OKTYABRSKY MASSIF

Geological structure

Oktyabrsky Massif appears as an oval body elongated in the north-eastern direction. It is 7-8 km long and 5-6 km wide, with total area of approximately 40 km^2. The massif comprises subalkaline mafic and ultramafic rocks (gabbro, pyroxenite, peridotite), and alkaline and nepheline syenite (foyaite, mariupolite). The rocks mentioned above are found in places as pegmatitic varieties and may form veins and dykes.

We consider all of the main varieties of the Oktyabrsky Massif rocks as co-magmatic phases. Post-magmatic alteration is evidenced by crystallization of biotite after primary mafic minerals, local development of albite, microcline, aegerine, zeolites and carbonates after alkaline rocks and in exocontact aureoles.

Host rocks

Host rocks of the Oktyabrsky Massif are represented by various granitoids. In the north, east and south biotite-amphibole and biotite microcline and plagioclase-microcline granites prevail. These rocks are revealed by the Dmytriivka quarry and outcrop in a valley of the river Kalka. At the south-western contact of the massif unusual granitoids called “diallag granite” were found. These rocks vary in composition from quartz-monzonitic syenite to granite and contain minor amounts of olivine and pyroxene (“diallag”) that compositionally resemble those of fayalite and Fe-augite present in rapakivi granites of the Korosten and Salmi plutons.

Granites known from the western contact of the Oktyabrsky Massif belong to the enderbite-charnockite family. These rocks can be seen in the Khlebodarivka quarry. Typical features of these rocks are two-pyroxene assemblage, presence of brown (Ti-bearing) biotite, antipertites in plagioclase and bluish quartz.

Mafic and ultramafic rocks

Gabbro is the prevailing rock type, less abundant are pyroxenite, peridotite and olivinite (Table 1). Transitions between the above rocks are gradual. The main rock-forming minerals are pyroxene (Ti-augite), intermediate plagioclase, and olivine (chrysolite Fa_{24-28}). Secondary minerals are amphibole that crystallized after pyroxene, and biotite after ilmenite. Opaque minerals are ilmenite and Ti-magnetite, whereas minor minerals are apatite, zircon and baddeleyite.

Large and small bodies of mafic and ultramafic rocks form a broken ring in the outer part of the massif; they are located between the alkaline syenite and the host granite. Small blocks (xenoliths) of mafic and ultramafic rocks are common among alkaline and nepheline syenite of the internal part of the massif.

The largest (1.5 × 3.5 km) arcuate body of mafic and ultramafic rocks is located in the north-western part of the massif. There are two zones of the body – its outer part comprises pyroxenite with small amount of peridotite, while the internal part is composed of gabbro. The endocontact part of the body consists of fine-grained gabbro interpreted as chilled margin against the host granite. Few meters away from the contact these rocks are replaced by medium- to coarse-grained alternating gabbro and predominant pyroxenite.

Gabbro and peridotite-pyroxenite of the Oktyabrsky Massif display a number of mineralogical and geochemical features distinguishing them from mafic and ultramafic rocks that compose "normal" mafic-ultramafic complexes. At the (Na_2O+K_2O)-SiO_2 plot gabbro of the Oktyabrsky Massif falls into the field of alkaline basalt. Ti-augite also indicates affinity of this rock to the alkaline family.

Despite its high abundance of Ti gabbro and pyroxenite, the Oktyabrsky Massif is characterised by very low concentration of phosphorus. Other indicator features are: (1) significant prevalence of Na over K (potassium is virtually absent in these rocks); (2) high abundance of such compatibile elements as Cr and Ni.

Alkaline syenite

Alkaline syenite is the most widespread rock variety in the Oktyabrsky Massif. Syenites of the marginal part of the massif, as well as their vein and pegmatitic varieties outcrop in the Vali-Tarama valley and the river Kalka. These rocks display massive and trachitic structures and fine-, medium- to coarse-grained (pegmatitic) textures.

Syenite of the Oktyabrsky Massif belongs mainly to the alkali-feldspar quartz-less variety that often contains small (up to 5%) amount of nepheline. At the marginal part of the massif mesocratic plagioclase-bearing syenite is also present. Primary alkaline feldspar of the syenite is of Na-K composition and is represented mainly by microcline-pertite. Optically homogeneous alkaline feldspar is also present in places.

Pyroxene is one of the main mafic minerals of the syenite. Its composition varies from Ti-Fe-augite and aegerine-bearing Fe-salite, that are common in endocontact syenite, to aegerine-hedenbergite found in the vein syenite varieties. Ti-Fe-augite was found in olivine-bearing syenite only. Pinky-grey in thin sections, Ti-augite is usually mantled by green aegerine-bearing Fe-salite.

Besides primary pyroxene, the syenite often contains secondary aegerine developed as fine-grained aggregates after primary eagerine-ferrosalite. Simultaneously with secondary aegerine, alkaline amphibole and biotite also crystallized.

