SUPPLEMENTARY MATERIAL TO

Application of analytical techniques for unveiling the glazing technology of medieval pottery from the Belgrade Fortress

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Serbian medieval glazed ceramics is diverse group of products dated from the first half of 13th century to the middle of 15th century. Archaeological investigations distinguished several workshops on the territory of medieval Serbian state. The earliest workshop discovered so far was in the Studenica Monastery dated at the first half of 13th century. Also, there were workshops in Ras area during 14th century and at the beginning of 15th century, and in Kruševac, Smederevo and Novo Brdo in the first half of the 15th century[1,2]. The relevant locations in medieval Serbia are shown in Fig. S-1.

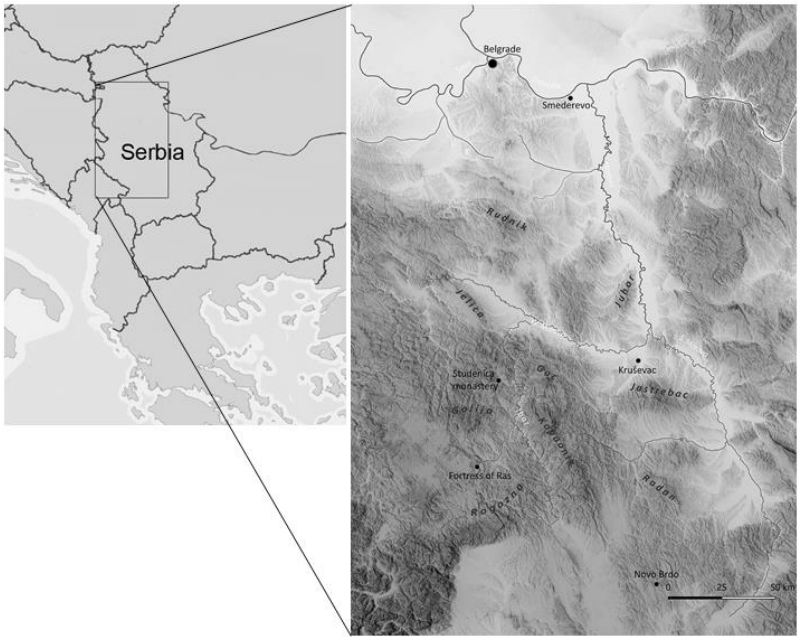
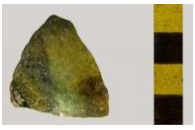
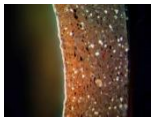
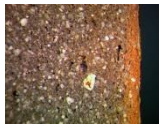
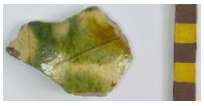
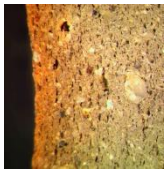
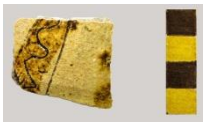
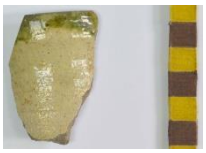
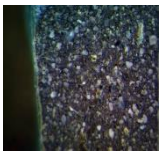
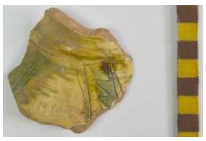
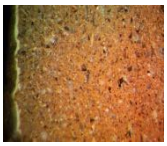
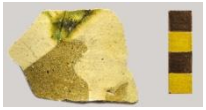
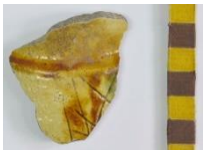
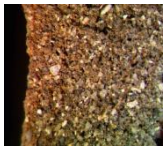
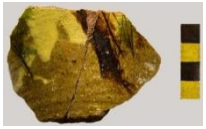
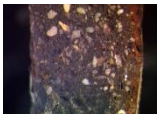
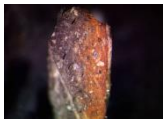


Fig. S-1. Map showing relevant locations in medieval Serbia (drawn by Uglješa Vojvodić)

Table S-I. Photographs and cross sections of the pottery samples (shards of jugs) from the Belgrade Fortress (denoted as BG) and the Studenica Monastery (denoted as S2); groups are based on decoration techniques and colours.

No.	Archaeological clasification	Sample code	Sample Photo Exterior	Cross section
1.	Group I	BG-1		
2.	Group I	BG-2		
3.	Group II	BG-3		
4.	Group I	BG-4		
5.	Group II	BG-5		
6.	Group II	BG-6		
7.	Group II	BG-7		

8.	Group II	BG-8		
9.	Group II	BG-9		
10.	Group II	BG-10		
11.	Group II	BG-11		
12.	Group III	BG-12		
13.	Group II	BG-13		
14.	Group II	BG-14		
15.	Group III	BG-15		
16.	Group II	BG-16		

17.	Studenica Monastery	S2.33		
18.	Studenica Monastery	S2.34		
19.	Studenica Monastery	S2.36		
20.	Studenica Monastery	S2.37		
21.	Studenica Monastery	S2.42		

Archaeological context of pottery. The Belgrade Fortress is multilayered archaeological site and monumental complex which has been changing for almost two millennia: from the first traces of settlements dated Late Stone Age (Neolithic) till the 18th century[3]. Because of very important geopolitical position, at the same location (hill above the confluence of the rivers Sava and Danube) a Roman castrum Singidunum (2nd century) and later Byzantine castel (12th century) were constructed. At the beginning of 15th century, during the reign of Despot Stefan Lazarević (1404-1427), Belgrade became capital of Serbia. It was fortified town where Despot resided in the palace located in thoroughly rebuilt Byzantine castel. Further changes in relief and more complex forifications occured during Austro-Turkish wars (17th-18th cenutry). Fortress was reconstructed three times and became one of the strongest defence points in Europe.

