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DISTRIBUTION OF SOME RARE ELEMENTS IN THE PALEOGENE SARNITSA MAGMATIC GROUP, EASTERN RHODOPES

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ABSTRACT. Sarnitsa Group unites the intermediate magmatic rocks of the late extensional Paleogene magmatism in the Northeastern Rhodope Depression. This group includes the successively formed Kolets basalt-andesite, Voinovo shoshonite-latite, Bukovo shoshonite-latite, Nikolovo latite, Bezvoden latite and Dragoina lartite complexes. Typical of these complexes is the similar content of the studied rare elements (Rb, Nb, Y, Zr, Sr). This supports the assumption that they originated during the evolution of a common magma chamber. The rocks of Sarnitsa Group differ essentially from those of Putocharka Subgroup of Dambala Group by considerably higher contents of Rb, Nb, Y and S. This suggests that they resulted during the evolution of two different magma chambers, located in depth within the Northeastern Rhodope and Momchilgrad Depression, respectively. The tectonic discrimination diagrams (Nb-Y; Rb-Y+Nd; Rb-SiO_2; Y-SiO_2; Nb-SiO_2; Rb/Zr-SiO_2) yield controversial results. This is probably due to the fact that they do not take into consideration magmatic rocks in extensional areas, the Rhodope massif being a typical example. The results obtained lead to the conclusion that the discrimination between different types of tectonic environment, based only on one type of diagram, is unreliable and incorrect.

РАЗПРЕДЕЛЕНИЕ НА НЯКОИ РЕДКИ ЕЛЕМЕНТИ В ПАЛЕОГЕНСКАТА СЪРНИШКА МАГМЕНА ГРУПА В ИЗТОЧНИТЕ РОДОПИ

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РЕЗЮМЕ. Сърнишката група обединява среднокиселите магмени скали на късноекстензионния палеогенски магматизъм в Североизточнородопската депресия. Тя включва последователно формираните Колецки базалт-андезитов, Войновски шошонит-латитов, Буковски шошонит-латитов, Николовски латитов, Безводенски латитов и Драгойновски латитов комплекси. Тези комплекси се характеризират с близките съдържания на изследваните редки елементи (Rb, Nb, Y, Zr, Sr), което подкрепя предположението, че те са резултат на еволюцията на една обща магмена камера. Скалите от Сърнишката група се различават съществено от тези на Путочарската субгрупа на Дамбалската група със значително по-високите си съдържания Rb, Nb, Y и Sr. Тези данни подкрепят предположението, че те са резултат от еволюцията на две различни магмени камери, разположени в дълбочина съответно на Североизточнородопската и Момчилградската депресии. Резултатите от дискриминационните диаграми за типа на тектонската обстановка са силно противотечиви (Nb–Y; Rb-Y+Nd; Rb-SiO_2; Y-SiO_2; Nb-SiO_2; Rb/Zr-SiO_2). Това вероятно се дължи на факта, че те не отчитат областите на екстензия, за каквато се възприема Родопският масив. От получените резултати може да се направи извода, че определянето на типа на тектонската обстановка само по един тип диаграма е ненадеждно и некоректно.

Introduction

The Northeastern Rhodope Depression is located between the Central Rhodope dome (metamorphic core complex) and Harmanli block (Georgiev, 2005). It originated during the Paleogene as the result of extensional processes in the Rhodope Massif (Ivanov, 2000). The depression is the locus of intense magmatism, the products of which cover about 1 800 km^2 and locally exceed 1 500 m in thickness. The earlier phases of Sarnitsa Magmatic Group (Late Priabonian-Early Rupelian) are intermediate in composition while the later phases of Chamdere Magmatic Group (Rupelian) are acidic (Georgiev, Milovanov, 2005, 2006a, 2006b).

The Sarnitsa Magmatic Group includes the successively formed (from base to top) Kolets basalt-andesite, Voinovo shoshonite-latite, Bukovo shoshonite-latite, Nikolovo latite, Bezvoden latite and Dragoina latite complexes (Fig. 1). The rocks of this group are spatially closely associated and are supposed to have a common magma source (chamber).

According to K_2O content, the rocks of Sarnitsa group are referred to the shoshonitic series. Only the trend of Kolets basalt-latite complex plots in the field of the high-potassium calc-alkaline series but close to the boundary with the shoshonitic one. According to K_2O+Na_2O content they belong mainly to the alkaline (trachytic) varieties.

