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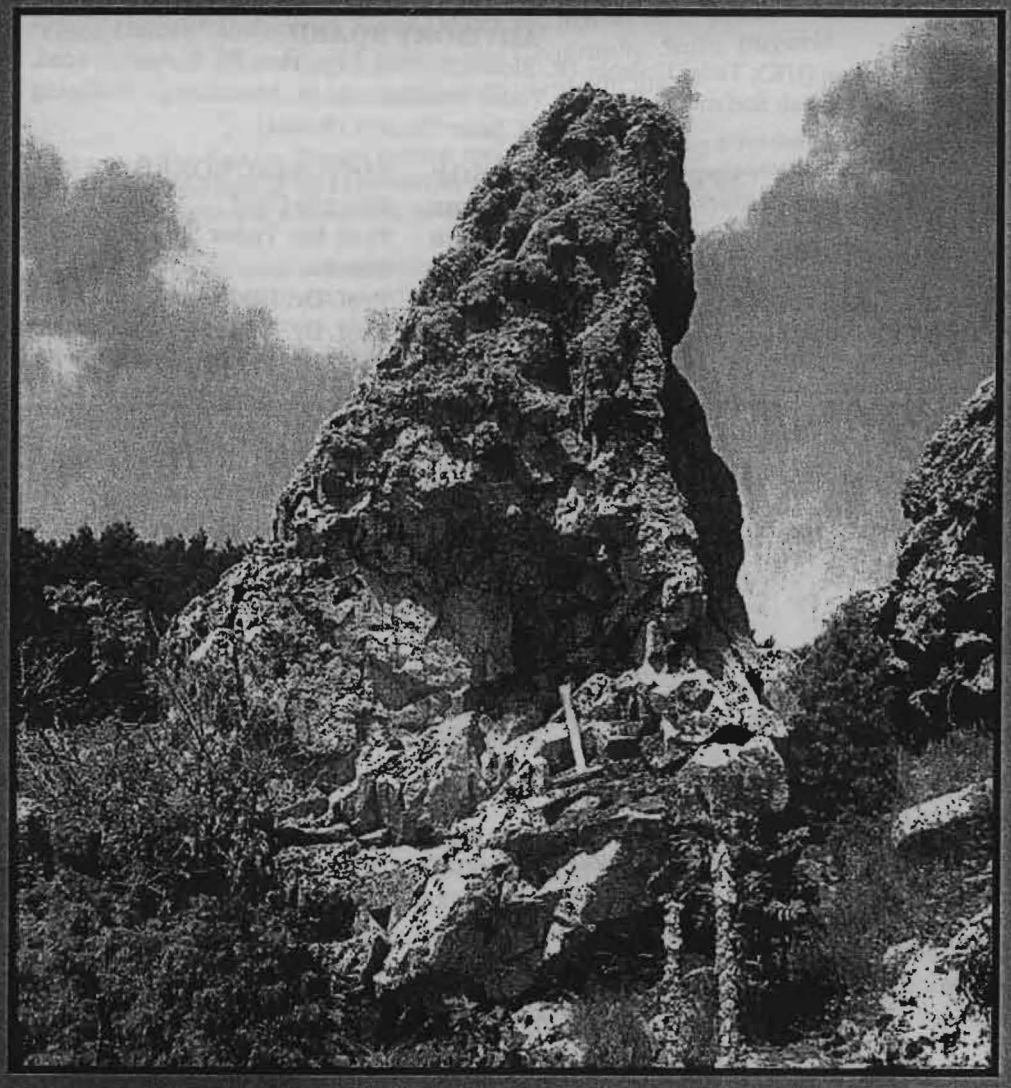

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MINERALOGICAL AND CHEMICAL CHARACTERISTICS OF THE MOST IMPORTANT MINERALS IN THE VOLCANIC ROCKS OF THE KRATOVO-ZLETOVO VOLCANIC AREA

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A b s t r a c t: The Kratovo-Zletovo volcanic area, which is interesting from the aspect of its Tertiary magmatism, occupies the mid portions of the Lece–Halkidi metallogenic zone (Серафимовски, 1990). Numerous deposits and occurrences of metallic and non-metallic mineral raw materials are spatially and paragenetically related to that magmatism.

The paper presents the latest understanding on mineralogical and chemical characteristics of rocks and minerals in the volcanic area. The results of the petrochemical studies point out pronounced calc-alkali magmatism present as volcanic rocks such as dacite-andesite, andesite, latites, andesite-dacites etc. Study of individual mineralogical phases indicated that plagioclases are of the order of oligoclases, andesites, labrador, bitovnite, and anorthoclase. The study of potassium of feldspars indicated that they belong to the sanidine group. The clinopyroxenes are of the diopside whereas augite and biotites belong to the phlogopite-anitite series with slightly pronounced nature of phlogopite component.

