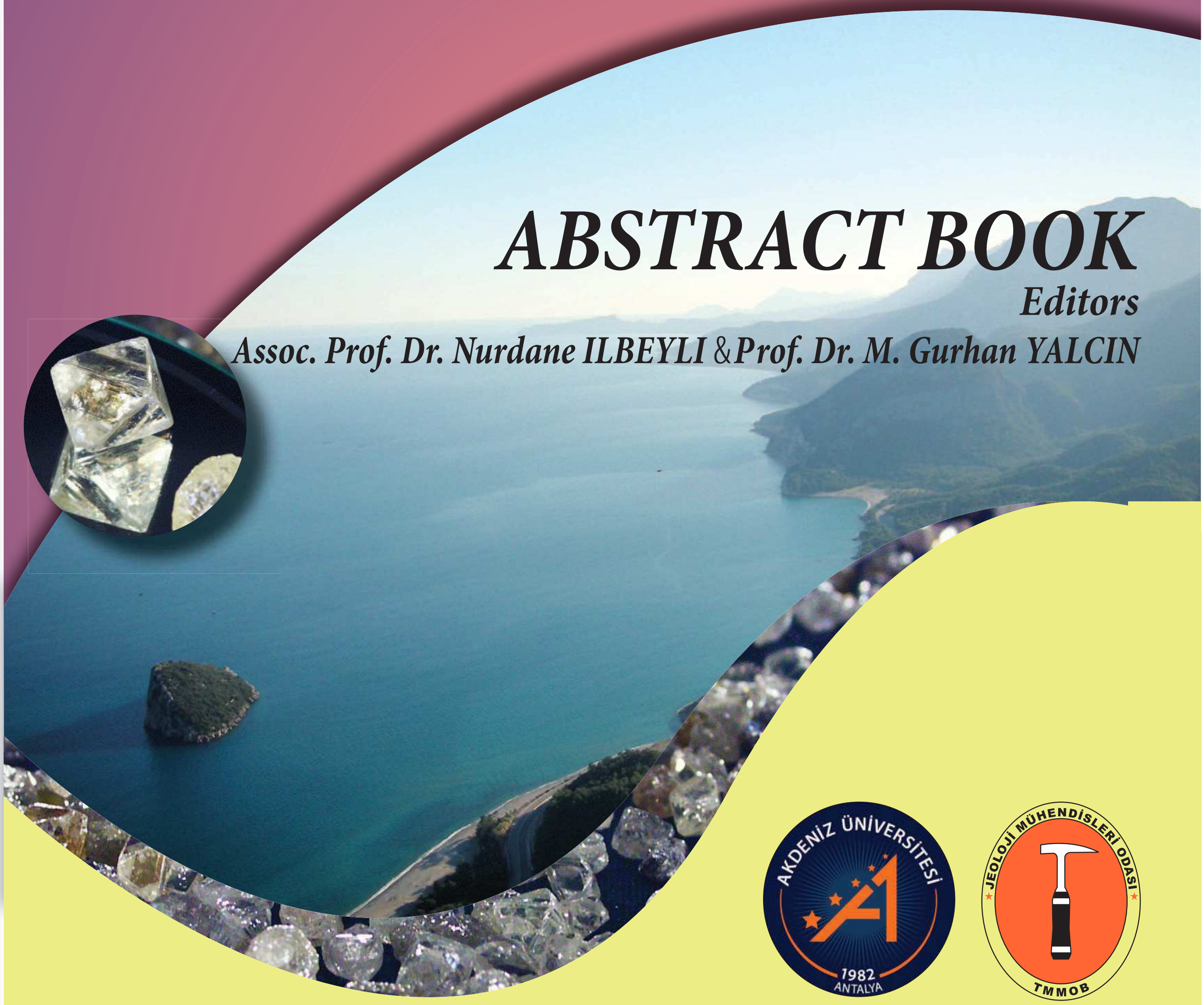
30th International Conference on "Ore Potential of Alkaline, Kimberlite and Carbonatite Magmatism"

