Геолошки анали Балканског полуострва Annales Géologiques de la Péninsule Balkanique	65 (2002–2003)	85–91	Београд, децембар 2004 Belgrade, December 2004

The Triassic metabasalts of Dudin Krš, near Kosovska Mitrovica, Serbia

Emin Memović[1], Vladica Cvetković[2], Vera Knežević[2] & Guram Zakariadze[3]

Abstract. This paper presents the geochemical characteristics of the metabasalts of Dudin Krš, near Kosovska Mitrovica. The Dudin Krš is the easternmost occurrence of Middle Triassic rift–related volcanic rocks in the Dinarides. Generally, these rocks show similarities to other Triassic volcanic rocks of the Dinarides. They are high–magnesian, ol and ne–normative basalts, with low Zr/Nb and medium/low Ti/Zr and Ti/Y ratios. They exhibit transitional geochemical characteristics, between E–MORB and subalkaline basalts of continental rift zones. Their presence and geochemical affinity is evidence of rifting processes along the continental slope of the Adria block during Middle Triassic.

Keywords: metabasalts, Triassic, rifting, Kosovska Mitrovica, Serbia.

Апстракт. У раду су приказане геохемијске карактеристике метабазалта Дудиног крша, близу Косовске Митровице. Ове стене представљају најисточније појаве тријаских вулканита у Динаридима, који су везани за средњотријаске рифтне процесе. Уопште узев, стене Дудиног крша показују сличности са осталим тријаским стенама Динарида. То су високомагнезијски базалти са ниским односом Zr/Nb и средњим/ниским односима Ti/Zr и Ti/Y. Метабазалти Дудиног крша показују прелазне геохемијске карактеристике, између E–MORB (enriched mid–ocean ridge basalt – обогаћени средњоокеански базалти) и субалкалних базалта континенталних рифтова. Утврђени геохемијски афинитет базалта Дудиног крша сведочи о рифтним процесима дуж континенталне падине јадранске континенталне плоче у време средњег тријаса.

Кључне речи: метабазалт, тријас, рифтни процеси, Косовска Митровица, Србија.

Introduction

The Mesozoic history of the western parts of the Balkan Peninsula has long been and still is a matter of debate. The study of Middle Triassic volcanic and metavolcanic rocks is very important in elucidating relationships between recently present tectonostratigraphic terrains/units and ancient geotectonic environments.

Middle Triassic igneous rocks of the Dinarides occur along NNW–SSE elongated tectonic lineaments, stretching from the South Alps in the north–west to the Albanides–Hellenides in the south to south–east. It is generally believed that they originated by rift-related processes, which occurred within the Adria plate, as a northern Gondwanaland promontory (Dimitrijević, 1998 and references therein). These rocks are variable in mineral composition and geochemistry, but also in their tectonostratigraphic position with respect to the presumed northern margin of the Adria. In this context, from south to north, five subparallel zones of Mid–Triassic extrusive rocks can be distinguished in Serbia and Montenegro (Fig. 1): (1) behind the carbonate platform at the continental margin, now represented by the Budva zone, (2) along fracture zones originating at the continental shelf in the Triassic carbonate platform or in the Paleozoic basement of the External Dinarides (northern Montenegro and further to the north–west), (3) along the main rifting zone (the precursors of the Dinaridic oceanic basin or marginal sea), (4) in the setting of the carbonate platform of the Drina–Ivanjica unit at the northern side of the Dinaridic oceanic basin, and (5) at the continental slope of the Adria block, sit-

[1] Technical Faculty, 27000 Kosovska Mitrovica, Serbia and Montenegro.

[2] Faculty of Mining and Geology, Djušina 7, 11000 Belgrade, Serbia and Montenegro. E-mail: cvladica@mkpg.rgf.bg.ac.yu

[3] Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences, Kosigina 19, 119 991 Moscow, Russia. E-mail: gurzak@rinet.ru

uated within the Triassic series, now on the western side of the Kopaonik block. These Middle Triassic rocks probably originated within the same geotectonic setting, i.e. they are related to rifting of the marginal parts of the northern Gondwanaland promontory.