Olivine (Mn-bearing fayalite) is a rare mineral and occurs in an assemblage with Ti-Fe-augite and aegerine-bearing Fe-salite in the endocontact syenite of the north-eastern part of the massif against the contact with gabbro.

Amphibole is represented by two generations – high-Fe hastingsite and alkaline variety riebeckite-arfvedsonite.

Biotite in the syenite could occur as secondary mineral; however, it may be late-magmatic or even primary mineral. Represented by Fe-rich variety, it is close to annite.

Nepheline is present in minor (< 5%) amounts. Nepheline-bearing and nepheline-free syenites are indistinguishable in terms of their chemistry. Nepheline always forms anhedral grains.

Accessory minerals include apatite, ilmenite, zircon, baddeleyite, titanite, fluorite, molybdenite and pyrite.

The main geochemical peculiarities of the syenites can be summarized as follows: (1) they belong to the K-Na series; with virtually equal amounts of Na_2O and K_2O; or slightly higher Na_2O; (2) most of the syenites belong to the normal series or slightly oversaturated with alkalis; more alkaline-rich vein syenite varieties contain enigmatite – mineral characteristic of agpaitic rocks; (3) Fe/Mg ratio in the syenite (and its mafic minerals) increases from the endocontact part of the intrusion inward. The endocontact syenites are also enriched in Ti and P compared to the alkaline and nepheline syenites of the internal part of the massif.

Nepheline syenite

This rock group is represented by hypersolvus foyaite and subsolvus mariupolite (Table 2). Nepheline-bearing and nepheline-poor (with up to 15% of nepheline) syenites, transitional from alkaline syenite to foyatite, are of subordinate importance. These rocks are usually separated in the space. Besides, dykes of foyaite and mariupolite may be found independently in alkaline syenite and in the host granite.

Foyaite is located predominantly in the south-western and central parts of the Oktyabrsky Massif where it forms a complex half-ring body. The length of this body reaches 5 km while its thickness is 500-800 m. These rocks can be seen in the Vali-Tarama valley near village Lasarivka in natural outcrops.

Numerous varieties of foyaite can be identified, i.e. gneiss-like, trachitic and massive; fine-medium grained and pegmatitic; leuco- and melanocratic. The medium-grained gneiss-like foyaite containing 10-15% of mafic minerals prevails. Mafic minerals comprise amphibole (taramite) and biotite; less common is aegerine-hedenbergite (aegerine-augite). Nepheline concentration is about 25%. The main rock-forming mineral is alkaline feldspar represented by microcline-pertite.

The texture of the foyaite is subhedral. The earliest, more or less euhedral mineral is alkaline feldspar. Trachitoid foyaite is made of elongated crystals of microcline-pertite; the interstitial space is occupied by nepheline and amphibole. Nepheline is more or less euhedral with square or hexagonal cross-sections; however, it is anhedral concerning microcline-pertite and contains it as inclusions. Amphibole forms elongated and irregular grains anhedral to microcline-pertite.

Other mafic minerals (biotite and pyroxene) occur as separate grains or replace amphibole. In some cases, amphibole is replaced by aegerine-riebeckite that forms fine “worm-like” grains along the contacts of alkaline feldspar and amphibole. In other cases, amphibole contains evidently inherited inclusions of bright green pyroxene (aegerine-hedenbergite).

Mafic minerals of foyaite yield high Fe/Mg ratio and alkalinity; however, primary alkaline pyroxene (aegerine) and amphibole (riebeckite, arfvedsonite) are absent. Amphiboles are represented by Ca-Na varieties – taramite and Fe-hastingsite. Katophorite was noted in albite-microcline-nepheline pegmatite (foyaite pegmatite). Pyroxene belongs to the aegerine-hedenbergite series, while biotite is classified as annite.

Minor minerals of foyaite include zircon, apatite, titanite, fluorite, britolite, pyrochlore etc.

The main geochemical features of the foyaite can be summarized as follows: (1) high Fe/Mg ratio with prevalence of Fe^{2+} over Fe^{3+}; (2) rather high, close to 1 or even over, agpaitic coefficient; (3) minor prevalence of Na_2O over K_2O; (4) less abundant phosphorus and titanium compared to alkaline syenite.

Mariupolite can be defined as aegerine-albite nepheline syenite. Mariupolite in the Oktyabrsky Massif significantly prevails over foyaite in the plan view; however, its volume and thickness are lower. Mariupolite occurs among gabbro and pyroxenite in the north-eastern part of the massif; in its central, south-western and southern portions outcrops among alkaline syenite, foyaite; and on the outside of the massif cuts the host granites. In most cases these are thin dykes that outcrop in the Vali-Tarama valley and the river Kalka.

The contacts of mariupolites against the host rocks are sharp, intrusive. In spite of variable composition of the host rocks (gabbro-pyroxenite, foyaite, granite), the mineral composition of mariupolites is rather constant (albite + nepheline + aegerine) and independent of their position. However, mariupolites are quite variable in terms of their structure and texture. Fine-grained, porphyric, gneiss-like, schlieren, coarse-grained, pegmatiod etc. varieties can be distinguished.

