EXPERIMENTAL STUDY OF LOMONOSOVITE MELTING AT ATMOSPHERIC PRESSURE

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Titanosilicate analogs of mica compose a large group of minerals, which are widespread in agpaitic rocks and pegmatites. One of the most important minerals of this group is lomonosovite. Up to now, there was no experimental evidence on its stability. A series of experiments was conducted to explore the melting of lomonosovite. Experiments were carried out by the quenching method using platinum capsules. In addition, one experiment with visual observation in an open platinum crucible was carried out.

The starting material was a sample of lomonosovite from the Koashva mine (Khibina massif, Kola Peninsula), kindly provided by I.V. Pekov. The duration of runs was 7 hours. The experimental products were examined in immersion oils under an optic microscope and analyzed with an electron microprobe (Camebax microbeam, GEOKHI RAS).

The starting lomoniosovite contains zones with high Nb concentrations. The compositions of lomonosovite are listed in tab. 1.

Table 1. Composition of starting material and crystal phases after experiments

	Lomonosovite *	High-Nb zone of lomonosovite*	Fraidenbergite**	Perovskite solid solution*	Phosphate material						
Run number	Starting material		Lom-871+	Lom-871+ Lom-871-	Lom-871-	Lom-871+	Lom-871-	Lom-871-	Lom-944	Lom-944	Lom-944
Na_2O	28.62	27.19	8.03	14.82	13.17	10.35	9.22	12.03	11.79	13.6	11.26
MgO	0.25	0.45	0.94	0.01	1.49	1.25	1.83	1.97	1.72	2.93	2.48
Al_2O3	0.00	0.00	0.03	0.01	0.14	0.5	0.17	0.32	0.13	0.22	0.31
SiO_2	24.08	23.53	1.17	2.06	9.71	7.25	8.64	5.17	6.44	2.72	3.15
P_2O_5	14.06	13.48	0.37	0.57	33.43	40.38	33.54	35.05	42.39	35.97	30.14
CaO	1.19	1.62	0.22	7.59	8.47	8.55	10.16	10.93	8.37	16.56	12.53
TiO2	26.87	19.42	76.05	19.70	7.45	3.98	2.29	1.84	4.15	1.66	1.33
MnO	0.78	1.85	2.34	0.22	3.82	3.51	5.56	6.56	4.86	5.88	5.97
FeO	1.29	2.52	10.14	0.38	0.89	0.81	2.83	3.05	1.93	3.13	3.09
Nb_2O_5	3.52	10.55	2.01	52.82	2.57	1.22	0.73	0.31	1.1	0.27	0.2
Total	100.67	100.60	101.27	98.18	81.14	77.8	74.97	77.23	82.88	82.94	70.46

Note: analyst V.G. Senin. *Average of 3 analyses, **Average of 2 analyses

The experiment with visual observation showed that the first droplets of liquid appeared at 820°C, and extensive melting started at 866°. After quenching from 871°C, the experimental products consisted of glass, phosphate globules and two titanates. One titanate forms long crystals and is chemically similar to freidenbergite, $Na_{1.82}Fe_{0.99}Ti_{6.66}Nb_{0.11}Mn_{0.23}Mg_{0.16}O_{16}$. The other titanate forms small isometric crystals and was chemically identified as the solid solution of 70% lueshite and 30% perovskite. In an experiment at 944°C titanates were not observed, and only silicate glass and phosphate globules were present.

The phosphate globules that formed at 871 and 944°C are rounded or oval. Sometimes they form chains.

In experiments at 1025°C or higher, only brown glass of the lomonosovite composition was found.

The compositions of experimental phases are given in tab 1.

The two last analyses in the table have the lowest titanium and silica contents. They are close to the formula $Na(Ca,Mg,Mn,Fe)PO_4$. Other globules have higher contents of titanium and silica, but some of them are richer in phosphorus. This implies that they cannot be mixtures of this phosphate and a silicate glass. Figure 1 shows the projection of these analyses onto the CaO-Na_2O-P_2O_5 diagram.

At the run temperature, the phosphate globules probably consisted of a mixture of alkali phosphates. Pure $NaCaPO_4$ is solid at the experimental temperature but richer in phosphorus and lies in the low-temperature part of the diagram. This means that the phosphate globules consisted at high temperatures of phosphate liquid or a mixture of phosphate liquid and phosphate crystals. Probably, droplets of phosphate liquid occurred on the dendrite crystals of phosphate.

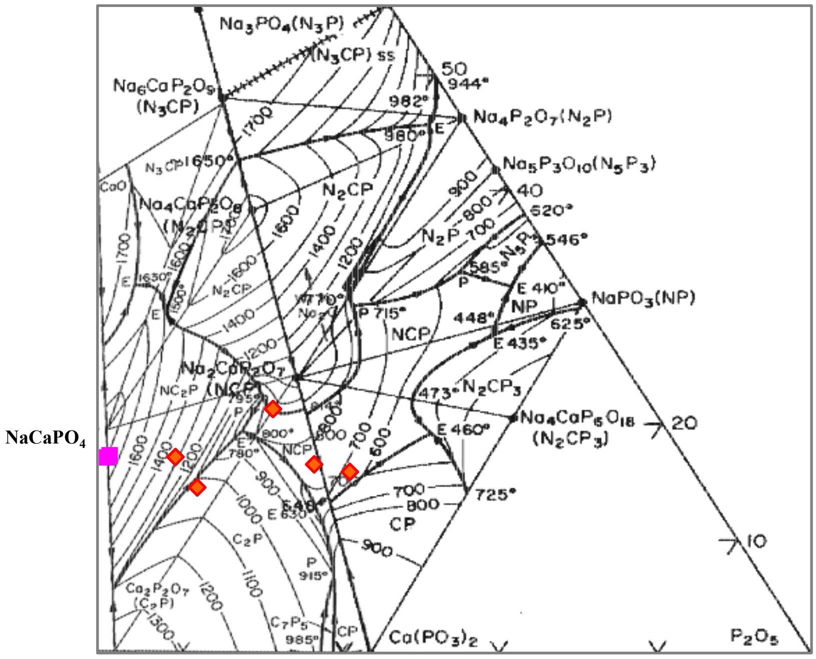

Fig.1. Analyses of phosphate materials projected onto the CaO-Na_2O-P_2O_5 melting diagram [1, 2]. Our experience in microprobe analysis suggests that the real compositions of the material are probably somewhat higher. This difference must be higher at high Ca/Na ratio.

Newly formed lomonosovite was never found below the melting temperature of lomonosovite. The experimental data show that lomonosovite melts incongruently with the formation of perovskite-lueshite solid solution, freidenbergite and two immiscible liquids (possibly also a solid phosphate). It is supposed, that silicate-salt liquid immiscibility can be important during late stages of alkaline magma evolution [3].

The separation of lomonosovite components into salt and silicate parts allows us to assume that lomonosovite can be formed through interaction between immiscible silicate and salt melts. The spatial movement of these immiscible liquids (for example, in the interstitial space) can be responsible for the non-uniform distribution of lomonosovite in the rocks.

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