UDC 55
CODEN – GEOME 2

In print: ISSN 0352–1206
On line: ISSN 1857–8586

GEOLOGICA MACEDONICA

Geologica Macedonica *Geologica Macedonica*	Vol. Год.	**30**	No Број	1	pp. стр.	1–98	Štip Штип	2016

Geologica Macedonica	Vol.	30	No	1	pp.	1–98	Štip	2016
Geologica Macedonica	Год.		Број		стр.		Штип	

GEOLOGICA MACEDONICA

Published by: – Издава:
The "Goce Delčev" University, Faculty of Natural and Technical Sciences, Štip, Republic of Macedonia
Универзитет „Гоце Делчев“, Факултет за природни и технички науки, Штип, Република Македонија

Language editor	Лектура
Marijana Kroteva	**Маријана Кротева**
(English)	(англиски)
Georgi Georgievski, PhD.	**д-р Георги Георгиевски**
(Macedonian)	(македонски)
Technical editor	Технички уредник
Blagoja Bogatinoski	**Благоја Богатиноски**
Proof-reader	Коректор
Alena Georgievska	**Алена Георгиевска**

Address	Адреса
GEOLOGICA MACEDONICA	**GEOLOGICA MACEDONICA**
EDITORIAL BOARD	**РЕДАКЦИЈА**
Faculty of Natural and Technical Sciences	Факултет за природни и технички науки
P. O. Box 96	пошт. фах 96
MK-2000 Štip, Republic of Macedonia	МК-2000 Штип, Република Македонија
Tel. ++ 389 032 550 575	Тел. 032 550 575

E-mail: todor.serafimovski@ugd.edu.mk

400 copies	Тираж: 400
Published twice yearly	Излегува два пати годишно
Printed by:	Печати:
2[ri] Avgust – Štip	2[ри] Август – Штип
Price: 10 €	Цена: 500 ден.
The edition is published in June 2016	Бројот е отпечатен во јуни 2016

Geologica Macedonica	Vol.	30	No	1	pp.	1–98	Štip	2016
Geologica Macedonica	Год.		Број		стр.		Штип	

TABLE OF CONTENTS

Geologica Macedonica	Vol.	**30**	No	1	pp.	1–98	Štip	2016
Geologica Macedonica	Год.		Број		стр.		Штип	

СОДРЖИНА

306
GEOME 2
Manuscript received: December 11, 2015
Accepted: May 9, 2016

Geologica Macedonica, Vol**. 30**, No. 1, pp. 23–31 (2016)
In print: ISSN 0352 – 1206
On line: ISSN 1857 – 8586
UDC: 553.556.06/.07:691.2-4(497.774)
Original scientific paper

MINERALOGICAL-PETROGRAPHIC AND PHYSICAL-MECHANICAL CHARACTERISTICS OF THE TRAVERTINE AND ONYX FROM BEŠIŠTE VILLAGE (WESTERN MACEDONIA)

Orce Spasovski, Blagica Doneva, Daniel Spasovski

Faculty of Natural and Technical Sciences, Institute of Geology, "Goce Delčev" University in Štip, Blvd. Goce Delčev 89, Štip, Republic of Macedonia
orce.spasovski@ugd.edu.mk

A b s t r a c t: The travertine and the onyx from the Bešište village in western Macedonia have been examined in order to determine the possibility to use them as architectural stone. The analyses and the laboratory examination were performed on samples of travertine and onyx. The samples were taken from the surface parts. The results for their physical mechanical features shown that the rock mass, according to the Macedonian standards, satisfies the requirements to be used as an architectural stone, The quality of the stone is higher in the deeper parts of the field where the external influences have a very small effect. This stone has highly decorative features but it also has fine grained structure which is a positive effect for the technical characteristics and the subjection for processing and production.

Key words: travertine; onyx; Bešište village; architectural stone; mineral-petrographic content; structural-textural characteristics; physical-mechanical characteristics

INTRODUCTION

The research area for travertine and onyx from the Bešište village is located in the south-western mountainside of Kozjak Mountain in Mariovo. The location is around 2 km away from the Bešište village and around 45 km from Prilep (Fig. 1). The research field of travertine and onyx is part of the Neogene period surrounded by different hill and mountain forms, with the most significant ones being St. Pantelej (1344 m), Perun (1730 m.), Gurov Kamen (1566 m), Cucul (1220 m), Baltava Čuka etc. The main water flow of this region is Crna Reka river which is the biggest right confluent of the river of Vardar. The first geological information of the field is related with the first geological research of the Pelagonian area, done in the beginning of the last century. Cvijić (1906) wrote about the crystal-like rocks with granite core of the Precambrian age. Kosmat (1924) made the first division of the field in units. Marić (1949) did a research on the rocks between Bakarno Gumno – Alinci and Vespec. Ilić (1953) conducted research on the pegmatite and the useful minerals related to them in the area of Babuna Mountain and the northern part of the Selečka Mountain. Colman (1951) and Izmajlov (1951) made a geological map of the field between the Mrzen and Galište villages in the valley of the river of Crna Reka.