& CVETKOVIĆ (2000) gathered the existing data for zones 1–4. They compared the geochemistry of the least evolved rocks from several localities and concluded that the Middle Triassic rocks were related to the opening of the Dinaridic oceanic basin. The authors emphasized

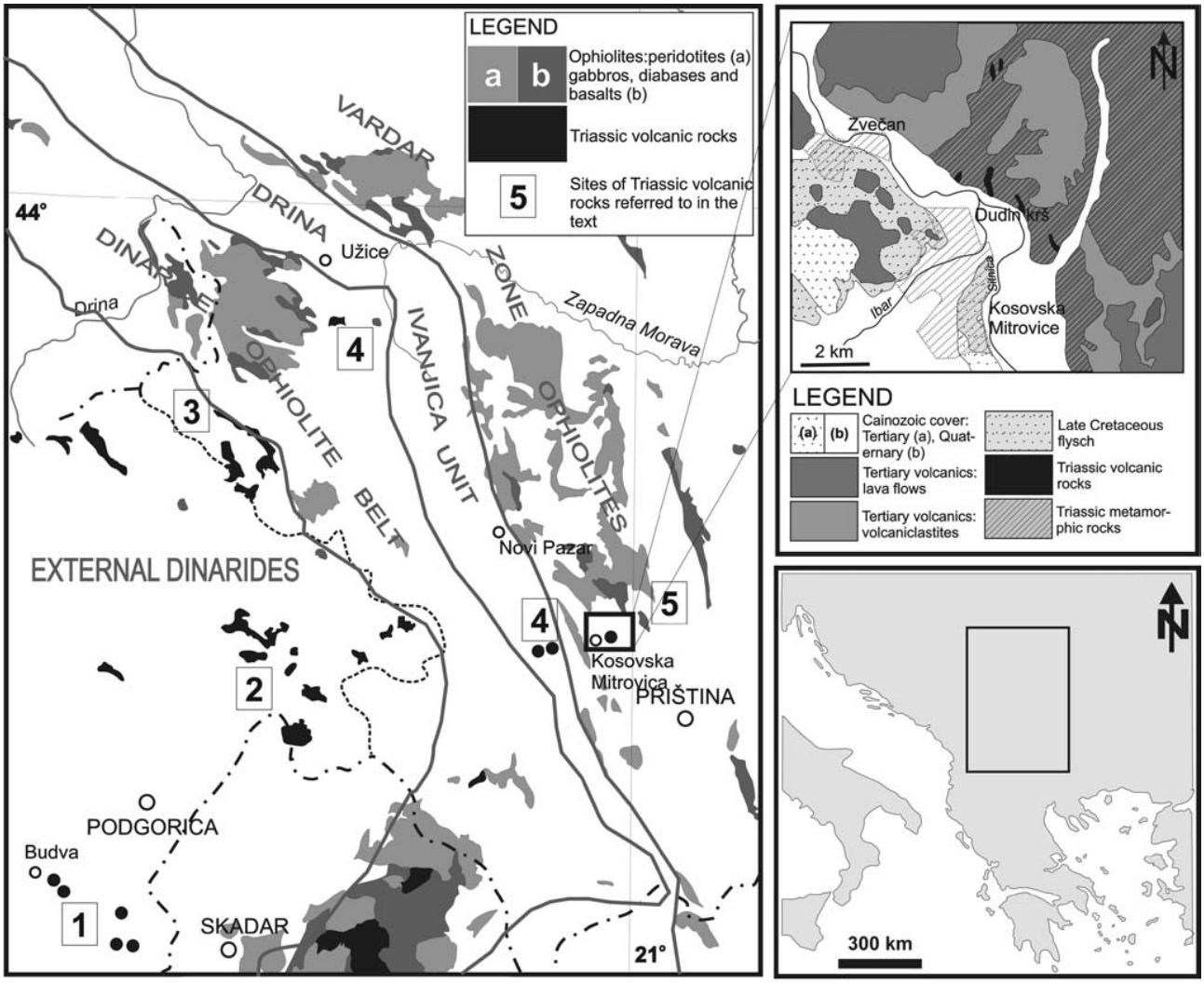

Fig. 1. Geographic and geotectonic position of Dudin Krš Triassic metavolcanic rocks. The left sketch displays the major geotectonic units and distribution of Mesozoic ophiolites and Triassic volcanics of the south–western Balkan Peninsula (after DIMITRIJEVIĆ, 1992 and KARAMATA *et al*., 1999). Simplified geology of the Dudin Krš area (after BOGDANOVIĆ *et al*., 1977). The zones 1–5 are referred to in the text and they are: 1 = Budva zone; 2 = Northern Montenegro; 3 = Triassic volcanics spatially related to the Dinaridic ophiolite belt; 4 = Triassic volcanics occurring in the Drina–Ivanjica unit; 5 = Triassic volcanics occurring at the western margin of the Kopaonik block.

