739	043, 143, 434, 215
23	3	2.954	12.0.1	67	3	1.3602	17.4.0, 28.1.0, 443
24	1	2.861	11.1.1, 802	68	4 _{diff}	1.3234	10.0.5, 27.2.0, 351
25	2	(2.74)	921β, 11.0.2β	69	3p	1.3151	750, 24.3.0, 16.2.4
26	3	2.671	920, 721	70	4p	1.2933	30.0.0, 325
27	2	2.609	102	71	3p	1.2880	17.2.4, 425
28	2	(2.52)	15.1.1β	72	2p	1.2752	12.3.4, 625, 26.2.2
29	6b	2.477	921, 11.0.2	73	3p	1.2571	20.4.1, 825, 14.0.6
30	1	2.424	16.0.0, 222, 15.1.0	74	3p	1.2401	24.2.3, 27.2.2, 652
31	3	2.381	12.0.2	75	3p	1.2299	21.4.1, 14.4.3, 26.3.1
32	1	2.328	522, 203	76	3p	1.2187	16.0.5, 15.1.5, 11.2.5
33	6	2.288	15.1.1, 403, 622	77	2	1.1982	644, 16.1.5, 17.0.5
34	2	2.247	230, 503, 13.2.0	78	3	1.1913	744, 11.5.2, 13.2.5
35	3	2.201	430, 213, 603	79	2p	1.1773	14.2.5, 31.2.0, 17.4.3
36	2	2.103	431, 613, 803	80	2p	1.1684	306, 353, 16.5.1
37	2	2.031	631	81	2p	1.1546	606, 216, 11.4.4
38	3	1.979	913, 15.2.1	82	3p	1.1433	516, 32.2.0
39	1	1.939	20.0.0	83	p _{diff}	1.1249	816, 360, 25.3.3
40	1	1.925	931, 023	84	2	1.0986	11.1.6, 661, 526
41	2	1.904	11.0.3, 032, 323	85	3	1.0938	781, 25.5.0, 960
42	3	1.880	332, 11.1.3	86	3	1.0806	14.0.6, 826, 961
43	1	1.859	12.3.0, 432	87	2	1.0744	926, 054, 20.6.2
44	1	1.841	18.0.2, 13.0.3	88	3	1.0682	645, 26.4.2, 454

Note: Conditions: unfiltered Fe radiation, $D_C = 114$ mm, corrected by means of a special photograph against NaCl. Analyst A. P. Denisov.

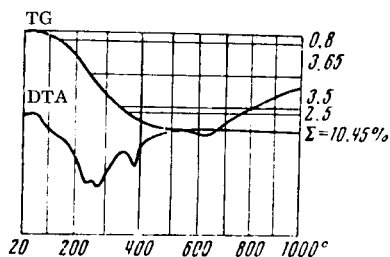


Fig. 2. Heating curve of lovdarite. Analyst N. V. Ivanova (All-Union Geological Research Institute).

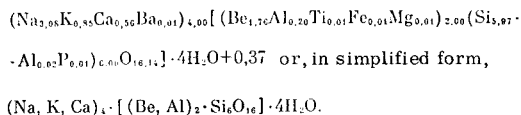
Table 2

Chemical Composition of Lovdarite and Chkalovite*

Constituent	Composition of lovdarite		Composition of chkalovite, weight percent
	weight percent	atomic proportions of cations	
SiO ₂	56.13	0.9342	57.64
TiO ₂	0.15	0.0019	0.00
Al ₂ O ₃	1.77	0.0347	0.00
Fe ₂ O ₃	0.18	0.0022	0.10
FeO	0.00	—	0.00
MnO	0.003	—	Tr.
MgO	0.06	0.0015	—
CaO	0.49	0.0087	0.46
BaO	0.20	0.0013	—
BeO	6.90	0.2759	12.32
Li ₂ O	—	—	0.001
Na ₂ O	14.95	0.4818	28.86
K ₂ O	6.28	0.1333	0.29
P ₂ O ₅	0.05	0.0007	—
H ₂ O ⁺	10.85	1.2044	0.67
H ₂ O ⁻	1.44	(0.1598)	0.11
F	0.07	(0.0037)	Tr.
Cl	0.00	—	—
Σ	99.52		100.45
—O=F	0.02		Ye. A. Kul'chitskaya
Total Analyst	99.50		100.45
	Ye. I. Uspenskaya		Ye. A. Kul'chitskaya

*Figures given in parentheses were neglected.

ratio is 2.4 (24 in chkalovite). The analysis of lovdarite was calculated to the formula



To determine the nature of endothermal peaks (Fig. 2) on the heating curve of lovdarite, we calcined the mineral for an hour at 240°, 300°, 420°, 640° and 800°. The products thus obtained were then studied by X-raying, which revealed that the water evolved from lovdarite in several stages between 0° and 400° had been absorbed. The diffraction pattern of the mineral changes above 300° with the transition of lovdarite to "metallovdarite". This process is reversible; the water removed below 300° was reabsorbed at room temperature, two hours later, and "metallovdarite" again changed into lovdarite. After being heated at 400° to 500°, the structure of lovdarite was restored only after the specimen had been kept in distilled water for 24 hours at room temperature. The endothermal peak at 640° marks the transition from "metallovdarite" to transparent amorphous glass with a quartz

phase that disappears upon further heating. The mineral melts at 1100°.

