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PETROLOGY AND METALLOGENY OF THE GRANITOIDS IN THE PIRIN MOUNTAIN, BULGARIA

(3 Figs., 3 Tabs.)

Abstract: The granitoid plutons are referred to four groups of relatively different age: Spanchevo Pluton (Upper Proterozoic ?), Bezbog Pluton (Hercynian) and young, Middle Alpine plutons - Central Pirin (Dautovo-Kresna, Central Pirin) and South Pirin (Teshovo, Goleshovo, Lehovo) Plutons. They show deficiency in ΣTR, Ce character of the lanthanoids and negative Eu anomaly. The young plutons exhibit above clark contents of W, Mo, Sn, Cu, Pb, Zn, As, Li, F. Specialization of rare metals is typical of them. The plutons form the Pirin ore region and its Teshovo ore ring. Twelve metallic and nonmetallic ore formations are established. Exoskarns with superimposed W-Mo mineralizations, vein and metasomatic polymetallic ores are of interest. Greisenization zones are also found.

Резюме: Гранитоидные плутоны представлены четырeми группами относительно разного возраста: Спанчевский плутон (верхний протерозой?), Безбогский плутон (герцинский) и молодые, среднеальпийские плутоны — Центральнопиринские (Даутовско-Кресненский, Центральнопиринский) и Южнопиринский (Тешовский, Голешовский, Леховский) плутоны. Они относится М-генетическому типу. Отличаются дефицитом Σ TR, цериевым характером лантаноидов и отрицательной Eu аномалией. Для молодых плутонов характерны надкларковые содержания W, Mo, Sn, Cu, Pb, Zn, As, Li, F. Для них характерна специализация на редкие металлы. Плутоны обуславливает существование Пиринского рудного района и его Тешовского рудного кольца. Установлено 12 металлических и неметаллических рудных формаций. Интерес представляют экзоскарны с наложенными W-Mo минерализациями, жильными и метасоматическими полиметаллическими оруденениями. Выявлены зоны грейзенизации.

Introduction

The Pirin horst-anticlinorium covers the southwestern parts of the Rhodope Massif. To the west, north and east it is bounded by the West Pirin, Predela and Mesta fault systems from the Struma, Razlog and Mesta grabens (Boyadjiev, 1971); to the south, in the area of the frontier with Greece, it is bounded by the Paril Saddle. In these boundaries Pirin Mountain covers an area of about 2600 sq. km. and along with the adjacent Stargach and Slavjanka Mts. - about 2700 sq. km.

A large part of Pirin region is made of Precambrian crystalline basement mainly of the Rhodope (Proterozoic) and in parts of the pra-Rhodope (Archean) metamorphic supergroups (Kozuharov, 1984). A characteristic feature of the crystalline complex, forming the host rocks of the discussed granitoids, is the wide distribution of the marble-carbonate formation, the so-called lower, middle and upper "variegated" units in which marbles and amphibolites

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are major components. The crystalline basement is intruded by abundant granitoid plutons of different age (Fig. 1). The young, Alpine type granitoids are of particular interest in genetic and practical respect. They exhibit a REE specialization and are the main energetic source for the diverse mineralizations in the Pirin ore region.