Key words: Kratovo-Zletvo volcanic area; petrologic characteristics; mineralogical characteristics; geochemical characteristics

INTRODUCTION

The Kratovo-Zletovo volcanic area is situated in the eastern part of the Republic of Macedonia. Different research workers offer different opinions on the metallogeny and the regional geotectonic position of the area. Some place it within the Macedonian Rodope–Asia–Minor Asia–Central massif (Богоевски, 1964), others in the Serbo-Macedonian massif (Иванов, 1966). Some authors place it in the Vardar zone (Dimitrievic, 1974, Арсовски, Петковски, 1975) whereas others believe that the young volcanics mark the traces of the deep fractures which are the boundary between the Dinarides and Internides (Pantic, 1966).

From the aspect of metallogenic regional setting some research workers classify the area as ore-fields (Rakićc, 1978, Petković, 1982, Blecić 1983) and others consider it as ore-region (Ivanov, 1966, Janković 1974, Ivanov, 1982) etc.

The Kratovo-Zletovo ore region includes the volcanic area of the same name, which is of interest for the Tertiary magmatism and mineralization.

Numerous deposits and occurrences of metallic and non-metallic mineral raw materials are spatially and paragenetically related to this magmatism.

The ore region is of complex structural-geologic and metallogenetic composition and is one of the more important ore regions. The geological composition (Fig. 1) of the Kratovo-Zletovo region consists of:

The Precambrian metamorphic rocks present as various types of gneiss, micashists, amphibole, biotite schists, etc. The rocks are older, of higher degree of metamorphism representing the fundament of the area that belongs to the Serbo-Macedonian massif.

The Paleozoic metamorphic rocks, which are present mostly as chlorite-sericite schists and phyllites, carbonate schists and marbles. Quartz-graphite schists can also be noticed. It can be said these rocks are interesting for their mineralization.

The Mesozoic rocks are present mainly as magmatic rocks such as serpentinites and granodiorite rocks, gabbros, and granodiorites.