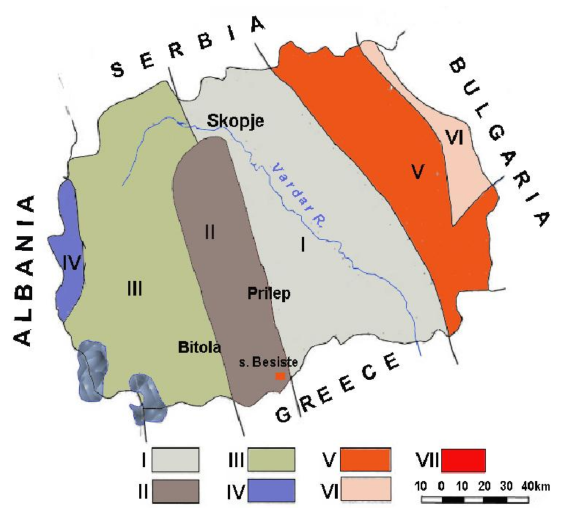

Fig. 1. Tectonic map of the Republic of Macedonia
I – Vardar zone; II – Pelagonian massif; III – Western Macedonian zone; IV – Krasta zone; V – Serbo-Macedonian massif, and VI – Kraistide zone (Arsovski, 1997)

Barić (1956) made the most detailed mineral examination of the disten from the Selečka Mountain. Stojanov performed a research (1958 and 1974) of the disten from the Selečka Mountain. Mayer (1960) in the area south from the village of Bonče, gave a description of meta-gabbro. Protić (1963) in the southwestern part of Selečka Mountain selected schist with smaller crystality. Teofilović (1966) made his research in the southern part of the Pelagonian massif. Within the process of making the geological map of SFRY, the authors of the sheets of Vitolište and Kajmakčalan, in a scale 1:100 000 (Dumurdžanov, Hristov, Pavlovski and Ivanova 1976), made a detailed elaboration of the sheet content of the rocks in the sheets of Vitolište and Kajmakčalan, describing the composition of the rocks considered the presence of onyx in the upper parts of the travertine rocks.

Recently, data for the investigations of travertine and onyx near the research area can be found in the works of Spasovski et al. (2012, 2015a, 2015b, 2016).

METHODOLOGY

The location of the Bešište village is explored using terrain and laboratory examinations. The terrain explorations have provided the distinguished insight of the terrain, familiarization with its geological and structural-tectonic characteristics, as well as collecting of representative samples from the travertine and onyx for defining their chemical and mineralogical composition, structural-textural and physical-mechanical characteristics.

The mineralogical-petrographic researches have been done at the Faculty of Natural and Technical Sciences in Štip, Institute for Geology, by the authors of the paper, while the chemical content of the travertine and onyx is determined in the chemical laboratory of the Faculty of Natural and Technical Sciences using the atomic emission spectrometry – inductively coupled plasma (AES-ICP). The research of the physical-mechanical characteristics was performed in the laboratory of the Faculty of Civil Engineering in Skopje. Because the rock masses are not well disposed, the samples were taken from the surface of the terrain. As a consequence, in the samples are some cracks which are result of the great influence of the atmosphere. However, the examinations of the samples have shown credible values of the physical-mechanical characteristics. It is certain that the samples from the greater depths would give much better results.

GEOLOGICAL FEATURES

In the geological constitution of the locality of Bešište of the striped muscovite-biotite and striped muscovite gneiss are mostly present, together with massive medium to large graned granodiorite, volcanic sediment products, quartzlatite agglomerate and tuff and carbonate-tuff products. The greatest presence is of volcanic sediment products and carbonate-tufa products (Figure 2).

Volcanic sediment products

The volcanic sediment products in slightly lesser masses are present in Bešište (Figure 2). During the intensive volcanic activity at the Kožuv volcanism, great quantities of volcanic material (volcanic sand, dust, ashes, volcanic lapilli, bombs and blocks of volcanic rocks – quartzlatite, andesite, tufa) have been erupted in this part of the field. In this volcanic material in the Pliocene–Quaternary lake reservoir, mostly stratified figures of volcanic agglomerate, breccia, pyroclasts, tuff, etc., have been formed, in which stratified figures with various thickness, dusty weakly-tied sands, clay and sandbanks, are embodied. There are often fragments and blocks of volcanic rocks in these layers.

Carbonate-tuffaceous products

The carbonate-tuffaceous products have been found in the center of the researched area (Fig. 2). These products are represented by stratified and flat tufa, tufaaceous limestone, travertine and onyx. They are mostly layered by interstratified sandbanks, dusty sands and grinded tufa. The tuff, the tufaaceous limestone, the travertine and the marble onyx are mostly brown and grey-yellowish massive and quite compact but in certain intervals they can be porous and with cavities (Figure 3). The travertine is with fine-grained structure, compact, massive and fairly porous texture. There can rarely be found cracks with length of 2 mm. The calcium carbonate rock is formed of calcite which is mostly found in crypto-crystal form. The calcite mass often produces irregular oolitic forms, round and oval with zoned structure of calcite mass. The oolitic forms on the parts of the edges are framed with stronger limonization. The cracks are not frequent and are fairly small. In the cracks as well as in the irregular forms, the rock is filled with recrystallized calcite – microcrystalized and pure.