Mariupolites are characterized by higher amounts of zircon, britolite and pyrochlore. At the same time, apatite is rather rare or absent. Instead of apatite its structural analogue – britolite crystallizes. Other accessory minerals are represented by fluorite, bastnaesite, rinkite, titanite.

Special attention must be paid to zircon in mariupolite. It is rather large in size (up to 1 cm and more), forms bipiramidal crystals, displays strong zonation and contains numerous inclusions of albite and sometimes of aegerine. Evidently zircon crystallized somewhat later than the rock-forming minerals.

The main rock-forming and probably earliest mineral of mariupolite is albite. It forms inclusions in other main (aegerine, nepheline) and accessory (zircon, britolite) minerals. Albite is developed as elongated-tabular or microlithic grains in mariupolite that form trachite-like texture.

Nepheline usually occurs between albite grains and forms euhedral (squared, hexagonal) crystals. Porphyric grains of nepheline are quite common in uneven-grained and coarse-grained mariupolites. Concentration of nepheline varies from 7.5 to 40%, with an average of about 30%.

Aegerine and aegerine-hedenbergite occur as fine elongated grains with wavy faces located between albite and nepheline crystals. More coarse grains of aegerine contain inclusions of albite, sometime also of nepheline. The amount of aegerine usually ranges 7–13%; it may reach 20% in gneiss-like mariupolite or 34% in melamariupolite.

Microcline is not a typical mineral for mariupolite. Its maximal content does not exceed 12%.

Evdialite-bearing agpaitic phonolite and dykes of nepheline syenite

Evdialite-bearing phonolite and dykes of nepheline syenite outcrop in two areas: 4 km north of the Oktyabrsky Massif in the upper part of the river Kalka (valley Kamennaya) and 10 km south of the massif in village Krasnovka (valleys Havalishina and Tunikova). At the first area outcrops of phonolitic mariupolite were found, while at the second - aegerine foyaite.

Evdialite-bearing phonolite and nepheline syenite occur as light-grey or yellow-grey massive fine-grained or hornfels rocks. Within the fine-grained groundmass rare phenocrysts of feldspar and nepheline can be distinguished. Aggregates of several phenocrysts of nepheline are sometimes present. Visible dispersion of fluorite was noted in places. Phenocrysts of dark biotite and amphibole occur in nepheline syenite of the valley Havalishina.

The main rock-forming minerals are alkaline feldspar (30-35%), nepheline (25-50%) and aegerine (15-20%). Minor minerals are sodalite (primary and secondary) and cancrinite (secondary).

Alkaline feldspar of the groundmass occurs as microlithes (up to 3 × 0.01 mm) or somewhat larger (up to 8 × 0.1 mm) very elongated tabular and prismatic crystals with irregular resorbed contours.

Nepheline forms euhedral (squared, prismatic) fine (2-3 × 0.01-0.1 mm) crystals or anhedral isomeric grains. It often contains fine inclusions of alkaline feldspar or rarely prismatic elongated crystals of aegerine. Nepheline is replaced by cancrinite. Aegerine usually forms elongated prismatic grains with irregular wavy outlines.

Oversaturation of the initial melts of phonolites and nepheline syenites with alkalis led to specific accessory mineralization. Instead of zircon and biotite that are typical for nepheline syenite and mariupolite of the Oktyabsky Massif, phonolite and dykes of nepheline syenite contain evdialite and astrophyllite.

Table 1. Chemical composition of the main varieties of the mafic minerals in the rocks of the Oktyabrsky Massif