The infrared absorption spectrum of lovdarite (Fig. 3) indicates the presence of OH⁻ and H₂O in different positions.

In terms of chemical composition and properties, lovdarite can be classified as a zeolitic hydrous alkali-beryllium tectosilicate of

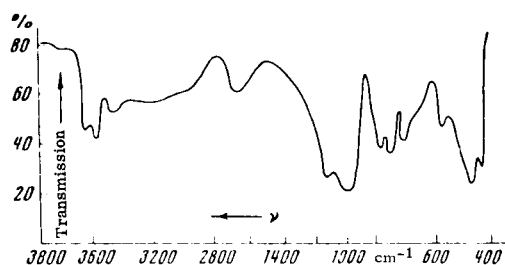


Fig. 3. Infrared absorption spectrum of lovdarite recorded with a UR-10 spectrometer made by the Zeiss Company, East Germany. Specimens were prepared on a vaseline-oil base as paste; a cell of variable thickness was used in the comparison channel to compensate for the vaseline. Analyst E.A. Lipatova (All-Union Geological Research Institute).

the aluminosilicate type, where aluminum is almost completely replaced by beryllium. It is a late hydrothermal mineral, which originated after natrolite and replaces chkalovite. The latter mineral has been synthesized at 320° [3]. No alteration products of lovdarite are known. Nor could any analogs of lovdarite be found in the literature.

We thank Professor V. B. Tatarskiy, E. M. Kupletskaya, N. V. Ivanova, E. A. Lipatova, L. M. Fedorova and K. G. Lokhonya for helping in the work and A. N. Mer'kov for collecting samples. Specimens of lovdarite have been sent to the Mineralogical Museum of the USSR Academy of Sciences, Moscow, and to the museum

of the Kola Branch of the USSR Academy of Sciences, Apatity.

Received September 3, 1972

REFERENCES

1. Bussen, I. V. and A. S. Sakharov. *Geologiya Lovozerskikh tundr (Geology of the Lovozero Tundra)*, Leningrad, 1967.
2. Bussen, I. V., L. F. Gannibal et al. *Zap. min. obshch.*, 101, No. 1, 1972.
3. Goryachev, A. A., O. S. Ignat'yev and D. L. Rogachev. *Dokl. Akad. Nauk*, 146, No. 5, 1179, 1962.

NEW VARIETY OF REPLACEMENT PRODUCT OF PYRRHOTITE¹

T. V. Ivanitskiy, R. A. Akhvlediani, E. I. Kakhadze and A. I. Tsepina

Geological Institute, Georgian Academy of Sciences, Tbilisi
Institute of Economic Geology, Petrology, Mineralogy and Geochemistry, USSR
Academy of Sciences, Moscow

(Presented by Academician G. S. Dzotsenidze, October 16, 1972)

While studying under the microscope copper-pyrrhotite ores from deposits of Kakhetia, we found that pyrrhotite, chalcopyrite, pyrite and other ore-forming minerals were accompanied by an unknown mineral with no completely identical analog in the literature.

The mineralization considered here forms veins and lenses in shatter zones. It occurs in clayey sandy rocks at different stratigraphic levels on the south slope of the folded mountain system of the Greater Caucasus. The unknown mineral is relatively widespread and in some ore deposits, for example the Artana, locally accounts for 5 to 10 percent of the ore by volume. Previous investigators did not mention this mineral, although it may have been identified as melnikovite-pyrite, which, according to our data, is absent in the ore.

In ore of the Artana deposit the mineral forms patches as large as 0.2 cm. It occurs widely as stringers in pyrrhotite and, less commonly, chalcopyrite. In many places its stringers are confined to the interstices of pyrrhotite grains and give the ore a reticulated

microtexture. We frequently observed relics of pyrrhotite and, less commonly, chalcopyrite in continuous segregations and comparatively thick stringers of our mineral, indicating that it replaces these minerals. In this respect the "tongues of flame" branching out from the unknown mineral in pyrrhotite are equally significant. The fact that continuous segregations of the mineral commonly inherit certain textural characteristics of pyrrhotite, i. e., granularity and cleavage, indicates the formation of replacement-type pseudomorphs.

As far as the relationships of our mineral to other ore-forming minerals are concerned, we should specifically note that it contains small crystals of pyrite, commonly connected by thin stringers, as well as small isometric grains of cobaltite and linnæite and stringers of hematite (hydrohematite?).

The diagnostic optical properties of our mineral are as follows. The color is grayish white. The reflectance ranges within a single grain from 41 to 44 percent (Fig. 1). The mineral exhibits no double reflection and is strongly anisotropic (Fig. 2) with a brown, gray and yellow color effect, which is especially clear in immersion.

The hardness is high, although the mineral crumbles under high pressure by a steel needle.

¹Translated from: O novoy raznovidnosti produkta zameshcheniya pirrotita. *Doklady Akademii Nauk SSSR*, 1973, Vol. 213, No. 3, pp. 688-691.