Triassic volcanic and metavolcanic rocks in the territory of former Yugoslavia have been studied by various authors (KARAMATA, 1952; KNEŽEVIĆ, 1960, 1962; PAMIĆ, 1962, 1963; KNEŽEVIĆ, 1975; JOVANOVIĆ *et al*., 1990; BILIK *et al*., 1993; MEMOVIĆ, 1993; DJUJIĆ *et al*., 1995; KARAMATA *et al*., 1995; MEMOVIĆ *et. al*., 1995; MEMOVIĆ & KNEŽEVIĆ, 1995; KARAMATA *et. al*., 1996; PAMIĆ *et al*., 1998; KARAMATA *et al*., 2000). KNEŽEVIĆ certain subduction-related geochemical signatures of these rocks.

This paper is focused on a more detailed geochemical identification of the metabasalts of group 5. These occur near Kosovska Mitrovica as small outcrops of Triassic metavolcanics, tectonically belonging to the northernmost parts of the Adria block. New samples of metabasalts from the locality of Dudin Krš are present-

ed and discussed. The contents of major and full-range trace element, including rare-earth element (REE) concentrations, were determined.

Geological Setting

The Middle Triassic metabasaltic rocks near Kosovska Mitrovica have a specific tectonostratigraphic position. They belong to the association formed on the continental slope of the Adria block. These rocks occur as lava flows or as dykes or sills, which alternate with silty–argillaceous rocks of the Central Kopaonik series of Middle Triassic (KLISIĆ *et al*., 1972) or Carnian (SUDAR, personal communication) age. Presently, they can be found on both sides of the Western Branch of the Vardar suture (zones 4 and 5).

The best outcrops of the seqence are found at the locality of Dudin Krš ("Dudas Rock"), at the right side of the river Ibar, along the road Kosovska Mitrovica––Zvečan (Fig. 1, upper right). Other outcrops may be found along the road Kosovska Mitrovica–Trepča Mine, and some are situated on the northern side of the Jošanica River**,** west of Jošanička Banja.

Metabasalts of Dudin Krš occur as flattened pillows (the larger axis ranges from n–dm to 2 m, the shorter one up to 5–6 dm) with well developed zoning. The cores often contain small chloritic amygdales, whereas the rims are compact. The rock mass of the pillows is schistose at the margins and sometimes foliation is present even through the entire body of the pillows. The color of the pillows is green and sometimes reddish along the rims. The pillows are embedded into a chloritic groundmass, containing minor calcite and haematite as main secondary minerals, which developed at the expense of hyaloclastic glass shards. The texture of the rocks is blastoophitic, intersertal to pilotaxitic, with a decrease of needle- and grain-sizes from the core of the pillows towards the almost glassy rims. The studied rocks ubiquitously express the effects of low- to medium-temperature metamorphism and show mineral composition characteristic for spilites. The major mineral constituents are relics of primary clinopyroxene, and an association of albite, chlorite, epidote and pumpellyite.

Geochemical Identification of Basalts

Analytical procedures

Major and selected trace element contents were analyzed by X–ray fluorescence (XRF) spectrometry in the IGEM Russian Academy of Sciences, Moscow, using glass discs (for major elements) and pressed powder pellets (for Rb, Sr, Ba, Y, Zr, Nb, and Th). LOI was separately determined. The routine relative standard errors of analysis in % are: SiO_2–1.7; Al_2O_3–5.8; FeO–4.5; MnO–2.4; MgO–6.70; CaO–5.4; Na_2O–8.5; K_2O–3.2; TiO_2–4.9; P_2O_5–5.6; and for the trace elements Rb, Y, Nb, Th, U (20%), Zr, (15%) and Sr (10%).

Concentrations of Th, U, Ta, Hf and the REEs were analyzed by instrumental neutron activation analysis (INAA) at the Vernadsky Institute of Geochemistry and Analytical Chemistry, The Russian Academy of Sciences, Moscow. The samples were irradiated in a "MIFI"–reactor (Moscow), at a neutron flux of $1.2*10^{13}$ m/cm^2*sec, for 15 hours. Then the samples were "cooled down" for 5–7 days and their activity measured on a multichannel gamma-spectrometer NUC–8192, with a Ge-detector GEM–15180–P ("Ortec"), with resolution on line near 1.7 keV, ^{60}Co (E_i=1332 keV). The spectra obtained were evaluated using the peak-fitting routine of SHUBINA & KOLESOV (1998). The concentrations were calculated by irradiating and counting of standards of basites (ST–1A, SGD–1A, AN–9) under identical conditions. La, Nd, Sm, Eu, Yb, Th, Hf and Ta have better than 5% and Ce, Gd, and Tb have 10% confidence limits.

