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Petrology

About the Geochemistry of Early Variscan Granitoids of the Main Range of the Greater Caucasus

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ABSTRACT. In the Greater Caucasus granite formations, provoked by Early Variscan (Bretonian) orogeny, is registered only within the Pass and Elbrus subzones of the Main Range structural zone. The distribution of RE and REE and geochemical parameters (Eu/Eu^*-Sr/Nd Rb/Sr-SiO_2, Rb/Sr, Eu/Eu, Sm/Nd, La_n/Yb_n) in Early Variscan granitoids of the Greater Caucasus as a whole is similar to that in the upper- and common-crustal granitoids of the other regions of the world. *©2008 Bull. Georg. Nati. Acad. Sci.*

Key words: *granitoids, Early Variscan, RE and REE.*

Regional metamorphism, connected with Early Variscan (Bretonian) orogeny, is wide-spread in the Caucasus. But granite formation, provoked by this orogeny, is registered only in the Pass and Elbrus subzones of the Main Range zone of the Greater Caucasus.

Data on the distribution of RE and REE in Bretonian granitoids of the Main Range zone are very scanty. The aim of the present paper is geochemical study and correlation of these granitoids on the basis of analytical data obtained by the authors of the paper.

In the Elbrus subzone granitoids associated with Bretonian orogeny are represented by plagiogranites, plagio- and granite-gneisses and quartz diorites. Rocks containing these granitoids build the Precambrian infrastructure of the subzone. The granitoids were formed by selective melting of thick metaterrigenous sediments, mainly in conditions of high-temperature amphibolitic facies and partly of low-temperature granulitic facies [1]. Two varieties of Bretonian granitoids are distinguished – anamphibolous (biotite and two mica-bearing plagiogranites, plagiogneisses and gneisses) and amphibolous (hornblende and biotite-hornblende-bearing quartz-diorites, rarely diorites and their gneissous analogues).

Bretonian granitoids of the Pass subzone are associated with the Late Proterozoic Gvandra suite of the Buulgen metamorphic complex. They are represented by leucocratic gneisses and granitoids, being synmetamorphic with Bretonian regional metamorphism. They include autochthonous bodies of leucocratic paragneisses of plagiogranitic, granodioritic and granitic composition – conformable with enclosing rocks- and sometimes unconformable allochthonous bodies of orthorocks – leucocratic plagioaplites, plagiogranites, aplites and granites [2].

Analytical data of 11 samples have been studied with a view to geochemical characterization of the granitoids. All the data are given in the Table and summarized in diagrams below.

The distribution of RE and REE in the granitoids varies within a broad range. In particular, the content of Sr, Y, Nb and Th is increased, Ba, La and Nd is decreased and Zr, Rb Yb and U is close to the mean content of these elements in Early Variscan granitoids of the Greater Caucasus.

According to Eu/Eu^* - Sr/Nd diagrams (Fig.1) only two figural symbols of the Elbrus subzone are disposed