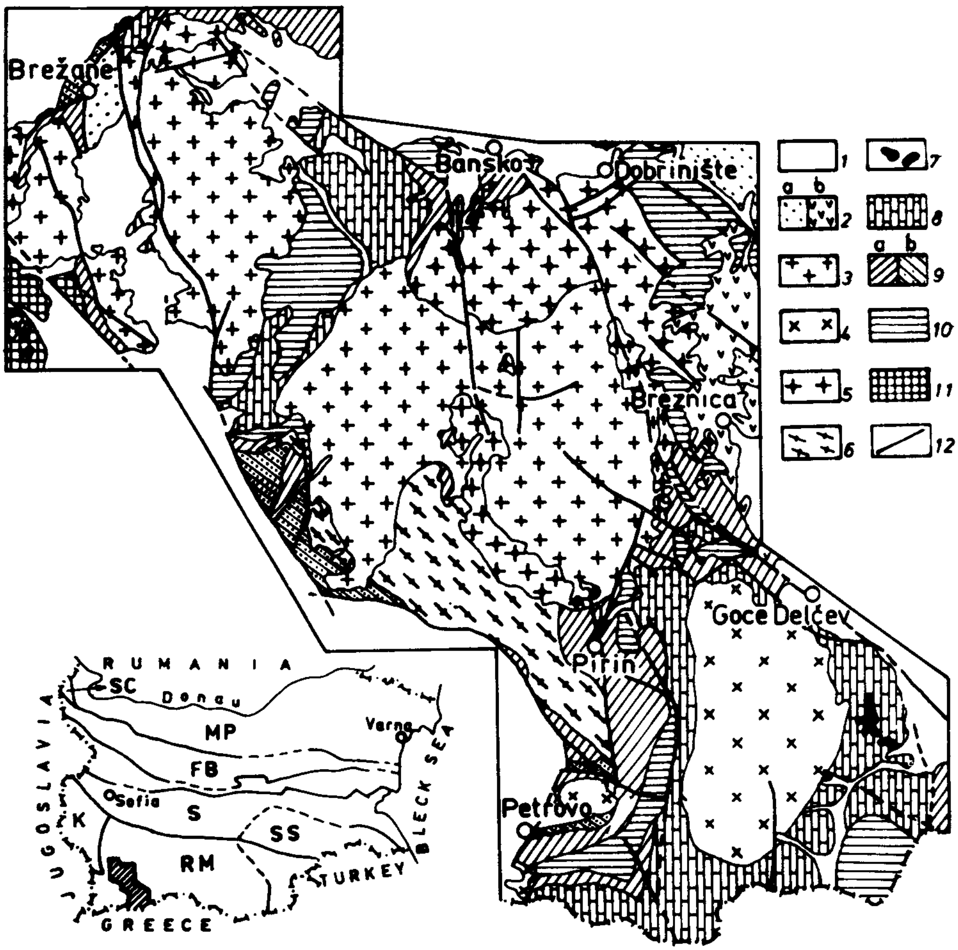

Fig. 1. Geological map of the Pirin Mountain.
1 — Quaternary and Neogene deposits; 2 — Paleogene sediments (a) and volcanic rocks (b); 3—6 — Pirin granitoids: 3 — Dautovo-Kresna and Central Pirin Plutons; 4 — South Pirin (Teshovo, Goleshovo and Lehovo) Plutons; 5 — Bezbog Pluton; 6 — Spanchevo Pluton; 7 — serpentinized ultrabasic rocks; 8—10 — Rhodope (Proterozoic) Metamorphic Supergroup: 8 — marble formation; 9 — lower, middle and upper variegated formations (a), mainly amphibolites (b), 10 — undivided formations dominantly of gneiss composition; 11 — pra-Rhodope (Archean) Supergroup; 12 — main faults.

Problems of the temporal development of the granitoids in the Pirin Mountain

The ideas on the age of the Pirin granitoid plutons are controversial. Dimitrov (1946) referred them to the group of "South Bulgarian granites" and advocated their Paleozoic and Later Caledonian age (Dimitrov, 1958). On the basis of the concept of the "identity of the structural-optical type of K-feldspar" phenocrysts, interpreted as a result of endoblastesis, Dimitrova (1971) assumed the same age. This concept was argued by Arnaudov et al. (1988). Other authors (Boyadjiev, 1959; Slavov et al., 1976) divided four groups of plutons of relatively different age on the basis of field works.

The results of radiogeochronological studies did not contribute to the resolution of the problem. On the basis of these data three different ideas were proposed: Paleogene age of all granitoids (Arnaudov — Arnaudova, 1981); Early Senonian and Eocene age (Zagorcev et al., 1987); Boyadjiev (1974) is of the opinion that this is a case of the so-called "mixed" data as a result of general and different in extent "radiogenic rejuvenation".

On the basis of the field relationships between the individual plutons and some petrochemical and metallogenic features (Boyadjiev et al., 1988) the following scheme for the temporal evolution of the granitoid magmatism in Pirin Mountain has been proposed: Spanchevo Pluton of Caledonian age, Bezbog Pluton - synonym of the Rila-Rhodope type granitoids of most probable Hercynian age and Middle Alpine (Laramide) granitoids represented by the South Pirin (Teshovo, Goleshovo, Lehovo) and Central Pirin (Dautovo-Kresna and Central Pirin) Plutons. The relatively different age of these plutons is determined also by the thermo-luminiscence method (Stoinov — Boyadjiev, 1972) as well as by petrophysical and paleomagnetic data (Nozharov — Dolapchieva, 1988). The Bezbog and Spanchevo Plutons show low magnetic susceptibility and negative magnetic anomaly and the young granitoid plutons - high and intermediate magnetic susceptibility and positive magnetic anomaly.

