

MINERALOGY

LOVOZERITE—A NEW MINERAL

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This mineral was found by the author in the summer of 1935 in the Lovozero alkaline massif located in the central part of the Kola peninsula. In the course of examination it was found to be unidentifiable with any mineral already known. Therefore, it has been named lovozerite, after its finding place.

Physical Properties. Lovozerite in crystals has not been encountered. It has been observed in grains up to 1—2 cm in size. The mineral is black, frequently dark-brown owing to an abundance of small inclusions of other minerals. Streak brown. Lustre resinous. Opaque. Cleavage not observed macroscopically. Fracture from uneven to conchoidal. Hardness about 5. Specific gravity as determined by means of a pycnometer 2.384.

Under a blowpipe easily melted into an opaque ball of white colour with a pink tinge. With borax in an oxidizing and reducing flame yields a bead of light-violet colour which is preserved after cooling. A phosphate bead in an oxidizing and reducing flame is greenish-yellow when hot, and almost colourless when cold.

Optical Properties. Optically lovozerite is uniaxial, negative. Refractive indices (as determined by immersion) $N_m=1.561$ and $N_p=1.549$. Cleavage imperfect, rarely observed, corresponding to N_m . Twins, not infrequently polysynthetic, are often observed in lovozerite. In twins N_p of one individual with N_p of the other forms an angle of 73—74°. The pole of the twinning suture with N_p of both individuals shows one and the same angle of 36—37°. Colour in thin-section light-pink with a slight yellowish tinge. Pleochroism poorly expressed. Parallel to N_p a slight deepening of the pink colour is observed. The colour of the mineral along cracks (frequently observed in lovozerite) and at the grain borders is usually light-pink with a brownish tinge, brown or rusty-brown. In the latter case the mineral in thin-section is frequently opaque. At the grain borders polyzonality is occasionally observed, manifested in that the outer border of the grains is usually brown and frequently isotropic. In one of the lovozerite grains in a section $\perp N_p$ zonality was observed along the hexagonal prism. Lovozerite usually contains abundant inclusions of other minerals, chiefly nepheline, K-feldspar, aegirite, etc.

The above characteristics of physical and optical properties refers to lovozerite observed in large grains. Besides, lovozerite is encountered in small grains, rarely exceeding 0.03 to 0.3 mm in size. Small lovozerite grains are transparent, unbroken, show light-pink colouring without brown tinges,

and contain no inclusions of other minerals. Twins are poorly expressed, showing mostly either wavy extinction, or else consisting in their turn of still smaller individuals which are not simultaneously extinguished when examined in thin-sections.

X-Ray Analysis. In order to determine the syngony of lovozerite the latter was subjected to X-ray examination which proved unsuccessful. The photographs were made by the Debye method (Fe-rays) three times, and only once when the exposure was about seven hours the film showed a few very weak lines resembling Debye lines.

Chemical Properties. Lovozerite is insoluble in acids—HCl, HNO₃ and H₂SO₄. Its chemical analysis has been made by T. A. Burova (deposit in the upper part of the Muruai river). The results are given in the table.

Chemical Analyses of Lovozerite, Eudialyte, Mesodialyte and Elpidite

Oxides	Lovozerite		Eudialyte % *	Mesodialyte % *	Elpidite % *
	%	equiv. quant.			
SiO ₂	52.12	0.868	49.16	51.23	59.44
TiO ₂	1.02	0.013	0.72	0.56	traces
ZrO ₂	16.54	0.134	14.17	13.98	20.48
TR ₂ O ₃	0.56	0.002	2.29	1.68	—
Al ₂ O ₃	0.40	0.004	—	—	—
Fe ₂ O ₃	0.72	0.005	0.78	0.67	—
FeO	—	—	3.57	3.39	0.14
MnO	3.46	0.049	1.64	2.50	—
MgO	0.76	0.019	—	2.27	—
CaO	3.34	0.059	7.01	9.62	0.17
SrO	0.06	0.001	1.42	—	—
Na ₂ O	3.74	0.060	15.82	11.16	10.41
K ₂ O	1.90	0.020	0.43	0.69	—
H ₂ O ^{+110°}	8.62	0.479	1.26	} 2.88	5.72
H ₂ O ^{-110°}	6.41	0.356	—		3.89
Cl	none	—	2.19	1.26	0.15
—O=Cl ₂	99.65	—	100.46	99.98	100.53
	—	—	0.49	0.27	—
Total	99.65	—	99.97	99.61	100.53

According to the data of the chemical analysis, the empiric formula of lovozerite is as follows: (H,Na,K)₂O. (Ca, Mn, Mg) O. (Zr, Ti)₂O. 6SiO₂. 3H₂O.

