# TIKSHEOZERSKIY MASSIF. COMPOSITION, CONDITIONS OF FORMATION, EXPERIMENTAL MODELLING OF MINERALOGENESIS

**Kovalskii A.M., Kovalskaya T.N., Kotelnikov A.R.** (IEM RAS)
*kovalsky@iem.ac.ru*; Fax: (252) 4-44-25; Phone: (252) 2-25-54

Key words: Tiksheozerskiy massif, ultrabasic rocks, carbonatites, pyroxene, amphibole, geothermometry, experimental modeling, mineralogenesis

Tiksheozerskiy massif (Northern Karelia) belongs to a formation of the ultrabasic alkaline massifs with carbonatites. Unlike of well-known alkaline massifs with carbonatites of middle Paleozoic age (Khibiny group, Kovdor massif, etc.), Tiksheozerskiy massif belongs to a Proterozoic subplatform complex, therefore the rocks of this massif have undergone significant changes during a geological history of region.

During our work with the samples of rocks of Tiksheozerskiy massif we had investigate material from natural exposals and from a core samples of drill holes in various places of the massif. It is shown, that Tiksheozerskiy massif is consisted of three groups of rocks: (1) ultrabasic rocks (pyroxenites ± olivinites); (2) alkaline rocks (syenites); (3) carbonatites.

All rocks are perfectly changed. All pyroxenites are carbonatizated and amfibolyzated to some extent. Presence of much amounts of carbonates in pyroxenites, both filling cracks, and forming independent grains and crystalline aggregates among pyroxene grains, indicates the active carbonatization of rocks during introduction of carbonatite melt, or a postmagmatic recrystallization of carbonates.

Two groups of pyroxene compositions can be identify in rocks:

1. pyroxenes of generality of pyroxenites correspond to a Di-Hed solid solutions with an average mole fraction of magnesium 0.8;
2. pyroxenes of samples containing such low-temperature minerals as cancrinite, natrolite, sodalite, zeolites, contain in their structure up to 15-20% of aegerine minal.

Amphiboles in rocks are rather various and according to the contents of alkalis and alumina can be divided in two groups:

1. alkaline amphiboles of syenites (richterite group);
2. amphiboles of the ultrabasic-basic rocks (pargasite group).

Ultrabasic rocks of Tiksheozerskiy massif are presented mainly by pyroxenites.

## Petrogenesis conditions of Tiksheozerskiy massif estimation

Different mineral paragenetic associations were used for an estimation of temperatures of formation of Tiksheozerskiy massif rocks. Definition of temperatures was carried out with an application of mineral geothermometers of Perchuk and Ryabchikov, 1976.

Temperatures of pyroxenites formation using Cpx-Amf, Bi-Amf and Px-Bi geothermometers are estimated in an interval 710-980°C.

The estimation of petrogenesis temperatures of perfectly changed (with secondary sodalite, natrolite, cancrinite and a carbonate) pyroxenites on relic associations of minerals gives a little bit higher values 870-1050°C.

Definition of temperatures using of two-carbonate geothermometer in this rocks is complicated, but uniquely indicates formation of paragenesis at temperatures less then 450°C. Sodalite, cancrinite and natrolite found out in some samples indicate significant hydrothermal change of rocks.

For the purpose of definition of metamorphism conditions occurring in the region of Tiksheozerskiy massif, two samples of biotite-garnet gneisses with association of quartz, plagioclase, biotite, garnet and accessory minerals: rutile, apatite, ilmenite and zircon, were investigated. Using a garnet-biotite geothermometer the temperature of metamorphism was estimated in an interval 500-550°C.

## Experimental modeling of mineralogenesis of Tiksheozerskiy massif

For the purpose of experimental modeling of mineralogenesis of Tiksheozerskiy massif, we take a shot at of synthesis of minerals in system Diopside-Hedenbergite - Annite with the excess content of sodium. Experiments were carried out using capsule technique in hydrothermal conditions at temperatures 650 and 750°C and pressure 1.5 kbar within 32 and 27 day correspondingly. Experiments were carried out on the high pressure cold seal vessels. The accuracy of control of temperature was 5°C, pressure - 50 bar. The mixtures of diopside, hedenbergite and annite gels were used as starting components in these series of runs. The gel of Na- analogue of phlogopite was used for introduction of sodium to the system. The association Fe-FeO was used as a buffer mixture. Starting materials were mixed up in a mechanical mixer and then they were placed into a gold capsule. The platinum capsule with a buffer mix was placed into the central part of a gold capsule and covered around by a starting mix. 10 wt. % of distilled water was added to a gold capsules before sealing.