All plutons are implaced in the Rhodope metamorphic supergroup which hampers the determination of their geological age. Both these plutons and their metamorphic host rocks are cut by different in thickness intermediate to acid dyke rocks of unknown age.

Petrographic characteristics and nomenclature of the Pirin granitoids

On the basis of microscopic analysis, mesonormative recalculations (after Vilinovič — Petrík's method, 1982) and respective graphical constructions (Fig. 2) the above mentioned granitoid groups may be described as follows.

Spanchevo Pluton. It is located northwest of the village of Pirin and covers an area of about 80 sq. km (Fig. 1). It consists of hornblende-biotite granodiorites which gradually pass into biotite granites towards the central parts of the body. As a result of marked quantitative variations of porphyroblastic feldspars (according to the parameters of the diagrams used) local tonalites to monzogranites may be deduced (Fig. 2 - A, C, D). In con-

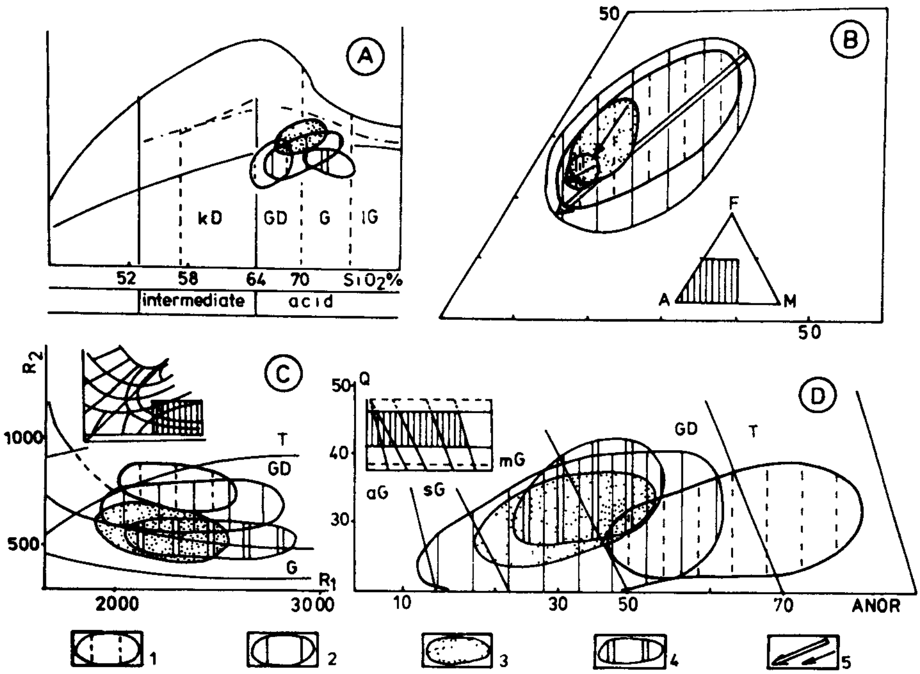

Fig. 2. Classification diagrams for the Pirin granitoids.
A. $SiO_2/Na_2O + K_2O$ diagram (after Andreeva et al., 1981); B. $A/Na_2O + K_2O/F$ $(FeO + 0.8998\ Fe_2O_3)$ — M(MgO) diagram; C. R_1—R_2 diagram (after De la Roche et al., 1980) based on mesonormative content. D. Q-ANOR diagram (after Streckeisen—La Maitre, 1979), based on mesonormative content.
1 — South Pirin Plutons; 2 — Central Pirin Plutons; 3 — Bezbog Pluton; 4 — Spanchevo Pluton; 5 — crystallization differentiation trend. The mesonormative content is calculated by the Mielke—Winkler's method (1979) adapted by Vilinovič—Petrík (1982).

trast to the other plutons, the Spanchevo body is rich and frequently cut by aplite-pegmatite veins intruded dominantly parallel to the "schistosity" of the rocks.

The rocks of Spanchevo Pluton show mainly gneissic to micro-fold structure (gneiss-granites), which gradually grades into practically massive towards the central parts of the body. The texture is mainly granitic to lepidogranoblastic and to different degree porphyric after feldspars. The porphyroblasts are about 2 cm long and form 20—30 to 70 % of the rock.

The mineral composition of this and the other plutons, based on petrographic analysis, is shown in Tab. 1.