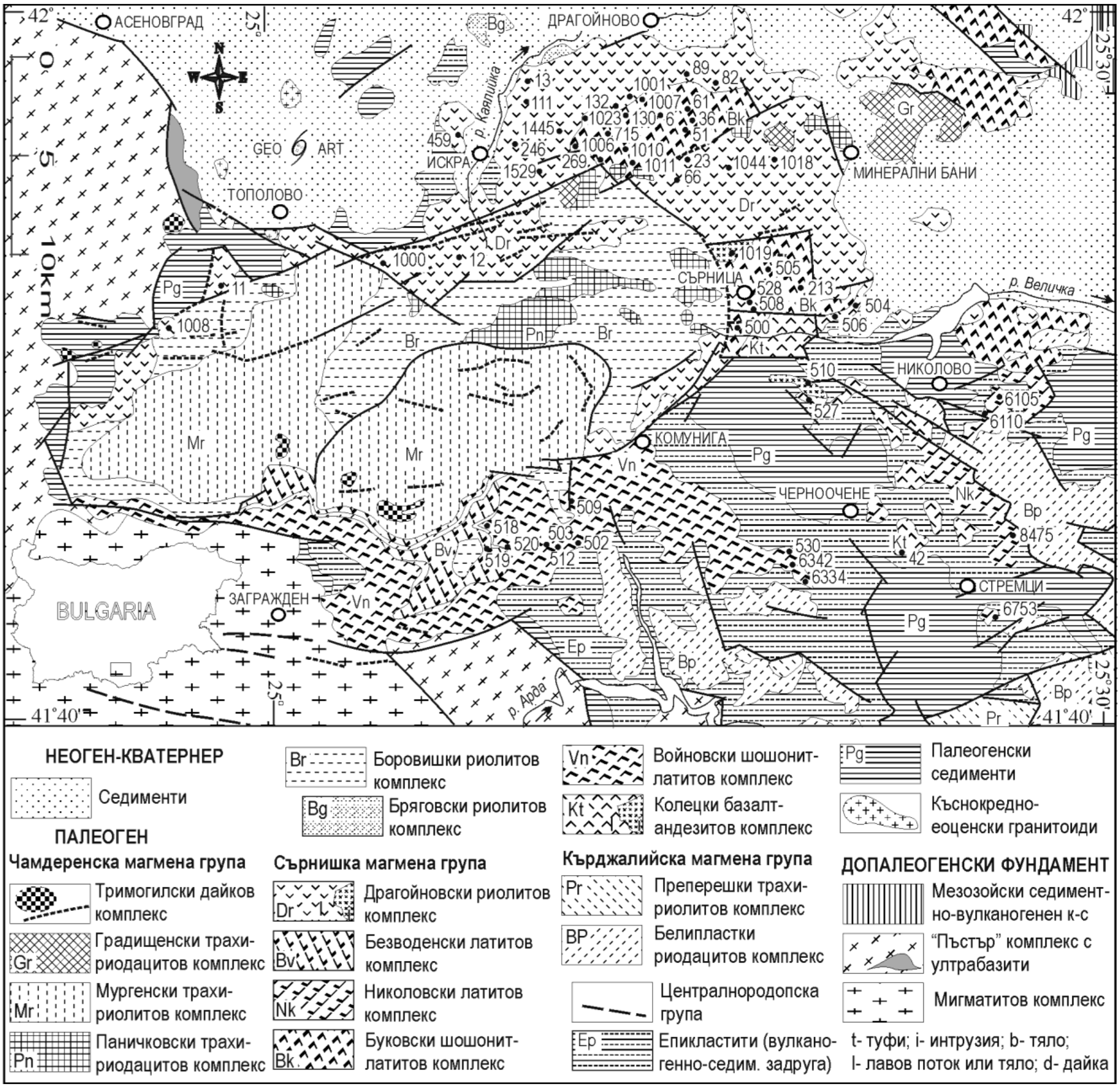

Fig. 1. Map of magmatic complexes in the Northeastern Rhodope Depression

Results

There are no essential differences in the distribution of the studied rare elements (Rb, Nb, Y, Zr, Sr) in the individual magmatic complexes of Sarnitsa Group (Fig. 2). Rb, Nb, Y и Zr in the earlier complexes (Kolets, Voinovo, Bukovo) show a tendency to increase towards the later (Nikolovo, Dragoinovo) complexes (Fig. 2). This tendency is best expressed with respect to Y and correlates well with the increasing content of K_2O and K_2O+Na_2O.

