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GRØNLANDS GEOLOGISKE UNDERSØGELSE

I.

THE LOVOZERO MINERALS – NENADKEVICHITE, GERASSIMOVSKITE AND TUNDRITE – FROM ILÍMAUSSAQ, SOUTH GREENLAND

CONTRIBUTION TO THE MINERALOGY OF ILÍMAUSSAQ, No. 6

BY E. I. SEMENOV, M. E. KAZAKOVA
AND R. A. ALEKSANDROVA

WITH 2 FIGURES AND 1 TABLE IN THE TEXT

С РУССКИМ РЕЗЮМЕ

II.

CHALCOTHALLITE – A NEW SULPHIDE OF COPPER AND THALLIUM FROM THE ILÍMAUSSAQ ALKALINE INTRUSION, SOUTH GREENLAND

CONTRIBUTION TO THE MINERALOGY OF ILÍMAUSSAQ, No. 7

BY E. I. SEMENOV, H. SØRENSEN,
M. S. BESSMERTNAJA AND L. E. NOVOROSSOVA

WITH 4 FIGURES AND 3 TABLES IN THE TEXT
AND 5 PLATES

С РУССКИМ РЕЗЮМЕ

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Abstract

Nenadkevichite $NaCaTiNbSi_4O_{14}.4H_2O$, gerassimovskite $NbTi(OH)_9$ and tundrite $Na_2Ce_2TiSiO_8.4H_2O$, which until now have been found only in the Lovozero alkaline massif in the Kola peninsula have also been found in the nepheline-sodalite syenites of the Ilímaussaq massif (South Greenland). Nenadkevichite and gerassimovskite occur in hydrothermal veins in the poikilitic sodalite syenites (naujaites) as alteration products of epistolite. Tundrite was found in pegmatites in nepheline syenites (kakortokites). A new formula of tundrite is suggested.

РЕЗЮМЕ

Ненадкевичит $NaCaTiNbSi_4O_{14}.4H_2O$, герасимовскит $NbTi(OH)_9$ и тундрит $Na_2Ce_2TiSiO_8.4H_2O$, ранее установленные в Ловозере (Кольский п-ов), теперь обнаружены в массиве нефелин-содалитовых сиенитов Илимауссак (ю.з. Гренландия). Ненадкевичит и герасимовскит находятся в гидротермалитах пойкилитовых содалитовых сиенитов, обычно в качестве продуктов изменения эпистолита. Тундрит обнаружен в пегматитах нефелиновых сиенитов (какортокитов). Предложена новая формула тундрита.

INTRODUCTION

During the investigation of the Lovozero alkaline massif in the Kola peninsula Soviet scientists have discovered a number of new minerals. Thus scientists from the Institute of Mineralogy, Geochemistry and Crystallo-chemistry of Rare Elements, directed by the late K. A. Vlasov, discovered nenadkevichite (Kuzmenko & Kazakova, 1955), gerassimovskite and tundrite (Semenov, 1957 & 1963).

In the summer of 1964 E. I. Semenov visited the Ilímaussaq alkaline massif in South Greenland, which is very similar to the Lovozero massif with regard to the rocks and minerals, and found among other minerals the three above-mentioned Lovozero minerals.

Nenadkevichite

Nenadkevichite occurs in a number of small scale pegmatites and hydrothermal veins intersecting eudialyte-rinkite naujaite and coarse-grained lujavritic rocks (of the type described by Sørensen, 1962, p. 81) on the north-east side of the Narssaq elv valley, on the north slope of Nákâlâq mountain. The marginal zones of the pegmatites are composed of microcline, arfvedsonite and rare steenstrupine and sodalite. The central part is occupied by ussingite and albite. In this central part nenadkevichite is associated with neptunite, sphalerite and beryllo-sodalite (tugtupite). Nenadkevichite (sample no. 77315) forms lamellar pinkish-white aggregates up to $1 \times 1 \times 0.3$ cm. The mineral possibly forms pseudomorphs after epistolite. In addition to the dense fresh nenadkevichite (table 1, no. 1b) there is an earthy variety of the mineral (table 1, no 1a).

As is the case with the Lovozero hydrokatapleiite, hydrorinkolite and hydroeudialyte, the high water content probably compensates for the deficiency of silica. Due to this deficiency the specific gravity and average refractive index of the Greenland hydrated nenadkevichite, which displays aggregate polarization, are lower than those of the Lovozero sample.