Bezbog Pluton. It is located between the towns of Bansko and Dobrinishte while isolated fragments occur northwest of Pirin Village, west of Breznitsa and others. It covers an area of a total of 160 sq. km. The rocks are medium- to coarse-grained granites to granodiorites, in parts tonalites

Table 1

Mineral composition of Pirin granitoids

Mineral composition wt. % / Plutons	Main rockforming minerals						Accessories														
	plagioclase	K-feldspar	quartz	biotite	hornblende	muscovite	magnetite	apatite	sphene	zircon	monazite	xenotime	rutile	anatase	orthite	Mg-orthite	moassanite	thorite	spessartite	garnet	Total %
Spanchevo	30—35	25—30	23—30	3—9, (up to 13)	1—5	1—3	+	+	+	+	+	+	±		+					±	1—2.5
Bezbog	28—30	25—35	22—25	1—8		1—2	+	+	+	+	+				+						1—3
Central Pirin	28—34	25—35	20—28	8—14	1—5 (up to 12)		+	+	+	+	+	+			+		+			±	4.5
South Pirin	19—70	4—65	8—30	6—13	1—8		+	+	+	+	+	+	+	+	+	+	+	+	+		5

with K-feldspar phenocrysts. The large quantitative variation of the phenocrysts (30—40 to 70—90 %) is responsible for transitions to subalkaline analogues and monzogranites (Fig. 2 - A, C, D). The structure is massive and the texture - porphyric after the feldspars.

Aplite-pegmatite veins and lenses are relatively rare, thin, of muscovite type.

Central Pirin granitoids. They are represented by Dautovo--Kresna (east of Brezani Village) and Central Pirin (between Bansko and Pirin Village) Plutons. They cover an area of 270 and 170 sq. km, respectively It is supposed that they are parts of a larger batholith. Their rock composition is identical: fine- to medium-grained, aphyric to the nacked eye, dominantly hornblende-biotite granodiorites to biotite granites of adamelitic type, locally to tonalites. The partial variations of the feldspars lead to transitions to subalkaline equivalents and monzogranites (Fig. 2 - A, C, D). The structure is massive and the texture - mainly hypidiomorphic-granular, granitic, in parts monzonitic.

The aplite-pegmatite phase is relatively poor and is related mainly to the peripheral parts of the bodies.

South Pirin granitoids. They include Teshovo (south of Gotse Delchev), Goleshovo (northeast) and Lehovo (south of Petrovo Village) Plutons. They cover an area of about 130, 6 and 2 sq. km, respectively. The different erosion level in individual plutons is responsible for the relative differences in the spatial distribution of the identical rock composition. They are made dominantly of hornblende-biotite granodiorites to tonalites with transitions to granites. The superimposed and variable K- and in parts Ca-Na autometasomatism (Marinova et al., 1964; Boyadjiev et al., 1988) leads to irregular development of monzogranites and transitions to subalkaline varieties (Fig. 2 - A, C, D). The structure of the rocks is dominantly heterogranular, hypidiomorphic-granular to monzonitic.

The aplite-pegmatite phase is represented by thin veins and lenses, in places with zonal structure and beryl, orthite, tourmaline and apatite, visible with nacked eye. There are also different in thickness veins with rock crystal, morion and amethyst.

Petrogeochemical features of the Pirin granitoids

According to Niggli's classification the Pirin granitoids belong to the Ca-alkaline series, granitic and granodioritic groups, oversaturated in SiO_2; $k \leqslant 0.40$. The subalkaline tendency is a result of the relatively irregular distribution of the porphyric K-feldspar generation which in places defines a monzonitic texture. On the background of this general pattern there are some specific features: dominantly granitic composition with partial transitions (in the peripheral parts of the bodies) to granodiorites in Spanchevo and Bezbog Plutons, and predominating granodioritic character with transitions to tonalites in the young South and Central Pirin Plutons (Fig. 2, C). This is a result of the limited in the older and relatively wider magmatic differentiation in the younger plutons. In this respect the analogy between the Central and South Pirin Plutons is remarkable (Fig. 2, B).

The crystallization differentiation in all plutons is normal, homodromous, as a result of which the boundaries between the individual rock varieties are transitional. This differentiation is related to a constant acidification, gradual decrease of Fe and parallel increase of alkalies; the role of MgO is limited (Fig. 2, B).