№	**SiO_2**	**TiO_2**	**Al_2O_3**	**Fe_2O_3**	**FeO**	**MnO**	**MgO**	**CaO**	**Na_2O**	**K_2O**	**F**	**H_2O**	**LOI**	**Total**	**Fe/(Fe+Mg)**
1	39.36	0.08	0.20	0.40	21.14	0.15	38.13	0.37	0.08	0.05	-	0.12	0.46	100.54	0.24
2	35.60	0.22	0.02	-	22.52	0.30	37.50	Not an.	Not an.	Not an.	-	Not an.	Not an.	97.06	0.256
3	34.79	0.04	0.61	-	41.34	0.74	24.39	0.02	0.18	0.00	-	-	-	102.11	0.49
4	33.25	0.00	0.16	-	47.87	0.64	18.31	0.05	0.13	0.00	-	-	-	100.41	0.60
5	30.10	0.00	0.02	-	60.76	4.32	2.97	0.01	0.10	0.00	-	-	-	99.28	0.3
6	30.09	0.00	0.00	-	62.82	4.49	1.98	0.00	0.09	0.00	-	-	-	99.47	0.95
7	46.90	1.98	4.40	1.47	7.30	0.12	15.51	20.73	0.28	0.07	-	-	1.14	99.90	0.24
8	47.25	1.85	6.13	1.35	5.76	0.38	13.75	22.46	0.64	0.08	-	traces	0.65	100.30	0.230
9	49.84	0.84	4.18	1.82	7.80	0.22	14.06	20.93	0.53	0.05	-	traces	traces	100.27	0.278
10	48.72	1.04	2.44	3.08	8.98	0.16	12.75	21.64	0.68	0.04	-	Not an.	Not an.	99.53	0.345
11	48.20	0.82	1.76	4.22	18.25	0.90	5.59	19.45	1.31	0.09	-	0.10	0.01	100.70	0.69
12	48.62	0.44	0.66	3.46	17.28	0.94	5.83	19.82	1.64	0.08	-	0.16	0.60	99.53	0.67
13	47.74	0.48	0.96	5.94	15.84	1.08	5.22	18.26	2.46	0.24	-	0.32	1.02	99.56	0.71
14	50.50	0.54	0.28	15.14	11.06	0.94	3.60	11.10	6.62	traces	-	Not det.	traces	99.78	0.80
15	48.82	0.66	1.25	13.37	12.96	1.14	1.03	14.30	4.94	0.10	-	0.12	0.88	99.57	0.94
16	50.40	0.24	2.58	12.58	12.40	1.36	2.55	12.10	5.82	0.30	-	0.01	0.10	100.44	0.84
17	50.36	0.65	3.02	19.64	6.50	2.12	1.28	7.89	8.62	0.28	-	Not an.	0.23	100.59	0.95
18	51.31	1.27	-	30.79	1.15	0.85	0.32	1.12	12.16	0.27	-	Not an..	0.35	99.59	0.98
19	51.74	0.15	4.48	26.12	1.72	0.65	1.01	0.94	12.17	0.18	-	0.01	0.49	99.66	0.93
20	51.00	0.29	2.63	26.95	1.44	0.47	0.51	3.62	11.74	0.22	-	0.66	0.66	99.53	0.97
21	36.72	3.42	10.94	4.01	22.84	0.63	4.60	10.62	2.52	1.69	0.23	0.07	2.00	100.28	0.77
22	37.60	3.50	10.60	4.50	23.28	0.66	3.30	10.50	2.86	1.70	0.28	<0.01	1.66	100.45	0.82
23	37.20	2.66	10.80	5.50	23.13	0.64	2.00	11.70	2.86	1.90	0.26	0.20	1.64	100.49	0.89
24	37.64	0.60	10.50	10.06	23.40	0.43	1.20	8.62	3.65	2.00	0.05	-	1.85	100.64	0.94
25	37.51	0.73	8.50	11.41	23.21	1.70	0.56	7.91	3.79	2.10	0.14	0.33	2.32	100.21	0.97
26	37.55	0.89	9.90	11.89	21.40	1.25	1.31	7.28	4.05	2.11	-	0.04	1.80	99.82	0.93
27	38.54	1.14	10.01	12.26	20.83	1.40	сл.	6.80	4.20	1.84	0.20	0.10	2.87	100.19	1.00

28	39.08	0.60	7.60	13.59	21.34	1.87	0.66	6.11	5.50	2.01	0.42	-	2.04	100.57	0.97
29	31.44	2.28	14.45	3.32	29.45	0.56	5.39	<0.01	0.20	8.46	0.10	0.01	4.30	99.97	0.77
30	32.80	3.29	12.80	4.50	30.17	0.56	3.20	0.46	0.40	7.66	0.09	0.40	3.33*	99.66	0.86
31	32.50	4.75	13.10	5.48	27.73	0.48	3.80	0.33	0.40	7.66	0.10	<0.01	3.25	99.59	0.83
32	31.60	0.90	11.23	12.47	27.86	0.78	2.61	1.12	0.71	7.68	-	0.28	1.55	100.42**	0.94
33	35.86	2.30	10.99	6.10	22.03	2.57	6.53	traces	1.02	8.56	1.52	0.52	2.41	99.78	0.81

Note: 1-6 – olivines from peridotites (1), olivine pyroxenites (2), Ti-augite gabbro (3, 4) and syenite (5, 6); 7-20 – pyroxenes from vehrlite (7), olivine pyroxenite (8), olivine-bearing Ti-augite gabbro (9, 10), endocontact alkaline syenite (11, 12, 13), enigmatite-bearing vein syenite (14, 15), pegmatitic foyaite (16), bekkelite mariupolite (17), melamariupolite (18), agpaitic phonolite (19) and dyke of aegerine microfoyaite (20); 21-28 – amphiboles from endocontact syenite (hastingsite 21-23), dyke of foyaite (hastingsite 24), foyaite (taramite 25-27), and albite-microcline-nepheline pegmatite (kataforite 28); 29-33 – biotites from nepheline-bearing syenite (29, 30), endocontact mesosyenite (31), foyaite (32) and mariupolite (33).

* Including 0.25% CO_2.