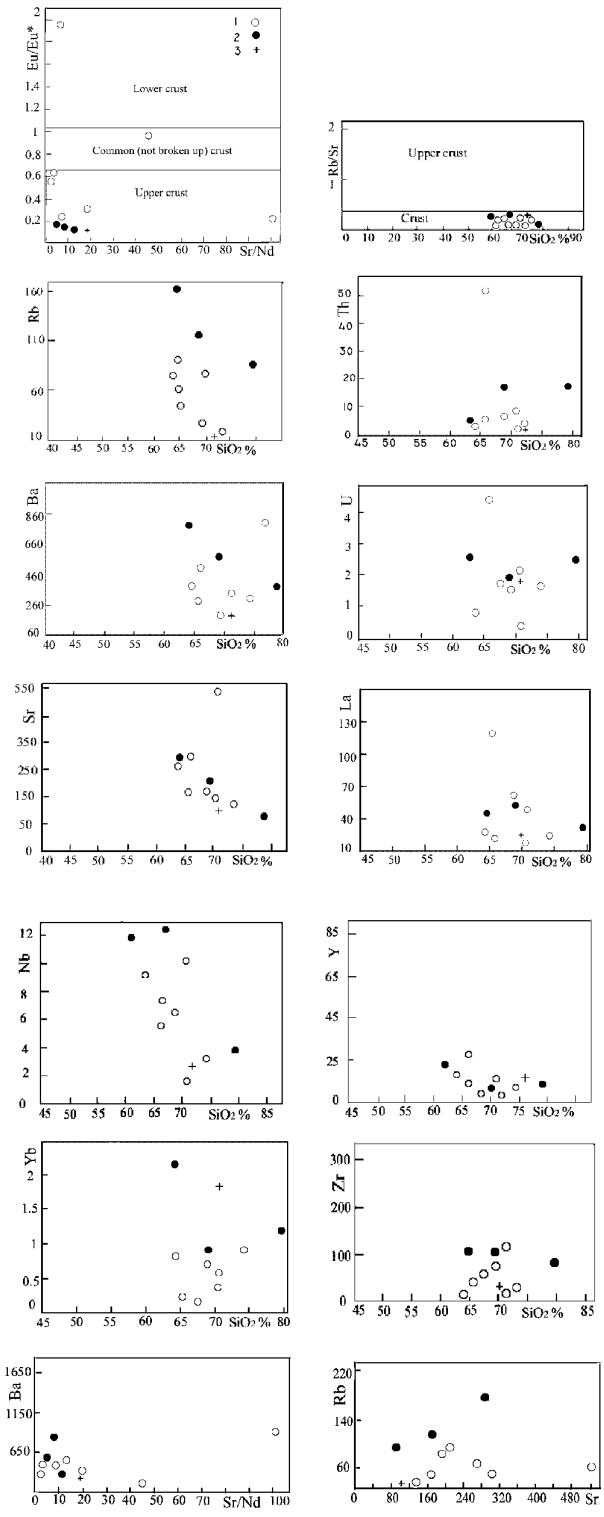

Fig 1. Variational diagrams for Early Variscan granitoids of the Main Range structural zone of the Greater Caucasus. The Elbrus subzone: 1 – plagiogranite, 2 – plagiogneiss; The Pass subzone: 3 – garnet bearing alaskite.

in the areas of the lower and common crusts. All the other figural symbols are disposed in the area of the upper crust. According to the Rb/Sr-SiO_2 diagram [3, 4], all the figural symbols are situated in the area of the common crust (see Fig.1) [5]. The presented variational diagrams – Rb/SiO_2, Th/SiO_2, Ba/SiO_2, Yb/SiO_2, Zr/SiO_2, and Rb/Sr clearly show that areas of figural symbols corresponding to varieties of Early Variscan granitoids are more or less isolated from each other (see Fig.1). In all other diagrams (U/SiO_2, Sr/SiO_2, La/SiO_2, Nb/SiO_2, |Y/SiO_2, Ba/Sr/Na) no regularities are recorded.

In plagiogranites of the Elbrus subzone Rb/Sr ratio varies from 0.118 to 0.460, in plagiogneisses of the same subzone – 0.045-0.665 and in garnet bearing alaskites of the Pass subzone this ratio corresponds to 0.059. It is assumed that the Rb/Sr ratio for the lower crust is 0.023, upper crust – 0.32 and common crust - H"0.03 [5]. Proceeding from the above data, plagiogranites of the Elbrus subzone in the main correspond to the upper crustal as well as to common crustal formations, but plagiogneisses and garnet-bearing alaskites – completely to the upper crustal ones.

In the plagiogranites and plagiogneisses of the Elbrus subzone and garnet bearing alaskites of the Pass subzone the Eu/Eu^* ratio varies in the ranges 0.269-2.745, 0.194-0.214 and 0.146, respectively. These values indicate Eu exhaustion in comparison with adjacent REE in plagiogneisses of the Elbrus subzone and partly in plagiogranites of the same subzone and garnet bearing alaskites of the Pass subzone. Eu enrichment is indicated in plagiogranites of the Elbrus subzone.