The rocks of Sarnitsa Group in the Northeastern Rhodope Depression show considerably higher Rb, Nb, Y and Sr values as compared to those of Putocharka Subgroup (likewise of intermediate composition) of Dambala Group in Momchilgrad depression (Georgiev, Milovanov, 2003). This difference is best expressed for Sr whose values in Sarnitsa Group are approximately two times higher that those in Putocharka Subgroup (Fig. 3).

The results form tectonic discrimination are controversial (Fig. 4). On the Rb-Y+Nb diagram, the plots cluster around the boundary VAG-WPG and close to the boundary with the syn-COLG field. On the Nb-Y diagram, the samples plot around the boundary VAG+syn-COLG-WPG and close to the boundary with ORG. On the Rb-SiO_2 diagram, the plots fall entirely within the VAG (WPG) field. On the Y-SiO_2 diagram the plots are mainly in the WPG+ORG field but close to the boundary VAG+COLG+ ORG whereas single samples plot in the field of VAG+COLG+ORG. The relations on the Nb-SiO_2 diagram are reverse. Most samples plot in the VAG+COLG+ORG field, close to the boundary with WPG+ORG and some samples – in the WPG+ORG field. On the Rb/Zr-SiO_2 diagram most plots cluster in the field of post-COLG+VAG and only an insignificant part – in the syn-COLG field.