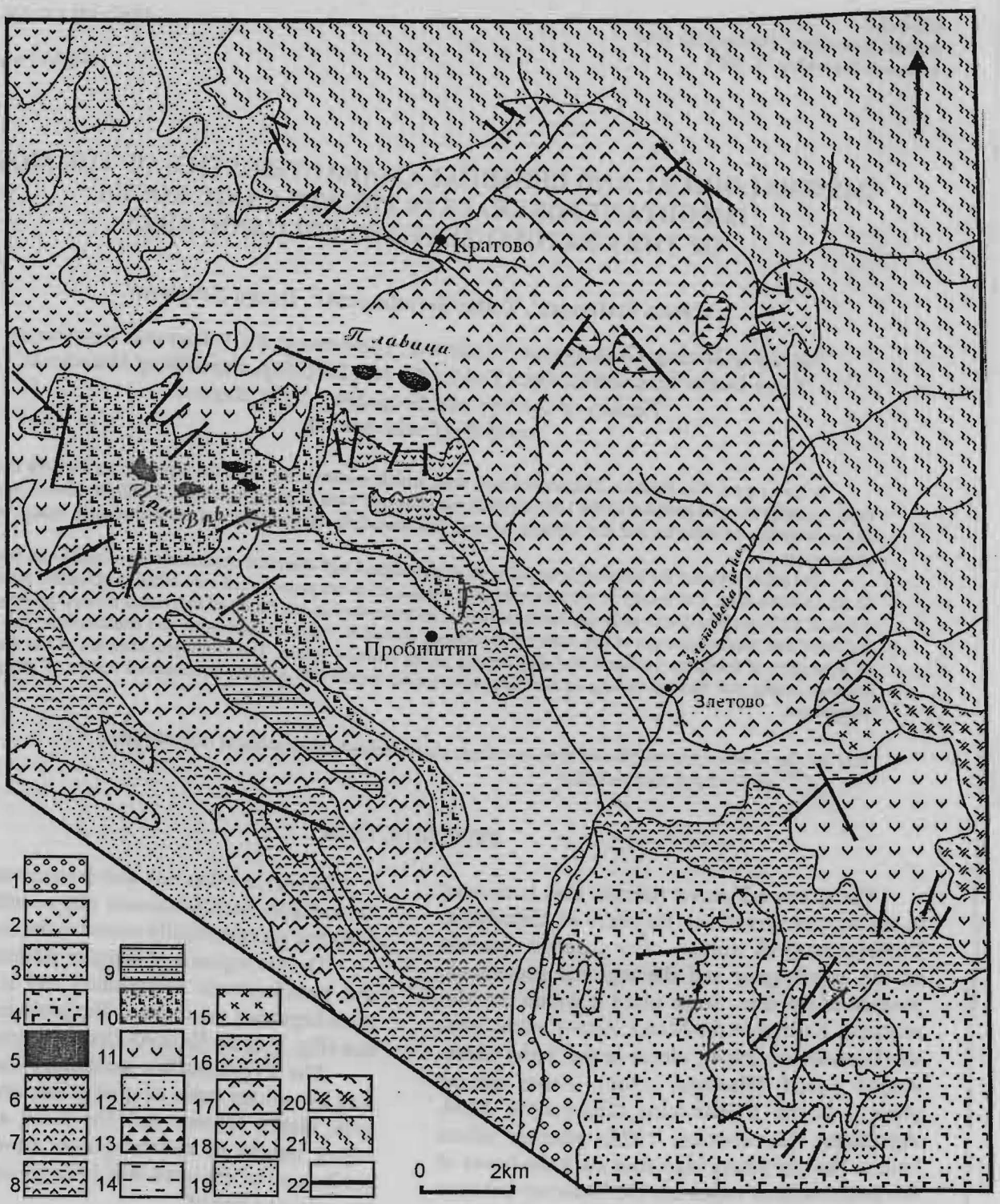

Fig.1. Schematic geologic map of the Kratovo-Zletovo ore region (Serafimovski, 1990)
1. Alluvium, 2. Biotite-augite andesites, 3. Augite-biotite andesites, 4. Volcanogene-sedimentary breccia, 5. Hydroquartzites, 6. Dacito-andesites, 7. Augite-labrador andesites, 8. Stratified tuffs and ignimbrites of dacito-andesite composition, 9. Bituminous slates and sandstones, 10. Red tuffaceous sandstones, 11. Hornblende-augite-biotite andesites, 12. Hornblende andesites, 13. Ignimbrites opalised breccia, 14. Conglomerates, 15. Quartz-monzonite phorphyry, 16. Clayey conglomerate sandstones, tuffaceous sandstones and breccias, 17. Ignimbrite of dacite composition, 18. Biotite-hornblende andesites, 19. Conglomerates, sandstones, marls and limestones, 20. Gabbro, 21. Chlorite-sericite schists and phyllites, 22. Faults

The Cenozoic rocks are wide spread in the region. They are present as Tertiary sediments, volcano-sedimentary rocks and a small part of Quaternary layers. Paleogene sediments and volcanic rocks developed mostly in Mid-Eocene – Upper-Oligocene and present as conglomerates, sandstones, limestones and marls. Volcanic rocks are present as andesites and dacites.

Clayey conglomerate, sandstones, tuffacious sandstones and breccia, marly limestone, sandstones and conglomerates appear as younger rocks. Here belong quartz-monzonite porphyry.

The Miocene volcanic and volcanogene-sedimentary rocks are rather widespread and present as biotite-augite andesites, conglomerates, tuff-sandstones and marls, ignimbrite opalised tuffs and breccia, bituminous sandstones and clays. Individual types of rocks such as Mid-Miocene volcanogene sedimentary series play an important role as an environment in which important lead; zinc and copper concentrations are placed. Of these the most widespread are the Mid to Upper Miocene volcanogene-sedimentary series which in the area of Plavica is intruded by many dykes and necks of dacite-andesite composition. It is hydrothermaly altered and mineralized.

The Mio-Pliocene volcanogenic sedimentary series is present as augite-labrador andesites, hydro-quartzites and clayey sandstones, marls, and marly tuffs.

The Pliocene members are the youngest sedimentary and volcanic rocks present as volcanogene-sedimentary breccia, augite-biotite andesites, freshwater limestones, tuffaceous sandstones, ignimbrites of andesitic composition, alkali basalt and Pliocene-Quaternary clays and tuffa limestones.

The Quaternary is not very common and does not play an important role in the composition of the ore region. It is present mostly as limnic and riverine terraces, deluvial layers and alluvial boulders present mostly near large rivers.

PETROLOGIC CHARACTERISTICS OF VOLCANIC ROCKS

The volcanic rocks in the area are of intermediary nature. They are products of granodiorite-tonalite to quartzmonzonite magma that hardened mainly during volcanic level.

Most of the rocks are present as andesites and trachyandesites (latites) which is an indicator that chemistry of the rocks is similar.

Dacites and trachyandesites can also be found (quartzlatites). In the region basalt trachyandesites or rocks of more basic nature can also be found as products of younger phases of volcanic activity.

Numerous investigations were carried out (Пенџерковски 1960, Мијалковиќ et al., 1966, Пантиќ 1972, Денковски 1984, Стојанов et al., 1990) for the determination of the petrochemical characteristics of the rocks. The results speak for pronounced calc-alkali nature of magmatism. Only a small number belong to the toleitic series.

Some rocks demonstrate more calcic nature with almost equal potassium and sodium component. This points out the increased presence of more basic members of intermediary calc-alkali series of the rocks, or larger presence of andesites in which calcic component predominates over the alkalis.

The magmatic activity offers intermediary calc-alkali magmatism which is characterized with pronounced explosive nature of volcanic equivalents such as ignimbrites, dacite-andesites, trachyandesites, volcanic tuffs, agglomerates, breccias etc. (Серафимовски, 1990).

The study of the chemical composition of some samples is shown in Table 1.

Based on the data classification was made on the volcanic rocks according to TAS diagram. According to the diagram (Fig. 2) the analyses fall in the field of latites, andesites and one sample plots in the dacite field.

Differentiation of magmatic melt is conditioned by the relationship between component parts and their distribution in individual differentiates of magmatic melt. The relationship between some components is an indicator of the nature of melt that can be seen in Fig. 3, which shows the relationship between potassium and silica. It is clear that rocks analyzed plot in the field of high potassium series and its calc-alkali nature of magmatism.