** Total include also 0.25% P_2O_5 and 0.84% SO_3.

Table 2. Chemical composition of mafic and ultramafic rocks of the Octyabrsky Massif

	Gabbro of the internal part of arch						**Gabbro of the endocontact part of arch**					**Pyroxenites of the endocontact part**							**Average composition**		
№	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
Sample №[1]	**121/ 710**	**124/ 710**	**134/ 710**			**91/ 710**	**3/ 820**	**8/ 820**	**19/ 820**	**20/ 820**	**16/ 820**	**4/ 820**	**11/ 820**	**13/ 820**	**21/ 820**	**22/ 820**	**30/ 888**	**143/ 819**			
SiO_2	40.32	47.13	44.15	41.40	35.60	41.28	46.82	44.15	50.45	45.74	39.40	45.77	45.06	43.28	44.60	47.18	41.74	45.43	46.99	44.39	40.35
TiO_2	7.02	2.86	5.90	4.50	6.40	6.14	5.00	6.18	4.52	4.94	6.90	3.43	3.58	4.25	3.67	2.22	5.70	2.28	1.77	2.45	0.34
Al_2O_3	12.55	14.50	11.77	16.20	12.90	12.92	12.50	12.24	12.47	13.71	12.60	6.48	7.03	6.76	5.90	4.06	8.21	4.55	5.01	4.04	1.73
Fe_2O_3	3.01	0.30	1.19	3.78	12.55	3.23	3.94	3.52	1.73	2.45	5.83	3.38	2.34	3.93	3.41	2.13	2.80	2.27	2.09	4.00	10.72
FeO	13.16	11.01	11.85	11.40	10.90	13.46	10.85	12.07	12.07	11.78	12.57	8.84	10.85	8.76	8.26	7.68	11.79	7.82	7.74	8.73	7.82
MnO	0.29	0.12	0.22	0.25	0.20	0.20	0.18	0.20	0.22	0.26	0.18	0.20	0.26	0.16	0.15	0.18	0.18	0.17	0.27	0.29	0.24
MgO	6.82	7.82	8.00	6.90	7.30	6.70	5.56	6.68	4.92	5.88	6.57	12.93	11.54	11.97	13.30	14.70	11.02	18.10	15.48	21.12	36.14
CaO	11.32	10.97	11.91	11.60	11.28	11.09	9.30	9.30	7.60	8.51	9.28	14.64	13.50	16.88	16.78	18.34	15.50	16.40	19.71	14.07	1.95
Na_2O	2.74	3.18	3.58	3.22	1.45	2.74	2.40	2.11	2.97	2.62	1.73	0.89	1.49	0.60	1.06	0.67	0.90	1.06	0.54	0.45	0.29
K_2O	0.40	0.40	0.30	0.74	0.35	0.30	1.42	1.42	1.86	1.57	1.65	0.86	0.86	0.43	0.40	0.27	0.46	0.20	0.13	0.14	0.14
S	0.26	0.12	0.15	0.31	0.06	0.04	0.25	0.32	0.27	0.18	0.42	0.25	0.10	2.35	0.26	0.19	0.30	0.05	0.23	0.12	0.10
P_2O_5	0.09	0.08	0.08	0.08	0.05	0.09	0.15	0.12	0.07	0.24	0.12	0.09	0.08	0.03	0.04	0.03	0.18	0.06	0.23	0.02	0.02
CO_2	0.48	0.55	0.32			0.38	0.70	0.53	0.70	0.53	0.66	0.73	1.44	1.05	1.16	0.98	0.46	0.54	0.00	0.00	0.00
H_2O	0.08	0.19	0.21			0.26	0.08	0.11	0.04	0.46	0.12	0.10	0.08	0.05	0.06	0.00	0.23	0.20	0.00	0.00	0.00
LOI	1.11	0.52	0.54			0.77	0.80	1.21	0.64	0.96	1.67	1.05	1.41	0.87	0.62	0.93	0.61	1.00	0.00	0.00	0.00
Total	***99.65***	***99.75***	***100.17***	***100.38***	***99.04***	***99.60***	***99.95***	***100.16***	***100.53***	***99.83***	***99.70***	***99.64***	***99.62***	***101.37***	***99.67***	***99.56***	***100.08***	***100.13***	***100.19***	***99.82***	**99.84**
#Fe	0.57	0.45	0.48	0.55	0.63	0.58	0.59	0.56	0.61	0.57	0.60	0.34	0.40	0.37	0.32	0.27	0.42	0.23	0.26	0.25	0.22
Na_2O+K_2O	3.14	3.58	3.88	3.96	1.80	3.04	3.82	3.53	4.83	4.19	3.38	1.75	2.35	1.03	1.46	0.94	1.36	1.26	0.67	0.59	0.43
Na_2O/K_2O	3.14	3.58	3.88	3.96	1.80	3.04	3.82	3.53	4.83	4.19	3.38	1.75	2.35	1.03	1.46	0.94	1.36	1.26	0.67	0.59	0.43
Cr	122	300	271			100	80	100	100	100	100	800	834	450	1371	2367	621	1646	1400	1600	490
Ni	60	79	60			100	60	80	30	30	50	200	45	200	200	116	100	400	280	330	370
Cu	85	25	24			48	22	76	29	30	65	200	45	130	239	200	55	204			

[1] Sample names: numerator - number of a sample, denominator – number of a drilling. Samples without numbers – according to data of Eliseev et al. (1965) and Fomin (1984). 19 – pyroxenite (average from 10 samples), 20 – peridotite (average from 8 samples), 21 – olivinite (average from 6 samples) after data of Fomin (1984).