The most significant growth of Belgrade was at the beginning of 15th century, when it became military, political, economic and cultural center of Serbia. Palace with court complex was town's most important part – Castle, protected in different ways by three separate fortifications: Upper Town, Western Suburb and Lower Town. Unfortunately, the parts of the walls and towers of this fortification, as well as buildings located inside, were destroyed in gun powder explosion in 1690[3].

Archaeological investigations of the Castle have been performed between 1963 and 1980, with occasional breaks. Extensive research related to late Middle Age and later periods are still unpublished[4]. However, information about condition, character and content of discovered archaeological unites can be obtained from available field documentation. Archaeological layers from the early 15th century were clearly separated at all investigated areas, but contained limited ceramic material. The most important layer where glazed vessels were found was located above the level of Palace's courtyard. The shapes and decorations of ceramic vessels provide insight into furnishing of the Despot's court.

Description of samples. Group I (BG-1, BG-2 and BG-4) is characterized by fine-grained fabric. The body colours are different shades of red, with uniformly colored cross sections. These samples are decorated in the same way: green, brown and yellow painted motives over white slip and transparent glaze. According to technological and decorative characteristics, this group of samples belongs to pottery produced at the north of the medieval Serbian Despotate at the beginning of 15th century, famous for jugs from nearby Smederevo Fortress[5].

Group II (BG-3, BG-5, BG-6, BG-7, BG-8, BG-9, BG-10, BG-11, BG-13, BG-14, BG-16) is characterized by medium-grained fabric. The body colours are brown, red and grey, uniform at cross sections or rarely with red boundary and brown core (BG-3, BG-5, BG-11). The shards were, contrary to group I samples, decorated by painted sgraffito technique. Characteristics of this technique are incisions of motives in white slip, green and yellow painting and, as the final step, application of transparent yellow or green (olive green) protective glaze. The samples from group II are related to pottery vessels produced in the Ras area during 14th and the first half of the 15th century[6].

Group III (BG-12 and BG-15) is characterized by medium-grained fabric. The body colour is red, uniform at the cross sections. The shards are decorated in painted sgraffito technique. The motives incised in the white slip are highlighted with green and brown colour, and surface is protected by yellow glaze. Even though by overall appearances these samples are similar to samples from group II, based on decoration and colour they are related to pottery produced in central Serbia to supply Kruševac the capital of Prince Lazar and neighborghing town Stalać[7].

Archaeologically significant pottery material found at the Studenica Monastery, the oldest workshop in medieval Serbia, recently has been a subject of archaeometric investigations[8,9]. Five representative pottery samples (S2.33, S2.34, S2.36, S2.37, S2.42) from this material were used in this work for comparison with pottery from the Belgrade Fortress in order to investigate similarities in pottery production. The samples from the Studenica Monastery were shards of painted and sgraffito jugs (Table S-I). They have the highest overall similarity with BG samples from group II, but pottery shards from Studenica have thicker walls compared to BG group II samples. This pottery is mostly of fine fabric and with uniform wall thickness[9,10]. Regarding the petrography, it is the uniform group, made of local raw material[6]. Compared to white painted olive-glazed jugs, which have brown and grayish brown body colour, the sgraffito vessels are red, in several nuances. Green, yellow and brown glazes were applied on the outer surfaces, over a white slip and sgraffito decoration[9,10].

Microstructure. Optical micrographs of polished cross sections can provide information about pottery fabrics and consequently indications about pottery production. The cross sections reveal differences in texture and colour of samples from group I (BG-4) compared to samples from the groups II (BG-5 and BG-8) and III (BG-15). Fine-grained fabric with small inclusions is characteristic of the samples from group I. Other samples (from groups II and III) have quite uniform medium-grained fabric, with rounded, medium-coarse inclusions with noticable particles that have equant angular shape. Micro-Raman spectroscopy revealed that majority of inclusions originate from quartz, which can be present as sediment but also as temper[11]. Voids present at cross sections of all samples may indicate release of the air trapped in clay paste during the kneading and construction process or insufficient and improper drying of the vessels. Uniform matrix colours, red for BG-1 and BG-4 and yellowish red for BG-2, and presence of hematite identifed by micro-Raman spectroscopy indicate firing in oxidizing conditions for

samples from group I[12]. For the samples BG-3, BG-5, BG-11, BG-12, BG-13 outer parts are light red and inner parts are darker different shades of brown, which indicates rapid firing procedure.

The pottery shards from the Belgrade Fortress, the groups II and III, have similar fabric and clay colour to the pottery shards from the Studenica Monastery. The samples from Studenica have medium-grained fabric, but particles are large and have different sizes contrary to samples from Belgrade Fortress which have uniform sizes of particles. The samples have either core darker than the edges (e.g. S2.37) or the bright outer edge and the dark inner edge (S2.42). Cross section of sample S2.34, dark grey core and orange-brown outer margin, indicate a short firing or hasty cooling in air when the vessel is still hot[11].

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