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On the Provenance of the Tesserae in the Mosaic Pavements of Parthicopolis (4th - 6th c.). Local Quarries, Deposits and Import (*Preliminary Report for Some Mosaic Tesserae from Basilica No 2*)

Parthicopolis'in Mozaik Döşemelerinin Tesserae Kökeni Üzerine (4.- 6. Yüzyıl). Yerel Ocaklar, Yataklar ve İthalat (*2 Numaralı Bazilika'dan Bazı Mozaik Tesseralar için Ön Rapor*)

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Abstract

This article examines several mosaic tesserae from the mosaic panel of the exonarthex of the early Christian basilica No 2 in Parthicopolis (today's town of Sandanski).

The studied mosaic tesserae are made of glass, brick and stone - marble and sandstone. After the analysis: micro- and macroscopic, method applied: EDS; XRD analysis of the mineral phases and others. The composition and possible production of glass for the smalta tesserae has been established, the composition of the brick tesserae; of two types of white marble tesserae, of sandstone tesserae has been determined.

In antiquity, and especially in the early Byzantine period, several marble quarries of very good quality were exploited in the Middle Strymon area. It has been established that the stone tesserae were mined from deposits around the ancient and early Byzantine city, quarries Ilindentsi ('The marble quarries of Trajan'), and the glass is imported. An assumption has been made about the possible production on site in the city of a type of glass tesserae - with a degree of crystallization. The chemical and structural analysis of the tesserae reveals the origin of the material, stone and glass, the latter in the form of a finished product distributed as an import by Thessaloniki merchants and undergoing only the final stage of heating, cutting and polishing in local workshops. Although research on the origin of tesserae from mosaic panels from the early Christian basilica complexes in Parthicopolis is only in the beginning, research proves the origin of tesserae materials, the supply of mosaic workshops mainly with local stone material, and trade in imported glass for enamel mosaic and its final stage of in situ preparation in Particopolis.

Keywords: *Mosaic pavement, analysis, tesserae, quarries, local production and import.*

Öz

Bu makalede, Parthicopolis'teki (bugünkü Sandanski Kasabası) 2 numaralı erken Hristiyan bazilikasının eksonarteksinin mozaik panelindeki birkaç mozaik tessera incelenmektedir.

İncelenen mozaik tesseralar cam, tuğla ve taş - mermer ve kumtaşından yapılmıştır. Analizden sonra, ki bu analizde mikro ve makroskopik yöntemler uygulanmıştır: EDS; Mineral fazların XRD analizi ve diğerleri yapılmıştır. Smalta tessera için camın bileşimi ve olası üretimi belirlenmiştir, ve tuğla tessera'nın bileşiminin, beyaz mermer tessera, kumtaşı tessera olmak üzere iki tipte olduğu tespit edilmiştir.

Antik çağda ve özellikle erken Bizans döneminde, Orta Strymon bölgesinde çok kaliteli birkaç mermer ocağı işletilmiştir. Taş tesseraların antik ve erken Bizans kenti, Ilindentsi taş ocakları ('Trajan'ın mermer ocakları') çevresindeki yataklardan çıkarıldığı ve camın ithal edildiği tespit edilmiştir. Şehirde bir tür cam tesseranın

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bir dereceye kadar kristalleşme ile üretildiği olasılığı üzerine bir varsayım yapılmıştır. Tesseraların kimyasal ve yapısal analizi, malzemenin, taş ve camın kökenini ortaya koymaktadır; ikincisi, Selanik tüccarları tarafından ithal olarak dağıtılan ve yerel atölyelerde yalnızca son ısıtma, kesme ve cilalama aşamalarından geçen bitmiş bir ürün biçimindedir. Parthicopolis'teki erken Hristiyan bazilika komplekslerindeki mozaik panellerdeki tesseraların kökenine ilişkin araştırmalar henüz başlangıç aşamasında olmasına rağmen, araştırmalar tessera malzemelerinin kökenini kanıtlamaktadır. Ağırlıklı olarak yerel taş malzeme ile mozaik atölyelerinin temini ve mine mozaik için ithal cam ticareti ve Particopolis'te yerinde hazırlığının son aşamasıdır.

Anahtar Kelimeler: *Mozaik kaplama, analiz, tessera, taş ocakları, yerli üretim ve ithalat.*

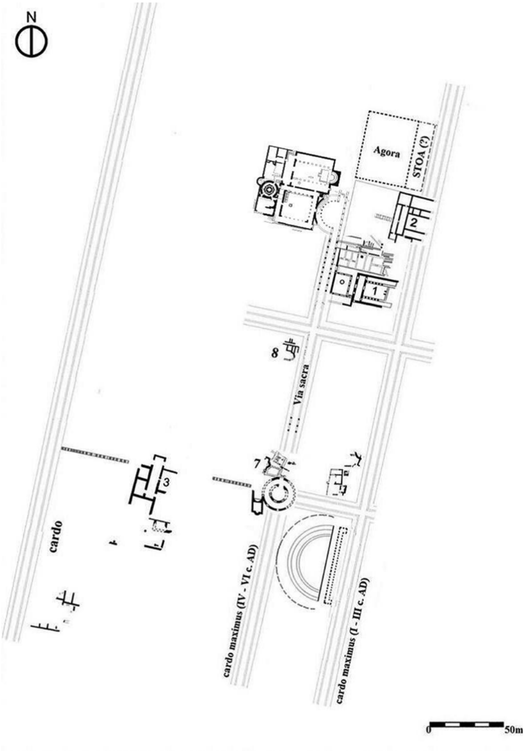
The Roman and the Early Byzantine city Parthicopolis, now hidden under the present-day town of Sandanski in Southwestern Bulgaria is situated in the most northeastern part of the province of Macedonia I (Fig. 1). It received its name around 116-117 in honour of the victory of the emperor Trajan in the Parthian war. The first biggest economic and cultural flourishment was in the period from the first quarter of 2nd up to the middle - the third quarter of 3rd century. In the next period 4th-6th century Parthicopolis becomes a famous bishopric in the eparchy of Macedonia I. In this way, the new flourishment of the most important economic, religious and cultural center in the valley of Middle Strymon begins from the third quarter of 4th – the beginning of 5th century.

Figure 1
Location of Parthicopolis (Sandanski) on the modern map of the Republic of Bulgaria (after Petrova - Petkov 2015: 341).

Four of the six basilicas in the center of the ancient city (No 1, 2, 3 and 4) are determined as urban episcopal ones[1] (Fig. 2). They are built from both sides of the main Early Christian/Early Byzantine street (*Via sacra*). Three of them (No 2-4) and the receiving room of the supposed episcopal residence between basilica No 1 and No 2 have mosaic pavements. The *baptisterium* to the magnificent main basilica No 4 is decorated with wall mosaics. In spite of the vast surfaces with mosaic floors and wall mosaics, no special study on the mosaic tesserae has been done so far for Parthicopolis[2], except for the sculpture and the architectonic

1 Generally, 10 basilicas have been excavated in Sandanski so far (urban, monastery and cemeterial ones), in different degree of preservation. On them see Petrova 2015: 161-184.

2 Relatively small number of marble monuments has been analyzed so far. These are mainly architectural elements (bases, columns and capitals), used as spolia in the building of the main basilica No 4 of Parthicopolis), see Petrova, Petrov 2008: 120-122). Few samples of marble from basilica No 1 and Roman sepulchral steles have been also studied for its provenance from concrete quarries and deposits (see Petrova 2017: 152-169).