Table 1

Chemical composition of the rocks of the Kratovo-Zletovo volcanic area

Sample	1	2	3	4	5
SiO_2	60.54	59.98	54.7	57.31	56.07
TiO_2	0.64	0.60	0.7	0.45	0.84
Al_2O_3	16.03	16.01	18.04	17.19	17.12
Fe_2O_3	3.02	3.61	5.24	6.04	5.89
FeO	2.61	2.23	1.46	1.78	1.82
MnO	0.12	0.13	0.09	0.09	0.8
MgO	2.27	2.36	1.69	1.82	1.52
CaO	5.71	5.44	7.44	6.32	5.9
Na_2O	2.78	3.01	3.76	3.03	3.09
K_2O	3.92	3.78	3.92	3.75	4.26
P_2O_5	0.25	0.2	0.27	0.32	0.35
H_2O^-	0.66	0.66	0.53	0.92	0.65
H_2O^+	1.03	1.70	1.38	0.97	0.91
Σ	99.58	99.71	99.22	99.99	99.22
Cr	44	34	18	20	36
Ni	5	<5	10	<5	5
Co	12	13	15	18	14
Li	22	24	12	15	9
Rb	127	116	100	111	130
Zn	1038	82	104	1761	1348
Cu	81	83	129	176	1496
Pb	59	15	9	118	48
Sr	17	1228	1986	7	68

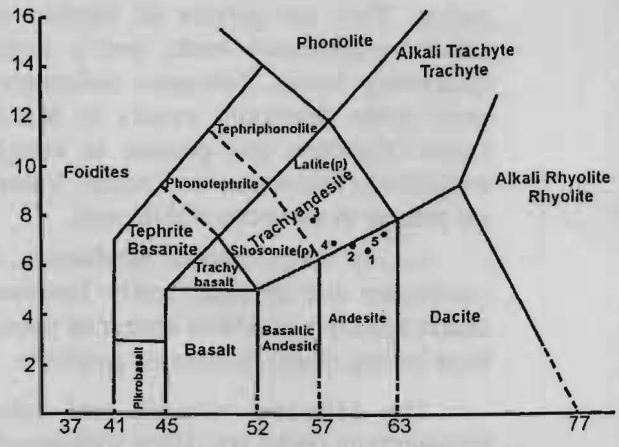

Fig. 2. Classification of the volcanic rocks of the Kratovo-Zletovo volcanic area based on TAS diagram (Le Bas et al., 1986)
Note: 1,2 – andesites south-eats of Zletovo; 3,4 – latites of Maracino; 5 – andesite-dacite of Slegovo

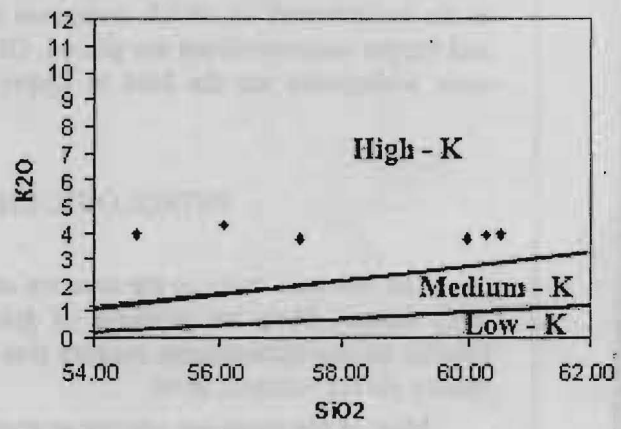

Fig. 3. Correlation diagram of K_2O and SiO_2

CHEMISTRY OF PETROGENE MINERALS

Some studies were carried out (Марић 1953) in order to determine the chemistry of mineral phases. The paper presents latest data on the chemicals composition of certain mineral phases determined by electronic micro probe.

Plagioclases: Plagioclase in andesites is characterized by strongly pronounced zonal composition. The chemical composition of plagioclases is shown in Table 2. They are oligoclase-andesines (An 19-47) with normal and reverse zoning.

Plagioclases in latites are characterized by normal zoning. In many cases reverse zoning can also be seen. Their composition varies from oligoclase in the outer zone to bitovnite in the centre and basic andesite to labrador (An_{41-68}).

Orthoclase component is higher in the more acid plagioclases. Plagioclases in andesites are of strongly pronounced zonal composition and well shaped core most often of biotite composition (An_{79-81}) and the periphery of plagioclase the composition varies from andesine to labrador (An_{48-62}). Microphotograph of zonal plagioclase is shown in Fig. 4.

Based on the chemical composition obtained (total of 32 analyses) carried out on plagioclase and the calculated crystallochemical classification was carried out on plagioclases as shown in Fig. 5. Data fall in the field of oligoclase, sanidine, labrador and bitovnite and one analysis fell in the field of anorthoclase.

Table 2

Chemical composition of part of plagioclases analyzed of the Kratovo-Zletovo volcanic area (calculation 8 O).