Major elements

Major element analyses are shown in Table 1. Connected with extensive low/medium–temperature metamorphism of the rocks, the studied samples show increased and variable contents of LOI (7.47–10.37 wt%). Nevertheless, there are features of the primary composition of the rocks which are preserved. Accordingly, samples DK–2, DK–3, DK–4 of rocks are olivine- and nepheline-normative basalts characterized by low silica (SiO_2

Table 1. Major element composition of Triassic metabasalts of Dudin Krš, near Kosovska Mitrovica.

Sample	DK-2	DK-3	DK-4
SiO_2 (wt%)	35.81	40.8	41.73
TiO_2	1.61	1.65	1.66
Al_2O_3	11.96	13.69	12.96
Fe_2O_3	10.87	11.39	10.55
FeO	0	0	0
MnO	0.27	0.26	0.22
MgO	9.38	11.04	9.96
CaO	14.6	9.03	10.5
Na_2O	2.93	2.89	2.63
K_2O	0.05	0.02	0.02
P_2O_5	0.162	0.173	0.195
LOI	10.37	7.47	9.17
H_2O^+	0	0	0
H_2O^-	0	0	0
CO_2	0	0	0
SUM	98	98.4	99.7

up to 42 wt%), medium titanium (TiO_2 ~1.6 wt%), low alumina (Al_2O_3 up to 14 wt%), high magnesium (MgO around 10 wt%), high and variable CaO (9–14.6 wt%), high MnO (~0.25 wt%) and very low K_2O (0.02–0.05 wt%) contents. The low contents of SiO_2 and Al_2O_3, along with the increased contents of MnO are apparently related to pervasive chloritization.

Trace elements and REEs

Trace element analyses and REE concentrations are shown in Tables 2 and 3, respectively. Because of potential mobility of most major and large-ion lithophile elements during post-magmatic low/medium-temperature metamorphic events, the geochemical identification of the studied samples are based on their HFSE, Th and REE contents and ratios. These elements are generally considered as immobile, and their stability during processes of alteration, low/medium and even high-grade metamorphism has been widely demonstrated (e.g. MÖRK & MEARNS, 1988; GRAUCH, 1989; BIENVENU *et al*., 1990; SHATSKY *et al*., 1990, etc.). However, the primary contents of these elements in some cases can be disturbed under low temperature conditions in the presence of CO_2-, F-, or Cl-rich fluids and at high fluid/rock ratios (MURPHY & HYNES, 1986; BIENVENU *et al*., 1990; VERMA, 1992). The primary contents of HFSE, Th and REE in the studied rocks are likely to have been preserved, which is suggested by: (a) the absence of a correlation of the contents of these elements with variations of LOI, K_2O, Na_2O and CaO, (b) the presence of regular variations of the contents of Ti and Zr and (c) rather smooth patterns on multi-element spiderdiagrams (Fig. 2).

The studied samples exhibits high concentrations of Nb, Zr, Sr, Y, P and low Zr/Nb and Ti/Zr ratios of ~8 and ~90, respectively.

The characteristic ratios of REE and Th/REE of the high-magnesian metabasalts $(La/Sm)_n$ ~2, $(La/Yb)_n$ ~4, $(Tb/Yb)_n$ ~1.5, Sm/Nd ~0.3, Th/La = 0.25, Th/Sm = 0.60, Th/Yb = 0.9, demonstrate their average relative enrichment by LREE and Th compared to basalts of normal segments of oceanic spreading zones (N–MORB). The other important features of these metabasalts are: a) the absence of negative geochemical anomalies of Ta, Nb, Zr and Ti (Fig. 2); b) high contents of HREE and Y, $(Yb)_{MORB} = (Y)_{MORB} = ~1$; and c) that they lie along the mantle correlation array on the Th/Yb–Ta/Yb diagram (Fig. 3). The established geochemical characteristics of the studied metabasalts may infer the nature of their mantle sources and conditions of origin of their primary melt. The major conclusion of the geochemical identification is that they correspond to a transitional type between E–MORB and subalkaline intraplate basalts or subalkaline basalts of continental rift zones (SUN & MCDONOUGH, 1989; HEGNER & PALLISTER, 1989; BARRAT *et al*., 1993; BRIAND *et al*., 1995, etc.). Such low Zr/Nb ratios have already been reported in Triassic basalts from the Vareš area (KARAMATA *et al*., 2000), which are spatially related to Dinaride ophiolites and probably represent relicts of the axial parts of the rift (zone 3 in Fig. 1), nowadays situated at its margin. In all other zones of Triassic rocks, the Zr/Nb ratios are above 10. However, the Dudin krš metabasalts show Ti/Zr and Ti/Y ratios similar to those of Triassic basalts in the External Dinarides (BILIK *et al*., 1993; DJUJIĆ *et al*., 1995). The presented data do not show clear evidence of crustal contamination. It is noteworthy that the Th/La, Th/Sm, and Th/Yb) ratios of the Dudin Krš metabasalts are slightly higher than those characteristic for basalts of a transitional type. This may be attributed to the involment of continental crustal components, as is typical for the initial stages of the formation of oceanic basins (HEGNER & PALLISTER, 1989; BARRAT *et al*., 1993; CHAZOT & BERTRAND, 1993; KAZMIN & BYAKOV, 2000, etc.).