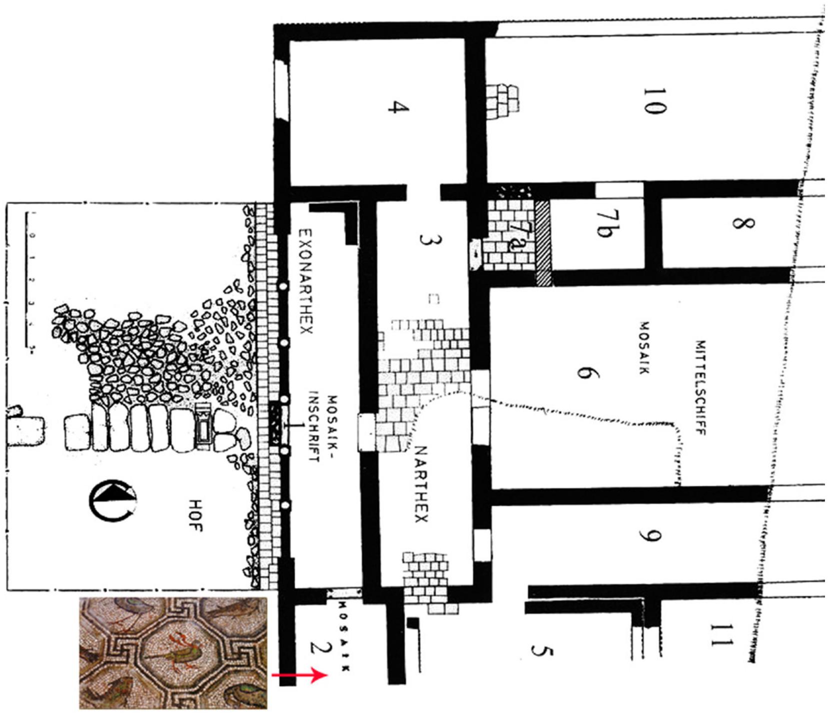


Figure 2
General plan of the discovered archeological structures in Parthicopolis: the early Byzantine main street - *Via sacra*, the basilicas, the theater, The North round(?) piazza, the South Rotunda (Fountain/ Nimphaeum), the Baths and the quarter of glass and pottery workshops (after S. Petrova).

Figure 3
Plan of basilica No 2 (after R. Pillinger 2006: Abb. 6).

elements and its provenance from the quarries in the area of Middle Strymon and Middle Nestos (generally in Southwestern Bulgaria, about 130 and 170 km north from Thessaloniki), and also from the quarries of Thassos and Proconessos. The offered here observations and analyses of several tesserae from basilica No 2 in Parthicopolis are putting the beginning of such a study in honour of Prof. David Parrish. The attention is concentrated on the provenance and the composition of a small number of tesserae used in the mosaic of the exonarthex of basilica No 2. Traditionally, the white and grey tesserae are referred by the researchers to the so-called 'Trajan's quarries' for extraction of marble[3]. In them are established several deposits for making architectural elements, round cult sculpture and sepulchral sculpture. The research on the mosaic tesserae has been done by a team under the direction of Denka Yanakieva from the Earth and Man National Museum in Sofia, Bulgaria to whom I express my deepest gratitude.[4]

Only half of basilica No 2 is preserved in its western and central parts (Ivanov et al. 1969: 105-209), while its eastern part together with the chancel and the apse come under the contemporary level of the main town street of Sandanski (Fig. 3). The basilica is erected on the remnants and debris of earlier Roman buildings from 2^{nd}-3^{rd} century.[5] The first researcher considered that the basilica was built in the first half of 6^{th} century, and the destruction happened in the last quarter of the same century (Ivanov et al. 1969: 105-209). V. Popova in her study on the mosaics of basilica No 2 relates the basilica and its pavements according

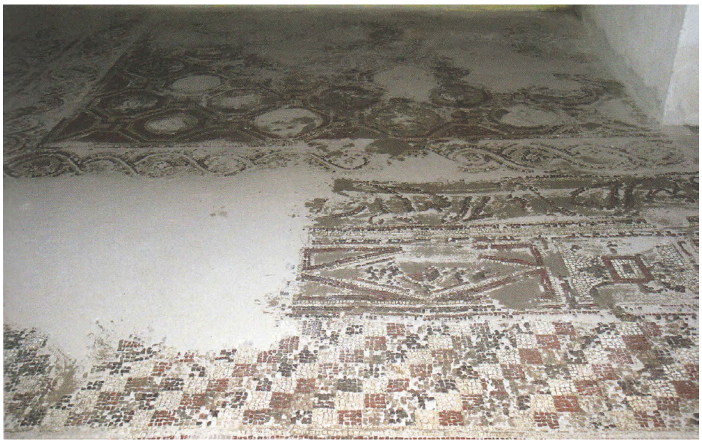
3 The popular name of these quarries is 'the quarries at Ilindentsi', with several different deposits. They are situated north of Sandanski, in the valley of Middle Strymon (now Struma), in the skirts and the first heights of Pirin Mountain. Its large dimensions-organization and activity on a large scale led to the growing of its significant importance namely in the period of Trajan, in connection with his urban policy in the Balkans, therefore I have named them 'the quarries of Trajan'.

4 I am also grateful to my colleague Dr. Anastasia Cholakova for the consultation on the glass.

5 The basilica has an atrium from west paved with medium-sized boulders, with a path of marble and granite plates in the middle axis, leading to the center and the entrance of the colonnade of the exonarthex. Then follows the narthex (esonarthex); the naos, separated by two colonnades in three aisles, and the back rooms sticking to the basilica from north and south.

to the mosaic inscription of bishop Ioannes and the style to the middle of 5th century (Popova 1981: 174 ff.; Pillinger et al. 2016: 356-371 (V.P.); the same dating is accepted also in the next publications, with the addition of B. Asamer for a second phase of part of the mosaics dated in the second half - end of 5th – the beginning of 6th century (Asamer-Zimmermann 1998: 31-44; Petrova 2012: 107; Pillinger et al. 2016: 367-368 (V.P.). In my opinion, the erecting of the basilica and the first mosaics may be referred to the last years of the second quarter - the middle of 5th century, supported by the other archaeological data, the architectural decoration, the liturgical planning and furniture and the urban planning and building of Parthicopolis in the first half of 5th century (the other basilicas, the main plaza and the street for church processions)[6]. The later mosaics in basilica No 2 from the new phase of mosaic decoration most probably relate to the second half of 5th- end of 5th – beginning of 6th century[7].

The three-aisled basilica of the Hellenistic type is similar to the other basilicas of Parthicopolis, and probably had one semi-circular apse from the east, not found (under the modern main city street). Both aisles are comparatively narrow, but the south one is a little bit wider (Ivanov et al. 1969: 119-165). Only the halves of two mosaic panels are preserved in the naos. The western one is of geometric character filled in the same way (Fig. 4a). The panel east of it depicts birds, fishes and vessels (Fig. 4b). The exonarthex, first colonnade and opened,



later was closed. Its floor was covered with several mosaic panels of geometric character, while the central one reveals the famous mosaic building inscription of bishop Ioannes[8] (Fig. 5). The floor of the room No 2 south of the exonarthex is determined as transitional from the basilica to the   near the Episcopeion (the episcopal residence) between basilica No 1 and No 2 (Fig. 6). This panel is covered with a splendid mosaic with different kind of birds and fishes placed in octogons, each connected with the others with swastika-meander (Popova 1981: 173-181; Pillinger et al. 2016: 356-371 (V.P.).

Figure 4a
Western panel of the mosaic in the middle nave of the basilica 2 (pfoto by S. Petrova).

Figure 4b
Eastern panel of the mosaic in the middle nave of the basilica 2 (pfoto by S. Petrova).

6 See: Petrova 2015: 161-184; Petrova 2018: 103-120.

7 In the first period the floors of the exonarthex and room 2 were covered with mosaic panels, and in the second period - the floor of the central nave. V. Popova dates the mosaic in the exonarthex and the mosaic in room 2 in the third quarter of the 5th century. The mosaic in the central nave dates from the time of Anastasius I (491-518) or Justin I (518-527), the end of the 5th or the first quarter of the 6th century. See Pillinger et al. 2016, 370 and cit.lit. (V.P.).

8 The inscription announces that the basilica was built by '…Ioannes, a man reasonable and wise who got the care for the hierarch's throne, and his predecessor was the pious man whose name was 'O…' (Иванов et al. 1969, 140-141). The inscription is not preserved at the southwestern corner therefore the name of the preceding bishop cannot be restored. But it could begin with 'O' or 'C' according to the opinion of the epigraphists (Pillinger et al. 2016: 360 and cit. lit. (V.P.)).

Figure 5
The mosaic floor in exonarthex (photo by V. Vasilev, AM Sandanski).

Figure 6
The northern part of the mosaic floor in room 2 (photo by V. Vasilev, AM Sandanski).

