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Original scientific paper

MIDDLE MIOCENE VOLCANISM IN ČITAKLIJA LOCALITY OF VARDAR ZONE, NORTH MACEDONIA

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A b s t r a c t: This paper presents the results of the investigations of volcanic rocks of Middle Miocene age in the central parts of the Varadar zone for the first time. The volcanic rocks that appear in the Čitaklija locality, according to their petrological and mineralogical characteristics, represent basic igneous rocks and they are transitional rocks between phonotephrites and high potassium shoshonites. The geochemical distribution of trace elements and elements from the group of rare earths (REE), as well as isotopes of $^{87}Sr/^{86}Sr$ (0.708348) and isotope values of $^{143}Nd/^{144}Nd$ (0.512319) indicate the fact that the magmatic sources of these rocks can be located in the border region between the upper mantle and the lower part of the continental crust.

Key words: Middle Miocene; Vardar zone; Roman province lavas; phonotephrites; potassium shoshonites

INTRODUCTION

Several occurrences of potassium-rich and ultrapotassic volcanic rocks of Late Miocene (6.5 Ma) to Pliocene (1.47 Ma) age occur within the Vardar zone of the Republic of North Macedonia (Yanev et al. 2008). Such lavas are present in the southern parts of Serbia as well. Three groups of volcanic rocks can be distinguished as follows:

1. The first group demonstrate shoshonitic affinity and these are the volcanic rocks from Kožuf Mountain (N. Macedonia) and Voras Mountain (Greece) (low-Mg-K group); they are shoshonites, less often rhyolites, with the presence of latites and trachytes and their transitional counterparts.

2. The second group is represented by potassium-rich volcanic rocks (high-Mg-K group, having K_2O/Na_2O between 1.0 and 1.8), and they also appear in southern Serbia (Slavujevac, Cer, Klinovac) and North Macedonia (Đurište near Sveti Nikole).

3. The third group of volcanic rocks that is present only on the territory of the Republic of North Macedonia is represented by ultrapotassic rocks (UK-group, with $K_2O/Na_2O > 1.8$, Mg#71) which are classified as ultrapotassic (UK) shoshonities, UK latites and UK phonotephrites, although they show "Roman Province type" affinity (Group III after Foley 1987). The geochemistry of lavas from all three groups demonstrates strong enrichment in LILE, Th and Pb, as well as relative depletion in Ta-Nb and Hf, which are usual characteristics of magmas generated in convergent geotectonic settings. In HMg-K and UK volcanic rocks, the Sr and Nd isotopes range from 0.70768 to 0.71040 and from 0.51243 to 0.512149 . Volcanic rocks from the LMg-K group show a relatively limited range in terms of Sr and Nd isotopes, from 0.7087 to 0.7093 and from 0.51233 to 0.51229, which correlate with the MgO and SiO_2 contents. The geochemical characteristics of the LMg-K group of volcanic rocks indicate that they were formed in the processes of fractional crystallization with a significant role in the contamination of magma with the continental crust.

In contrast, the HMG-K and UK rocks have not been significantly modified by crustal contamination, and their geochemical features are considered to reflect lithospheric mantle heterogeneity acquired during the Mesozoic subduction processes. The metasomatizing agents were more enriched in Zr, Th, Ta, and Ce than in fluid-mobile elements such as Pb and Sc, suggesting that it was characterized by a high melt/fluid ratio.

In this study, we present the petrological, geochemical and isotopic characteristics of the volcanic rocks from the Čitaklija site, in the central parts of the Vardar zone. These lavas belong to UK group and according to our new geochronological data, represent the oldest magmatic activity of this group.

MATERIALS AND METHODS

Whole-rock major and trace elements geochemistry

Concentrations of major and trace elements were measured by ICP-OES and ICP-MS at Actlabs. The samples are dissolved using the most aggressive fusion technique that involves a lithium metaborate/tetraborate fusion. Fusion is performed by a robot at Actlabs, which provides a fast fusion of the highest quality in the industry. The resulting molten beads are rapidly digested in a weak nitric acid solution. The fusion ensures that the entire sample is dissolved. It is only with this attack that major oxides including SiO_2, refractory minerals (i.e., zircon, sphene, monazite, chromite, gahnite, etc.), REE and other high field strength elements are dissolved.

Whole-rock Sr and Nd isotopic compositions

For Sr isotopes, the rock powders were dissolved in $HF+HNO_3$ at 150 ºC for 5 days, and the chemical separation procedures for Sr follow the methodology of Creaser et al. (2004) and Holmden et al. (1997). Isotopic analysis for Sr used MC-ICPMS methods. All analyses are presented relative to a value of 0.710245 for the SRM987 Sr isotopic standard.

For Nd isotopes, sample dissolution was performed in HF + HNO_3 at 150 ºC for 5 days, and the chemical separation procedures followed Creaser et al. (1997) and Unterschutz et al. (2002) with isotopic analysis by MC-ICPMS (Schmidberger et al., 2007). Dissolution occurred in mixed ^{24}N HF + ^{16}N HNO_3 media in sealed PFA teflon vessels at 160 ºC for 6 days. The fluoride residue is converted into chloride with HCl, and Nd and Sm are separated by conventional cation and HDEHP-based chromatography. Chemical processing blanks are < 200 picograms of either Sm or Nd and are insignificant relative to the amount of Sm or Nd analyzed for any rock sample. We analyzed the Geological Survey of Japan Nd isotope standard "Shin Etsu: J-Ndi-1" (Tanaka 2000) as an unknown, which has a ^{143}Nd/^{144}Nd value of 0.512107 ± 7 relative to a LaJolla ^{143}Nd/^{144}Nd value of 0.511850, when normalized to ^{146}Nd/^{144}Nd = 0.7219. The value of ^{143}Nd/^{144}Nd determined for the JNdi-1 standard conducted during the analysis of the samples reported here was 0.512081 ± 8 (2SE); the long-term average value is 0.512095 ± 8 [1SD, n = 7, past year).