Lovozerite is to be referred to the group of Zr silicates. Its chemical composition points to a closest relation to eudialyte (and its varieties, mesodialyte and elpidite). Their analyses are given for comparison in the table. Spectroscopic examination carried out by S. A. Borovick (Institute of Geological Sciences of the Academy of Sciences of the USSR) showed it to contain Be and Hf (weak lines), beside the elements found by chemical analysis. Qualitative X-ray chemical analysis of lovozerite made by I. B. Borovsky (Institute of Geological Sciences of the Academy of Sciences of the USSR) showed that apart from the elements detected by chemical analyses it contains Hf~0.1% and U~0.2%.

* Analyses taken from the book «Minerals of the Chibina and Lovozero Tundras», 1937. Published by the Academy of Sciences of the USSR, p. 298 and 304.

Occurrence and Paragenesis. Lovozerite in the Lovozero alkaline massif is one of the rock-forming or secondary minerals of certain varieties of porphyry-like luyavrite. The latter are most widely spread in the northern and western parts of the massif. The fine-grained groundmass of porphyry-like luyavrites containing lovozerite consists of microcline, nepheline and aegirite. The following secondary minerals have been observed: eudialyte, lovozerite, lamprophyllite, sodalite, albite, zeolite and occasionally neptunite. Of these eudialyte and lovozerite are frequently found in considerable quantities. The zeolites and probably all the sodalite are secondary minerals after nepheline, while albite is secondary after microcline. Phenocrysts in porphyry-like luyavrites containing lovozerite consist of: lovozerite, murmanite, lamprophyllite, alkaline amphibole and nepheline. Of these lovozerite and murmanite are usually quantitatively prevalent. The content of lovozerite in porphyry-like luyavrites sometimes amounts to 10—20%.

Lovozerite is of various genesis. It may probably be of primary and secondary origin. When observed in large grains, lovozerite is to be regarded in all probability as a primary mineral crystallized together with murmanite (hydrous niobo-titano-silicate) towards the end of the formation of porphyry-like luyavrite, at the expense of residual magma considerably enriched with water and probably relatively impoverished in alkalis. The latter were largely spent for formation of nepheline, microcline and aegirite which crystallized (possibly except aegirite) previous to lovozerite. The primary formation of lovozerite encountered in large grains is evidenced by the following data: 1) the presence in lovozerite of a large number of inclusions of other minerals (microcline, nepheline, sometimes lamprophyllite, aegirite, etc.) which are usually absent in eudialyte; 2) the outlines of separate lovozerite grains are usually uneven and sometimes sinuous, while those of large eudialyte grains substituted with lovozerite are even, and 3) under the microscope large lovozerite grains become extinguished simultaneously or in accordance with the twinning observed in it.

Lovozerite observed in small grains is a secondary mineral—after eudialyte. This is shown by the following:

1. In thin-sections there may be frequently observed substitution of lovozerite for eudialyte.

2. The shape and size of small lovozerite grains and of the associated non-substituted eudialyte are similar.

3. Small lovozerite grains not infrequently consist of minute individual aggregates which are extinguished not at the same time.

4. Eudialyte contains no inclusions of other minerals, and the lovozerite formed after it must not contain such. The absence of inclusions of other minerals in small lovozerite grains (these inclusions always being found in large lovozerite grains) is also an indirect evidence of the secondary formation of lovozerite (in small grains).

Aside from this it should be noted that the postmagmatic processes in porphyry-like luyavrites are manifested alongside of the substitution of lovozerite for eudialyte also in the albitization of microcline, in the formation of sodalite and zeolites after nepheline.

Lovozerite differs from eudialyte in that it contains less alkalis and more water. On account of this and of the fact that secondary processes took part in the formation of porphyry-like luyavrites, the conclusion suggests itself that in the course of crystallization of primary lovozerite the conditions for the previously crystallized eudialyte were unfavourable, and the latter was substituted with lovozerite. Thus, along with crystallization of primary lovozerite, the formation of secondary lovozerite (after eudialyte) took

place simultaneously with and possibly also subsequent to this process.

The discovery in the Lovozero alkaline massif of a new mineral—lovozerite (hydrous zirconium silicate) is a fact of great interest. So far it has been known that in the rocks composing this massif along with anhydrous titanium silicates (ramsayite, loparite, lamprophyllite) a hydrous titanium silicate—murmanite—was encountered which has been formed later. It was natural to suppose that an analogous phenomenon would be observed among the zirconium silicates, too. This assumption was justified by the finding of lovozerite—a hydrous Zr silicate—along with an anhydrous Zr silicate—eudialyte. According to the time of formation, lovozerite is a later mineral than eudialyte and is encountered together with murmanite.

The discovery of secondary lovozerite still more emphasizes the important part played by postmagmatic processes in the formation of the Lovozero alkaline massif, which have been manifested in the substitution of sodalite and zeolites for nepheline, of ussingite and zeolites for sodalite, of astrophyllite for aenigmatite, of albite and ussingite for microcline. It is to be noted, moreover, that the part played by water was considerable.

Taking into account the enormous reserve of eudyalite, economic utilization of lovozerite can scarcely be discussed until due research and prospecting work is carried out.

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