Zn	115	75	86			119	108	112	50	104	84	89	53	33	64	36	50	62			
Ga	10	10	10				20	10	15	20	30	10		10							
Pb		11	5				5	10	15	17	12	10			5	10	17	8			
Th		5	5			5		5	5	5											
Rb	20	20	5			20	34	48	41	48	67	39	43	15	30	11	21	4			
Sr	805	958	930			945	633	635	541	983	698	250	263	181	135	112	292	103			
Y	25	14	13			13	29	29	30	26	13	14	15	6	6	11	10	10			
Zr	65	60	60			60	135	210	165	145	80	75	130	35	55	60	95	40			
Nb	35	25	25			25	35	20	25	40	20	3	10	3			12	5			
Ba	250	325	245			245	590	565	1110	685	610	295	230	120	140	80	190	50			
La	30	20	20			20	65	30	40	35	25	7	15	10	20	15	15	25			
Ce	40	25	30			30	90	70	75	65	40	25	50	25	20	25	30	30			

Table 3. Average compositions of the main types of alkaline rocks of the Oktyabrsky Massif

	1	**2**	**3**	**4**	**5**	**6**	**7**
SiO_2	54.55	58.01	53.54	58.79	58.66	53.43	55.06
TiO_2	1.33	1.01	0.20	0.05	0.15	0.09	0.06
Al_2O_3	17.47	15.80	21.02	19.64	20.97	19.34	19.99
Fe_2O_3	1.46	3.13	1.48	2.19	2.62	6.59	5.95
FeO	7.46	5.03	5.40	2.30	1.74	1.41	1.01
MnO	0.19	0.25	0.22	0.17	0.17	0.49	0.54
MgO	1.09	1.29	0.23	0.58	0.34	0.20	0.28
CaO	4.26	2.82	2.40	2.00	0.75	1.70	1.06
Na_2O	5.46	5.75	8.24	9.56	11.86	9.45	11.00
K_2O	4.30	5.05	5.52	3.40	1.42	4.58	4.40
S	0.03	0.07			0.02	0.03	Сл.
P_2O_5	0.41	0.27	0.14	0.18	0.06	0.08	0.07
CO_2	0.40	0.58		0.21			0.20
F			0.18		0.20	0.65	
H_2O	0.02	0.13		0.05	0.09		
LOI	0.92	0.51	1.07	0.45	0.75	2.07	0.21
Total	***100.00***	***99.70***	***99.64***	***99.57***	***99.80***	***100.11***	***100.23***
Fe/(Fe+Mg)	0.82	0.77	0.94	0.81	0.87	0.96	0.93
Na_2O+K_2O	9.76	10.80	13.76	12.96	13.28	14.03	15.40
Na_2O/K_2O	9.76	10.80	13.76	12.96	13.28	14.03	15.40
Na+К/Al	0.78	0.82	0.93	0.99	1.00	1.06	1.15
Cu	55	40	28	50	46	33	40
Zn	130	138	70	65	86	261	255
Ga	13	24	21	40	102	60	52
Pb	13					28	32
Th					11	45	28
Rb	108	141	136	130	120	388	405
Sr	1513	260	90	115	48	99	35
Y	25	38	40	20	162	202	243
Zr	243	341	316	1050	3793	2222	3049
Nb	63	121	196	165	1334	598	532
Ba	4288	729	126	282	19	29	50
La	26	38	117	23	143	285	240
Ce	90	104	183	63	273	426	390
Pr					48	52	60
Nd					184	241	235
Li	8	11	8	10	9	21	13

1 – average composition of endocontact syenite (average from 4 samples), minor elements according to two XRF analyses (including 0.65% BaO); average composition of syenites of the central part (average from 3 samples); 3 – average composition of the taramite foyaite (average from 4 samples); 4 – amphibole-aegerine foyaite, valley Lisitsya; 5 – mariupolite (average from 6 samples, including 0.51% ZrO_2); 6 – dyke of aegerine foyaite (average from 6 samples); 7 – agpaitic phonolite (average from 3 samples, including 0.40% ZrO_2).

Khlebodarivka quarry is located west of the Oktyabrsky Massif. The quarry reveals charnockite rock cut by veins of rapakivi-like granite, camptonite and carbonatite. The prevailig variety of charnockite in the Khlebodarivka quarry is plagioclase charnockite (enderbite). In places, charnockite contains xenoliths of two-pyroxene schists.