K-Ar methodology

The received samples were dated by K-Ar method. Three portions of each sample were weighted: the first two for potassium, and the third one for argon measurements. The potassium contents were measured using Sherwood Model 420 flame photometer. Radiogenic argon measurements were performed on Nu Instruments Noblesse multi-collector noble-gas spectrometer (NG039). The tantalum foil-wrapped portions were loaded into a titanium holder which is a part of the preparatory line. The aliquots were subsequently evacuated to approximately 10-10 mbar pressure. Each sample was melted by a defocused 972 nm infrared laser. CuO added to the samples enhances oxidation of organic matter during this step. Pure ^{38}Ar, used as the spike, was introduced to the extraction line directly prior to the sample extraction, using a calibrated pipette.

Titanium sublimation getter was the first cleaning level of gases extracted from the samples. The final purification of argon was carried out in an isolated section of the line by a getter pump (Z-100, SAES Getters, previously baked overnight to remove excess argon). The amounts of gases poured into the spectrometer were optimized to keep ^{40}Ar at the level below 0.15 V, because for higher pressures fractionation on the Nier ion source can occur. Gas aliquot released from the sample was measured and transferred to the spectrometer by opening and closing valves of the line in a certain sequence. The same sample was melted for the second (or third, if necessary) time, using the same procedure of measurements, but with higher laser power. The amount of the original aliquot of ^{38}Ar spike was determined by measuring international standard GL-O. This standard is measured at least four times with every batch of ten samples. Additionally, every day, the $^{40}Ar/^{36}Ar$ and $^{40}Ar/^{38}Ar$ ratios are measured for air sample aliquots, delivered from a calibrated air pipette. Based on these results, $^{40}Ar/^{36}Ar$ and $^{40}Ar/^{38}Ar$ ratios were corrected for instrument mass fractionation and detector efficiencies assuming atmospheric ratios of $(^{40}Ar/^{36}Ar)air = 298.57$ and $(^{40}Ar/^{38}Ar)air = 1583.5$). Age errors were calculated from the law of error propagation, taking into account uncertainties of spectrometric measurement of argon isotopes, weighting, potassium measurements, normalization of amount of ^{38}Ar in spike based on dating of GL-O standard and assessment of $^{40}Ar/^{36}Ar$ and $^{40}Ar/^{38}Ar$ ratios, measu-red every day for air aliquots. Potassium measure-ments were performed on the two portions of HF dissolved (with 3-4 drops of H_2SO_4) samples in order to increase the precision of K content estimation. After the reaction, HF was evaporated, and the procedure was repeated. Finally, the samples were dissolved in diluted HCl and proceeded to photometric measurements. The final amount of potassium in each sample was calculated as an average of the results received for the two aliquots. For each sample, an average was calculated, along with the error of this average taking into account errors of single measurements.

For age calculations the international values of constants were used as follow:

$\lambda K = 0.581 \cdot 10^{-10} y^{-1}$,

$\lambda\beta- = 4.962 \cdot 10^{-10} y^{-1}$,

$^{40}K = 0.01167$ (at.%).

GEODYNAMIC FRAMEWORK

The terrains of North Macedonia and the southern parts of Serbia are located in the core of the Dinaric orogen, where the oceanic crust of the Vardar zone is sandwiched between the rocks of the continental crust of the upper Western European plate (Serbo-Macedonian metamorphic plate) and the lower Apulia plate (Pelagonian units). The subduction record goes back to at least the Paleocene, but evidence from the Cretaceous supports an earlier onset. The collision took place in the Paleocene-Eocene (Pamić et al., 1998).

The terrains of North Macedonia and the southern parts of Serbia are still in an active subduction zone, as a consequence of the active subduction process of the eastern parts of the Adriatic plate (Battaglia et al., 2004).

The occurrence of the calc-alkaline and shoshonite volcanic rocks in the terrains of North Macedonia and the southern parts of Serbia is a consequence of these subduction-collision-post-collisional processes.

The extension processes that occurred in these areas, starting from the Paleogene are also important for the occurrence of volcanic rocks in these areas in the Miocene-Pliocene period.

Starting in the Jurassic-Cretaceous, the central and north-eastern parts of the Balkan Peninsula were affected by NE-directed subduction, with both SW (Hellenides-Dinarides) and NE (Balkans) migrations of the conjugate orogenic fronts and intervening later extension (Doglioni et al.,1996).

As a result of this complex geotectonic evolution, a calc-alkaline shoshonitic volcanism was active during the Late Paleogene-Middle Miocene (Figure 1, Pamić et al., 1998). The volcanic products of the NW-SE belt extend for about 1600 km starting from the south-eastern parts of Austria to the northwestern parts of Turkey, passing through the Balkan Peninsula (Harkovska et al., 1989; Kovacs et al., 2007).

The main phase of orogenic magmatism was locality followed by scattered potassic to ultrapotassic volcanism (Cvetković et al., 2004, 2007; Yanev, 2003, Yanev et al., 2003; Agostini et al., 2007) that developed from Serbia to Turkey.

From the Late Miocene to Pleistocene, in the region between southern Serbia and north Macedonia, shoshonitic to ultrapotassic volcanism formed a discontinuous belt starting just south of the Scutari-Peć fault zone, regarded as the northern limit of the extensional area associated with the Hellenic subduction system (Bocaletti et al., 1974) (Figure 1).

The ultrapotassic volcanism in the southern parts of Serbia and north Macedonia is the subject of a large number of research works, mostly concentrated on the petrological, geochemical isotopic characteristics of these rocks (Cvetković et al., 2003; 2007; Alther et al., 2004; Prelević et al., 2001, 2005, 2007; Boev and Yanev, 2001; Yanev et al., 2003).