The content of O, C and S isotopes indicates that the discussed plutons may be referred to the specific, transitional M-genetic type (Popov, 1983). According to the nomenclature of Tauson (1988) the young granitoids on their hand likewise exhibit features of transitional character — between palyngenic granitoids of the Ca-alkaline series and the plumasite rare metal geochemical types.

Content of rare and trace elements. The old and young granitoid plutons show considerable difference in respect of rare and trace elements. The rock varieties of Spanchevo and Bezbog Plutons have content of main microcomponents around clark values; the local and irregular peak contents in some isolated cases result from later superimposed hydrothermal metasomatic and ore processes. However, the data on the young granitoids (Tab. 2) demonstrate a stable tendency to above clark contents (compared after Beus — Grigorian, 1975) for: W (3—5 ×), Mo (4 ×), Sn (up to 3 ×), Cu (2—3 ×), Pb (up to 2 ×), As (3 ×), Cr (5—10 ×), Ni (up to 2 ×), Li (2 ×), F (2 ×). This leads to the conclusion that genetically predestined and indicator components for the South and Central Pirin Plutons are: lithophilic fluids F, Li, ore-chalcophilic and oxiphilic microcomponents: W, Mo, Sn, Cu, As, Pb, Zn. The statistical analysis of the trace elements shows the following versions of positive correlation - for the South Pirin granitoids: W-Sn, Mo-Cu-As, Mo-Pb (Cu, As), F-Zn, F-Be; for the Central Pirin granitoids: W-Mo-Cu, Cu-Zn-F, Li-As, Sb-B. The subclark content of Sr and Ba is symptomatic in both cases.

The above clark contents and correlations suggest a genetically motivated rare metal and polymetal specialization of the generating magmas and their potential metal content. The above clark contents of the siderophilic group of elements in both groups of young plutons is evidently inherited from anatectically reworked substratum but without concentrations which govern the respective metallogenic specialization of the respective magmas.

In this respect the higher contents of some microcomponents in the South Pirin granitoids versus the Central Pirin is indicative. This is in correlative links with their specific metallogeny as: As - presence of gold-bearing pyrite--arsenopyrite mineralizations; Cu - practically constant presence of chalcopyrite in hydrothermal ore associations; B - presence of tourmaline in the skarns and pegmatites related to these plutons.

The specific rare metal specialization of the young granitoid plutons is suggested also by the symptomatically higher content of the following accessories: magnetite up to 6000 g/t and apatite over 0.5% for the South Pirin granitoids, sphene, monazite, thorite and occurrence of fluorine. The higher content of F and REE in the accessories formed during the autometasomatic process (Marinova et al., 1964) is also remarkable.

At the same time the extremely low content (below the sensitivity of the method) of a number of microcomponents in the rock varieties of the adjacent

Table 2

Content of rare and trace elements (statistical mean values in ppm) in the granitoids of Pirin area and the volcanics of Mesta extrusive complex

Elements, clark content	Plutons, volcanics (number of samples)	Lithophile								Chalcophile						
		Li 30—40	Rb 160—210	Cs 3.8—5.2	Ba 450—840	Be 2.5—3.5	Sr 200—400	F 630—830	B 12—15	Pb 15—19	Zn 39—56	Cu 10—26	Sn 2.5—3	Ga 20—	As 1.5—1.9	Sb 0.2—
South Pirin	Teshovo (6)	70	170	4	617	4	244	2500	10	47	53	77	5	30	2.6	0.89
South Pirin	Goleshevo (2)	35	150	2.3	705	3	150	1000	10	30	85	40	4.6	30	51.0	0.25
South Pirin	Lehovo (2)	70	157	3.3	600	3	233	850	10	30	85	360	3	30	4.9	0.30
Central Pirin	Central Pirin (7)	20	169	6	561	5	454	1700	3	27	103	27	9	24	1	0.31
Central Pirin	Dautov-Kresna (3)	23	197	4.4	227	5	227	1000	—	27	80	18	3.7	30	2	0.20
Mesta volcanic complex	Extrusive facies (4)	57	227	6	621	—	—	862	—	—	65	—	—	28	2	1
Mesta volcanic complex	Subvolcanic facies (11)	34	224	6	744	—	—	830	—	—	42	—	—	24	2	2