Table 2. Trace element analyses of Triassic metabasalts of Dudin Krš, near Kosovska Mitrovica (ppm).

Sample	Rb	Sr	Y	Zr	Nb	Ba	Th	U	Hf	Ta
D K - 2	7	397	30	119	17	100	1.2	2.6	0.79	1.68
D K - 3	6	318	34	137	16	79	2	0.9	4.93	6.19
D K - 4	7	494	34	132	16	67	3.4	3.9	3.52	4.69

Table 3. REE analyses of Triassic metabasalts of Dudin Krš, near Kosovska Mitrovica (ppm).

Sample	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
D K - 2	14	28.9	3.34	13.8	3.72	2.67	4.6	0.67	4.02	0.85	2.27	0.34	1.72	0.28
D K - 3	7.19	17	2.41	11.7	3.77	1.56	5	0.76	4.5	1	2.73	0.41	1.99	0.35
D K - 4	11.7	24.7	3.03	12.8	3.59	2.08	5.48	0.9	5.6	1.34	4.02	0.61	3.73	0.63

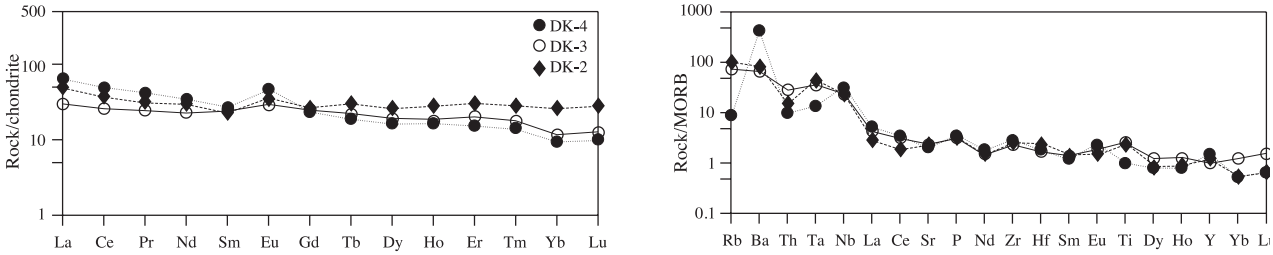

Fig. 2. Multi-element patterns of Dudin Krš metabasalts of the Adria block. The concentrations are normalized with respect to the composition of C1 chondrite and N–MORB from SUN & MCDONOUGH (1989).