The onyx is with brownish-yellow color in various nuances (Fig. 4) and it can be found in the more shallow levels (up to 30 meters), while the limestone tuff is very compact and firm and it can be found in the deeper levels of these series. It has compact, massive and slightly distinguished striped texture. The calcite crystals that constitute the onyx are thin, long and straw-like forms, crystallized diagonally on stratification. It is possible that the calcite is presented by aragonite, as a polymorphic modification of calcite. In most of the examined holes, presence of vulcanite in the tuff series has been found, which points to the fact that there has been sedimentation of both carbonate and volcanic agglomeration.

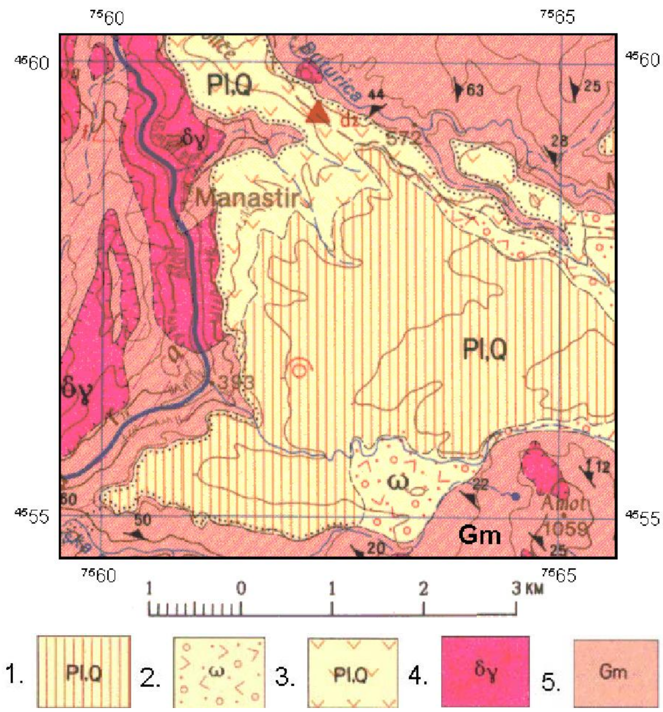

Fig. 2. Geological map of the locality of Bešište village BGM SFRY 1:100 000, sheet Vitolište.
1 – travertine and onyx, 2 – carbonate-tuffaceous products, 3 – volcanic sediment products, 4 – granodiorite, 5 – gneisses

Fig. 3. Stratified, porous and cracked light grey travertine

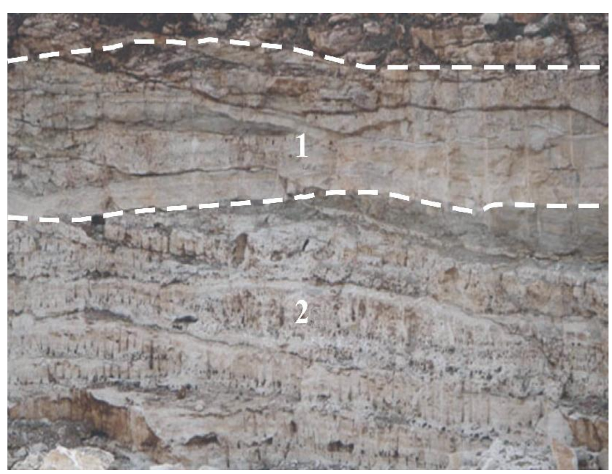

Fig 4. Thin layers of brownish-yellow onyx (1) and massive brownish-grey travertine (2)

MINERALOGICAL AND PETROGRAPHIC FEATURES

Represented samples from the Bešište village have been selected for the petrographic-mineralogical examinations. The petrographic preparations were made, reviewed microscopically with a polarized microscope with transmitting light brand Leitz, Wetzlar Germany. The petrographic-mineralogical examinations were done at the Faculty of Natural and Technical Sciences at the Institute for Geology by the authors of the paper.

The travertine has red-brown colour with rare irregular forms that are light coloured. They are characterized with fine grained composition, compact, massive and fairly hollow texture. Cracks are found rarely, with length of 2 mm.

The rock is made of calcite, which basically is with crypto-crystal form and structure. The calcite structure often makes irregular oolitic shapes, round and oval with zonal structure of the calcite mass (Figs. 5a, 5b). The rock is filled with recrystallized calcite – microcrystal and pure. The granulation of the calcite in these forms is around 50 μ. The irregular forms are rarely found, gloomy brownish, i.e. strongly coloured with limonitized oxide. As secondary minerals appear quartz grains and rarely lamina of mica, and it can also be said that there are only residues.