Continuation of Tab. 2

Elements, clark content		Siderophile				Radioactive		Oxiphile					
Plutons, volcanics (number of samples)		Cr 10—2.2	Co 1—7	Ni 4—15	V 44—88	U 2.6—3	Th 12—17	W 1.7—2.2	Mo 1.2—1.3	Zr 160—180	Ta 1.8—2.5	Hf 3.2—3.9	Sc 7—14
South Pirin	Teshovo (6)	114	10	14	63	6	20	10.7	4	102	2	4	10
	Goleshevo (2)	150	7	7.5	75	3.1	15.4	3.4	4	97.5	1.6	4.2	7.8
	Lehovo (2)	117	10	3	60	2.9	20	5.5	27	95	1.2	3.3	8.9
Central Pirin	Central Pirin (7)	160	8	14	54	4	16	6.1	6.2	100	2	4	7
	Dautov-Kresna (3)	100	6	9.7	43	6.7	21	8.2	2.3	123	1.6	4.7	7.8
Mesta volcanic complex	Extrusive facies (4)	15	5	—	—	9	26	8	3	—	2	4	5
	Subvolcanic facies (11)	13	5	—	—	9	31	10	4	—	2	4	5

The samples are analyzed by: atom-absorbtion analysis for Pb, Cu, Zn, Sr in the Geological Institute, Bulg. Acad. of Sciences by A. Tomova; spectral semiquantitative analysis for V, Ni, Li, F, B, Sn, Be, Ga by R. Rashkova and neutron-activation analysis for the other elements by D. Matanov and B. Marinov (Geochemical Laboratories, Commitee for Geology). Data for Mesta extrusive complex are from: Harkovska et al. (1983), Eskenasi et al. (1984). Clark contents for granodiorites and granites are of the Beus—Grigorian (1975). The symbol "dash" indicates that the content of the respective element is below the sensitivity of the method.

Table 3

Content (mean values in ppm) of REE in the Pirin granitoid plutons

Elements clark contens / Plutons (number of samples)	La 40—50	Ce 80—93	Sm 8.3—10	Eu 1.4—1.6	Tb 1.4—1.6	Yb 3.2—4	Lu 1—1.2	Y 34—40	Σ TR	Eú*	$\frac{\Sigma Ce}{\Sigma Y}$	$\frac{La}{Yb}$
Teshovo (7)	50.6	106	5.8	1.23	1.1	2.2	0.71	13	180.6	0.31	9.7	23.3
Goleshevo (2)	34.6	82	3.1	0.7	0.6	1.8	0.46	15	138.6	0.34	6.7	19.2
Lehovo (2)	37.1	110	3.3	1.0	0.7	2.2	0.44	17	171.7	0.43	7.3	16.8
Central Pirin (3)	57.3	111.3	6.1	1.47	1.1	2.5	0.48	12.3	192.6	0.37	9.5	25.6
Dautovo-Kresna (3)	53.6	106	5.6	1.07	1.0	2.1	0.81	10	180.2	0.30	11.9	25.1
Bezbog (3)	56.3	98.2	6.2	0.95	1.2	2.3	1.13	11.7	178.1	0.22	11.9	26.0
Spanchevo (5)	41.0	87.6	3.7	0.80	0.8	1.9	0.45	9.6	145.9	0.29	9.4	20.0

Remark: The samples are studied by neutron-activation analysis in the Laboratory of the Committee for Geology by D. Matanov and B. Marinov. The content of Nd is below the sensitivity of the method. The maximum error is below 10 %. Clark contens (for granodiorite-granites) are after Beuss — Grigorian (1975).

* Europium anomaly is theoretically calculated.

Mesta volcanic complex, as compared to the Central Pirin Plutons (Tab. 2), is also symptomatic.

These features are in favour of the concept on their common "volcano-plutonic development" (Arnaudov—Arnaudova, 1981; Zagorcev et al., 1987). In the volcanics the content of Cr, in parts Co, Ni, V is also very low. At the same time these volcanics show higher content of U and Th which suggests the possibility for a temporal paragenetic link between the uranium mineralizations and the Late Alpine tectono-magmatic activization of the Rhodope Massif.