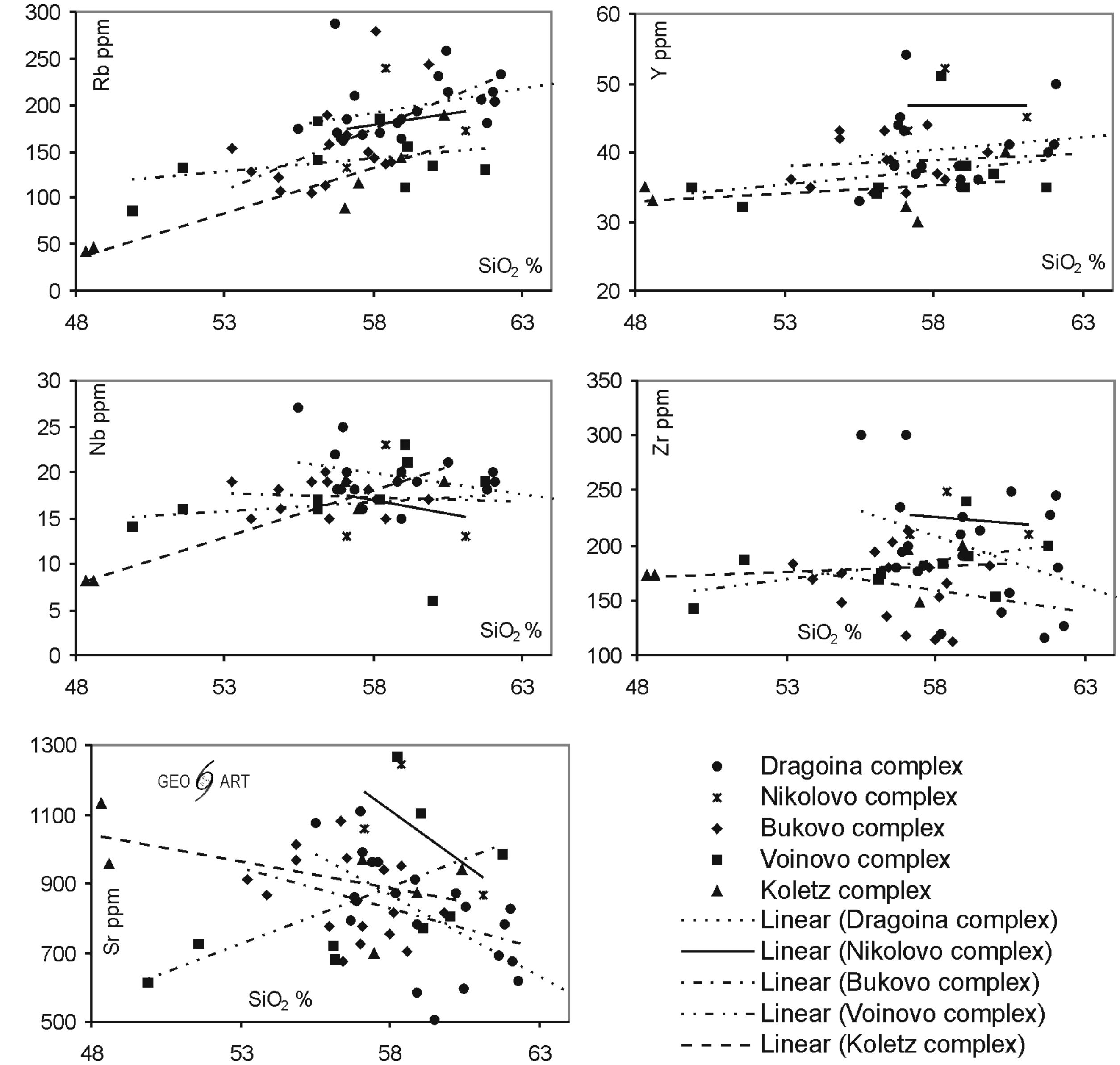

Fig. 2. Diagrams showing distribution of Rb, Nb, Y, Zr, Sr in rocks from Sarnitsa Group

Discussion

The rocks from the individual complexes of Sarnitsa Group do not differ essentially by the content of the studied rare elements (Rb, Nb, Y, Zr, Sr). This supports the assumption that the magmatic complexes of Sarnitsa Group have a common origin and resulted from separate phases, generated by a single magma chamber (Georgiev, Milovanov, 2006a).

The rocks of Sarnitsa Group differ essentially from those of Putocharka Subgroup of Dambala Group by considerably higher content of Rb, Nb, Y and Sr. These data support the assumption that they resulted during the evolution of two different magma chambers, located in depth within the Northeastern Rhodope and Momchilgrad depression, respectively.

The results from tectonic discrimination, attempting to infer the type of tectonic environment, are controversial and mutually excluding. This is probably due to the fact that the diagrams do not take into account extensional areas, the Rhodope massif being a typical example (Ivanov, 2000). Yanev (1998), using only the Rb/SiO_2 diagram and only acidic rocks from the Eastern Rhodopes, defined them as syn-COLG. The data of Georgiev, Milovanov (2001, 2003) and those from the present study show that the intermediate rocks plot definitely within the VAG (WPG) field of these diagrams. The results obtained lead to the conclusion that the discrimination between tectonic environments, based on one type of diagram only, is unreliable and incorrect.