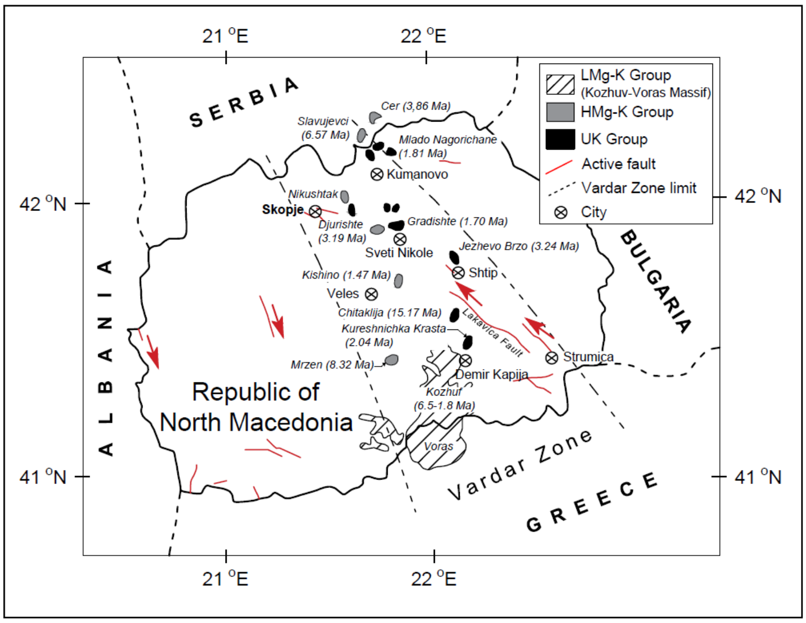

Fig. 1. Neogene volcanism in the Republic of North Macedonia (Yanev et al., 2008)

LOCAL GEOLOGY

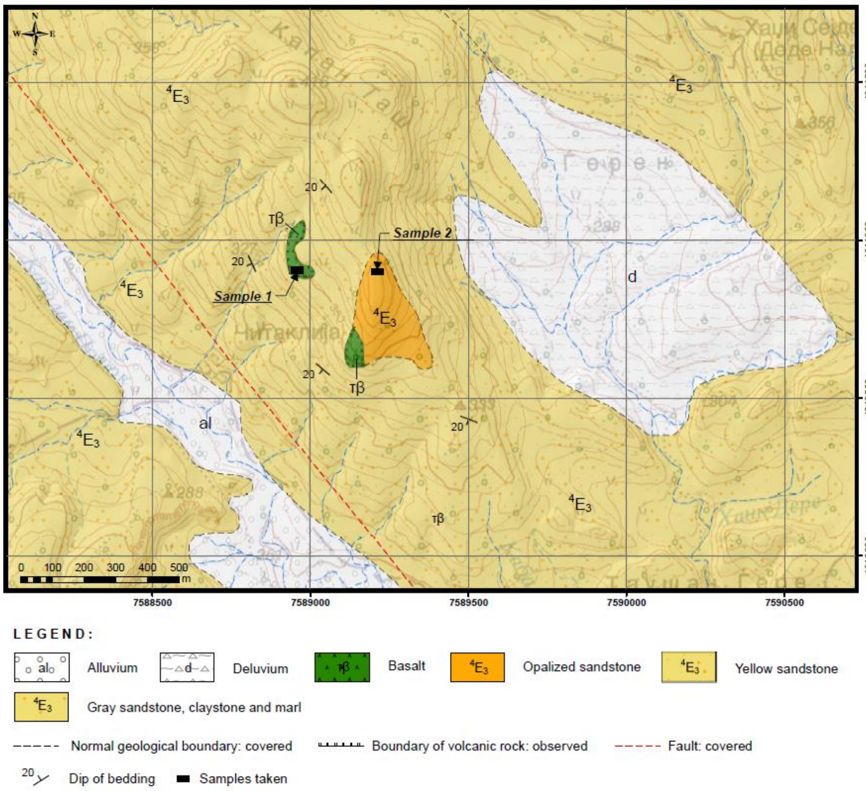

Fig. 2. Geological map of Čitaklija locality

Investigated volcanic rocks of Čitaklija intrude Upper Eocene sediments that comprise the majority of sedimentary sequences of the Tikveš basin. According to the lithological composition and the position within the sedimentary formation, these sediments are divided into the following zones and subzones (Figure 2):

– the conglomerates with different lithological compositions,
– the lower zone of flysch,
– the lower zone of yellow sandstones,
– the upper zone of flysch (grey sandstones, marls and clays, yellow sandstones).

East of the abandoned village of Čitaklija, at the contact between the marls and the upper flysch zone and the upper yellow sandstones, there is an occurrence of volcanic rocks that intrude the Upper Eocene sediments. The contact with the surrounding sediments is clear and represented by the silification of the sediments and the zone of about 10 to 15 meters in thickness. The volcanic body appears as a sill and has the same dip and extension as the surrounding sediments.

Five samples were taken from the volcanic body itself for detailed petrological, mineralogical, geochemical and isotopic investigations.

PETROGRAPHY AND MINERALOGY

Macroscopically, the rock has a fine-grained porphyritic structure, trachytic in places, and the colour of the volcanic rock is dark grey. The structure of the volcanic rock is porphyritic and in places poikilitic. The presence of pyroxene, biotite, olivine, leucite, and magnetite can be observed.

Fine-grained laths of plagioclase and subordinate clinopyroxene phenocryst, olivine, probably orthopyroxene, and biotite are randomly oriented within a very fine-grained unresolved groundmass. The fine-grained porphyritic microstructure is heterogeneously overprinted (Figures 3a, 3b).

Based on microscopic examinations, it can be concluded that the volcanic rocks from the Čitaklija locality can be determined as phonotephrite with transitions toward shoshonite.

