MAGMAS OF THE MELILITOLITES OF THE BELAYA ZIMA CARBONATITE COMPLEX (EASTERN SAYAN, RUSSIA)

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The Eastern Sayan province of ultrabasic igneous rocks and carbonatites comprises a number of Nb, Ta, REE, U, Pb, Zn, and P deposits. The Belaya Zima massif is one of the largest niobium deposits in this province. The massif is built up of a variety of silicate, silicate-carbonate, and carbonate rocks including jacupirangite-melteigite-ijolite-urtite series rocks, nepheline and peralkaline syenites, melilitolite, picrite, early ore-free and late niobium-bearing carbonatites. The determination of the compositions of mineral-forming media using melt and fluid inclusions is of special importance for the silicate and nonsilicate rocks of the Belaya Zima deposit, because their genesis (magmatic or metasomatic) is still a matter of debate. To this end, we studied the mineral and chemical compositions of inclusions in minerals of the melilitolite of the Belaya Zima using electron microprobe analysis.

Primary melt inclusions and coexisting crystalline inclusions were explored in nepheline and perovskite from the melilitolite. The crystalline inclusions are phlogopite, perovskite, apatite, garnet and pyrrhotite in nepheline and calcite, sodalite, and titanomagnetite in perovskite (Tables 1).

Table 1. Chemical composition of crystalline inclusions in nepheline and perovskite and daughter minerals in melt inclusions in perovskite from the melilitolites. wt %

	1	2	3	4	5	6	7	8	9	10	11	12
SiO_2	34.24	37.42	0.29	0.10	1.70	1.40	37.92	0.05	0.06	37.17	30.72	0.60
TiO_2	0.00	0.02	51.04	0.00	0.02	0.00	0.32	0.00	8.80	5.80	33.42	0.02
Al_2O_3	12.04	23.12	0.57	0.12	0.09	0.00	32.25	0.04	3.29	12.18	3.82	0.06
FeO	22.38	0.96	1.31	62.80	0.03	2.74	0.41	0.16	83.18	6.25	1.59	0.00
MnO	0.58	0.10	0.03	0.03	0.14	0.04	0.01	0.00	1.47	0.38	0.04	0.09
MgO	17.59	0.04	0.04	0.11	0.03	0.04	0.09	0.02	2.09	22.15	0.02	0.05
BaO	0.00	0.03	0.00	0.00	0.03	0.00	0.08	0.00	0.13	1.05	1.02	0.00
SrO	0.10	0.00	0.10	0.14	0.04	0.27	0.02	0.87	0.06	0.00	0.15	0.23
CaO	0.25	37.43	42.47	0.02	56.75	54.90	0.24	60.82	0.03	0.67	27.54	60.49
Na_2O	0.69	0.48	0.57	0.08	0.11	0.14	20.69	0.01	0.05	0.16	0.26	0.03
K_2O	10.78	0.34	0.15	0.00	0.04	0.00	2.58	0.00	0.00	9.28	0.23	0.05
P_2O_5	0.08	0.04	0.00	0.01	38.73	38.41	0.01	0.00	0.00	0.00	0.28	0.00
Ce_2O_3	0.04	-	1.24	-	0.20	0.23	0.02	0.00	-	-	0.35	-
La_2O_3	0.00	-	0.17	-	0.03	0.09	0.01	0.00	-	-	0.00	-
ZrO_2	0.00	-	0.00	-	0.00	0.00	0.01	-	-	-	0.00	-
Nb_2O_5	-	-	1.65	-	-	-	-	-	-	-	0.77	-
Ta_2O5	-	-	0.00	-	-	-	-	-	-	-	0.00	-
F	0.00	-	0.04	-	2.81	2.01	0.15	0.00	-	-	0.69	-
Cl	0.00	0.02	0.00	0.01	0.01	0.04	5.27	0.03	0.01	0.02	0.00	0.00
S	0.00	0.01	0.02	35.02	0.00	0.00	0.01	0.00	0.00	0.00	0.02	0.04
Total	98.77	100.01	99.69	98.42	100.74	100.31	100.09	62.00	99.15	100.22	100.92	61.66
HM	Ne	Ne	Ne	Ne	Ne	Prv	Prv	Prv	Prv	Prv	Prv	Prv

Note: FeO is total iron. (HM) Host minerals: (Ne) nepheliene, (Prv) perovskite. (1-9) Crystalline inclusions: (1) phlogopite, (2) garnet, (3) perovskite, (4) pyrrhotite, (5, 6) fluorapatite, (7) sodalite, (8) calcite, (9) titanomagnetite. (10-12) Daughter minerals in melt inclusions in perovskite: (10) phlogopite, (11) sphene, (12) calcite.

Melt inclusions are randomly distributed within nepheline and perovskite crystals. They have oval shapes and are from 5 to 40 μm in size. The material of inclusions in nepheline is fully crystalline and contains a number of daughter minerals including phlogopite, nepheline, apatite, garnet, wollastonite, zeolite, calcite, perovskite, magnetite, pyrrhotite, and an unusual mineral of the stronalsite group with up to 12.6 wt % SrO (Table 2). Phlogopite, sphene, calcite, and magnetite were identified among the daughter phases of inclusions in perovskite (Table 1).