The mosaic pavements of the exonarthex and the naos are placed over a thin mortar layer (3,5-3,6 cm) directly over the layers of the previous existing and ruined massive representative Roman building, without the presence of *statumen* and *rudus*. Only the *nucleus, the bedding layer* and the *tessellatum* can be distinguished very clearly. The preparing of the *statumen* and the *rudus* have been omitted intentionally, and their technological role have been played by the walls of the preceding ruined building. It would be only hypothetical speculations to affirm which namely were the reasons for this: the lack of time, finances or simply the desire to avoid the hard removing of the remnants of the solid Roman building. Most probably this was a casual technological practice and possibility to diminish the volume of work, the time of laying the mosaic and the necessary sum by using the debris and the walls of the preceding buildings, seen also from the example of the Metopolitan basilica of Philippopolis in Thrace (Kantareva-Decheva - Decheva 2018: 230-240 fig. 1).

In our study are published the results of the study of six samples of mosaic tesserae coming from the exonarthex of basilica No 2, i. e. only from the earlier mosaics. The tesserae are made of glass[9], brick and stone. After the mechanical and chemical cleaning of the tesserae, the samples are differentiated by the following designations: T-1(S B-2 en)[10] – a tessera of pale green color; T-2(S B-2 en) – a tessera, yellow-greenish; T-3(S B-2 en) – a tessera, brick-colored; T-4(S B-2 en) – a tessera, white; T-5(S B-2 en) –a tesserae, white; T-6(S B-2 en) – a tessera, black. The methods applied in the research on the samples are: macroscopic and microscopic characteristics[11]; X-ray-diffraction (XRD) analysis[12] and SEM/EDS – elemental analysis[13]. Geological attachment of the material to possible natural sources according to literature data has also been performed[14].

Macroscopic characteristic of sample T-1(S B-2 en)[15]: a tessera of pale green color, of glass to pearl brilliance, and subconchoidal fracture up to uneven surface (Fig. 7). The tessera possesses diverse transparency, from non-transparent up to half-transparent, in separate thin strips. The coloring is mostly mobilized on the horizontal surface of the tessera. It can be observed not the same coloring under the binocular microscopes: from pale green up to almost white main aggregation, with friable dark green spots and points. There are numerous small gas bubbles in the whole mass of the non-colored strips. Under microscope are seen crystal phases. The microscopically sample has the characteristic of an amorphous phase, with abundance of bubbles of different micrometer dimensions, needle-like crystals and rare fine skeletal crystals (Fig. 8 a-c).

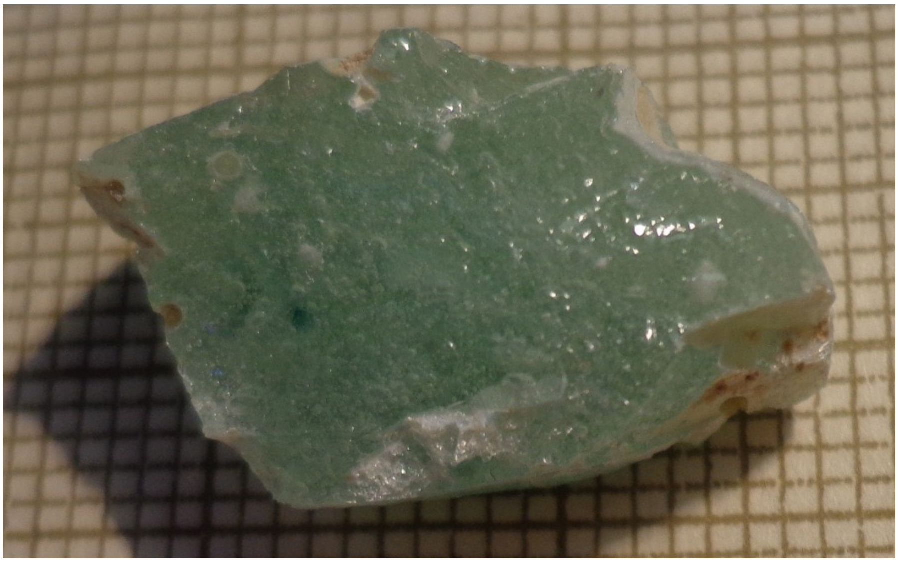


Figure 7
Macroscopic photography of sample T-1(S B-2 en) (photo by D. Yanakieva).

9 The non-transparent glass is known as smalta.

10 (S B-2 en), where S = Sandanski, B-2 = Basilica No 2, en = exonarthex.

11 All the microscope observations are done by polarization microscope Amplival Pol D with camersa ProgRes CT3 of Jenoptic, Germany.

12 XRD analisys of the mineral phases are performed using TUR M 62 difractometer (Germany) whit a standart two-circle goniometer in Bragg-Brentano geometry with secondary graphite monochromator using CuKα radiation (l=0.15418nm) with the following measurement conditions: tube voltage of 32 kV, tube current 15 mA, step scan mode with a step size of 0.02o 2Θ and a counting time of 2 s per step.

13 The analyses are made on the scanning electronic microscope JEOL JSM 35 CF upgrade DISS 5 with Rhoentgen microanalisator of company SAMx. The method applied: EDS.

14 The identification of the sources of the material is done on the base of references to the geological literature. The points of starting were the Map lists and the Description Notes to them of the Geological map of Bulgaria M 1:100 000. The next detail work was done by using publications. The local biding is relative. More correctly, it is done in single cases, when peculiar rocks are exposed in limited areals, or there are well-known quarries or typical deposits with a possible certain correlation.

15 A tessera with dimensions 1x1x0.5 cm.

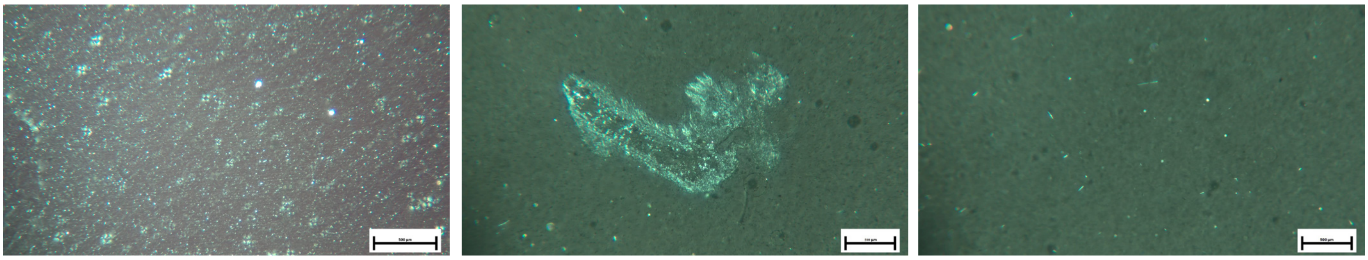


Figure 8a-c
Microscopic photos of sample T-1(S B-2 en): a) amorphous phase with many bubbles – crossed polars; b) amorphous phase with many bubbles and fine crystalline phases – parallel polars; c) skeletal crystal – crossed polars (photos by D. Yanakieva).

The XRD analysis: – the quality one outlines very strongly expressed amorphous halo in the area 20-30^0 2Ɵ, but also the presence of crystal phases (Fig. 9). The analysis reveals the presence of devitrite (56.0%), tridymite (24.8%) and wollastonite (19.2%). The amount of amorphous phase is not taken into account by the method of determination.