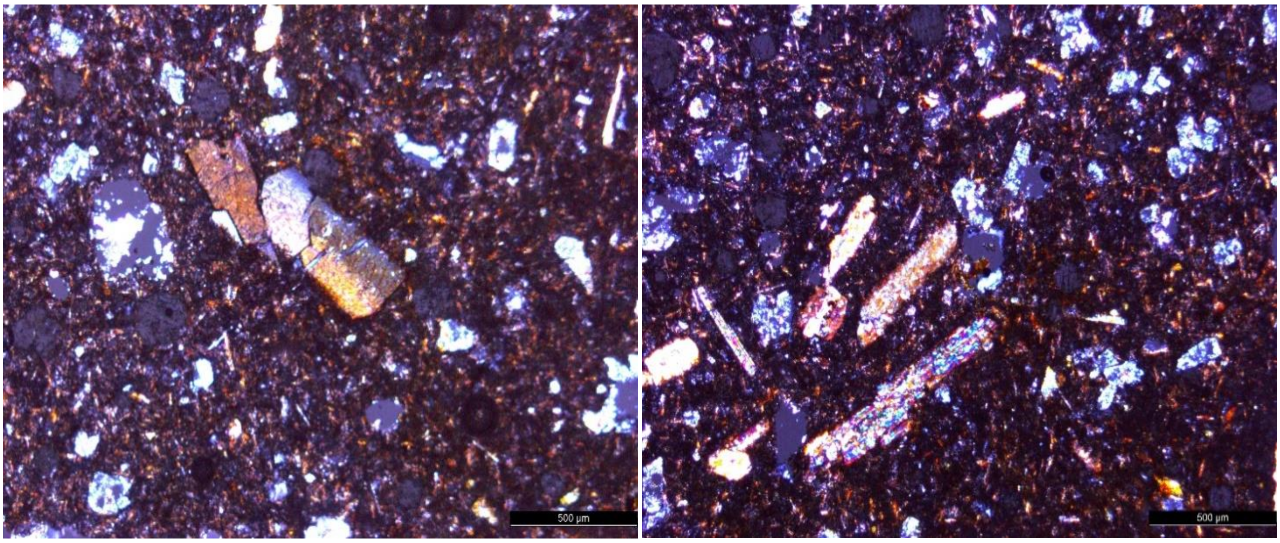

Fig. 3a, 3b. Microscopic fhotographs of volcanic rocks from Čitaklija (Crossed polarizers transmitted light.)

GEOCHEMISTRY OF ČITAKLIJA LAVAS

The results obtained from the examination of the chemical composition of the volcanic rocks from the Čitaklija locality are shown in Table 1.

Most samples are ultrapotassic as defined by Foley et al. (1987), i.e., they have MgO > 3%, K_2O > 3% and K_2O/Na_2O > 2% (Table 1), and plot in the fields of basaltic trachyandesite and phono-tephrites on TAS diagram (Figure 4). Potassium enrichment with relatively high SiO_2 is a specific feature of Mediterranean ultrapotassic lavas and is especially unusual if we consider their near primary, mantle-derived origin, given relatively high Cr and Ni contents (Table 1). Using the "resemblance" classification proposed by Foley et al. (1987), Čitaklija volcanics may be classified as Roman-Province lavas (Figure 5).

Table 1

Chemical and geochemical composition of volcanic rocks of Čitaklija area (ICP-MS-FUS)

	C-1	C-2	C-3	C-4	C-5
SiO_2	47.17	46.89	45.99	47.24	46.38
Al_2O_3	14.7	14.9	14.5	14.3	14.3
Fe_2O_3	6.7	7.1	6.9	6.9	7.5
MnO	0.118	0.120	0.13	0.125	0.133
MgO	3.6	3.8	4.3	3.7	4.2
CaO	9.73	9.89	10.70	9.86	9.99
Na_2O	2.34	2.58	2.89	2.45	2.96
K_2O	4.56	4.99	4.70	4.65	4.89
TiO_2	1.77	1.98	2.02	1.87	1.95
P_2O_5	1.45	1.56	1.88	1.54	1.80
LOI	6.75	6.61	6.40	6.87	6.21
Sum	**98.888**	**100.3**	**100.41**	**99.505**	**100.313**

	C-1	C-2	C-3	C-4	C-5
Sc	20	22	19	18	21
Be	4	3	4	5	4
V	167	159	163	172	168
Cr	180	187	185	182	178
Co	21	22	24	20	21
Ni	120	122	125	130	131
Cu	40	42	43	41	45
Zn	90	95	98	95	90
Ga	19	20	20	18	20
Ge	2.1	2.2	2.6	2.4	2.7
As	<5	<5	<5	<5	<5
Sr	1767	1780	1770	1765	1755
Y	26.2	27.8	25.4	28.9	28.7
Zr	403	400	411	413	405

	C-1	C-2	C-3	C-4	C-5
Mo	<2	<2	<2	<2	<2
Ag	<0.5	<0.5	<0.5	<0.5	<0.5
In	<0.1	<0.1	<0.1	<0.1	<0.1
Sn	3	3	2	2	3
Cs	16.8	17.3	18.2	17.7	17.2
Ba	3502	3500	3550	3450	3500
La	124	125	125	123	124
Ce	231	232	230	243	234
Pr	26.5	25.2	24.3	26.2	25.4
Nd	97.7	98.9	98.2	97.9	97.5
Sm	13.6	13.4	13.2	13.8	13.8
Eu	3.08	3.05	3.04	3.08	3.08
Gd	8.31	8.45	8.42	8.33	8.41
Tb	1.03	1.05	1.03	1.05	1.04
Dy	5.12	5.15	5.23	5.18	5.16
Ho	0.92	0.95	0.93	0.91	0.93
Er	2.42	2.4	2.4	2.44	2.43
Tm	0.322	0.321	0.32	0.318	0.32
Yb	2.09	2.08	2.05	2.09	2.04
Lu	0.317	0.319	0.321	0.32	0.318
Hf	1.3	1.44	1.38	1.32	1.32
Ta	1.4	1.6	1.5	1.4	1.5
W	2	2	2	2	2
Tl	0.59	0.58	0.6	0.61	0.6
Pb	32	33	34	36	36
Bi	0.2	0.2	0.2	0.2	0.2
Th	25.5	26.2	27.1	24.3	26.7
U	4.65	4.64	4.56	4.65	4.53