The marble onyx is characterized with large crystalized structure, compact, massive and with slightly distinguished striped texture. The calcite crystals are thin, long and straw-like forms, crystallized diagonally on stratification. It has light brownish and brown-yellowish colour, with nuances of lighter and darker spots which give the rock a better appearance. It is composed of calcite, which has large crystal structure. Those are long straw-like crystals of calcite with radiant rayed darkening (Figs. 6a, 6b). Separate parts of the calcite are strongly coloured with limonized oxide, which point the striped structure of the rock. This is a result of the genetic background of the onyx, i.e. the inflow of tinctures of limonized oxide. Not so often, visible diagonal transections of calcite can be seen in partly rhomboid crystals. It is possible that the calcite is presented by aragonite, as a polymorphic modification of calcite. Very rarely there can be crystals which resemble the dolomite–ancerite

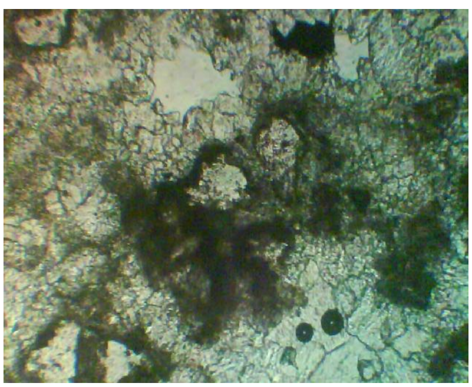

Fig. 5a. Microphoto of the sample Bs-3 100 × (N^-)

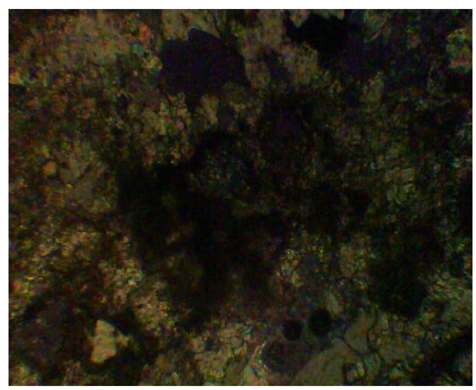

Fig. 5b. Microphoto of the sample Bs-3 100 × (N^+)

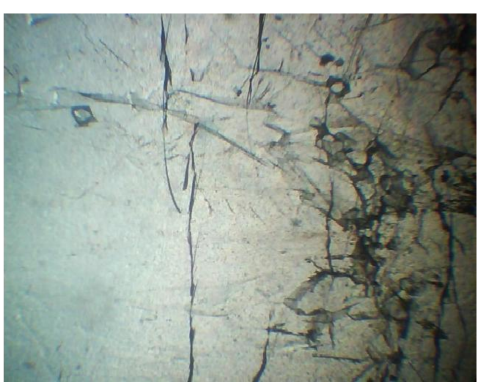

Fig. 6a. Micro photo of the sample GP-4 100 × (N^-)

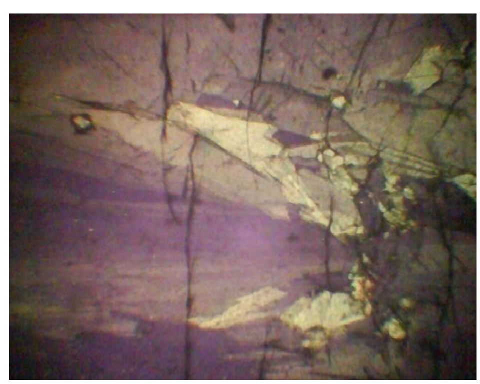

Fig. 6b. Micro photo of the sample GP-4 100 × (N^+)

CHEMICAL COMPOSITION

The chemical characteristics of the travertine and the onyx from the locality of Bešište village, represent an addition in the process of expanding the findings of this type of rocks in the territory of the Republic of Macedonia. Considering the composition, the structural tectonic features, the color and the manner of their appearing, these rocks are clearly different from the surrounding ones.

From the Table 1 it can be stated that the analyzed samples of travertine are characterized with a constant chemical composition, which can be seen in the content of CaO (range of 51.14 – 51.30% CaO).

In the travertine from the Bešište village the content of P_2O_5 is low and varies in close interval from 0.032 to 0.065. The content of the iron systematically decreases from 0.16 to 0.30%.

The content of MgO in travertine from the Bešište village ranges from 1.60 to 2.07%, content of MnO was from 0.060 to 0.096%. The content of Na_2O was from 0.035 to 0.08%, while the content of K_2O ranged from 0.02 to 0.08% and the content Al_2O_3 was from 0.11 to 0.14%.

The onyx is with a constants chemical composition, which can be seen in the content of CaO (range of 49.83 – 49.84% CaO).

In the onyx from the Bešište village the content of P_2O_5 is low and varies in close interval which is from 0.069 to 0.076. The content of the iron systematically decreases from 0.11 to 0.13%.