Camptonite dykes occur as thin (up to 1-1.5 m wide) subvertical veins with sharp straight contacts against charnockite. Camptonite is a grey to dark-grey fine-grained rock laden in places with numerous phenocrysts. Most abundant phenocrysts are: clinopyroxene (augite), Ti-amphibole (kaersutite), Ti-bearing biotite, lepidomelane, alkaline feldspars, magnetite, high-Al spinel and apatite.

There are two varieties of the clinopyroxene phenocrysts: sub-Ca low-Na and low-Ti Al-bearing augite (6.17-10.60% Al_2O_3) and sub-Ca low-Al and low-Ti high-Cr augite (1.06-1.47% Cr_2O_3; 3.67-4.17% Al_2O_3).

Ti-bearing biotite occurs in aggregates with Al-augite and kaersutite while lepidomelane is more common in assemblages with feldspar and magnetite.

Feldspars contain a lot of Ba (up to 1.5%) and Sr (up to 0.5%) and very small amount of alkalis (Rb_2O – up to 0.003%, Cs_2O – up to 0.001%).

Spinel is high-Al and low-Cr (Al_2O_3 – 53.66-55.94%; MgO – 15.82 -16.90%). Magnetite contans some Ti, high-Al and low-Mg (2.13-7.71% TiO_2; 3.52-4.60% Al_2O_3; 0.36-0.36% MgO, up to 0.02% V_2O_5).

All of the mentioned phenocrysts are interpreted as high-pressure near-liquidus phases that crystallized from the same initial melt.

Table 4. Chemical composition of the camptonite

	Khl-2007	**Khl-1-2007**	**Khl-2-2007**	**Khl-3-2007**	**85-13/19**	**Dm-1-2007**	**Dm-1A-2007**
SiO_2	41.44	40.46	40.88	44.68	41.05	43.43	44.98
TiO_2	1.47	1.48	1.47	2.29	1.46	1.92	2.12
Al_2O_3	14.37	13.79	14.88	15.56	13.98	14.71	16.27
Fe_2O_3	4.49	5.46	4.56	4.86	4.90	4.14	4.09
FeO	8.65	8.51	8.29	8.44	8.58	15.09	11.58
MnO	0.24	0.24	0.19	0.12	0.26	0.35	0.17
MgO	4.84	4.98	4.63	5.66	5.49	4.64	5.00
CaO	9.58	10.16	10.23	8.55	9.46	1.94	4.20
Na_2O	3.40	3.45	3.20	3.88	3.25	4.20	3.96
K_2O	2.43	2.84	4.00	2.73	3.50	2.94	2.48
P_2O_5	1.35	1.35	1.27	0.66	1.24	0.76	0.81
H_2O^-	0.18	0.22	0.22	0.16	0.14	0.14	0.48
LOI	7.06	7.12	5.79	1.86	6.27	5.76	3.41
Total	99.56	100.06	99.61	99.55	99.58	100.04	99.59

Table 5. Chemical composition of phenocrysts in camptonite

Mineral	**SiO_2**	**TiO_2**	**Al_2O_3**	**Fe_2O_3**	**FeO**	**MnO**	**MgO**	**CaO**	**Na_2O**	**K_2O**	**P_2O_5**	**SO_3**	**H_2O^-**	**H_2O^+**	**Total**
augite	50.36	0.65	6.5	2.86	4.37	0.2	17.5	16.4	0.92				0.09	0.16	100.01
augite	47.75	1.23	6.87	2.55	5.39	0.2	16.79	16.35	1.16				0.29	0.85	99.59
kaersutite	39.63	3.20	15.02	3.38	11.70	0.12	8.18	11.30	2.15	2.27	0.15	0.03	0.11	2.70	100.37
kaersutite	37.82	3.76	15.22	3.36	10.29	0.10	11.13	11.10	2.25	5.51	0.13	0.34	0.28	2.13	100.42
kaersutite	37.18	3.30	14.73	5.51	10.34	0.15	8.63	11.10	1.85	2.51	0.07	0.10	0.52	3.75	99.74
kaersutite	43.58	0.91	9.68	4.66	9.88	0.33	10.05	13.55	2.24	1.73	0.57	0.27	0.38	2.09	99.05
kaersutite	40.19	2.10	13.11	2.63	15.02	0.24	9.60	11.72	1.60	17.00			0.04	1.08	99.93
kaersutite	42.34	5.10	13.88	15.34		0.18	6.55	10.09	2.47	1.71					97.67
biotite	37.18	6.09	16.26	9.87		0.05	11.89	0.02	0.98	8.97					91.30
biotite	35.62	7.50	15.89	2.19	10.43	0.04	13.86	0.12	0.62	9.08			0.11	3.15	99.69
biotite	36.36	6.50	15.94	3.32	9.78	0.04	13.28	0.60	0.22	8.60			0.14	3.76	99.58
biotite	33.20	6.14	14.60	7.88	16.62	0.13	7.23	0.80	0.70	7.40			0.36	3.79	99.98
biotite	33.87	1.87	15.17	6.27	22.82	0.23	5.97	0.18	0.56	8.00			0.24	4.53	99.98
feldspar	64.94		19.98	0.16			0.02	0.73	6.58	7.01					99.41
feldspar	65.08		20.42	0.20	0.36	0.02	0.09	1.05	5.96	6.50	0.08	0.14		0.47	100.37
feldspar	63.32		19.56		1.08	0.02	0.08	0.98	3.94	9.00	0.14	0.34	1.22		99.68
feldspar	65.29		20.37		0.36	0.02	0.11	1.05	5.96	6.60	0.08	0.26		0.37	100.47
feldspar	64.16	0.12	21.06	0.12	0.18			0.80	8.19	3.07	0.10		0.10	0.58	98.46