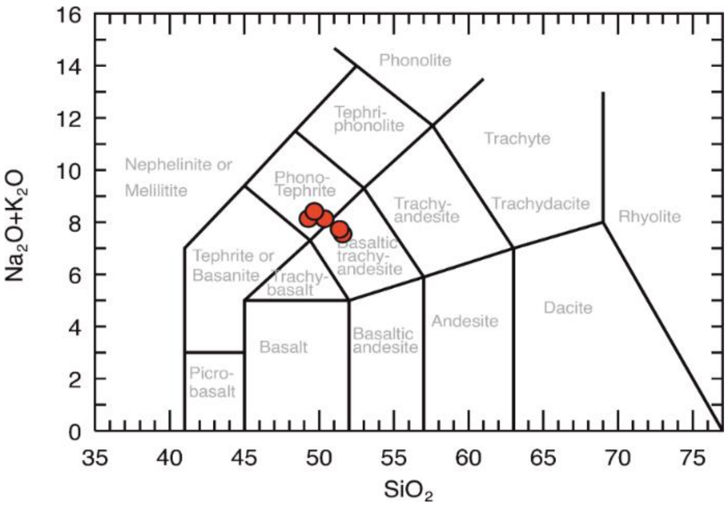

Fig. 4. TAS diagram (Le Maitre, 1989) for the Middle Miocene volcanic rocks of Čitaklija area

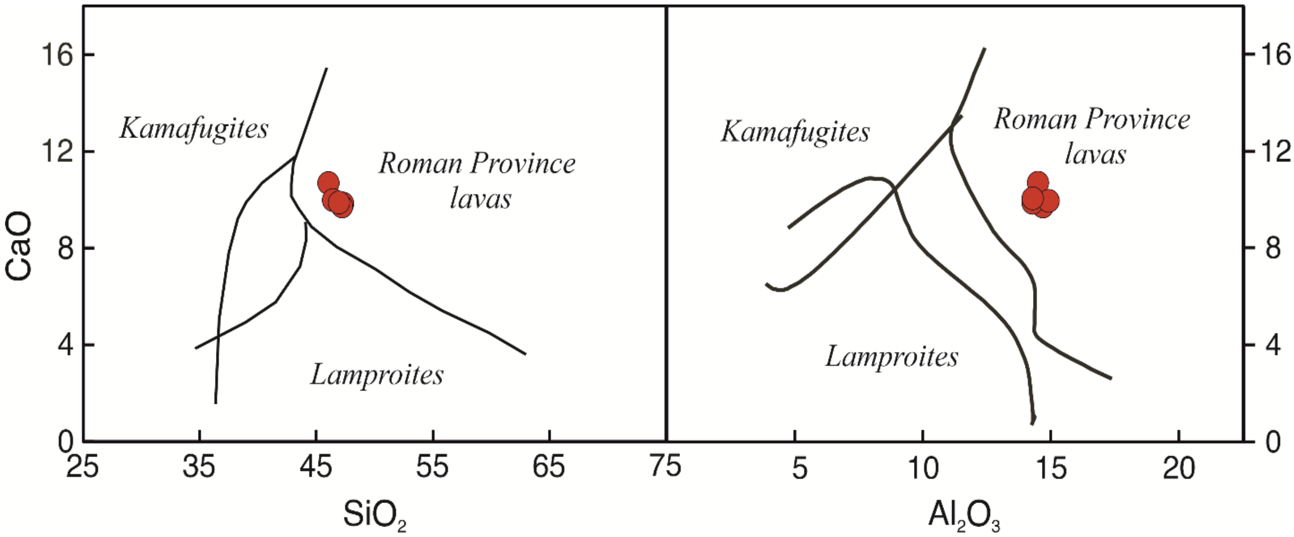

Fig. 5. SiO_2/CaO and Al_2O_3/CaO diagrams for Čitaklija volcanic rocks (Foley et al., 1987)

The incompatible trace element variations of Čitaklija lavas are summarized in Figure 6 on primitive mantle-normalized diagrams. Generally, they show enriched patterns, with LILE up to 2000 x primitive mantle in all samples. They also show a Pb peak, Ta and Ti, and Zr troughs. This type of trace element pattern is a signature typical for the continental crust, which may support the interpretation of a major role for subduction-related processes in the origin of Čitaklija lavas. In terms of REE contents, studied samples demonstrate considerable LREE/HREE fractionation, with La/Yb ratios of around 60 and with slight- or without negative Eu-anomaly.