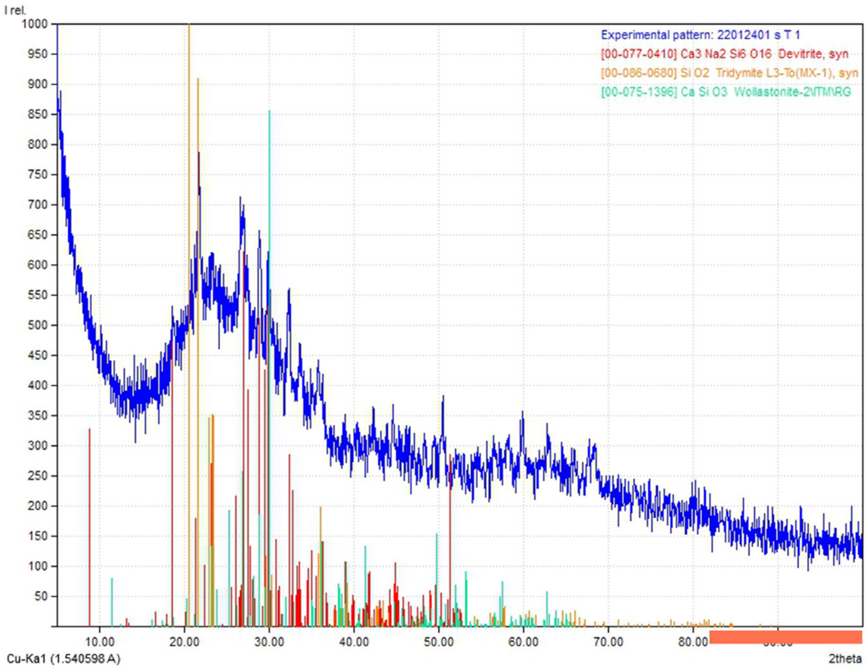


Figure 9
Diffractogram of sample T-1 (S B-2 en) with phase analysis.

The analysis of elements (SEM/EDS) of sample T-1 reveals the presence of the chemical elements: Na, Mg, Al, Si, S, Cl, K, Ca, Cu and Pb. Additional analyses have been done on the surface of another small piece of s.T-1(S B-2 en) with the presence of separate fine black holes (Fig. 10): T-1a (the surface of the tesserae-hole), which showed an increased amount of sulfur, which is evident from the analysis (see Table 1).

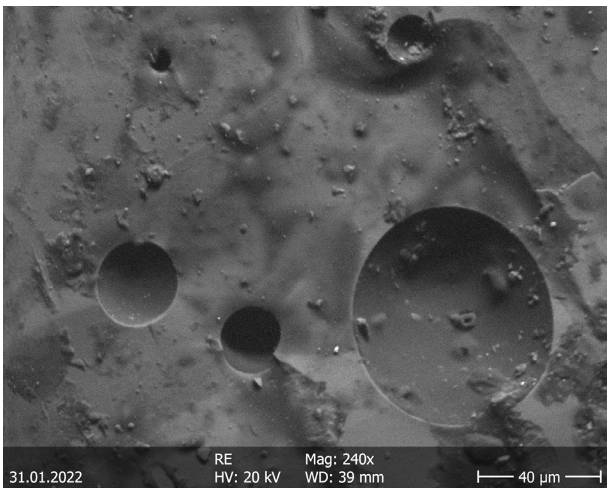
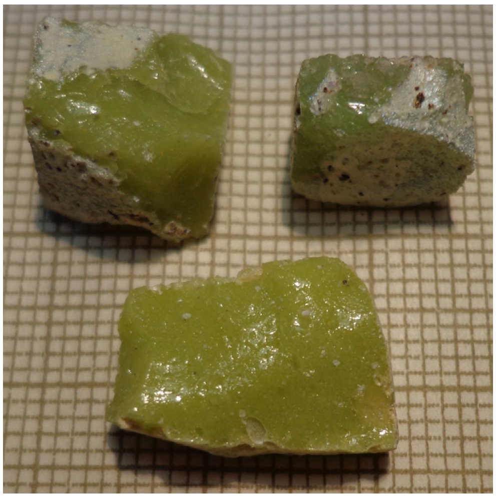
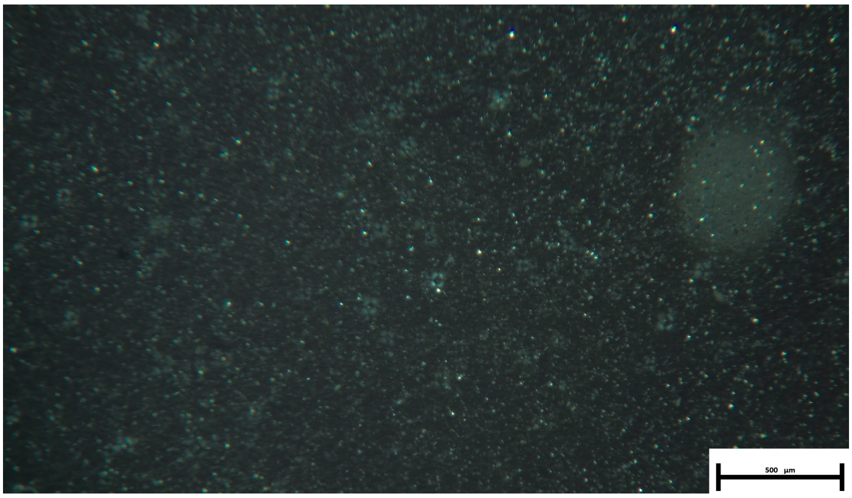


Figure 10
SEM/BSE surface photo - bubbles (photo by D. Yanakieva).

The macroscopic characteristic of sample T-2(S B-2 en)[16] is with yellow-greenish color and from brilliant to lustrous black one. The tesserae are homogenously colored, non-transparent, with conchoidal fracture. The observation under binocular microscopes, over the crushed small pieces (prepared from the samples for analysis), prove that they have absolutely identical coloring and appearance (Fig. 11). The microscopic characteristic of the samples reveal features of an amorphous phase, with the presence of bubbles with micronic dimensions (Fig. 12).The diffractogram of the XRD- analysis outlines a very strongly expressed halo typical for the amorphous phase of the area 20-30^0 2Ѳ. There were no crystal phases (Fig. 13). Quantitative chemical EDS analysis is richer than that after coating the samples with carbon, finding the disappearance of sulfur, chromium and lead from the substances. The information got from the physical qualities, the behavior during the research by polarized microscope and the data from XRD–analysis proves indisputably that the material the tesserae are made is glass. The chemical composition and the relationship of its main elements allow relate the tesserae s.T-1(S B-2 en) s.T-2(S B-2 en) to the Roman glass of the type Na_2O- CaO - SiO_2.





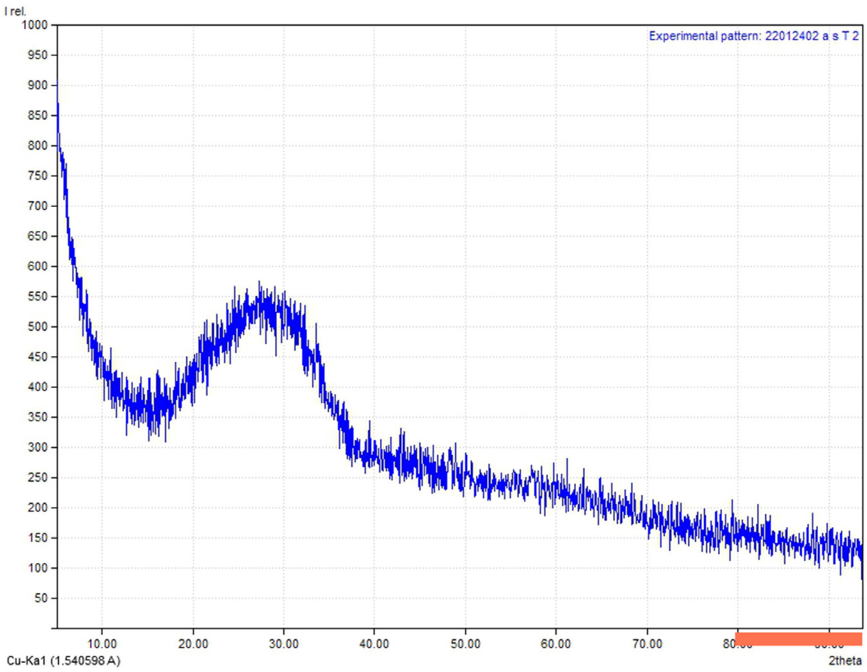


Figure 11
Macroscopic photography of sample T-2(S B-2 en) (photo by D. Yanakieva).

Figure 12
Photomicrograph of sample T-1(S B-2 en): amorphous phase with many bubbles – crossed polars (photo by D. Yanakieva).

Figure 13
Diffractogram of sample T-2(S B-2 en) with phase analysis.