The general formula of the minerals of the labuntzovite-nenadkevichite group is

$$(Ba, Ca, K, Na)\,(Ti, Nb)\,Si_2O_7.2H_2O,\ (Z = 8).$$

The distribution of Ti and Nb (and perhaps also of Ba, Ca – K, Na ?) may be ordered:

$$KBa_3\,(Ti_3\,Nb)\,Si_8O_{28}\cdot 8\,H_2O\ \text{(Nb-labuntzovite)}.$$

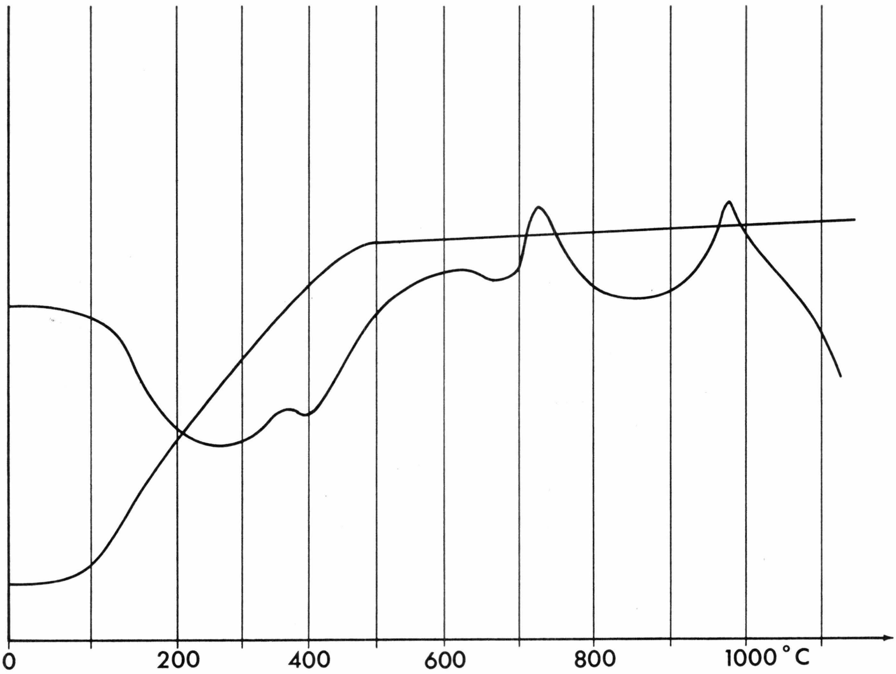

Fig. 1. Differential thermal analysis and thermogravimetric examination of nenadkevichite from Ilímaussaq. Analyst: N. S. GOROKHOVA, IMGRE.

The formula of the usual type of nenadkevichite may be written:

$$Na_2Ca_2Ti_2Nb_2Si_8O_{28}.8H_2O = NaCaTiNbSi_4O_{14}.4H_2O.$$

From the results of the chemical analyses no. 1 b and 2 the following approximate formula was calculated:

$$Na_3Ca(TiNb_3)Si_8O_{28}.8H_2O.$$

The Greenland nenadkevichite differs from all minerals of the above mentioned group in its complete lack of barium and from epistolite in lower contents of sodium and niobium and a higher content of silica.

The spectrographic analysis (by N. V. LIZUNOV) revealed Sn, Be and Sr.

The X-ray powder diagrams (examined by R. A. ALEKSANDROVA) and the D.T.A. and thermogravimetric diagrams of the mineral (fig. 1) are analogous to those of the type material.

Gerassimovskite

Gerassimovskite in Ilímaussaq, as in Lovozero, forms silvery-grey scales up to 0.5 cm across. It is found in a large ussingite body which