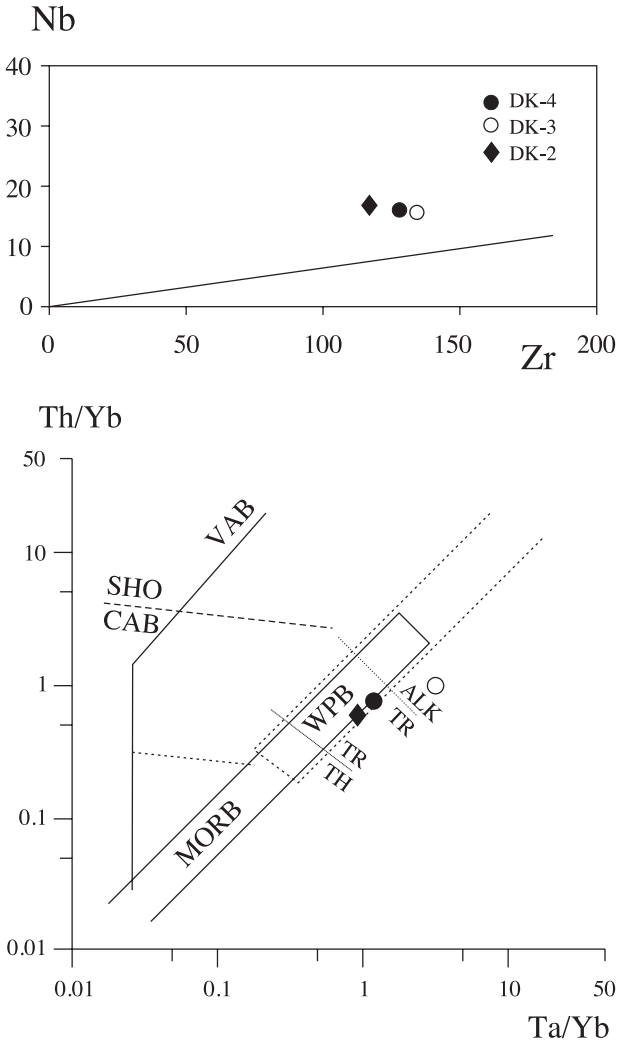

Fig. 3. Trace element discrimination diagrams for distinguishing basalts which originated in various geotectonic settings. A) Covariation of Nb and Zr. Dividing line Zr/Nb=16 for N–MORB and T–MORB fields from LE ROEX (1987); B) Th/Yb–Ta/Yb covariation. Fields of magma composition from PEARCE (1983).

Concluding Remarks

The metavolcanic rocks of Dudin Krš, near Kosovska Mitrovica, belong to rift-related Triassic volcanic rocks, which occur at various places in the Dinarides. Geological observations imply that the studied basaltic rocks were emplaced along the ancient continental slope of the Adria block. These rocks represent the easternmost occurrences of Middle Triassic rift-related rocks in the Dinarides. Strictly speaking, the applied methods of geochemical identification generally fail to unambiguously classify basalts erupted on an attenuated continental crust. Nevertheless, the following characteristics were recognized: they belong to the high-magnesian group, and also display low Zr/Nb and medium/low Ti/Zr and Ti/Y ratios. These rocks show similarities with other occurrences of Triassic volcanic rocks in the Dinarides. The transitional character between E–MORB and subalkaline intraplate basaltic series can be considered as evidence of stretching imposed on the continental slope zone of the Dinarides in the Middle Triassic.

Acknowledgement

This study was supported by the Serbian Academy of Sciences and Arts, Geodynamics Project. Discussions with S. KARAMATA and his critical reading of earlier versions of the manuscript are greatly appreciated. IVAN ZAGORCHEV is acknowledged for his revision of the original manuscript. VC is indebted to the Ministry of Science, Technology and Development, Project No 1767.

References

BARRAT, J.A., JAHN, B.M., FOURCADE, S. & JORON, J.L., 1993. Magma genesis in an ongoing rifting zone: The Tadjoura Gulf (Afar area). *Geochimica et Cosmochimica Acta*, 57: 2291–2302.

BIENVENU, P., BOUGAULT, H., JORON, J.L., TREUIL, M. & DMITRIEV, L., 1990. MORB alteration: rare earth elements/non-rare earth hygromagmophile elements fractionation. *Chemical Geology*, 82: 1–14.

BILIK, I., KNEŽEVIĆ, V., ARVA–SOS, E., JANOSI, M. & KARAMATA, S., 1993. The spilites of Bečići, in the neighbourhood of Budva, initiators of the rifting in the Budva–Cukali zone. *Geološki anali Balkanskoga poluostrva*, 57 (1): 215–238.

BOGDANOVIĆ, P., UROŠEVIĆ, M., UROŠEVIĆ, D., DIMITRIJEVIĆ, M.D., MARKOVIĆ, B., PAVIĆ, A., MENKOVIĆ, LJ. & FOLGIĆ, K., 1972–1977. Geological map 1:100 000 of the Sheet Kosovska Mitrovica. Savezni geološki zavod Beograd.

BRIAND, B., BOUCHARDON, J–L., OUALI, H., PIBOULE, M. & CAPIEZ, P., 1995. Geochemistry of bimodal amphibolitic-felsic gneiss complexes from eastern Massif Central, France. *Geolical Mag*azine, 132: 321–337.

CHAZOT, G. & BERTRAND, H., 1993. Magma sources and magma-continental crust interactions during early Red-Sea-Gulf of Aden rifting in southern Yemen: Elemental and Sr, Nd, Pb, isotope evidence. *Journal of Geophysical Research*, 98, B2: 1819–1835.

DIMITRIJEVIĆ, D.M., 1992. Geological Atlas of Serbia 1:2 000 000. Republički fond za geološka istraživanja i Geološki institut "Gemini", Beograd.

DIMITRIJEVIĆ, D.M., 1998. On Palinspastics of the Dinarides. *13. Kongres geologa Jugoslavije*, 2: 21–30, Herceg Novi (in Serbian, English abstract).