29 September - 02 October 2014
Antalya - TURKEY



ABSTRACT BOOK

Editors

Assoc. Prof. Dr. Nurdane ILBEYLI & Prof. Dr. M. Gurhan YALCIN

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TYPOCHEMISM OF THE APATITE SUPERGROUP MINERALS FROM DEVONIAN ULTRABASIC ALKALINE ROCKS FOUND IN THE BRAGINSKY AND LOEVSKY SADDLE (BELARUS)

Ignatkevich E.S.[1], **Varlamov D.A.**[2]

1 Belarusian scientific research and designed institute of oil, Gomel, Belarus
e.ignatkevich@beloil.by
2 Institute of Experimental Mineralogy RAS, Chernogolovka, Rassia

Braginsky and Loevsky saddle is the western segment of Pripyat-and-Donetsk aulacogene located within the ancient East European platform. Devonian alkaline magmatism is associated with tectonic and magmatic cycles of intracratonic rifting of Paleozoic Pripyat-and-Donetsk rift belt. On the territory of Belarus it is expressed in the form of buried pipes of explosions, dikes, volcanic structures and sills; the scale of its manifestation offers prospects for searches of primary sources of diamonds, industrial clusters of rare metals and rare earth elements.

Work to identify the composition and typochemism of the apatite supergroup minerals of alkaline ultrabasic rocks of Braginsky and Loevsky saddle (as for the whole Devonian magmatic complex of Belarus) was held for the first time. The data are obtained by microanalysis of polished thin sections of alkaline picrite from Vasilyevskaya 1 drill-hole core (1785-1788 m depth) and nephelinite from Yastrebovskaya 3k drill-hole core (957-1207 m depth). Compositions of minerals were studied with a scanning electron microscope Tescan VEGA-II XMU with energy dispersive spectrometer INCA Energy 450 at the Institute of Experimental Mineralogy (Chernogolovka, Russia).

In alkaline picrite and nephelinite of the apatite supergroup minerals are contained in the amount of 1-2% of the total volume of the rock, they form small idiomorphic crystals (up to 0.1 mm in length), zoned crystals up to 0.1–0.3 mm of the long axis, and also microinclusions (up to 20 microns) in the clinopyroxene phenocrysts. In the studied rocks the composition of the phosphate glass (observed in some samples) is approximate to the composition of apatite. The apatites represent species containing fluorine and strontium (up to the composition of fluorcaphite), Ba, Th, REE concentrate as impurities. The BaO content reaches 5 wt. %, ThO_2 – 0.5 wt. %, TR_2O_3 – 1.8 wt. % (Table). Entering of REE in the apatite structure occurs according to heterovalent isomorphism $REE^{3+} + Si^{4+} = Ca^{2+} + P^{5+}$. Evidence of this is the presence of silicon in REE-bearing apatite (0.4-1.6 wt. % SiO_2) [1, 2].

Table - Chemical compound of the apatite supergroup minerals (wt. %)

	CaO	P_2O_5	F	SiO_2	SrO	BaO	Na_2O	Y_2O_3	La_2O_3	Ce_2O_3	Nd_2O_3	ThO_2	As_2O_5	Fe_2O_3	MgO	Total
Ap I	48.86	40.89	4.79	1.03	2.32	-	-	-	0.43	0.94	0.46	-	-	-	-	99.72
ApII (c)	52.32	41.50	1.08	0.48	3.08	-	-	-	-	-	-	-	*0.22*	-	-	98.68
ApII (r)	50.17	37.92	2.66	0.68	5.47	-	-	0.44	*0.23*	0.88	0.36	0.49	*0.23*	-	-	99.53
ApII (r)	43.27	39.48	3.61	0.38	11.97	-	-	-	*0.03*	*0.17*	-	-	*0.38*	-	-	99.29
ApII (r)	38.29	37.49	2.95	1.18	17.11	-	-	-	-	-	-	-	-	0.66	*0.10*	97.78
ApII (r)	39.69	35.69	1.28	1.03	13.76	5.30	1.30	0.44	-	-	-	0.06	*0.22*	-	-	98.77
ApII (r)	33.36	35.67	2.40	1.58	25.87	-	-	-	-	0.54	-	-	-	-	-	99.42
ApII (i)	36.90	31.84	1.39	2.04	13.23	5.27	1.53	-	-	-	-	-	-	0.59	0.50	93.29
ApII (g)	51.99	39.47	1.79	0.91	5.02	-	-	-	-	*0.18*	*0.06*	-	-	-	-	99.42