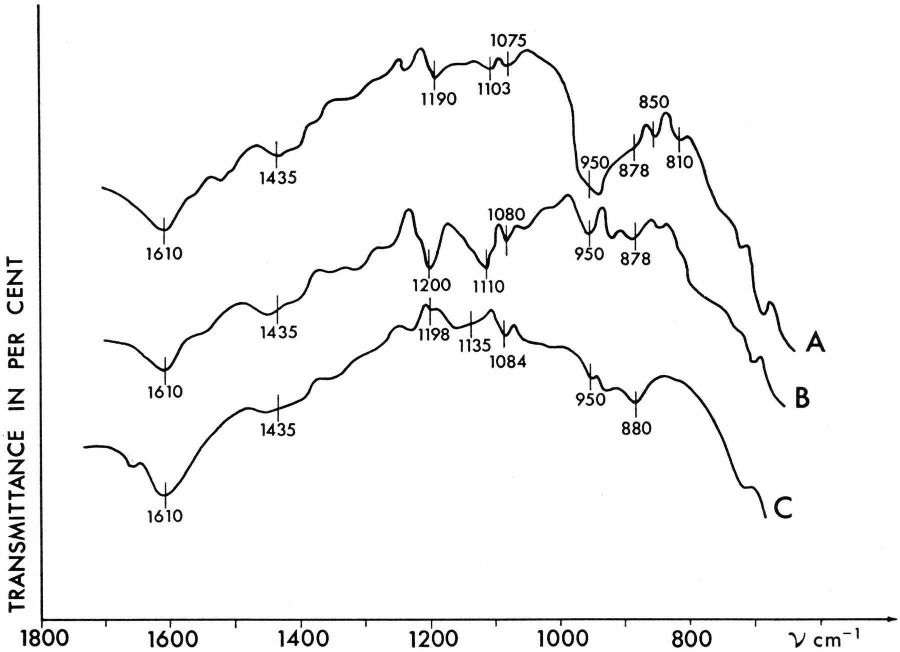

Fig. 2. Infra-red absorption spectra of gerassimovskite (A), beliankinite (B) and Mn-beliankinite (C). Examined in the laboratory of E. S. RUDNITSKAJA, IGEM, Ac. Sc. U.S.S.R.

intersects the naujaite of the north-west part of Nákâlâq mountain. Gerassimovskite (sample no. 77358) occurs together with analcime, sphalerite and tugtupite in a mass of ussingite. In the fresh parts of the vein similar scales (but of a pink colour) are formed by epistolite. It might be suggested that gerassimovskite is a product of alteration of epistolite.

The chemical formula deduced from the chemical analysis is the same as determined for this mineral in other localities:

$$2TiO_2.Nb_2O_5.7\text{–}9H_2O \sim TiNb(OH)_9.$$

The results of a new chemical analysis of the Lovozero gerassimovskite (from the mountain Karnasourt, not from the mountain Punkaruaiv where the mineral was discovered) are presented in the table. This gerassimovskite differs from the Greenland mineral in having a higher Nb content. Otherwise the two minerals are practically identical.

The lines of the X-ray powder diagram of both minerals are few, weak, and they are completely coincident at 3.20; 2.90; 2.08; 1.89 and 1.65 Å.

The infrared absorption spectra of both minerals are also identical; they display distinct maxima at 525 cm^{-1} (which is typical for oxide minerals), 950, 1640 and 3600 cm^{-1}. The last two maxima characterise molecular water. The maximum at 1435 cm^{-1}, corresponding to hydroxyl, is not pronounced.

The infrared spectra (fig. 2) of gerassimovskite, beliankinite and mangan-beliankinite are rather similar and these minerals probably belong to the same group. The chemical composition of gerassimovskite differs from that of beliankinite by lacking calcium and zirconium. It is a remarkable fact that murmanite and its alteration product beliankinite contain zirconium, while gerassimovskite and epistolite, from which the gerassimovskite is probably formed, are without zirconium.

Tundrite

Tundrite was discovered in two pegmatites in the kakortokites of Kringlerne (the south coast of Kangerdluarssuk). The one is a small pegmatoid vein on the left side of a brook which crosses the whole massif of kakortokites. In this vein the tundrite (sample no. 77343, analysis no. 5 in table 1) forms spherulitic masses up to 0.5 cm across. They occur between crystals of microcline and arfvedsonite.

The second locality is a huge pegmatitic zone situated along the contact between kakortokite and the marginal augite syenite (cf. USSING, 1912, p. 48). In this pegmatite the stellate groups of tundrite (measuring up to 0.5 cm across, sample no. 77356, analysis no. 6 in table 1) occur together with albite, eudialyte, polylithionite and earthy pyrochlore. The optical properties, the X-ray powder diagram and the unit cell dimensions of the tundrite from Ilímaussaq are practically identical with those of the Lovozero type specimen: $a_0 = 7.54$, $b_0 = 13.98$, $c_0 = 5.02$ Å; $\alpha = 101°30'$, $\beta = 70°25'$, $\gamma = 101°30'$ (A. A. VORONKOV).

Tundrite is a greenish-yellow acicular mineral, in appearance resembling aegirine-acmite from which, however, it differs in chemical composition and physical properties.