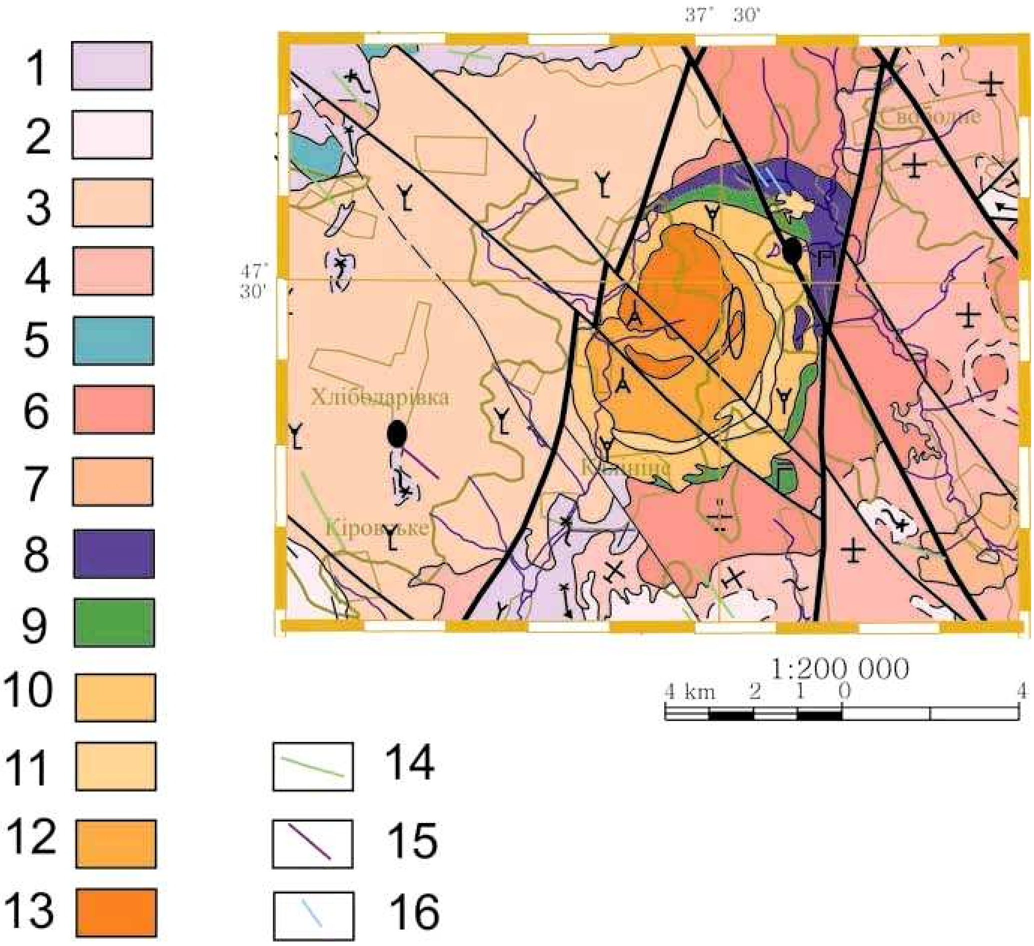

Fig. 1. Geological map of the Oktyabrsky Massif and surrounding area

1 – Zakhidnopryazovska Series AR_1: plagiogneisses, schists, amphibolites.

2 – Temrukska suite AR_3: plagiogneisses, gneisses, schists, amphibolites.

3 – Khlebodarivka complex PR_1 (2040 Ma) – twopyroxene-amphibole granite

4 – Anadol complex PR_1 (2081 Ma) – biotite granite

5 – Mangush complex AR_3: metagabbronorite

6 – Khlebodarivka complex PR_1 – biotite-amphibole granite

7 – Pivdennokalchiksky complex PR_1 (1800 Ma) – olivine-twopyroxene monzonite

8-13 – Oktyabrsky Massif PR_1 (1750 Ma): 8 – pyroxenite and peridotite; 9 – gabbro; 10 – syenite and alkaline syenite; 11 – mariupolite; 12 – foyaite; 13 – pulaskite;

14-16 – dyke complexes: 14 – dolerite; 15 – camptonite; 16 – carbonatite.