According to S. Taylor and S. McLenan [5] the Sm/Nd ratio for the lower crustal formations is assumed as 0.25-0.25, for the upper crustal varietis – H" 0.17. These parameters in plagiogranites of the Elbrus subzone vary from 0.181 to 0.258, in plagiogneisses of the same subzone – 0.186-0.203, but in garnet-bearing alaskites of the Pass subzone they are 0.272. It results from this that plagiogranites of the Elbrus subzone correspond to upper crustal formations and rarely to common crustal ones. Plagiogneisses of the Elbrus subzone and garnet-bearing alaskites of the Pass subzone have been attributed to upper crustal formations. According to the above mentioned authors, the La_n/Yb_n ratio for the upper crust is > 9.2, common crust – 9.2-3.8 and lower crust – < 3.8. This ratio for plagiogranites of the Elbrus subzone varies within 9.5-52.5, for plagiogneisses of the same subzone – 24.10-36.67 and for garnet-bearing alaskites of the Pass subzone 9.34. According to these figures, the plagiogranites correspond to the upper-crustal, rarely to common-crustal formations, plagiogneisses and garnet-bearing alaskites – to upper crustal ones.

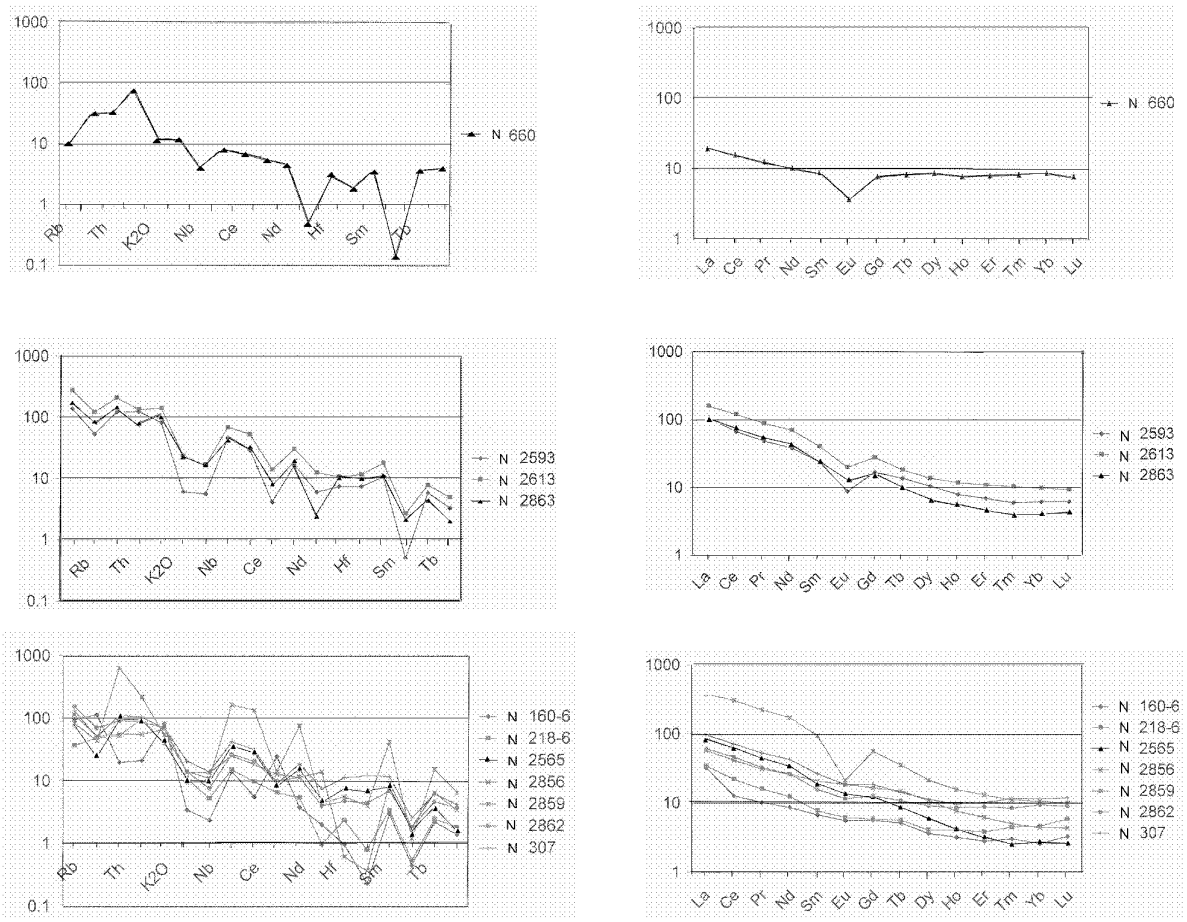

Fig. 2. Spidergrams of RE and REE in Early Variscan granitoids of the Main Range of the Greater Caucasus. Standadizated to chondrite (Taylor, McLennan, 1985). Sample numbers correspond to the same numbers in the Tab. 1.

Spidergrams of plagiogranites of the Elbrus subzone are characterized by little angle of dip and smoothly expressed Eu minimums. In one case only (sample N 2859) rather clearly expressed Eu minimum is recorded (Fig. 2). In spidergrams of plagiogneisses of the Elbrus subzone and garnet-bearing alaskites of the Pass subzone clearly expressed Eu minimums are plotted. In Fig. 2 the regularities of RE distribution are shown.

Issuing from the above mentioned, it can be supposed that in Early Variscan granitoids of the Main Range zone of the Greater Caucasus distribution of RE and REE as a whole is similar to the distribution of these elements in upper-crustal and common-crustal granitoids of the other regions of the world.

Table 1

Distribution of RE and REE in Early Variscan granitoids of the Main Range zone of the Greater Caucasus