The content of MgO in onyx from the Bešište village ranges from 2.73 to 2.80%, content of MnO was from 0.30 to 0.35%. The content of Na_2O was from 0.04 to 0.05%, while the content of K_2O ranged from 0.01 to 0.02% and content of Al_2O_3 was from 0.30 to 0.32%.

The chemical content of the analyzed samples are presented in Table 1.

For determination of chemical composition of onyx with scanning electron microscopy (SEM) there was separated representative and fresh onyx.

The results from the performed examinations with scanning electron microscopy on onyx from the locality of the village of Bešište are presented in Tables 2 and 3, the position of the analyzed points is shown on Figures 7, 8, 11 and 12, and EDX spectrums are presented on Figures 9, 10, 13 and 14.

From the Tables 2 and 3 is obvious that the main components (O, C, Ca) show continuity in their content within the analyzed samples. Also, it can be seen that with these examinations are not determined impurity elements that would have negative effects on the decorativeness of the stone which increase its market price.

T a b l e 1

Chemical composition of the travertine and the onyx (%)

Components	Bs-1	Bs-2	Bs-3	Bs-4	Bs-5
SiO_2	0.10	0,12	0.11	0.10	0.12
Al_2O_3	0.11	0.14	0.11	0.32	0.30
Fe_2O_3	0.20	0.30	0.16	0.11	0.13
MnO	0.096	0.060	0.096	0.35	0.30
MgO	1.64	2.07	1.60	2.80	2.73
CaO	51.20	51.30	51.14	49.83	49.84
Na_2O	0.04	0.035	0.08	0.05	0.04
K_2O	0.03	0.08	0.02	0.01	0.02
P_2O_5	0.065	0.060	0.032	0.069	0.076
Moisture (110^o)	0.032	0.041	0.034	0.036	0.032
Loss on ignition	45.89	45.26	45.90	45.80	45.76
Total	**99.403**	**99,466**	**99.282**	**99,565**	**99.348**

Note: The analyses Bs-1 Bs-2 and Bs-3 are travertine, while the analyses Bs-4 and Bs-5 are onyx.

T a b l e 2

Chemical composition of marble onyx from the locality of the Bešište village (%)

Element (K)	Sample 1		Sample 2	
	Weigh	Atomic	Weigh	Atomic
C	14.56	23.07	20.85	30.10
O	50.90	60.54	54.75	59.34
Ca	34.54	16.40	24.40	10.56
Total	100.00		100.00	

T a b l e 3

Chemical composition of marble onyx from the locality of the Bešište village (%)

Element (K)	Sample 3		Sample 4	
	Weigh	Atomic	Weigh	Atomic
C	14.00	23.19	18.03	26.27
O	45.69	56.81	57.71	63.14
Ca	40.31	20.01	24.26	10.59
Total	100.00		100.00	