16 Two tesserae, with dimensions 1x1x0.5 cm; 1 tessera with dimensions 1x1x0.25 cm.

Table 1
Quantity chemical EDS – analysis of the glass samples tesserae. General Plate.

	T-1	T-1	T-1a glass	T-1a hole	T-2	T-2
Na_2O	16.28	16.87	12.19	1.49	20.85	20.05
MgO	4.31	4.20	0.89	0.48	1.58	0.91
Al_2O_3	2.47	2.22	3.32	1.29	3.49	3.02
SiO_2	70.46	69.20	65.13	34.64	60.53	60.19
SO_3		0.20	7.52	59.01		0.65
Cl			1.34	1.57	0.91	0.84
K_2O			1.10	0.56	0.63	0.59
CaO	6.48	7.31	7.45	0.98	5.54	6.87
MnO					0.73	1.01
Fe_2O_3			0.62		0.51	1.02
CuO			0.37			
PbO					5.12	4.77
Cr_2O_3						0.06

The presence of S and Cl points to the idea of using in the composition of the natural soda, the trona $Na_3H(CO_3)_2.2H_2O$, with the constant admixtures of thenardite – Na_2SO_4 and halite – NaCl. The fluctuation of the content of Mg and S is obvious. It may be due to the specific of the pre-preparation, as well as to the local processes of non-homogeneity during fusion; it may also reflect secondary processes applied on the surface. The lack of correlation between K and Mg excludes of the usage of plant ash.

It is difficult to affirm in relation to the other chemical differences assuring the particular color and non-transparency in referring Fe, if they are the result of using different raw materials, or have been included additionally for receiving the coloring. Supposedly, Mn is applied additionally for getting the color, and Pb also for the same purpose and the assurance of non-transparency. It may be supposed that the reason of the color of s.T-1(S B-2 en), are the ions of Fe and Cu, and in the case of of s.T-2(S B-2 en) these are Fe, Cr and Pb (Arletti et al. 2006: 28-36; Palomar et al. 2011: 635).

The tesserae s.T-1(S B-2 en) and s.T-2(S B-2 en) are quite different in the structure of forming the material, while the material of s.T-2(S B-2 en) is entirely amorphous (Fig. 14). Sample T-1(S B-2 en) is formed by the combination of an amorphous and a crystal phase - devitrite, tridymite and wollastonite[17].

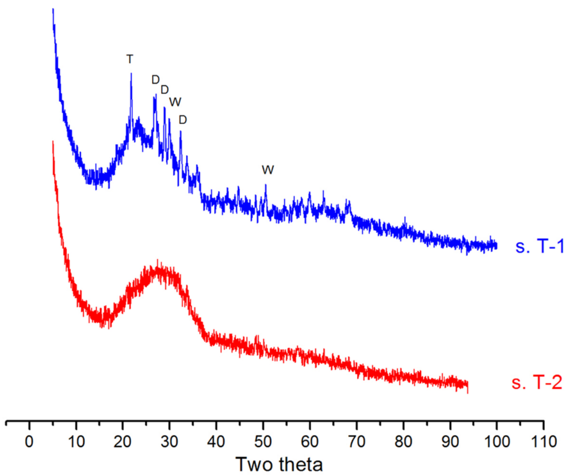


Figure 14
Aggregate graphics from XRD- tesserae analysis s. T-1 и s.T-2. Phase designations: D - devitrite, T - tridymite, W - wollastonite.

17 Wollastonite has a thermal resistance of 1050-1250°.

Principally, the aforementioned crystal phases are among the possible non-wished crystal admixtures during the fusion, forming, heating or secondary work of the sodium-lime-silicate window glass (Georgieva et al. 2003: 145), which is the result of breaking the technology connected with the temperature behavior in some of its stages.

The abundance of bubbles and crystal phases assures to a great degree the non-transparency of the material. In this case, the most logical supposition is that specific conditions have been created for getting the special effect of the non-transparency of the material of the tessera s.T-1(S B-2 en). That means that during the production of glass s. T-1(S B-2 en) intentionally has been applied the technology of elongated period of cooling different from the one of production of glass in the case of s.T-2(S B-2 en). While in the latter s.T-2(S B-2 en) is relied on the chemical processes assuring the non-transparency, in the former s.T-1(S B-2 en) – on the effects in the structure.

The serious differences in the structure of the tesserae s. T-1(S B-2 en) and s. T-2(S B-2 en) give enough ground to suppose the provenance from different production centers or workshops. Can semi-finished glass be considered to come from one or different production centers or workshops? It is not possible to say with certainty whether it is one or several production centers, because the compositions of the main elements - silicon oxide, calcium carbonate and sodium bicarbonate are close.

Then, at the final working of the glass 'cakes' in situ a new heating with a slow cooling is possible, achieving the crystallization we found in s. T-1(S B-2 en). However, the numerous variations of the chemical composition of glass in s. T-1(S B-2 en) are due to its chemical non-homogeinity. Therefore, it can't be excluded the possibility the glass of these tesserae to be of local production, or of a local workshop with more primitive methods of work having in mind the lower quality of the end product, the glass for smalta tesserae.

The second kind of tesserae from the exonarthex are the brick ones – s. T-3(S B-2 en). The macroscopic characteristics reveal a solid brick-colored tessera. The appearance under the binocular microscopes is of a strongly-sanded, fine-sanded and sanded brick (Fig. 15). The microscopic characteristic shows that the sample is built of sand fraction, strongly-sanded in the whole volume, and of clay binder of red color due to the ferrous oxides-hydrooxides (Fig. 16). The relation sand fraction-clay binder is approximately 70%:30%. The main components of the sand fraction are quartz, plagioclase, potassium feldspar and mica (biotite and muscovite). Amphibole and minerals of the epidote group can be observed in a subordinated quantity. Its dimensions are predominantly from 100-200 μm up to the rarer 300-400 μm, and separate ones up to 500 μm.; of different-grained and not sorted kind, mainly ribbed and solid, with separate spores in the clay binder.

Figure 15
Macroscopic photography on a sample T-3(S B-2 en) (photo by D. Yanakieva).

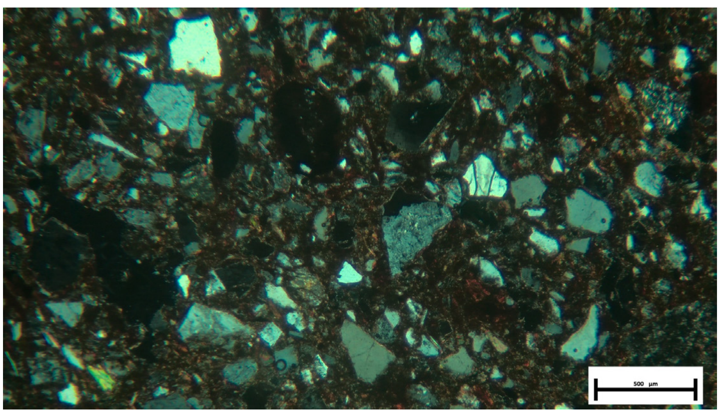


Figure 16
Microphotograph of the sample s.T-3(S B-2 en): pieces of sand and binder in the brick – crossed polars (photo by D. Yanakieva).

Figure 17
Macroscopic photography on sample T-4(S B-2 en) (photo by D. Yanakieva).

From the stone tesserae have been analyzed the one made of white and black stones. The macroscopic characteristic of s. T-4(S B-2 en) reveals from middle-grained to coarse large-grained white rock with massive texture (Fig. 17). The structure is irregular grained granoblastic. The main rock-forming minerals are the dolomite and the calcite, and the accessorial mineral is the mica – muscovite (Fig. 18 a-b).

The calcite-dolomite grains are of different dimensions: from 0,1 mm up to 2,0 mm, thus determing the structure as heteroblastic. Typical are the dynamogennial poly-sinthetian lamels, characteristic of the metamorphic calcite-dolomite. The XRD analysis shows the presence of dolomite and calcite (Fig. 19). The quantitative (half-quantitative) analysis reveals the following relation of the phases: dolomite [97.6% - Ca Mg (C O_3 $)_2$], calcite [2.4% - (Ca C O_3)].