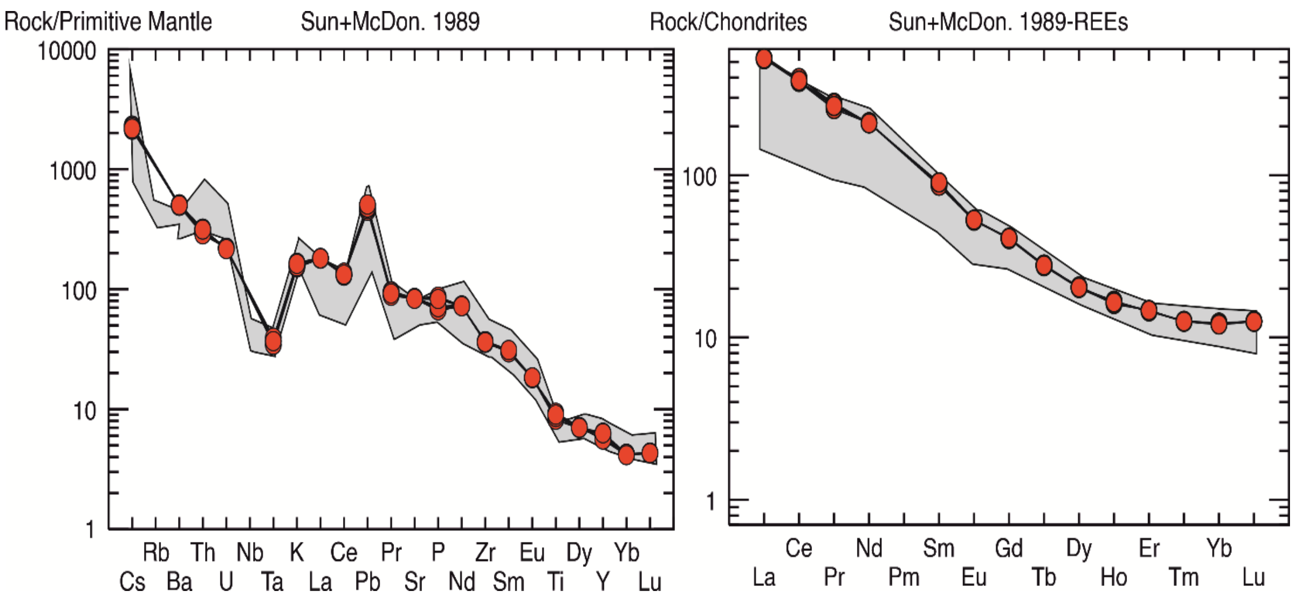

Fig. 6. Chondrite normalized REE patterns for the Čitaklija volcanic rocks primitive mantle values after Sun and Mc Donough, 1989

Figures 7.1 and 7.2 show a uniform distribution of the elements in the studied samples. This can be explained by the fact that it is a small homogeneous magmatic body in which we do not have pronounced elements of differentiation, which is intruded at the subvolcanic to volcanic level.

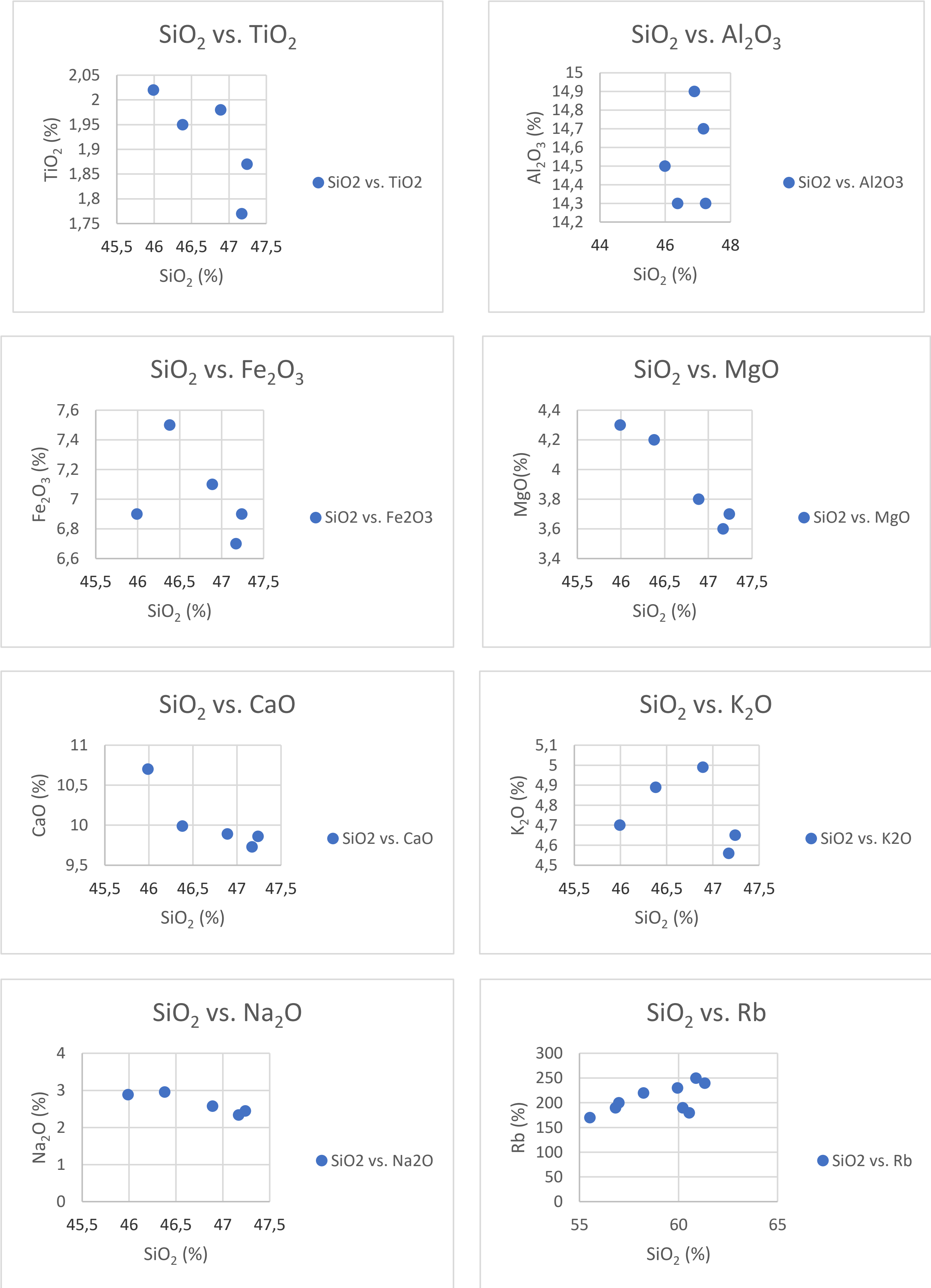

Fig. 7/1. Major (wt.%) and selected trace element (ppm) vs. silica diagrams for the Čitaklija volcanic rocks