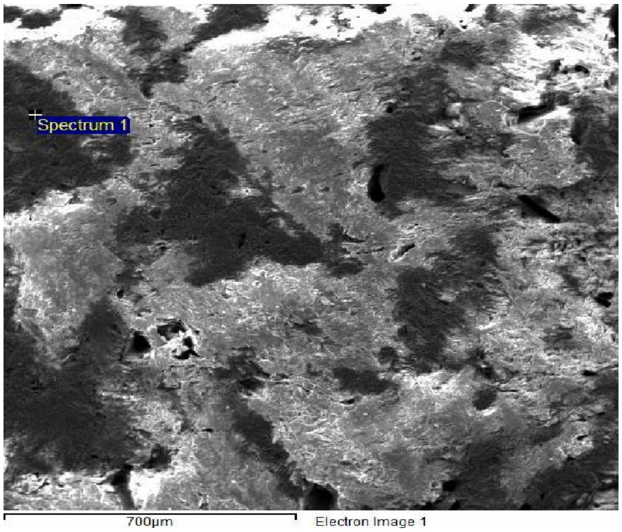

Fig. 7. SEM image of marble onyx, sample 1

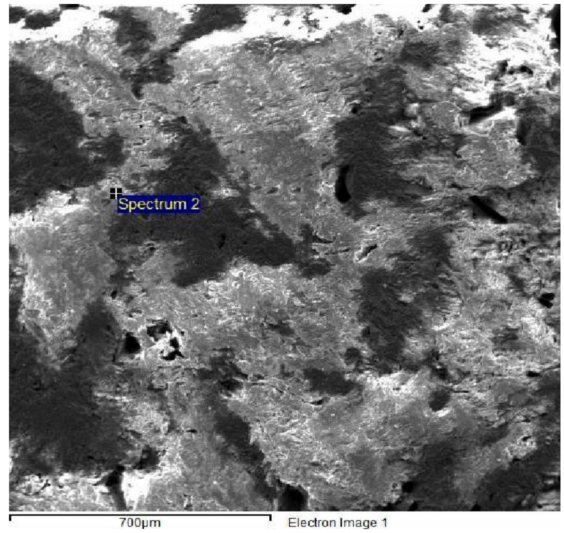

Fig. 8. SEM image of marble onyx, sample 2

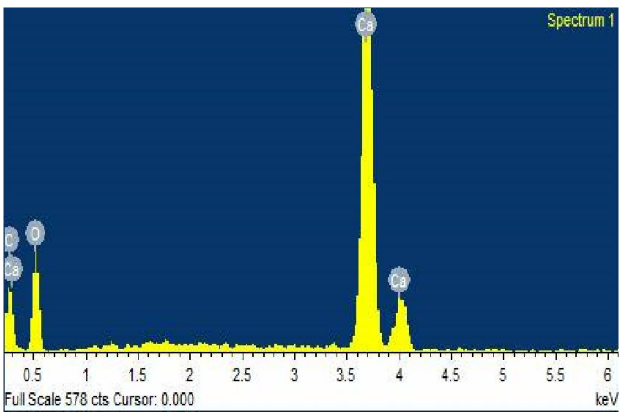

Fig. 9. EDX spectrum of marble onyx, sample 1

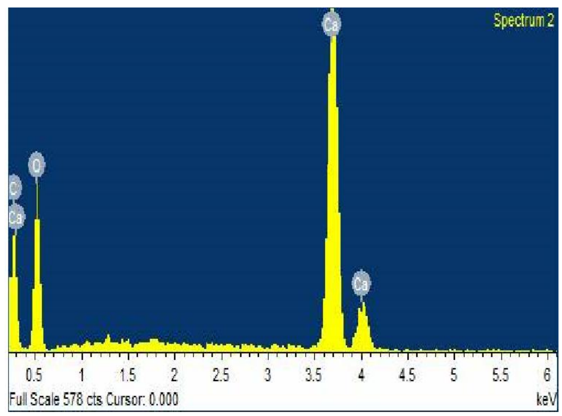

Fig. 10. EDX image of marble onyx, sample 2

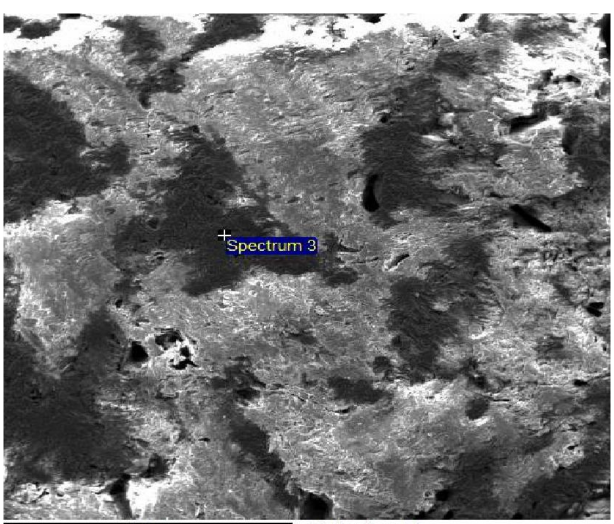

Fig. 11. SEM image of marble onyx, sample 3

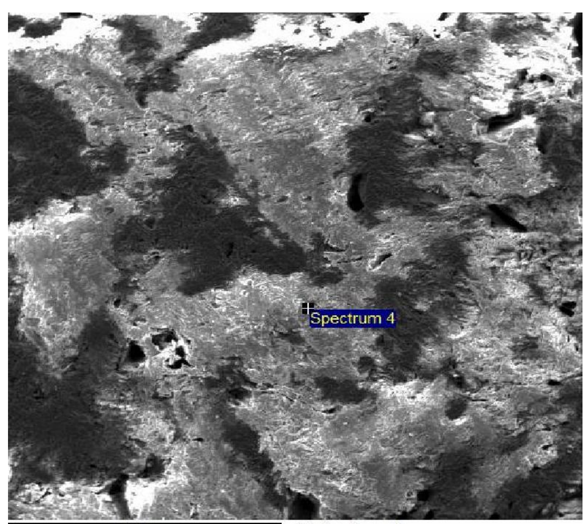

Fig. 12. SEM image of marble onyx, sample 4

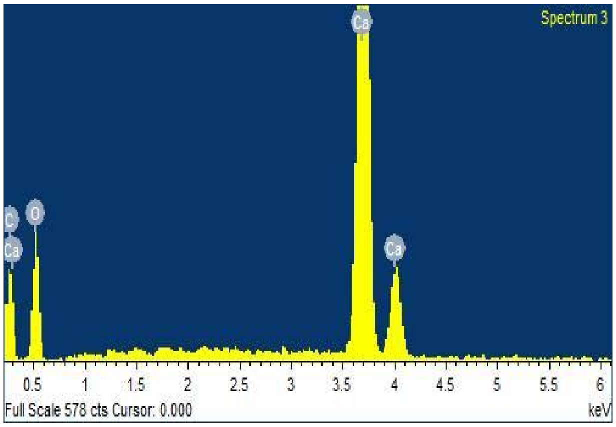

Fig. 13. EDX spectrum of marble onyx, sample 3

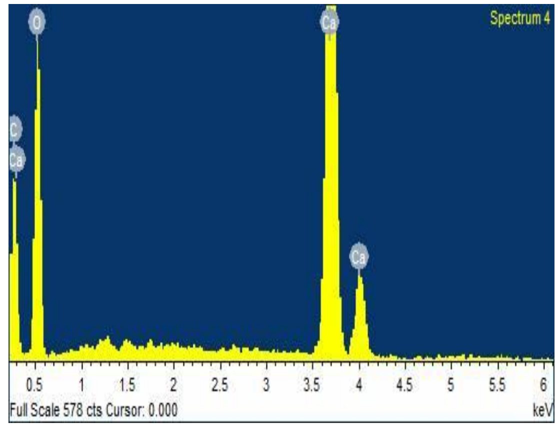

Fig. 14. EDX image of marble onyx, sample 4

PHYSICAL-MECHANICAL CHARACTERISTICS

An appropriate methodology of laboratory examination has been applied in the process of research in accordance with the existing standards of this type. Mostly used are existing state standards (MKS), but the recommendations of examination by the international society for rock mechanics (ISRM – International Society for Rock Mechanics) were also considered.

Based on the performed evaluations, analyses and statistic elaboration the following description of the obtained values from the examined samples is presented:

Marble onyx

– Mean value for the strength to pressure in dry condition is

$$\sigma_p = 57.23 \text{ MPa}.$$

– Mean value for the strength to pressure after 25 cycles of freezening and melting is

$$\sigma_{pm} = 50.66 \text{ MPa}.$$

– Mean value of the index of strength parallel of the levelness of the onyx in dry condition is

$$J_s\,(50) = 1.58 \text{ MPa}.$$

– Quotient of proportionality is

$$K = \sigma_p/J_s = 57.23/1.58 = 36.22.$$

– According to the value of absorption (U), the rock belongs to the class of rocks with low absorption of water (less than 0.5) ($U = 0.085\%$).

– Mean value of weight capacity is

$$\gamma = 27.76 \text{ kN/m}^3 \text{ (hard stone)}.$$

– Quotient of resistance to ice is

$$(K_m = 50.66/57.23 = 0.88).$$

– According to the strength to pressure it is considered medium strong rock (50 – 100 MPa).

Travertine

– Mean value for the strength to pressure in dry condition is

$$\sigma_p = 68.68 \text{ MPa}.$$

– Mean value for the strength to pressure after 25 cycles of freezening and melting is

$$\sigma_{pm} = 51.52 \text{ MPa}.$$

– Mean value of the index of strength parallel of the levelness of the travertine in dry condition is

$$J_s\,(50) = 4.21 \text{ MPa}.$$

– Quotient of proportionality is

$$K = \sigma_p/J_s = 68.68/4.21 = 16.31.$$