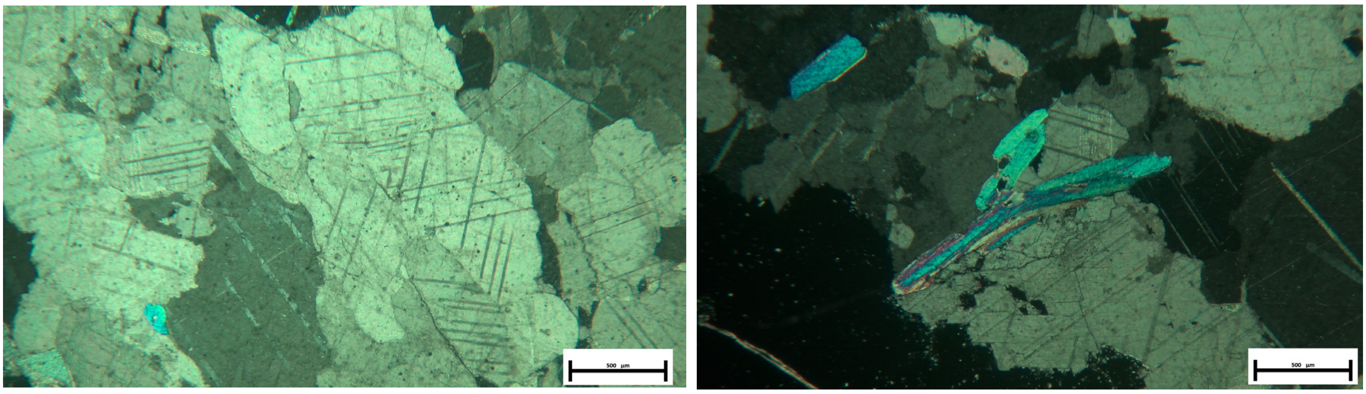


Figure 18
Sample photomicrograph T-4(S B-2 en):
a) dolomite-calcite crystalblasts with sizes from 0.2 mm to 1 mm and characteristic dynamogenic lamellae - crossed polars.
b) flakes of white mica in the center – crossed polars (photo by D. Yanakieva) (photo by D. Yanakieva).

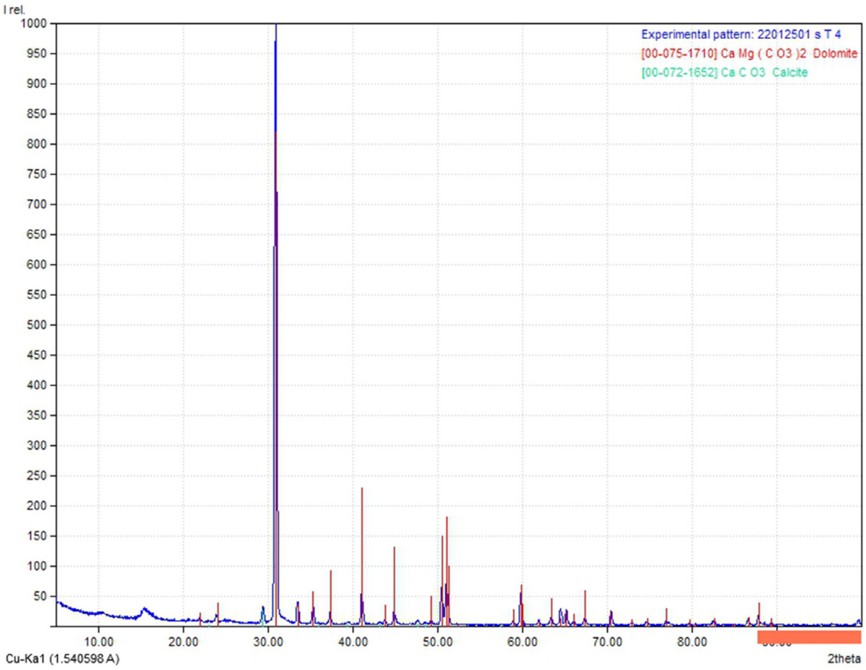


Figure 19
Diffractogram of the sample T-4(S B-2 en).

The analysis of the provenance of the sources of rock material establishes its characteristics: white-snow, with scales of muscovite, small-grained up to middle-grained, made of dolomite-calcite. The marble is adequate to decorative type 'И-1-2' (Petrov 1994: 80), established in the quarries of Ilindentsi, municipality of Strumyani, situated in the massive marbles of the Dobrostan marble formation (Marinova - Zagorchev 1990, k.l. Razlog; Marinova - Zagorchev 1993, k.l. Razlog). In Antiquity, this marble was extracted in 'the quarries of Trajan', the deposit Ermilovets (Petrova 2017: 153-154).

The macroscopic characteristic of s. T-5(S B-2 en) demonstrates white tesserae[18]. They were taken out from a mosaic fragment, then cleaned mechanically and also by HCl (Fig. 20). In appearance, the rock is medium-grained. The texture is massive; the structure is unevenly grained granoblastic. The dolomite and calcite are the main rock-forming minerals. Absent are the accessorial minerals (Fig. 21 a-b).

The calcite-dolomite crystalblasts are of different dimensions: from 0,1 mm up to 0.5 mm, by that determing the structure as heteroblast. Typical are the dynamogenninan poly-synthethian lamels, characteristic of the metamorphous calcite-dolomite. The XRD analysis confirms the presence of dolomite and calcite in the following relation of the phases: dolomite (73.3%), calcite (26.7%) (Fig. 22).

Figure 20
Macroscopic photography on a sample T-5(S B-2 en) (photo by D. Yanakieva).

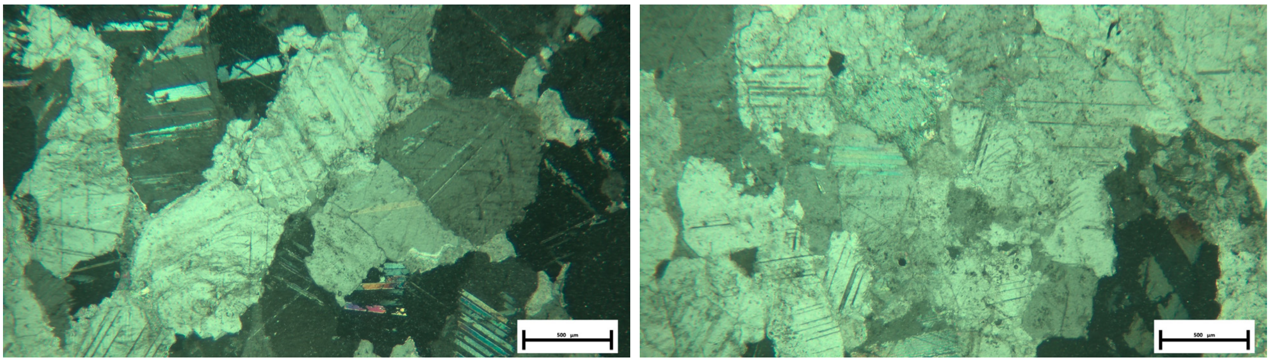


Figure 21
Microphotographs of a sample T-51(S B-2 en):
a) dolomite-calcite crystalblasts with dimensions from 0,1 mm to 0.5 mm and characteristic dynamogenic lamellae – crossed polars (photo by D. Yanakieva).
b) dolomite-calcite crystalblasts with dimensions from 0.05 mm to 0.5 mm and characteristic dynamogenic lamellae - crossed polars (photo by D. Yanakieva).