DJUJIĆ, A., KARAMATA, S., KNEŽEVIĆ, V. & CVETKOVIĆ, V., 1995. Triassic igneous rocks of the Knin area (Republic Serbian Krajina). Zbornik radova Rudarsko–geološkog fakulteta, Beograd, 34: 11–18 (in English, Serbian summary).

GRAUCH, R.I., 1989. Rare earth elements in metamorphic rocks. *In*: LIPIN B.R. & MCKAY G.A. (eds.), Geochemistry and Mineralogy of rare earth elements. *Reviews in Mineralogy,* 21: 146–167.

HEGNER, E. & PALLISTER, J.S., 1989. Pb, Sr, and Nd isotopic characteristics of Tertiary Red Sea rift volcanics from the Central Saudi Arabian Coastal Plain. 1989. *Journal of Geophysical Research,* 94, B6: 7749–7755.

JOVANOVIĆ, V., KNEŽEVIĆ, V. & MILOJKOVIĆ, R., 1990. Triassic volcanic-sedimentary series of Bobija (Western Serbia). *XII Congress of Geologists of Yugoslavia*, 257–266, Ohrid.

KARAMATA, S., 1952. Allgemeine Charakteristik der Melaphyre in der Umgebung von Vareš (Bosnien). *Spomenica Miše Kišpatića*, 237–243 (in Serbian, German abstract).

KARAMATA, S., DIMITRIJEVIĆ, N.M. & DIMITRIJEVIĆ, D.M., 1999. Oceanic realms in the central part of the Balkan Peninsula during the Mesozoic. *Slovak Geological Magazine*, 5 (3): 173–177.

KARAMATA, S., KNEŽEVIĆ, V. & CVETKOVIĆ, V., 2000. Petrology of the Triassic basaltoid rocks of Vareš (Central Bosnia). *Acta Geologica Hungarica*, 43 (1): 1–14.

KARAMATA, S., KNEŽEVIĆ, V., MARCHENKO, T. & CVETKOVIĆ, V., 1996. Volcanic rocks of the Sirogojno Formation. *Geology of Zlatibor*. Geoinstitute, Special Publication, 18: 21–23.

KAZMIN, V.G. & BYAKOV, A.F., 2000. Magmatism and crustal accretion in continental rifts. *Journal of African Earth Sciences*, 30 (3): 555–568.

KLISIĆ, M., MIĆIĆ, I., PAJIĆ V., SIMIĆ, D. & KANDIĆ, M., 1972. Contribution to the stratigraphy of the metamorphic Trepča series. *Zapisnici Srpskog geološkog društva za 1998, 1999 i 1970. godinu*, 105–107 (in Serbian).

KNEŽEVIĆ, V., 1960. Albite diabase from the Trepča Area. *Zbornik radova Rudarsko–geološkog fakulteta*, Beograd, 6: 121–124 (in Serbian, English abstract).

KNEŽEVIĆ, V., 1962. Albitized diabases in the neighborhood of Trepča and Zvečan. *Zbornik radova Rudarsko–geološkog fakulteta*, Beograd, 7: 71–78 (in Serbian, English abstract).

KNEŽEVIĆ, V., 1975: Triassic igneous rocks of Montenegro. *Acta Geologica,* 8, 41: 107–147. (in Serbian, English abstract)

KNEŽEVIĆ, V. & CVETKOVIĆ, V., 2000. Triassic rifting magmatism of the Dinarides. *In*: KARAMATA S. & JANKOVIĆ S. (eds.), *Geology and Metallogeny of the Dinarides and the Vardar zone*. Akademija nauka i umjetnosti Republike Srpske, Odelenje za prirodne, matematičke i tehničke nauke, 1: 149–160 (in Serbian, English abstract).

LE ROEX, A.P., 1987. Source regions of mid-ocean ridge basalts: evidence for enrichment process. *In*: MENZIES, M.A. & HAWKESWORTH, C.J. (eds.). *Mantle Metasomatism*, 389–419. Academic press, London.

MEMOVIĆ, E., 1993. *Petrology of the Mesozoic volcanic rocks of south-easatern Serbia and the evolution of the oceanic crust in this area*. Unpublished Doctoral thesis, 240 pp, Rudarsko–metalurški fakultet, Kosovska Mitrovica (in Serbian).

MEMOVIĆ, E. & KNEŽEVIĆ, V., 1995. Triassic volcanic rocks from the Trepča area: their petrology and tectonic setting. *Geološki anali Balkanskoga poluostrva*, 59 (1): 247–260 (in Serbian, English abstract).