The chemical formula deduced from the chemical analyses (table 1, nos. 5 and 6) of the Ilímaussaq tundrite is as follows:

$Na_2Ce_2(Ti,Nb)SiO_8.4H_2O$, or simply:

$$Na_2Ce_2TiSiO_8.4H_2O \ (Z = 2).$$

There is a deficiency in Na and to a lesser degree of Ce in this formula. The formula may therefore also be written:

$$Na_3Ce_3Ti_2Si_2O_{14}.8H_2O \ (Z = 1).$$

The content of lanthanides is rather unusual in sample no. 5 which has a high proportion of Nd:

Table 1. *Chemical analyses of nenadkevichite, gerassimovskite and tundrite.*

	Nenadkevichite			Gerassimovskite		Tundrite		
	1. Ilímaussaq		2. Lovozero	3. Ilímaussaq	4. Lovozero	5. Ilímaussaq	6. Ilímaussaq	7. Lovozero
	1 a	1 b						
SiO_2	31.15	36.40	37.80	–	3.58	10.98	10.15	8.76
TiO_2	11.76	9.77	7.72	23.39	21.00	11.21	10.14	13.11
Nb_2O_5	28.10	28.36	29.40	40.60	43.32	6.09	4.26	2.86
Ta_2O_5	0.37		–	0.0	0.02	–	–	–
TR_2O_3	–	0.15	–	–	–	48.78	49.92	48.53
Al_2O_3	2.03	0.50	0.47	–	2.54	–	–	1.37
Fe_2O_3	1.20	1.03	0.50	1.08	2.46	1.00	0.46	0.45
MnO	0.12	4.73	–	–	2.09	–	tr.	0.40
MgO	1.31		–	0.80	0.65	–	tr.	0.42
CaO	1.70	0.30	4.50	0.58	1.59	0.97	0.74	3.07
Na_2O	2.25	4.11	4.70	–	0.15	(7.08)[4]	6.25	n.d.
K_2O	4.51	2.17	3.00	–	0.15	–	1.31	–
H_2O^+	10.14	7.12	10.80	9.87	10.20	13.65	13.37	15.09
H_2O^-	5.91	4.80	–	9.51	11.20	0.24	1.48	–
Others	–	0.37[1]	0.95[2]	–	0.90[3]	–	0.70[5]	4.42[6]
Total	100.55	99.81	99.84		99.85	(100.00)	98.78	98.48
Analyst	T. A. KAPITONOVA	Z. T. KATAEVA	A. V. BYKOVA	M. E. KAZAKOVA	Z. N. BUROVA	M. E. KAZAKOVA		
sp. gravity	2.5		2.76	2.5	2.52	4.02		3.70
$N\gamma$	1.75		1.768	1.75	1.81	>1.8		1.88
$N\alpha$	1.67		1.665		1.74	1.731		1.743

Others: [1]) U_3O_8 – 0.05, F – 0.55, –O = F – 0.23; [2]) BaO – 0.95; [3]) P_2O_5 – 0.90; [4]) Calculated as difference; [5]) ThO_2 – 0.70; [6]) P_2O_5 – 3.64 and ThO_2 – 0.78

$La_{24}Ce_{7.5}Pr_{12}Nd_{45}Sm_{6.6}Eu_{0.1}Gd_4Tb_{0.3}Dy_{0.5}$ (analysis by R. L. BARINSKY). In sample no. 6 a more usual proportion is found: $La_{24}Ce_{55}Pr_{6.5}Nd_{15}Sm_{0.3}$.

Mn and Al were determined spectrographically.

The Ilímaussaq tundrite is distinguished from the Lovozero type material by higher contents of Nb, Nd and Na and lower contents of water and phosphorus. The Lovozero mineral, so it appears, has been substantially altered by supergene and epithermal processes and is partially replaced by rhabdophanite. This resulted in a removal of sodium and in an enrichment in water and phosphorus, and—as a consequence—in a decrease of the specific gravity.

Discussion

A high niobium content which substitutes for titanium ($NaNb \rightarrow CaTi$?) is typical for the minerals of Ilímaussaq in general. Therefore the Ilímaussaq minerals are essentially niobium-bearing, while the Lovozero minerals usually are essentially titanium-bearing.

Among these three titano-niobium minerals of Ilímaussaq, tundrite is formed at the highest temperature and is a pegmatite mineral, nenadkevichite is a hydrothermal mineral and gerassimovskite is a low temperature epithermal or hypergene mineral.

Editor's note

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