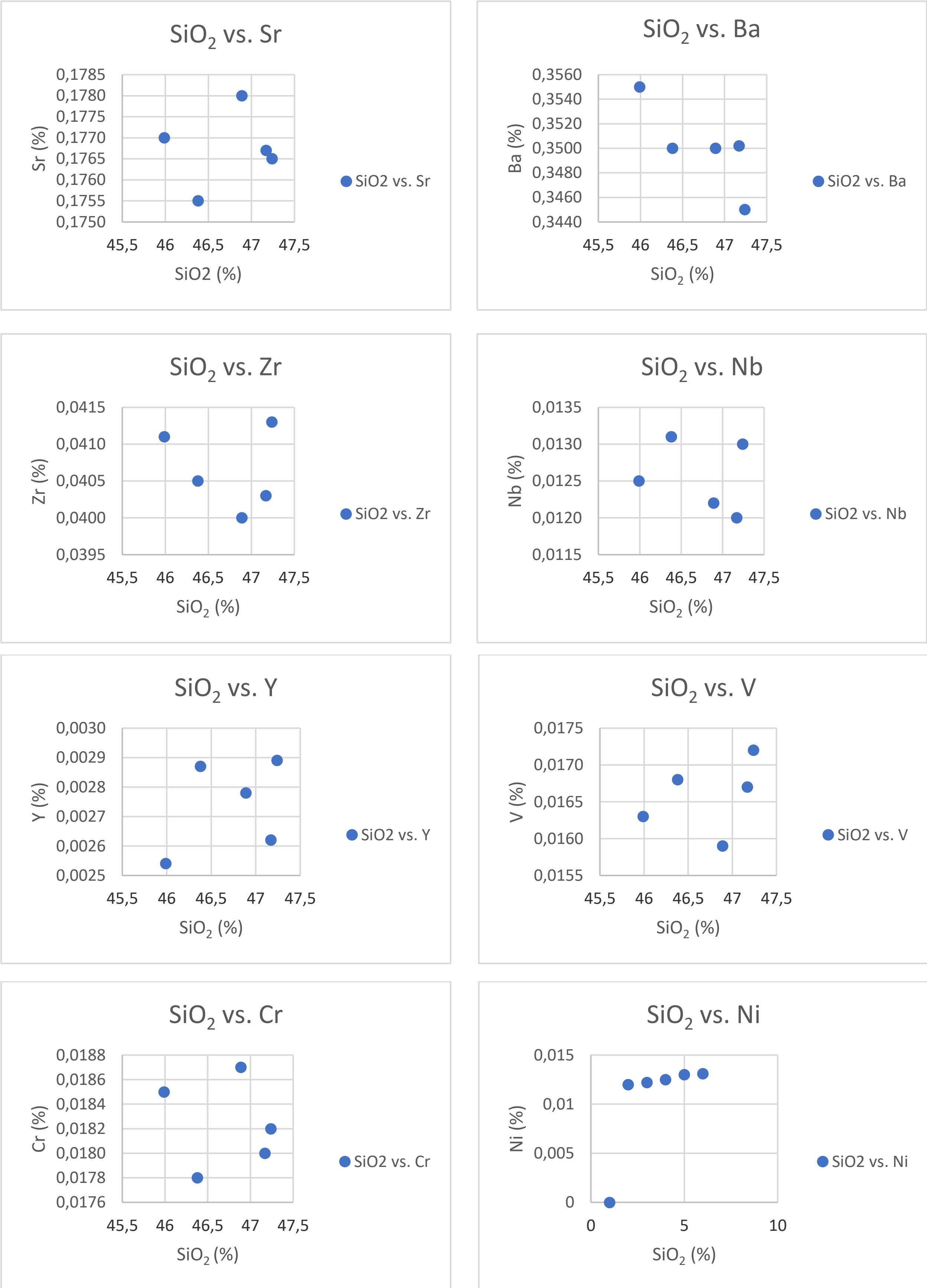

Fig. 7/2. Major (wt.%) and selected trace element (ppm) vs. silica diagrams for the Čitaklija Čitaklija volcanic rocks

Sr-Nd ISOTOPE GEOCHEMISTRY

The Sr and Nd isotopic composition of five samples of Čitaklija lavas are shown in Table 2. All samples show radiogenic $^{87}Sr/^{86}Sr$ isotopic signatures with ranges from 0.708342 to 0.708354, and unradiogenic $^{143}Nd/^{144}Nd$i as low as 0.512318 – 0.512411. Both isotopic systems show no or slight variation.

T a b l e 2

$^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ isotope ratio in Middle Miocene volcanic rocks in the Čitaklija area

	$^{87}Sr/^{86}Sr$	± 2 SE	$^{143}Nd/^{144}Nd$	± 2 SE	ƐNd0 *
C1	0.708348	0.000015	0.512319	0.000007	–6.2
C2	0.708349	0.000016	0.512318	0.000006	–6.1
C3	0.708348	0.000015	0.512411	0.000009	–6.2
C4	0.708354	0.000018	0.512320	0.000008	–6,1
C5	0.708352	0.000017	0.512321	0.000009	–6.1

*Uncertainty in Sr and Nd isotopic composition is ± 2 Standard Error. ƐNd0 is the epsilon ^{143}Nd value calculated on 15.17 Ma

The examined volcanic rocks from the Čitaklija area clearly demonstrate considerable similarity with the volcanic rocks of Kišino Brdo and ultrapotassic lavas from southern Serbia (Figure 8).