Note: italics gives definitions with values of concentration of an element more low 2 θ (a root-mean-square error of the analysis); r - the grain rims, c - the grain centre, i - inclusion, g - glass.

Apatites of the studied rocks show significant similarity in the outward look and composition, and are generally zoned for strontium. It made possible to distinguish among them the same species formed at different stages of evolution of melts. Less strontium apatite-I contains up to 2-3 wt.% SrO, forms automorphic small crystals, and also composes the core of strontium zoned crystals. High strontium apatite-II forms a micro-inclusions in clinopyroxene phenocrysts (Fig.1), forms rims of strontium zoned crystals, it is probably the source of phosphate glass; contains from 5 to 26 wt.% SrO, its composition is approximate to fluorcaphite [3].

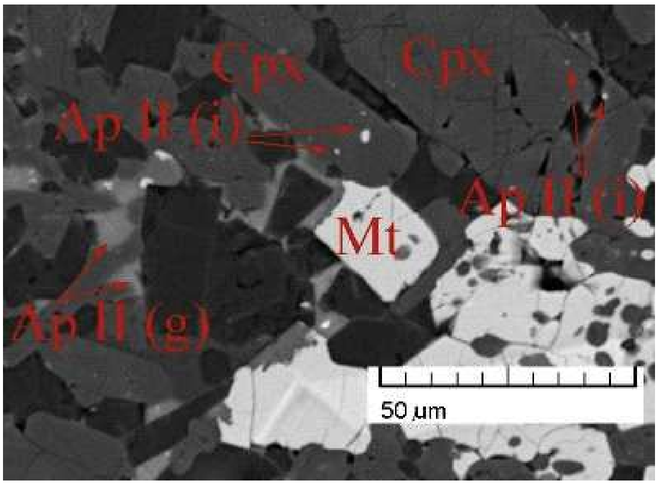

Figure 1: Alkaline picrite from Vasilyevskaya 1 drill-hole core.

In the study of “kindred” alkaline ultramafic platform rocks the composition of the apatite supergroup minerals is involved to solve formation problems. The examples of the Khibiny Massif and the Massif of Inagli proved a direct correlation between the amount of strontium in apatites and alkaline environment of their formation [4]. Apatites from kimberlites contain up to 3-4 wt.% SrO and a similar amount of fluoride, from lamproites – to 7 wt.% SrO. BaO content in the apatite supergroup minerals of these rocks sometimes reaches 1-2 wt.%. In carbonatites’ apatites the content of these elements is much higher, up to the formation of independent mineral phases [5,6]. So fluorcaphite, fluorstrophite, stronadelphite are found only in abnormally enriched with strontium ultragpaitic rocks (the Khibiny Massif on the Kola Peninsula, the Massif of Inagli in South Yakutia) [4,7].

The content of strontium and barium in the apatite supergroup minerals of the studied ultrabasic rocks of Braginsky and Loevsky saddle significantly exceeds the number of those in kimberlites’ and lamproites’ apatites, reaching the values inherent to the apatite supergroup minerals of carbonatites (up to 5 wt.% BaO, and to 13-26 wt .% SrO). In the studied rocks thepresence of the apatite supergroup minerals containing REE, fluoride, barium and high strontium (up to the composition of fluorcaphite) indicates high-alkali conditions of mineral formation, the enrichment of melts with incoherent rare metal and rare earth elements and suggests a possible association of alkaline ultrabasic rocks of Braginsky and Loevsky saddle with rare metal carbonatites.

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