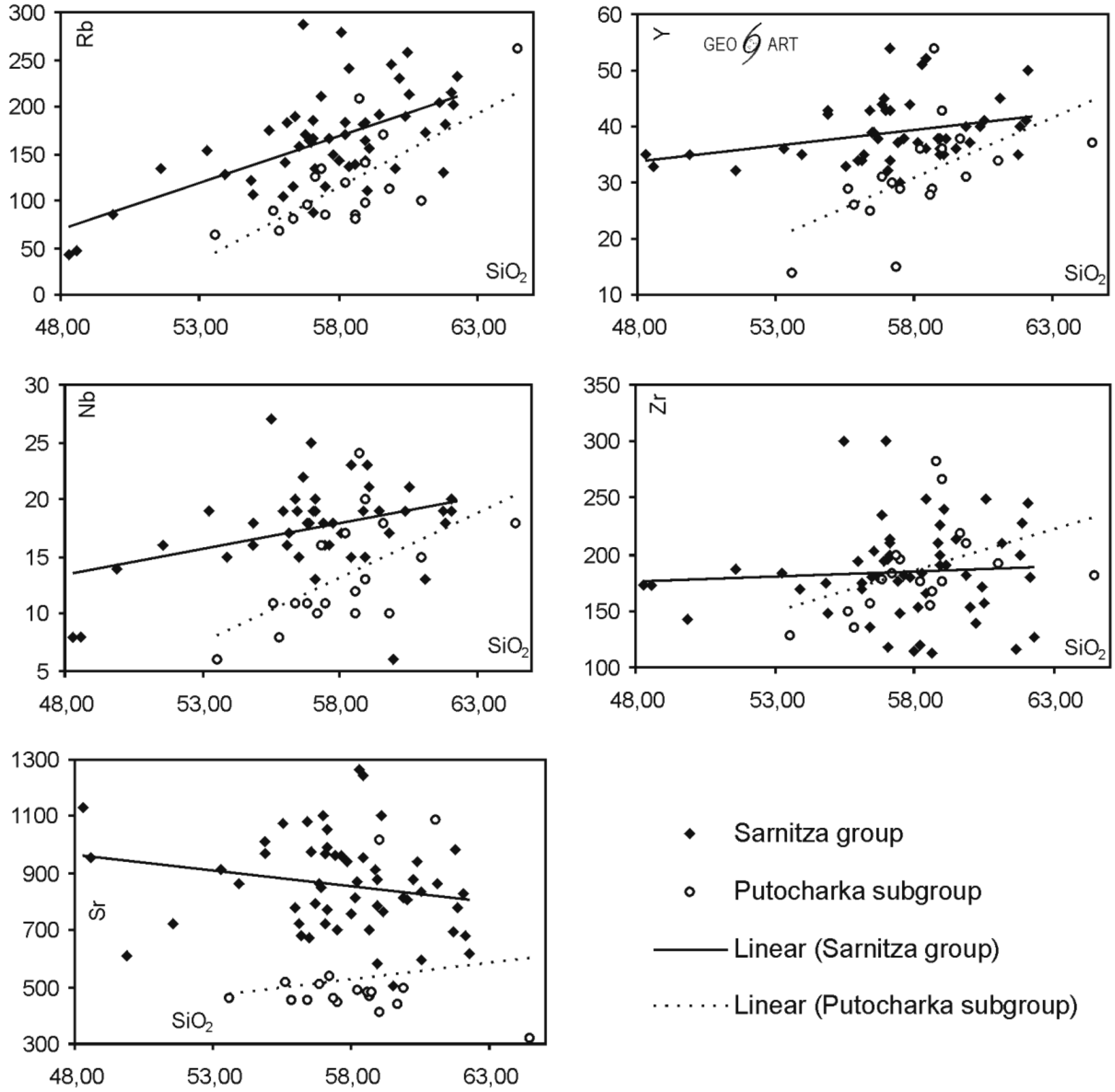

Fig. 3. Comparative diagrams showing distribution of Rb, Nb, Y, Zr, Sr in rocks from Sarnitsa Group and Putocharka Subgroup

Table 1

Representative analyses of Sarnitsa group

No	SiO_2	Rb	Nb	Y	Sr	Zr
Bukovo complex						
1007	54,84	122	18	42	970	174
269	56,55	158	15	39	974	202
6	58,60	138			703	112
715	57,81	149	18	44	941	179
1023	58,00	142			756	114
1006	53,91	127	15	35	866	170
1010	56,38	114	20	43	1079	135
1011	54,88	107	16	43	1012	148
61	59,85	244	17	40	813	181
36	58,10	278	17	37	814	153
23	57,02	163			724	118
519	56,44	189	19	39	674	180
500	55,96	104	19	34	777	194
505	57,10	167	19	34	775	213
213	53,25	154	19	36	911	183
51	58,40	137	15	36	952	166

No	SiO_2	Rb	Nb	Y	Sr	Zr
Voinovo complex						
6342	60,00	134	6	37	806	153
6334	58,25	184	17	51	1268	183
509	49,90	86	14	35	611	142
518	56,14	183	17	35	679	175
520	56,10	140	16	34	720	170
503	61,78	130	19	35	984	200
502	59,12	155	21	38	768	190
530	59,05	111	23	35	1102	240
512	51,58	133	16	32	726	186
Koletz complex						
6110	48,56	46	8	33	957	172
42	48,30	43	8	35	1130	173
510	58,93	143	20	38	874	200
527	57,50	115	16	30	700	147
504	57,05	88	19	32	970	195
506	60,40	189	19	40	938	171