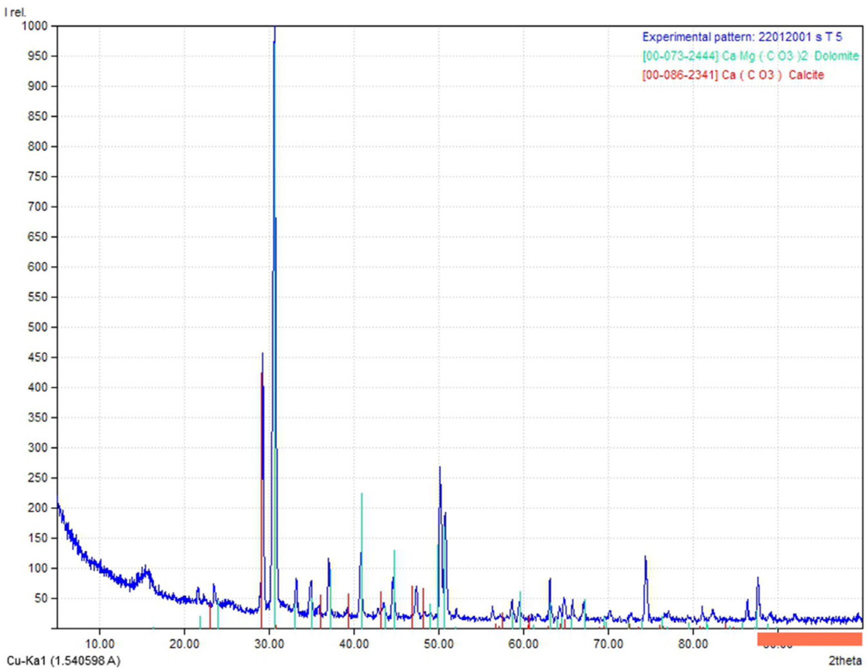


Figure 22
Diffractogram of sample T-5(S B-2 en) with phase analysis.

The indexes of the qualitative chemical EDS analysis and the microscope studies of the sample allow to make the analysis of the initial rock material which can be characterize as snow-white, middle-grained, dolomite-calcite type. The marble of the tesserae corresponds to the decorative type 'И-2' (Petrov 1994: 85-90) established in the quarries of Ilindentsi, municipality of Strumyani, situated in the massive marbles of the Dobrostan marble formation (Marinova - Zagorchev 1990, k. l. Razlog; Marinova- Zagorchev 1993, k. l. Razlog), or the so-called

18 The dimensions of the tesserae 1x1x0.6 cm.

Figure 23
Macroscopic photography on a sample T-6(S B-2 en) (photo by D. Yanakieva).

'Marble quarries of Trajan', deposit Galchovo gnezdo-Gingera (Petrova 2017: 154).

On the ground of the analyses made can be affirmed that both samples s.T-4(S B-2 en) and и s.T-5(S B-2 en) represent dolomite-calcite marbles with a strong domination of the dolomites. The half-quantitative XRD analyses reveal 97.6% dolomite and 2.4% calcite for s.T-4(S B-2 en) and 73.3% dolomite and 26.7% calcite for s.T-5(S B-2 en); however, the EDS elemental analysis reveals almost equal content: 19.57% Mg and 47.88% Ca for s.T-4(S B-2 en) and 19.79% Mg and 47.55% Ca for s.T-5(S B-2 en). The differences among the marbles are most of all in the dimension of the grains and in the presence of accessorial minerals. Middle to large-grained, with the presence of scales of muscovite for s.T-4(S B-2 en), and middle-grained dolomite-calcite marble without accessorial for s.T-5(S B-2 en). The features of both materials correspond to the highly decorative types of dolomite-calcite marbles in the quarries of Ilindentsi, municipality of Strumyani, situated in the massive marbles of the Dobrostan marble formation, the decorative type 'И-1-2' for s.T-4(S B-2 en), and decorative type 'И-2' for s.T-5(S B-2 en).

The macroscopic characteristic of the next tesserae, from the rock material s. T-6(S B-2 en), reveal black (brown-grey-black) tesserae[19]; they are extracted from a mosaic fragment and cleaned both mechanically and by HCl. They look like sandstone (Marinova - Zagorchev 1990, k. l. Petrich; Marinova - Zagorchev 1993, k. l. Petrich) (Fig. 23). It can be clearly seen under the binocular microscopes different in size white grains and brown to black binder with numerous bubble-like holes in it (Fig. 24 a-b). The macroscopic characteristic

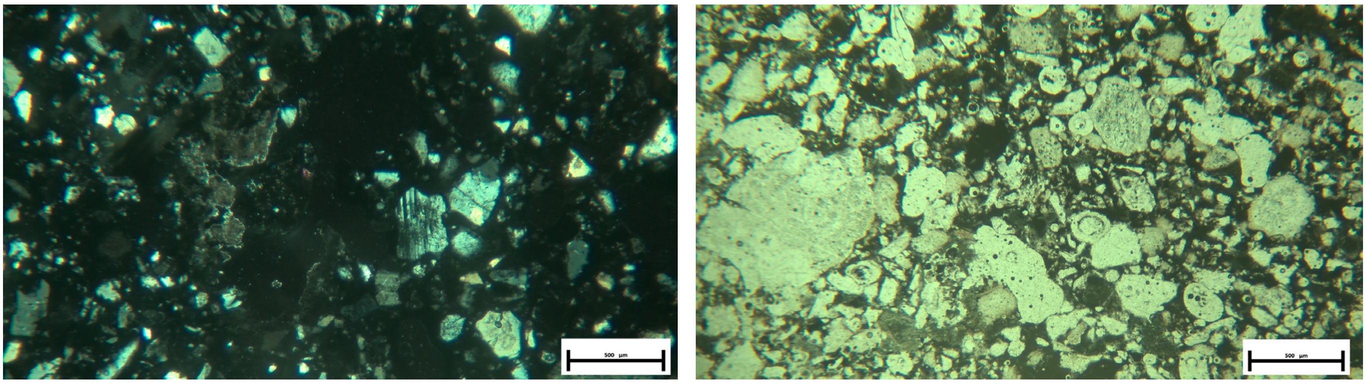


Figure 24
Microphotographs of a sample a T-6(S B-2 en):
a) multi-grained, mainly fine-grained, rounded clast component and irregular pores – crossed polars (photo by D. Yanakieva).
b) multi-grained, mostly fine-grained, rounded clastic component, dominant (90-95%), black-brown binder (5-10%), perfectly round and irregular pores – parallel polars (photo by D. Yanakieva).

determines the sample as sandstone. The clastic fragments dominate in quantity, occupying 80 – 90% of the surface of the thin section. Its dimensions vary strongly: from very fine sand (0,01 – 0,02 mm); through the fine sand ones, correspondently small-grained (0,1 - 0,2 mm), medium sand (0,25 – 0,5 mm), and very rarely grain of coarse sand (0,5 – 1,0 mm). Its forms are irregular, more often rounded and rarely ribbed. The main components of the sand fraction are: plagioclase, potassium feldspar, quartz, mica. The binder is of black-brown-red color, probably due to the ferrous and mangan oxide-hydroxides. It is crypto-grained and indeterminable. The pores are numerous: the round and evenly distributes are dominating, with varying dimensions from 0.05 mm up to 0.1 mm. The quantitative Rhoentgen-Diffraction analysis (XRD) reveals the presence of albite and orthoclase (feldspare), quartz, biotite and goetite (Fig. 25). It is read the presence of an amorphous phase, expressed as halo in the region of 20-30^{0} 2Θ. The quantitative (half-quantitative) analysis reveals the

19 Its dimensions are 1,5x1x0.6 cm.

following relation of the phases[20]: albite (46.5%), orthoclase (22.2%), quartz (20.7%), biotite (5.4%), goethite (5.2%).

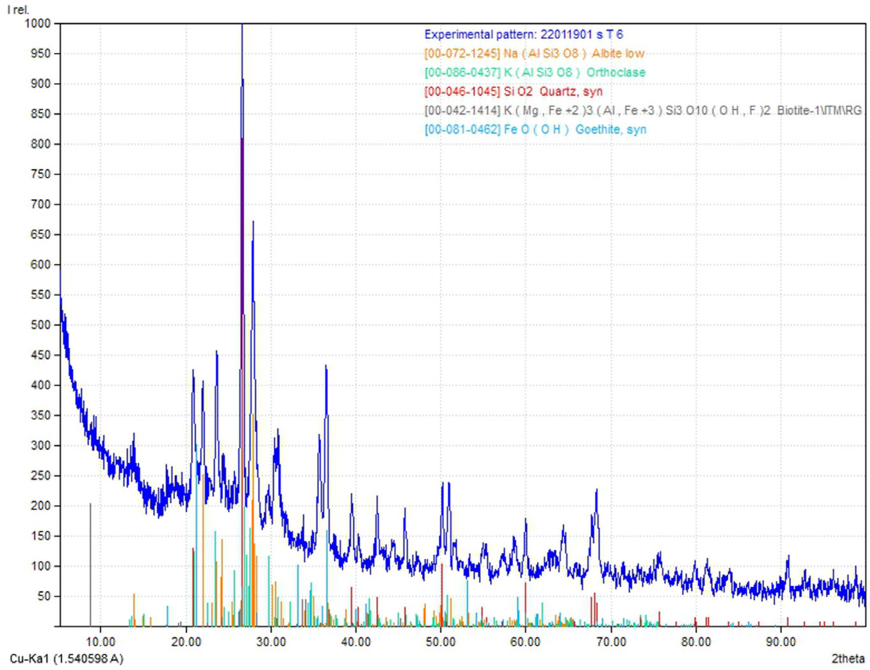


Figure 25
Diffractogram of sample T-6(S B-2 en).