MEMOVIĆ, E., KNEŽEVIĆ, V. & JOVANOVIĆ, V., 1995. Triassic igneous rocks of the Kopaonik. *In*: *Symposium of Geology and Metallogeny of the Kopaonik Mt*., 195–200. Republički fond za geološka istraživanja Republike Srbije, Beograd (in Serbian, English abstract).

MÖRK, M.B. & MEARNS, E.W. 1988. Sm–Nd systematics of a gabbro-eclogite transition. *Lithos*, 19: 255–67.

MURPHY, J.B. & HYNES, A.J. 1986. Contrasting secondary mobility of Ti, P, Zr, Nb and Y in two metabasic suits in the Appalachians. *Canadian Journal of Earth Science*, 23: 1138–44.

PAMIĆ, J., 1962. The spilite–keratophyre association in the area of Prozor and Jablanica (Bosnia and Herzegovina) *Acta Geol*ogica, 3: 5–80 (in Croatian, English summary).

PAMIĆ, J., 1963. The volcanics of Triassic in the area of Červljanovići and short survey of the Triassic volcanics activity in the zone Borovica–Vareš–Čevljanovići. *Geološki glasnik*, 7: 9–20 (in Croatian, English summary).

PAMIĆ, J., GUŠIĆ, I. & JELASKA, V., 1998. Geodynamic evolution of the Central Dinarides. *Tectonophysics*, 297 (1–4): 251–268.

PEARCE, J.A., 1983. Role of the sub-continental lithosphere in magma genesis at active continental margins. *In*: HAWKESWORTH, C.J. & NORRY, M.J. (eds.), *Continental Basalts and Mantle xenoliths*, 230–249. Shiva, Nantwich.

SHATSKY, V.S., KOZMENKO, O.A. & SOBOLEV N.V., 1990. Behavior of rare-earth elements during high-pressure metamorphism. *Lithos*, 25: 219–226.

SHUBINA, N.A. & KOLESOV, G.M. 1998. Allocation of analytical signals and estimation of an interference of gamma-lines in instrumental neutron-activation analysis of rocks. *The Journal of the Analytical Chemistry*, 53 (9): 902–908.

SUN, S.S. & MCDONOUGH, W.F., 1989. Chemical and Isotopic Systematics of Oceanic Basalts: Implications for Mantle Composition and Process. *Geological Society, London, Special Publication*, 42: 313–345.

VERMA, P.V., 1992. Seawater alteration effects on REE, K, Rb, Cs, Sr, U, Th, Pb, and Sr-Nd-Pb isotope systematics of Mid-Ocean Ridge Basalt. *Geochemical Journal*, 26: 159–177.

Резиме

Тријаски метабазалти Дудиног крша, Косовска Митровица, Србија

У раду су приказане и дискутоване анализе садржаја главних и елемената у траговима на примерцима метабазалта Дудиног крша, код Косовске Митровице. Подаци су добијене коришћењем метода рендгенске флуоресценције и инструменталне неутрон активационе анализе.

Утврђено је да метавулканити Дудиног крша припадају вулканским стенама које су формиране у току средњотријаског рифтовања, тачније, да су то најисточније продукти тријаских рифтних процеса у Динаридима. Ове метавулканске стене показују сличне петрографске и геохемијске карактеристике којима се одликују вулканске стене у осталим подручјима тријаског вулканизма (нпр. Будва зона, Вареш, западна Србија и др.). Геолошки подаци указују да су метавулканске стене Дудиног крша примарно образоване магматским процесима који су се одвијали дуж континенталне падине некадашње јадранске плоче.

Геохемијска карактеризација испитиваних стена је у великој мери отежана због ефеката процеса алтерације и метаморфизма ниског степена. Стога је интерпретација била усмерена на дискусију садржаја елемената који су у таквим процесима имобилни (нпр. елементи јаког поља, односно high–field strenght elements – HFSE). Геохемијска интерпретација је показала да је реч о високомагнезијским базалтима који се одликују ниским Zr/Nb и средњим до ниским Ti/Zr и Ti/Y односима и који су обогаћени лаким елементима из групе ретких земаља (light rare–earth elements – LREE). Ови метабазалти показују прелазне карактеристике E–MOR базалта (enriched mid–ocean ridge basalts – обогаћени средњоокеански базалти), на једној, и субалкалних континенталних базалта, на другој страни. Ове одлике представљају доказ за екстензионе текстонске процесе који су се одвијали током средњег тријаса у подручју континенталне падине некадашње јадранске плоче.