– According to the value of absorption (U) the rock belongs to the class of rocks with great absorption of water (2.5–5.0%) ($U = 3.06\%$).

– Mean value of weight capacity is

$$\gamma = 23.77 \text{ kN/m}^3 \text{ (medium hard stone)}.$$

– Quotient of resistance to ice is

$$(K_m = 51.52/68.68 = 0.75).$$

– According to the strength to pressure it is considered medium strong rock (50–100 MPa).

CONCLUSION

The travertine is compact and quite firm with not clearly distinguished striped texture, changing the not equal stripes of light brownish coloring and the thinner layers with lighter, i.e. light greyish color. The color is light brownish – beige to lighter greyish glassy occasions which change irregularly. In separate parts of the travertine there are cracks filled with recrystallized calcite.

The marble onyx is characterized with large crystallized composition – structure and with compact, massive and slightly striped texture. The calcite crystals are thin, long and straw like forms, crystallized diagonally on stratification. The onyx has light brownish and brown-yellowish color, with nuances of lighter and darker spots which gives the rock a better appearance.

Due to the petrographic-mineral characteristics, as well as the chemical content of the travertine and the onyx they can have great application. Primarily, the travertine can be used as architectural stone, i.e. for cutting tiles for surfaces. These are especially applicable for internal and external tiling on vertical surfaces. For the external surfaces the selection of the less cracked ones is a better choice. The remains of the cutting process may be used as macadam in concrete mixtures, as fillers for concrete pavement tiling, etc.

It was determined that the marble onyx is a relatively hard rock with low absorption of 108 water and with weight capacity which categorizes the rock in the group of hard decorative stones, with a quotient of resistance to ice within the normal limitation.

The travertine was determined to be a medium hard rock with high absorption values which categorizes the rock in the group of medium hard decorative stones, with a quotient of resistance to ice within the normal limitation. According to the physical-mechanical characterristics it is considered a high quality decorative stone for internal and external decoration in the civil engineering.

REFERENCES

Arsovski, M.: *Tectonic of Macedonia*. Faculty of Mining and Geology, Štip, 1997.

Barić Lj.: Disten, andalusite and silimanite in the area of Yugoslavia. *Papers of the Geological Institute of SRM*, 8, Skopje, 1956.