Sample	1	1	2	2	3	3	4	4	6	6
Mineral	Pl	Pl (r)	Pl (m)	Pl (r)	Pl (r)	Pl (c)	Pl (r)	Pl (c)	Pl (c)	Pl (m)
SiO_2	59.63	59.64	59.54	60.33	48.71	44.81	48.36	54.64	52.25	59.81
TiO_2	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.07	0.00
Al_2O_3	23.39	24.03	22.98	23.57	30.03	32.87	31.2	26.86	28.25	22.84
FeO	0.26	0.35	0.41	0.19	0.89	0.68	0.66	0.55	0.45	0.59
MnO	0.00	0.00	0.09	0.00	0.11	0.00	0.00	0.00	0.00	0.00
MgO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CaO	7.83	7.80	9.18	9.07	14.98	18.55	15.48	10.47	17.07	10.53
Na_2O	8.39	8.39	6.11	6.42	4.87	2.67	3.99	7.3	2.07	5.85
K_2O	0.13	0.70	0.83	0.73	0.31	0.18	0.11	0.72	0.22	0.85
BaO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**100.26**	**100.93**	**99.28**	**100.33**	**99.94**	**99.78**	**99.83**	**100.56**	**100.41**	**100.50**
Si	10.75	10.66	10.78	10.79	9.04	8.39	8.94	9.93	9.53	10.75
Al	4.96	5.05	4.90	4.96	6.56	7.24	6.79	5.75	6.07	4.83
Ti	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Fe	0.04	0.05	0.06	0.03	0.13	0.10	0.102	0.08	0.07	0.09
Mn	0.00	0.00	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	1.51	1.49	1.78	1.73	2.98	3.72	3.06	2.04	3.33	2.02
Na	2.93	2.90	2.14	2.22	1.75	0.96	1.43	2.57	0.73	2.03
K	0.03	0.16	0.19	0.17	0.07	0.04	0.03	0.16	0.05	0.19
Ab	65.5	63.7	52.1	53.9	36.5	20.5	31.6	53.8	17.8	47.8
An	33.8	32.7	43.2	42.1	62.0	78.6	67.8	42.7	81.0	47.6
Or	0.7	3.5	4.7	4.0	1.5	0.9	0.6	3.5	1.2	4.6

Note: 1, 2 – Andesites south-west of Zletovo; 3 – Latites of Maracino; 4 – Latites west of Probištip; 6 – Andesite of Pikovci. Pl – plagioclase; c – centre; m – middle; r – margin.

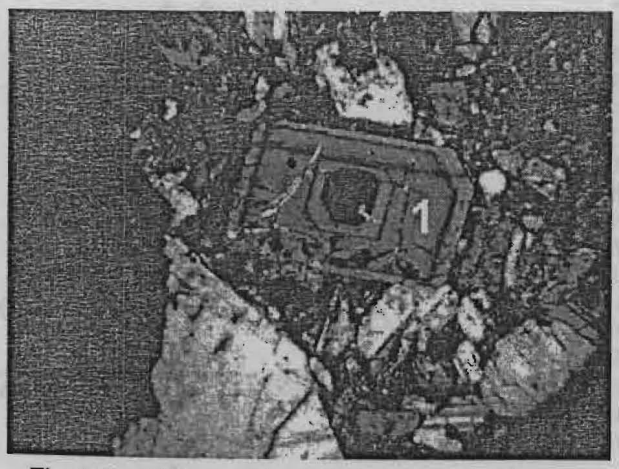

Fig. 4. Zonal idiomorphic plagioclase (1) of the Kratovo-Zletovo area II N magnification 6.3

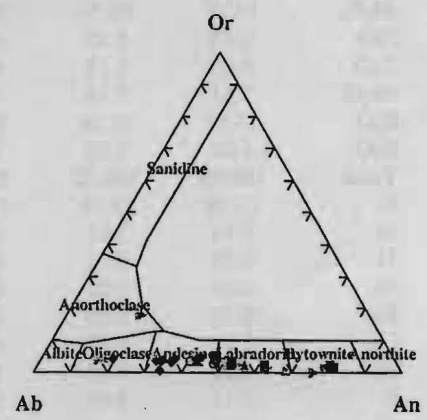

Fig. 5. Classification of the plagioclase of the volcanic rocks of the Kratovo-Zletovo volcanic area (Deer et al., 1972). ♦ – probe 1; ● – probe 2; ▶ – probe 3; ▲ – probe 4; ■ – probe 6

Potassium feldspars – were analyzed in andesites. Phenocrysts include clynopyroxenes and biotites. Based on chemical composition determined (Fig. 6) and crystallochemical relations calculated, potassium feldspars were defined as sanidine.