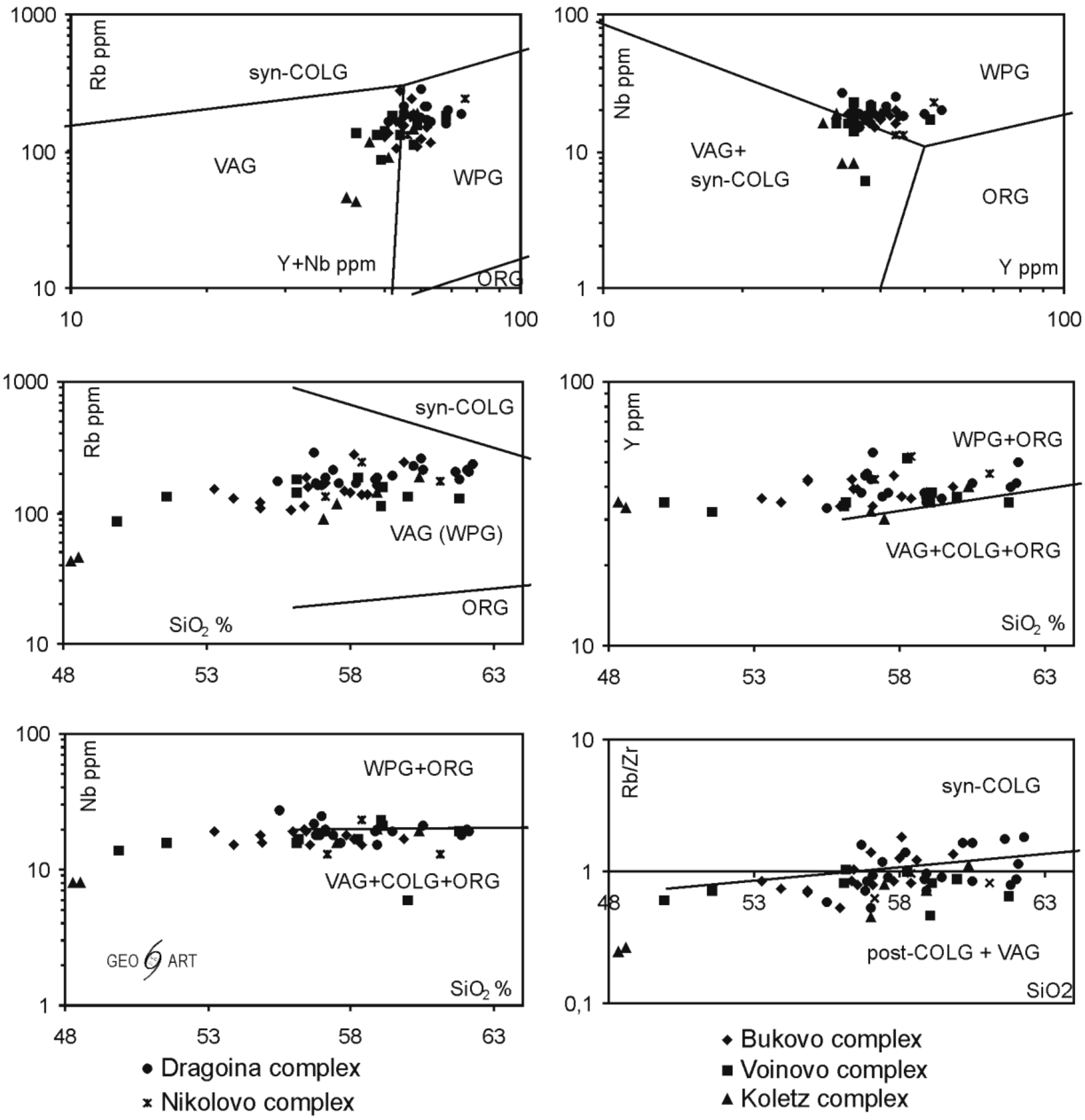

Fig. 4. Discrimination diagrams for the tectonic environment of Sarnitsa Group (after Pearce et al., 1984 ; Harris et al., 1986)

Table 1. Continuation

No	SiO_2	Rb	Nb	Y	Sr	Zr
Dragoina complex						
130	62,05	215	20	41	829	245
11	62,10	203	19	50	677	179
132	60,54	213	21	41	835	249
66	60,20	230			874	139
12	57,10	185	20	54	989	199
1008	56,71	288	22	38	795	180
459	58,92	163	15	36	783	226
1000	56,90	163	18	45	848	194
1001	56,80	170	18	44	860	234
246	61,83	180	18	40	782	228
1529	59,47	192	19	36	504	213
13	58,20	170			872	120

No	SiO_2	Rb	Nb	Y	Sr	Zr
Dragoina complex						
111	58,85	181	19	38	912	210
1445	57,63	167	16	38	960	182
1018	62,27	232			620	126
1044	60,49	258			596	156
1019	61,65	205			691	116
508	57,00	161	25	43	1106	301
528	55,49	174	27	33	1076	300
89	58,92	184	20	35	582	191
82	57,40	210	18	37	963	176
Nikolovo complex						
8475	58,40	240	23	52	1242	249
6753	57,14	133	13	43	1056	210
6105	61,10	173	13	45	866	210

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