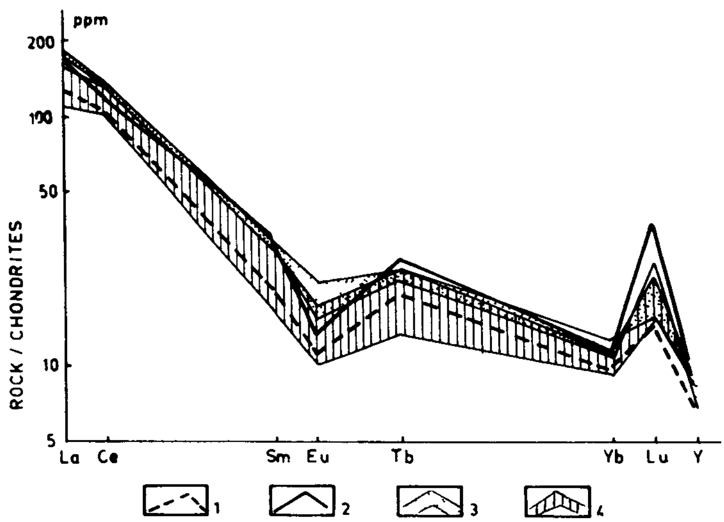

Fig. 3. REE fractionation diagram for the Pirin granitoids (based on data from Tab. 2) 1 — Spanchevo Pluton; 2 — Bezbog Pluton; 3 — Central Pirin Plutons; 4 — South Pirin Plutons.

Content of rare earth elements. On the basis of the available data (Tab. 3) and the constructed chondrite-normalized curves for the lanthanoide fractionation (Fig. 3) the following features are established:

1. Deficiency in Σ TR in all granitoids in respect of all equivalent rock types (after Alexiev, 1974 = 263 ppm; after Balashov, 1974 = 249 ppm). It is two times lower in Spanchevo Pluton. At the same time there is a complete analogy between the group of Central Pirin Plutons which is in support of the idea on their petrological and evidently chronological unity. The partial variation in the South Pirin Plutons is probably a result of the variable amount of K-feldspar as one of the main concentrators of REE.

2. The moderate slopes of the chondrite-normalized curves is in co-variant link with the limited crystallization differentiation (granodiorites to granites). The close features and symmetry of the curves for Central Pirin and Dautovo--Kresna Plutons, parallel to the petrological unity, is again in support of the idea on their spatial connection in depth in a single granitoid batholith (Boyadjiev, 1988).

3. In all granitoid plutons REE are of marked Ce character: 6—7 times higher content of light in respect of intermediate and heavy lanthanoids (Tab. 2) which is due to the relatively higher general and in parts K-alkalinity as well as to the content of accessories, Mg- orthite, thorite, monazite (Tab. 1).

The La/Yb ratio is of particular interest and according to Lutch (1974) indicates the depth of magma generation. The available data suggest analogous (Tab. 2) depth for anatectic formation of the magma of all granitoid plutons which explains some of their common petrological features.

4. The considerable variations in the Eu content indicate repeated inversions in the lanthanoid fractionation and the respective absence of a direct chronological link between the above mentioned groups of plutons. The values of the negative Eu anomaly (Eú) are also indicative. They evidently demonstrate the inversions in the old plutons. This is again in support of the idea on the process of lanthanoid fractionation, i.e. the discontinuity of the granite generation in Pirin area. Both the contents of Eu and Eú are an indirect criterium for the lack of chronological links between the discussed groups of plutons irrespective of their analogous granitoide character.

Consequently the quantitative relations of REE and the type of lanthanoid fractionation are in support of a number of petrological and metallogenic considerations on the formation of Pirin granitoid plutons: analogous initial material for the primary anatectic magma generation; distant in time granite generation responsible for the formation of chronologically different groups of granitoid plutons.

Metallogenic specialization and potential of the Pirin granitoids

About 170 ore occurrences are known in Pirin region. Their structural and spatial links show that the main ore generating factor are the young granitoid plutons which define the specific features of Pirin ore region (Boyadjiev et al., 1988). Spanchevo and Bezbog Plutons are in genetic respect not of metallogenic interest. The high concentration (about 100) of ore occurrences, laterally and genetically related to the South Pirin Plutons, defines the Teshovo ore ring; the southern segment of the ring lies on the territory of Greece and is related to Ser-Drama Pluton (Theodorakis, 1983) which is similar in magmatic and metallogenic respect to the South Pirin granitoids.

Main ore elements for the magmatic mineralizations in the region are: W, Mo, Pb, Zn and subordinate - Cu, Ag (dominantly with polymetallic mineralizations), Au (with pyrite-arsenopyrite mineralizations), Cd (isomorphic with sphalerite), Bi, Sb, As.