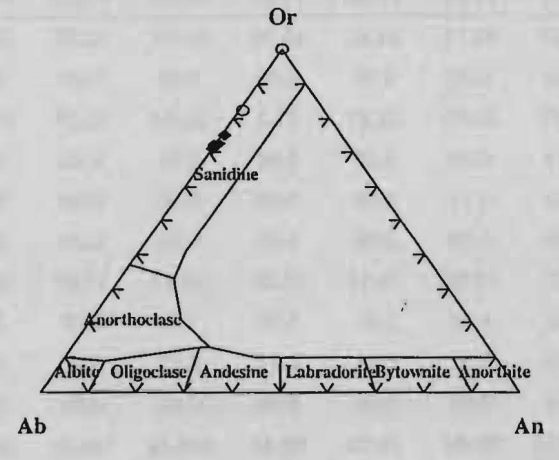

Fig. 6. Classification of the feldspars of the volcanic rocks of the Kratovo–Zletovo volcanic area (Deer et al., 1972).
♦ – probe 1;

Microprobe analyses indicate that they contain significant amount of BaO (Cn = 2–3). The chemical composition of feldspars is shown in Table 3.

Table 3

Chemical composition of the feldspars of the volcanic rocks of the Kratovo-Zletovo volcanic area calculated on 8 O).

Sample	1	1	1	1
mineral	Kfs (r)	Kfs do Bi	Kfs(c)	Kfs (c)
SiO_2	66.37	66.57	64.66	65.55
TiO_2	0.00	0.07	0.11	0.00
Al_2O_3	15.77	16.77	16.59	16.86
FeO	0.00	0.30	0.00	0.09
CaO	0.00	0.15	0.09	0.15
Na_2O	3.31	3.18	3.49	2.83
K_2O	13.17	13.24	13.16	13.33
BaO	1.45	0.00	1.52	1.05
Total	**100.09**	**100.32**	**99.64**	**99.89**
Si	12.29	12.18	12.08	12.14
Al	3.43	3.61	3.65	3.67
Ti	0.00	0.01	0.02	0.00
Fe	0.00	0.05	0.00	0.01
Ba	0.10	0.00	0.11	0.07
Ca	0.00	0.03	0.02	0.03
Na	1.19	1.13	1.26	1.01
K	3.11	3.09	3.14	3.14
Ab	27.7	26.6	28.6	24.2
An	0.0	0.7	0.4	0.7
Or	72.3	72.7	71.0	75.1

Note: 1. Andesites; Kfs – potassium feldspar; Bi – biotite; (c) centre, (r) margin

Clynopyroxenes are idiomorphic and sometimes indicate poor zoning under a microscope. Chemical composition varies from diopside to augite (Wo 42–49, En 34–39, Fs 15–19).

Magnesia varies within Mg# = 0.65–0.87 with no significant difference between the chemical composition between the centre and the periphery of the grains. The chemical composition of clinopyroxenes is shown in Table 4. Microphotograph of clinopyroxenes is given in Fig. 7.

Fig. 7. Zonal plagioclase (1) with porphyry of clynopyroxene (2) of the Kratovo-Zletovo volcanic area; X N magnification 6.3.

The chemical composition calculated and the crystallochemical relationships helped carry out classification of clynopyroxenes as shown in Fig. 8. It can be seen that the clynopyroxenes fall in the diopside and augite field.

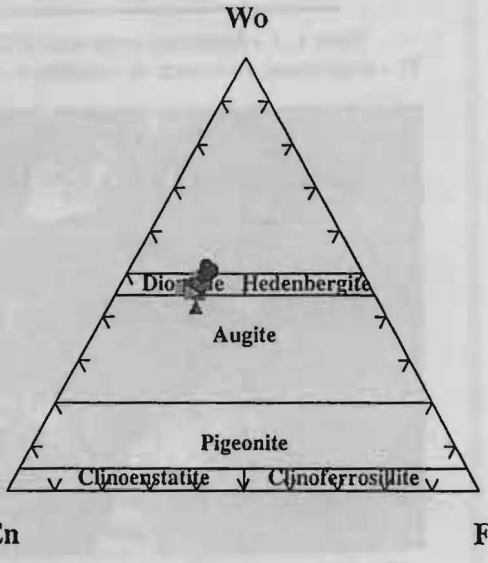

Fig. 8. Classification of the clynopyroxenes of the Kratovo-Zletovo volcanic area (Morimoto, 1989).
♦ – probe 1; ● – probe 2; ▶ – probe 3; ▲ – probe 4; ■ – probe 6

Table 4

Chemical composition of clynopyroxenes in the volcanics in the Kratovo – Zletovo area (calculated on 6O).