Solid products of experiences were investigated by a microprobe method and represent associations of clynopyroxenes of Di-Hed-Aeg system and alkaline amphiboles. In the products of runs (5778-5781) which had been carried out at 650°C pyroxenes are represented by $Aeg_{4-12}Di_{38-85}Hed_{10-58}$, and amphiboles are represented by minerals of richterite-kataforite-pargasite-edenite system.

Pyroxenes in products of more high-temperature runs (5757-5759) which had been carried out at 750°C are represented by $Aeg_{7-8}Di_{75-83}Hed_{9-18}$, and amphiboles are represented by more alkaline (than in experiments at 650°C) differences of system richterite-kataforite-glaucophane.

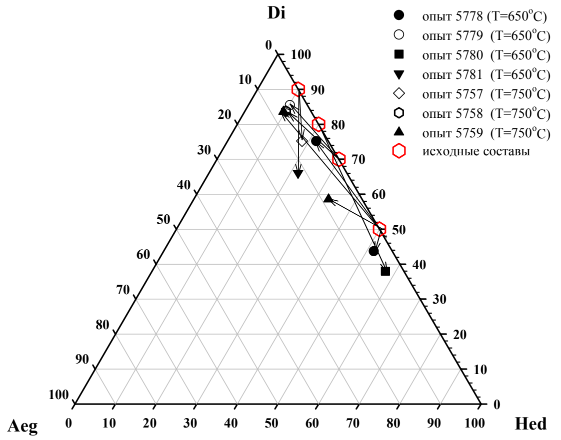


**Fig.1.** Compositions of clynopyroxenes synthesized in experiments on modeling of mineralogenesis of Tiksheozerskiy massif.

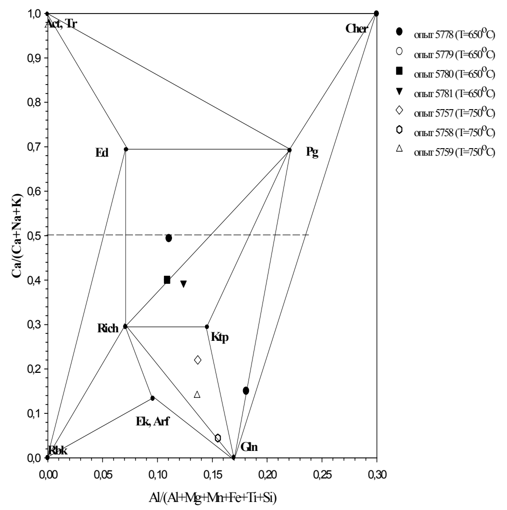


**Fig.2.** Compositions of amphiboles synthesized in experiments on modeling of mineralogenesis of Tiksheozerskiy massif.

Thus, the pyroxenes of close compositions with small variations of Ca/Mg ratio and the identical aegirine content were synthesized at 750°C. The compositions of these pyroxenes are analogical to Tiksheozerskiy massif pyroxenes. However, Amphiboles of massif are more calcium then ones synthesized at 750°C. It is possible to assume, that natural amphiboles, which are in association with pyroxenes, are not in paragenesis each other, or have been changed probably during the processes of carbonatization. The last hypothesis can be confirmed by the presence of calcite together with pyroxenes and amphiboles in rocks.

*Work is executed at support of the RFBR, grants №№ 04-05-64649, 06-05-64904, 04-05-64706, grants of the President of Russian Federation MK-2948.2006.5, MK-3499.2006.5 and Fund of native science support*

*Electronic Scientific Information Journal "Herald of the Department of Earth Sciences RAS" № 1(24)'2006*
*ISSN 1819 – 6586*
*Informational Bulletin of the Annual Seminar of Experimental Mineralogy, Petrology and Geochemistry – 2006*
*URL: http://www.scgis.ru/russian/cp1251/h_dgggms/1-2006/informbul-1_2006/mineral-17e.pdf*

*Published on July, 1, 2006*