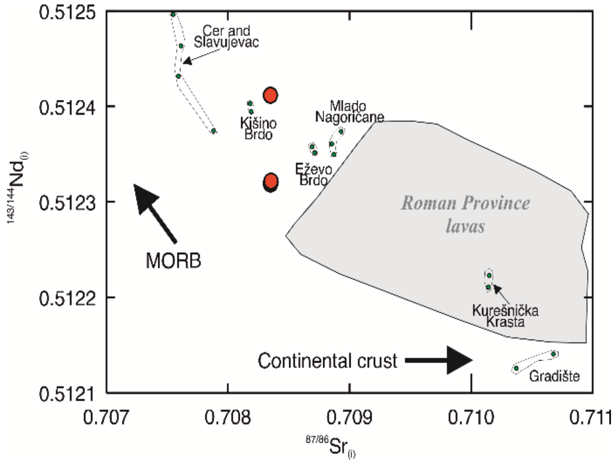

Fig. 8. $^{87/86}Sr/^{143/144}Nd$ isotopic variation of Čitaklija volcanic rocks (Zhang et al., (2005)

K-AR GEOCHRONOLOGY

Five analyses of the age of the volcanic rocks in the vicinity of Čitaklija were performed using the method of K/Ar and the obtained data are shown in Table 3. The presented data show that the age of these rocks is Middle Miocene.

T a b l e 3

K/Ar age determination of Middle Miocene volcanic rocks from the Čitaklija area

	K, % ± σ	^{40}Ar rad, (ng/g) %	^{40}Ar atm	Age, Ma	Error 2σ
C-1	4.107±0.04	4.05±0.007	95.95	15.17	11.16

GENESIS OF VOLCANIC ROCKS AND GEODYNAMICS

The genesis of the volcanic rocks in the Vardar zone can be best explained if we consider the Vardar zone as a rift zone, which recurred several times during its evolution.

Based on available data related to the magmatic activity that took place in the Vardar zone from Oligocene to the Pleistocene, it can be assumed that the evolution of this geotectonic unit can be related to processes that took place in continental rift zones. The formation of magmatic sources in areas of increased thermal activity must be related to partial melting that took place in the metasomatized parts of the lithospheric mantle: this part of the mantle may be the most viable host for the enriched portions of the peridotite that underwent processes of considerable metasomatism during the previous subduction events. This enrichment has been reflected in the composition of the lavas, including also Čitaklija rocks, that are ultrapotassic and with considerable enrichment in incompatible trace elements, which exceeds the composition of the lavas derived from the normal mantle to a significant extent (e.g. MORB or OIB).

The extreme enrichment in Th-U-LREE (light rare earth elements) and the depletion in (Ta)-Nb-Ti as well as the strontium and neodymium isotope ratios are typical signatures of the orogenic mantle. This signature resembles the signature of Mediterranean Cenozoic ultrapotassic lavas, implying that the Čitaklija ultrapotassic rocks are most probably derived from a mantle source that is metasomatized by recycled continental crust (Prelević et al., 2005) typically for lamproites along the Alpine-Himalayan belt.

In addition, normalized values of the distribution of rare earth elements (Figure 6) are applied to explain the genesis of the volcanic rocks. Figure displays that there is no pronounced anomaly of Eu or predominance in fractionation processes of primary magma materials. The content of rare earth elements, enrichment in light rare earth elements as well as the relatively moderate LREE/HREE indicates that the primary melt has been formed in the lithospheric mantle above the garnet stability field (45 to 50 km depth).

The position of the volcanic centre of the Čitaklija area (in the central part of the Vardar zone, wide terrain of the Tikveš Valey) can be clearly related to the very formation of this valley in the extension processes (Dumurdžanov et al., 2005) that took place in Miocene (16 MA–8 MA) in the northern parts of the Aegean region. During this period, as a consequence of the subduction processes in the Aegean region, a wide zone of extension with a NS direction is formed, with the formation of the Tikveš Valey and the emergence of volcanic activity in the Čitaklija region and later with the advancement of the extension processes in the south parts of the valley when it came to the formation of the Kožuf Mountain.

CONCLUSION

In the central parts of the Vardar zone, in the wider surroundings of the Tikveš Valey, in the Čitaklija locality, volcanic rocks appear in the series of Upper Eocene flysch sediments. The mineralogy and petrology of these rocks indicate that they are basic volcanic rocks that represent a transition between phonotephrites and ultrapotassic shoshonites. The isotopic age of these volcanic rocks is Middle Miocene (15.17 Ma) and they are the oldest volcanic rocks in this part of the Vardar zone that can be brought into relation with the Upper Miocene volcanic rocks from the vicinity of Mrzen and the Pliocene volcanic rocks from Kozuf Mountain. The isotopes of $^{87}Sr/^{86}Sr$ and the isotope values of $^{143}Nd/^{144}Nd$ indicate that the magmatic sources of these rocks are situated in the metasomatized lithospheric mantle which is enriched by recycled continental crust during the previous subduction events.

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Р е з и м е

СРЕДНО МИОЦЕНСКИ ВУЛКАНИЗАМ ВО ЛОКАЛИТЕТОТ ЧИТАКЛИЈА ВО ВАРДАРСКАТА ЗОНА ВО СЕВЕРНА МАКЕДОНИЈА

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Клучни зборови: среден миоцен; Вардарска зона; фонотефрити; калиумски шошони

Во трудот за првпат се прикажани резултатите од испитувањата на вулканските карпи од средномиоценска старост во централните делови на Вардарската зона. Вулканските карпи кои се појавуваат во локалитетот Читаклија по своите петролошко-минералошки карактеристики претставуваат базични магматски карпи и тие се преодни карпи помеѓу фонотефритите и висококалиумските шошонити. Геохемиската дистрибуција на елементите во траги и елементите од групата на ретките земји (REE), како и изотопите на $^{87}Sr/^{86}Sr$ (0.708348) и изотопи на and $^{143}Nd/^{144}Nd$ (0.512319) укажуваат на фактот дека магматските извори на овие карпи можат да се лоцираат во граничното подрачје помеѓу горната обвивка и долните делови на Земјината кора.