Sample	1	1	2	2	3	3	4	4	6	6
Mneral	Cpx	Cpx	Cpx	Cpx	Cpx (c)	Cpx	Cpx (c)	Cpx (r)	Cpx	Cpx
SiO_2	54.62	52.74	53.25	53.21	50.28	51.47	51.18	51.42	52.91	53.24
TiO_2	0.21	0.10	0.06	0.09	0.45	0.29	0.17	0.15	0.12	0.16
Al_2O_3	0.95	1.03	0.62	0.00	4.34	2.59	3.03	2.08	0.96	1.09
FeO	8.93	10.41	10.18	9.34	8.12	9.09	10.69	10.01	9.57	9.45
MnO	1.03	0.75	0.79	0.70	0.38	0.47	0.57	0.68	0.76	0.91
MgO	12.06	10.81	10.69	11.17	13.83	12.51	13.25	12.91	12.65	11.59
CaO	21.57	23.85	24.09	25.14	22.65	22.5	19.95	22.97	22.69	22.61
Na_2O	0.00	0.00	0.00	0.00	0.00	0.00	0.6	0.00	0.00	0.00
K_2O	0.63	0.07	0.00	0.12	0.14	0.00	0.27	0.00	0.00	0.00
BaO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**100.05**	**99.79**	**99.71**	**99.80**	**100.23**	**99.76**	**99.74**	**100.24**	**99.69**	**99.07**
Si	2.05	2.00	2.02	2.02	1.86	1.95	1.47	1.93	1.99	2.03
Al	0.00	0.00	0.00	0.00	0.136	0.05	0.53	0.07	0.002	0.00
Fe	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	0.04	0.04	0.03	0.00	0.05	0.07	0.49	0.02	0.04	0.05
Ti	0.01	0.003	0.002	0.003	0.01	0.008	0.004	0.004	0.003	0.005
Fe_3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe_2	0.274	0.33	0.32	0.29	0.17	0.22	0.00	0.25	0.24	0.29
Mg	0.67	0.61	0.61	0.63	0.76	0.71	0.49	0.72	0.71	0.66
Fe_2	0.01	0.00	0.00	0.00	0.08	0.07	0.26	0.06	0.06	0.01
Mn	0.03	0.02	0.03	0.02	0.01	0.02	0.01	0.02	0.02	0.03
Ca	0.87	0.97	0.98	1.02	0.90	0.91	0.615	0.92	0.92	0.92
K	0.03	0.003	0.00	0.006	0.01	0.00	0.01	0.00	0.00	0.00
cat	3.97	3.99	4.00	3.99	3.99	4.00	3.99	4.00	4.00	4.00
Wo	46.75	50.09	50.67	51.80	46.67	47.49	42.248	46.61	46.92	48.28
En	36.37	31.59	31.29	32.03	39.65	36.74	39.07	36.45	36.39	34.43
Fs	16.87	18.31	18.03	16.16	13.67	15.76	18.64	16.94	16.69	17.29
Mg#	0.71	0.65	0.65	0.68	0.82	0.77	0.68	0.87	0.74	0.70

Note: 1, 2 – Andesites south-west of Zletovo; 2 – Latites of Maracino; 4 – Latites west of Probistip; 6 – Andesite of Pikovci.
Cpx – clynopyroxenes, (c) centre, (r) rim

Biotites are of minor values in the square coordination $Al^{(iv)}$ and magnesia that varies between Mg # 0.49 – 0.66 being rather lower than that of the pyroxenes. It can often be strongly resorbed. The chemical composition of biotites is shown in Table 5. The microphotograph of biotites is shown in Fig. 9.

The chemical composition and crystallochemical relationships calculated made it possible to carry out the classification of biotites (Fig. 10). The biotites of the volcanics studies fall in the phlogopite-anite series of biotites with a slight nature of phlogopite component (Fig. 11).

Table 5

Chemical composition of biotites in the Kratovo–Zletovo area (calculated on 22O).

Sample	1	1	1	1	1	2	2	2	4
Mineral	Bi (r)	Bi (c)	Bi	Bi (r)	Bi to Kfs	Bi	Bi	Bi	Bi
SiO_2	34.44	37.92	35.42	36.07	37.82	38.07	40.36	40.38	37.01
TiO_2	3.19	2.78	3.44	3.35	3.03	3.50	3.28	2.78	4.84
Al_2O_3	13.28	13.87	13.54	14.05	14.45	11.34	11.55	10.04	14.54
FeO	24.23	18.95	19.50	18.85	16.50	20.15	18.04	19.35	14.19
MnO	0.00	0.24	0.00	0.19	0.22	0.40	0.50	0.28	0
MgO	13.09	12.54	13.74	13.89	14.43	11.36	13.09	12.32	15.15
CaO	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.12
Na_2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41
K_2O	8.55	9.80	9.28	9.28	9.76	10.46	9.51	10.26	8.87
Total	**96.81**	**96.13**	**95.05**	**95.70**	**96.24**	**95.30**	**96.35**	**95.44**	**95.16**
Si	5.56	5.99	5.71	5.74	5.89	6.15	6.31	6.45	5.76
Al IV	2.43	2.01	2.29	2.26	2.10	1.84	1.69	1.55	2.23
Al VI	0.09	0.57	0.27	0.37	0.55	0.31	0.43	0.34	0.43
Ti	0.38	0.33	0.15	0.40	0.35	0.42	0.38	0.33	0.57
Fe	3.27	2.50	2.63	2.51	2.15	2.72	2.36	2.58	1.85
Mn	0.00	0.03	0.00	0.03	0.03	0.05	0.07	0.04	0.00
Mg	3.15	0.295	3.30	3.29	3.35	2.74	3.05	2.93	3.52
Ca	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02
Na	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12
K	1.76	1.97	1.91	1.88	1.94	2.16	1.89	2.09	1.76
Mg #	0.49	0.54	0.56	0.57	0.61	0.50	0.56	0.53	0.66

Note: 1, 2 – Andesites south-east of Zletovo; 4 – Latites west of Probištip; Bi – biotites; Kfs – potassium feldspar

Fig. 9. Phenocrysts of plagioclase (1), pyroxenes (2) and biotite (3) of Kratovo-Zletovo; II N magnification 6.3.