The elemental (SEM/EDS) analyses show: Na, Mg, Al, Si, K, Ca, Ti, Mn and Fe. The material represents black-brown sandstone with a ferrous binder (Fig. 26). The binder is of black-brown-red color, due to the ferrous and mangan oxide-hydrooxides. The element composition reveals a high content of Fe – 4.75%, Mn – 0.17% and Ti – 0.55%. The pores are numerous. The round ones distributed regularly dominate, and the dimensions vary from 0.05 mm up to 0.1 mm. The established characteristic of the material corresponds to the seams of the reddish-brown medium-grained to fine-grained sandstones of the Delchev formation, in the limits of the map list 'Petrich' (Marinova - Zagorchev 1990, k. l. Petrich; Marinova - Zagorchev 1993, k. l. Petrich). The Delchev formation is spreading over a narrow long strip on the left bank of the river Struma, beginning south from Strumyani to south of Damyanitsa (Fig. 27).

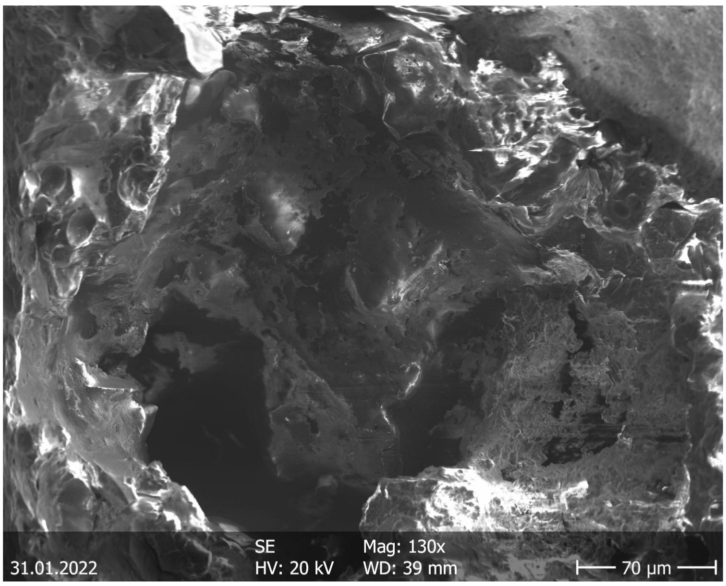


Figure 26
SEM/BSE photos: sample T-6(S B-2 en). Round pores in the sandstone binder (photo by D. Yanakieva).

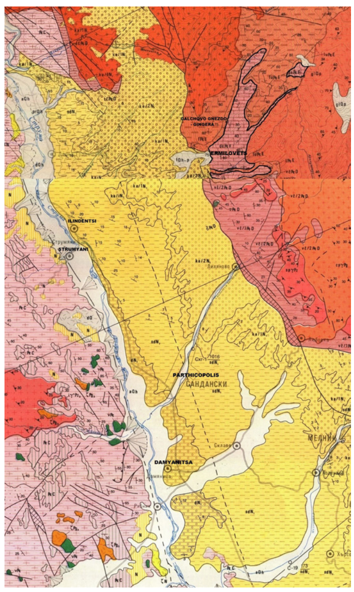


Figure 27
Geological map: Dobrostan marble formation; Delchev formation – sandstone (by S. Petrova).

20 The content of the amorphous phase is not read by the method.

The observations and the analysis of the stone and the brick tesserae from the earlier mosaics in the exonarthex of basilica No 2 established that its provenance is local. In Antiquity, particularly in the Roman and Early Byzantine period in the area of Middle Strymon, several quarries have been exploited with a very good quality of white marble.[21] The quarries at Ilindentsi, or 'the Trajan's quarries', are situated around 12 Roman miles from Parthicopolis (now Sandanski). Up to the present moment the provenance of the sandstone of the mosaic tesserae was unknown, but supposedly descending somewhere from the area of Southwestern Bulgaria. The analysis proved that it comes really from a narrow strip alongside the left bank of the river Struma[22], long around 11 Roman miles. The glass tesserae reveal some particularities in the technology of frosting the glass aiming at receiving its non-transparency. A quarter of craftsmen existed in the western fortified area of Parthicopolis: immediately under the church St. George was excavated a glass tank furnace for making glass vessels, and ceramics from a supposed pottery workshop. Also imported half-manufactured glass pieces have been both excavated, and occasionally found in Sandanski (see Popova 2017: 267-284, Plates: III 1-4, IV 1-4, V 1-10). Such 'cakes' (Popova 2017: Pl. V 5-10) (Fig. 28) or bigger glass half-manufactured pieces have been a subject of trade, brought by sea to Thessaloniki from the ancient glass workshops situated in present-day Egypt, Syria, Lebanon and Israel. Thessaloniki was the most important artistic and trade center of North Greece and Macedonia. From there, by land the route of half-manufactured glass trade passes alongside the river Strymon up to Parthicopolis and higher to the modern town of Pernik and the city of Sofia (ancient Serdica). The 'cakes', colored beforehand, or in the ancient city itself, where the mosaic should be laid, are used for cutting the necessary smalta tesserae, used in the pavement and wall mosaics. In the analysis is also supposed on the base of some more primitive technological features, that some of the smalta tesserae could be prepared by local workshops, not imported.

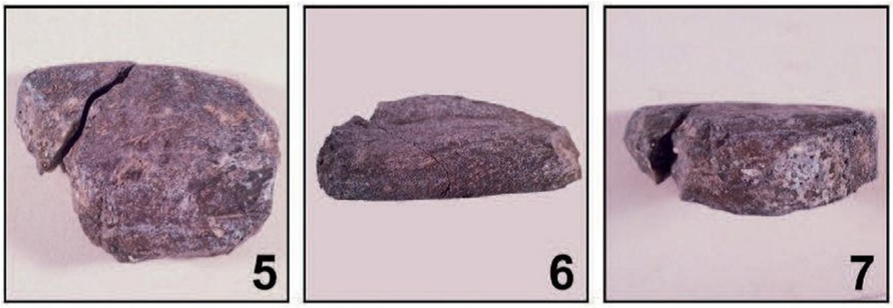


Figure 28
Ingot/cake A from Sandanski (Popova 2017: pl. V 5-7).

In this way, the chemical and structural analyses of the tesserae reveal the provenance of several stone, brick and glass tesserae. The stone material of the most frequent white stone tesserae, come from the local quarries of Ilindentsi. The black sandstone was also local, extracted from a very narrow strip alongside the river Strymon near to Parthicopolis. The brick material is also locally made, which is evident from the mineral composition of the sandy component of the bricks. The half-manufactured smalta was most probably imported from Asia Minor and Middle Asia. In Parthicopolis it should pass through the final working: heated once more in a tank furnace, sometimes additionally colored, then poured out, cooled down, polished and cut into tesserae. We hope that the future research on the stone and mosaic tesserae in rich palette from basilica No

21 'The quarries of Trajan' at Ilindentsi with its deposits and the ones at the village of Petrovo, with its deposits Solishte and Chrevenkovitsa southeast of the site (see Petrova 2017: 152-164).

22 Parthicopolis (and the contemporary town Sandanski) is situated also very near to the left bank of the river Struma.

2, 3 and 4 will enlarge our knowledge on the production and trade of stone and smalta tesserae in Parthicopolis, Macedonia I, and the western parts of the nearly situated Thrace and Rhodope. This is only the beginning of a long study on the mosaic tesserae in Parthicopolis and Southwestern Bulgaria.

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