Dumurdžanov, N., Hristov, S., Pavlovski, B., Ivanov, V.: *Explanation for the page Vitolište–Kajmakčalan*, *BGM SFRY 1 : 100 000*, Geological Institute, Skopje, 1976.

Dumurdžanov, N., Hristov, S.: *Basic Geological Map 1 : 100 000 for the sheet Prilep*, Geological Institute, Skopje, 1976.

Colman C.: *Previous report for the results of the geological mapping in the area of the lower part of the river Crna in the region between Mrzen and Galište*. Papers of the Geological Institute of SRM, 2, Skopje, 1951.

Ilić, M.: General characteristic of pegmatite from Babuna Mountain and the vicinity of Prilep and useful minerals there. *Gazette of Natural museum of Serbian country, A, III*. Belgrade, 1950.

Izmajlov, N.: Mariovo, Preliminary report of geological mapping south of Crna Reka in Klinovo – Rozden area. Мариово, Претходни извештај на геолошкото картирање јужно од Црна Река. *Papers of Geological Institute of the Republic of Macedonia Vol. 2,* 1951.

Kossmat F.: *Geologie der zentralen Balkan Halbinsel*. Mit einer Übersicht des dinarischen Gebirgsbaues. Berlin, 1924.

Marić, L.: Metamorphic rocks formcopper area in Veslec south and southwest from Prilep. *Discussions of the Academy of Sciences and Arts IV*. Ljubljana, 1949.

Mayer B.: *Meta-gabbro from Selečka Mountain*. Papers of the Geological Institute of SRM, 7, Skopje, 1960.

Protić M.: About the metamorphism and alkaline metasomatosis in the area of Selečka Mountain in Macedonia. *Geological Annals of the Balkan Peninsula.* XXX, Belgrade, 1963.

Spasovski Orce, Kostovski Zoran, Spasovski Daniel: The possibilities to use the travertine and onyx – Gulabova cave, Bešište village (western Macedonia) as an architectural stone. *Proceedings*. 2012, pp. 103–108,.

Spasovski Orce, Spasovski Daniel: Possibiliies for using travertine from the Nabigori deposit, village of Velmej (western Macedonia) as architectural stone. *Geologica Macedonica*, **29** (1), pp. 47–52 (2015). ISSN 0352-1206.

Spasovski Orce, Spasovski Daniel: Possibilities for using travertine Police, village Manastir (western Macedonia) as architectural stone. Podeks-Poveks '15. VIII Expert Conference "Technology of underground and surface mining of mineral raw materials" Krusevo, 2015, pp. 35–41. ISSN 978-608-65530-3-6.

Spasovski O.: Elaborate for detailed geological investigations of the mineral raw material onyx and travertine on locality of the village of Bešište, Municipality of Prilep. Professional fund of Amadeus stone DOOEL Skopje, 2016, pp. 0–75.

Stojanov R.: *Petrologic characteristics of igneous and metamorphic rocks from the wider vicinity of Prilep*. Doctoral thesis. Faculty of Mining and Geology, Belgrade, 1974.

Teofilović M.: *Geological composition and tectonic structure of mountain complex Kozjak – Nidže and Selečka Mountain*. Spacial issue I.G.R.N.M.S. vol. **1,** 1966, Belgarde.

Cvijić J.: *Fundamentals of Geology and Geography of Macedonia and Old Serbia*. *SCAN*. Vol. **I** (1906), Belgrade.

Р е з и м е

МИНЕРАЛОШКО-ПЕТРОГРАФСКИ И ФИЗИЧКО-МЕХАНИЧКИ КАРАКТЕРИСТИКИ НА ТРАВЕРТИНОТ И ОНИКСОТ ОД ЛОКАЛИТЕТОТ СЕЛО БЕШИШТЕ (ЗАПАДНА МАКЕДОНИЈА)

Орце Спасовски, Благица Донева, Даниел Спасовски

Факултет за природни и технички науки, Институт за геологија, Универзитет „Гоце Делчев“,
бул. Гоце Делчев 89, 2000 Штип, Република Македонија
orce.spasovski@ugd.edu.mk

***Клучни* зборови:** травертин; оникс; село Бешиште; архитектонски камен; минералошко-петрографски состав; структурно-текстурни карактеристики; физичко-механички карактеристики.

Травертинот и ониксот од селото Бешиште (западна Македонија) се испитувани со цел да се утврди можноста за нивно користење како архитектонски камен. Анализите и лабораториските испитувања беа извршени на примероци од травертин и оникс. Примероците се земени од површинските делови. Резултатите од нивните физичко-механички испитувања покажаа дека карпестата маса ги исполнува сите барања за употреба како архитектонски камен според државните стандарди на Р. Македонија. Исто така, квалитетот на каменот е повисок во подлабоките делови на теренот, каде што надворешните влијанија имаат многу мал ефект. Овој камен има високи декоративни својства, а ситнозрнестата структура претставува позитивен ефект врз техничките карактеристики и подложност на обработка.