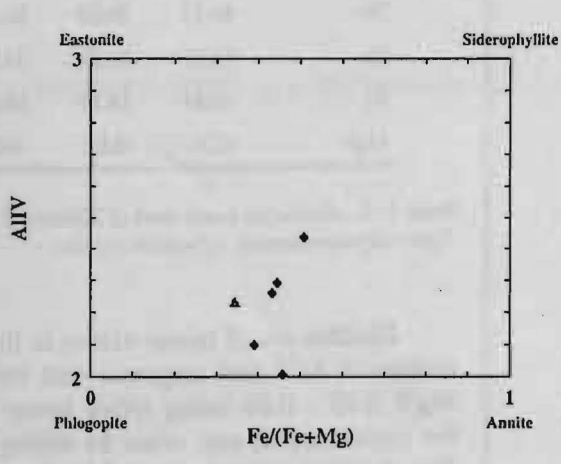

Fig. 10. Classification of the biotites of the Kratovo-Zletovo volcanic area (Feldstein, et al., 1993)
♦ – probe 1; ● – probe 2; ▲– probe 4

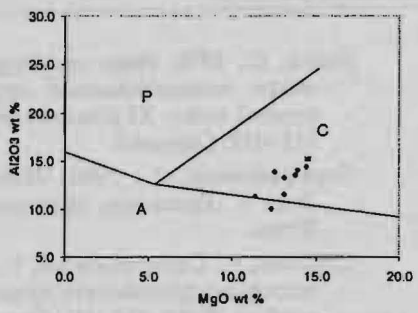

Fig. 11. $MgO–Al_2O_3$ discrimination diagram of biotite (according to Abdel et al., 1994) for biotites from the ignimbrites of Zletovo (probes 1 and 2) and for andesites of Probištip (probe 4). A – biotites of the anorogene alkali series. P – biotites of peraliminia magmatic series (S – type granites). C – biotites of Ca-alkali orogene magmatic series

The composition of magmatic biotite was used to carry out a discrimination diagram to see the composition of magma that biotite originates from. Anorogene (A) alkali complexes (Abdel-Rahman, 1994) developed in conditions of tectonic extension. Most of them are so called A-type of granites; (P) – peraliminium series that include collision and S-type granites and (C) – calcalkali orogene complexes (more than 1 type of granite) formed in subduction conditions. The discrimination diagram shown that the rocks of the area fall in the field of Ca-alkali orogene magmatic series.

CONCLUSION

New data presented for the chemical composition of the rocks of the Kratovo-Zletovo volcanc area indicated that volcanism in the area is characterized as calc-alkali present as andesites, latites, andesite-dacites, etc. The study of individual mineral phases of the rocks indicated that plagioclases are present as oligoclase andesines, labrador, bitovnite and anorthtite. Potassium feldspars studied are sanidine in composition, whereas clynopyroxenes are present mostly as diopsides and less as augite. The bitites studied fall in the group phlogopite-anorite series with more pronounced phlogopite series. The composition of biotites also indicated that the rocks of the volcanic area belong to the Ca-alkali orogene magmatic series that were most probably formed in subduction conditions.

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Резиме

МИНЕРАЛОШКИ И ХЕМИСКИ КАРАКТЕРИСТИКИ НА ПОЗНАЧАЈНИТЕ МИНЕРАЛИ ВО ВУЛКАНСКИТЕ КАРПИ ОД КРАТОВСКО-ЗЛЕТОВСКАТА ВУЛКАНСКА ОБЛАСТ

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Клучни зборови: кратовско-злетовска вулканска област; петролошки крактеристики; минералошки карактеристики; геохемиски карактеристики.

Во рамките на рудниот реон Кратово–Злетово, кој ги зазема средишните делови на металогенетската зона Лече – Халкидик влегува истоимената вулканска област која е посебно интересна од аспект на терцијарниот магматизам и минерализација. Со овој магматизам просторно и парагенетски се поврзани бројни наоѓалишта и појави на метални и неметални минерални суровини.

Во овој труд се презентирани најновите сознанија добиени со поновите испитувања вршени со цел добивање нови сознанија за минералошките и хемиските карактеристики на карпите и минералите во кратовско-злетовската вулканска област. Резултатите од петрохемиските испитувања укажуваат на нагласен калко-алкален магматизам кој е претставен со вулкански карпи од редот на дацито-андезити, андезити латити, андезит-дацити и други претставници. Извршени се и испитувања на одделни минералошки фази кои покажаа дека плагиоклазите се од редот на олиго клас, андезин, лабрадор, битовнит и анортоклас. Испитувањата на калиските фелдспати покажаа дека тие спаѓаат во групата на санидините. Клинопироксените се од типот на диопсид и аугит, а биотитите спаѓаат во групата на флогопит-анитската серија со мал нагласен карактер на флогопитската компонента.