№	160-6	218-6	2565	2856	2859	2862	307	mean	2593	2613	2863	mean	660	∑ mean
Rb	61.61	23.59	48.12	73.19	53.43	99.30	83.88	51.98	88.86	175.02	114.81	126.23	7.03	61.74
Sr	521.85	138.24	174.54	271.15	297.30	211.28	190.24	197.09	87.39	296.91	172.19	129.79	118.73	148.53
Y	6.35	8.41	7.39	15.55	29.82	17.02	19.39	12.35	14.93	22.37	9.27	15.52	17.14	15.00
Zr	2.60	9.06	80.00	4.14	45.57	50.26	136.15	77.99	82.83	129.23	112.02	108.02	21.96	69.29
Nb	1.69	3.78	6.75	9.64	7.86	5.41	10.02	5.95	3.98	11.92	12.19	4.07	2.99	4.33
Ba	801.27	338.32	174.95	363.26	310.25	497.39	355.73	466.23	374.79	851.73	586.30	467.07	209.44	380.90
La	10.06	10.75	27.24	17.96	118.29	19.01	30.19	19.20	32.94	49.18	30.81	37.64	5.99	20.94
Ce	10.27	17.84	51.49	33.71	249.54	37.90	58.12	39.81	53.74	97.14	61.28	57.51	12.51	36.61
Pr	1.25	1.95	5.53	3.81	27.60	3.99	6.55	6.62	5.94	10.85	6.77	6.35	1.50	4.73
Nd	5.21	7.49	20.88	15.73	104.77	15.98	25.84	11.10	22.88	41.98	26.30	26.07	6.12	14.43
Sm	1.32	1.52	3.78	4.07	18.60	3.08	5.22	3.16	4.66	7.95	4.91	5.84	1.67	3.55
Eu	0.41	0.46	1.01	1.38	1.58	0.66	1.37	0.98	0.65	1.47	0.96	1.02	0.27	0.75
Gd	1.47	1.53	3.21	4.34	14.74	3.31	4.88	3.12	4.33	7.19	4.07	5.19	2.03	3.44
Tb	0.25	0.27	0.42	0.72	1.70	0.52	0.68	0.65	0.65	0.86	0.48	0.66	0.40	0.57
Dy	1.18	1.32	1.95	3.52	6.99	2.95	3.69	2.43	3.37	4.41	2.14	3.53	2.80	2.92
Ho	0.23	0.30	0.31	0.56	1.14	0.62	0.70	0.55	0.57	0.85	0.39	0.60	0.58	0.57
Er	0.60	0.82	0.68	1.32	2.80	1.88	2.18	1.68	1.45	2.29	0.96	1.56	1.74	1.66
Tm	0.10	0.15	0.08	0.16	0.37	0.28	0.38	0.5	0.19	0.33	0.13	0.21	0.28	0.24
Yb	0.55	0.99	0.57	0.94	2.25	2.00	2.43	1.39	1.29	2.04	0.84	1.40	1.79	1.52
Lu	0.11	0.19	0.09	0.14	0.33	0.29	0.39	0.22	0.20	0.30	0.14	0.21	0.25	0.22
Hf	0.30	0.74	2.34	0.19	1.74	1.50	3.50	1.18	2.30	3.33	3.25	2.77	0.96	1.63
Ta	0.14	0.44	0.38	0.56	0.58	0.57	0.85	0.50	0.24	0.95	0.91	0.7	0.46	0.55
Th	1.59	4.28	8.81	4.48	51.66	7.40	9.00	5.92	9.83	16.70	11.62	11.8	2.68	6.81
U	0.43	1.97	1.75	1.12	4.39	1.77	2.10	1.52	2.50	2.69	1.59	2.26	1.64	1.8

The Elbrus subzone – plagiogranites: two-mica bearing – 160 (the Pshikhashkin massif), 218 (canyon of the river Bolshaya Laba), biotite bearing – 2859 and 2856 (canyon of the river Baksan), 307 (canyon of the river Teberda), biotite and garnet bearing – 2863 (canyon of the river Baksan); plagiogneisses: biotite bearing – 2613 (canyon of the river Bezengian Cherek), 2565 (canyon of the river Balkarian Cherek) and 2863 (canyon of the river Baksan), biotite and garnet bearing – 259 (canyon of the river Bezengian Cherek). The Pass subzone: garnet bearing alaskite - 660 (canyon of the river Atsgara).

∑ mean - RE and REE mean distribution in granitoids of all varieties.

პეტროლოგია

კავკასიონის მთავარი ქედის სტრუქტურული ზონის ადრევარისკული გრანიტოიდების გეოქიმიის შესახებ

დ. შენგელია*, თ. წუწუნავა, გ. ჭიჭინაძე**, ნ. მაისურაძე**, ქ. ვარდანაშვილი****

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კავკასიაში დანაოჭების ადრევარისკული (ბრეტონული) ოროგაზისით გაპირობებული გრანიტწარმოშობა დაფიქსირებულია მხოლოდ კავკასიონის მთავარი ქედის სტრუქტურული ზონის — იალბუზისა და საუღელტეხილო ქვეზონებში. იშვიათი და იშვიათმიწა ელემენტების შემცველობისა და გეოქიმიური მახასიათებლების (Eu / Eu*–Sr/Nd, Rb/Sr–SiO_2, Rb/Sr, Eu/Eu, Sm/Nd, La_n/Yb_n ფარდობების) განაწილება კავკასიონის ადრევარისკულ გრანიტოიდებში ძირითადად ისეთივეა, როგორიც მსოფლიოს სხვა რეგიონების საერთო და ზედაქერქულ გრანიტოიდებში.

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