At the present state of knowledge 12 mineralogic-geochemical types of metallic and nonmetallic formations may be distinguished: muscovite-quartz-oligoclase, quartz-tourmaline-beryl, quartz-amethyst-morion, quartz-molybdenite ("Sinanitsa" greissen type), skarn-magnetite, quartz-feldspar-molybdenite, quartz-molybdenite-sheelite, gold-pyrite-arsenopyrite, quartz-chalcopyrite, quartz-bismutite-chalcopyrite, quartz-pyrrhotine-chalcopyrite, quartz-galena-sphalerite, quartz-sulphoantimonite-sphalerite. In the area of the young plutons and their host rocks there is a zoning in the distribution of the endogenic mineralizations (Mânkov in Boyadjiev et al., 1988).

Direct bearers and concentrators of rare metal (W-Mo) and other superimposed hylrothermal ore associations are the exoskarns where scheelite and molybdenite are dominantly in the form of fine-grained crystals or aggregates. The process of additional remobilization is responsible for the formation of different in thickness quartz-scheelite (±Mo) veinlets. Ca-skarns are predominant and contain: garnet (andradite to andradite-grossular, rarely uvarovite), diopside, hornblende and tremolite-type amphibole, vesuvian, epidote, zoisite, tourmaline (schorl.), ± K-feldspar, phlogopite, wollastonite, skapolite, magnetite, apatite, titanite, orthite. Relatively thick zones of hornfelses and skarnoids of analogous mineral composition are also related mainly to the Central Pirin granitoids. Magnesium skarns are of limited size and contain olivine, respectively serpentine, phlogopite.

The factors which favour the processes of ore deposition and regional metallogenic forecasts are: repeated granitoid intrusions in the crystalline basement of the region as a criterium for high extent of crustal mobilization of ore components in the host rocks; Alpine granitoid magmatism with expressed rare metal and polymetallic specialization; carbonate host rocks which favour the ore processes and concentration of ore components; pulsating development of ore controling fault structures; direct spatial relation of skarn and vein ore zones to the young plutons; characteristic hydro- and lithogeochemical anomalies (W, Mo, Cu, Pb-Zn) spatially related to particular ore occurrences.

The rare metal specialization and potential perspectives of the young plutons are demonstrated also on Kozlov's diagram (1974) where they fall within the field of "ore-bearing granitoids".

Conclusions

The specific features of the main petrochemical parameters, the content of O, C and S isotopes, the initial $^{87}Sr/^{86}Sr$ ratios, the content of REE and the type of their fractionation, the specific higher content of many microcomponents define both some general and specific petrogeochemical and metallogenic features of the discussed plutons. A general crustal genesis with mobilization of components of mixed, sedimentary-volcanogenic type is suggested. The source of the "anatectic" magmas is a substance with the features of the Precambrian crystalline basement. This is responsible for the granitoid character of the produced magmas and their intermediate M-genetic type; the partially higher content of siderophilic elements indicates local involvement also of ultrabasic derivatives of primary mantle genesis.

At the same time the granite generation process developed during a long time interval and this governed the specific features of the respective granitoid magmas. On the basis of geophysical (Nozharov — Dolapchieva, 1988), structural (Slavov et al., 1976), radiogeochronological (Zagorcev et al., 1987) and geochemical (Arnaudov — Arnaudova, 1981) data different levels of magma generation and crystallization are suggested; the crystallization differentiation of the young plutons occurred at hypabyssal level and that of Spanchevo and Bezbog Plutons - in the cata- and mesozone, respectively. The discontinuity in the granite generation and the relatively different level of magma formation and crystallization predestine some of their specific petrogeochemical features including also their metallogenic specialization. Each subsequent deep magmatic activization is evidently accompanied by the tendency of gradual accumulation and increasing K-potential and parallel metallogenic concentration of ore components of crustal origin. This tendency is particularly well expressed in the young granitoids which show a rare metal specialization and the South Pirin granitoids - also K-autometasomatic processes. This tendency is reflected in the temporal paragenesis of the hydrothermal ore mineraliatzions with the final stages of plutonic activity - the dyke formation. The Alpine magmatic activation, as well the hypabyssal to subvolcanic level of the crystallization differentiation determined a repeated and relatively rapid deposition of the ore components. This explains the pulsation character of the ore deposition and particularly the polycomponent character of the skarn zones.

The Paleogene magmatic activity evidently played some part in the formation of polymetallic mineralizations. The product of this activity is the Mesta volcanic complex. The uranium mineralizations and the total radiogenic rejuvenation of the granitoid-consolidated crystalline basement of the Rhodope Massif (Boyadjiev, 1974) are probably also related to the Late Alpine tectonomagmatic "autonomous" (Shteglov, 1967) activization.

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