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ANNALES

du 21e CONGRÈS de l'ASSOCIATION INTERNATIONALE pour l'HISTOIRE du VERRE

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efe glass

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Cover image: Roman handle applique found in the Marmaray-Metro Excavations - Istanbul. 4th Century

in memoriam
YOKO SHINDO

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A DIVERSE PRODUCTION METHOD OF GOLD GLASS MOSAIC TESSERAE FROM MEDIEVAL HUNGARY, ROYAL BASILICA OF ALBA REGIA/SZÉKESFEHÉRVÁR

INTRODUCTION

The aims of the study were to present the context and results of the investigation of archaeological mosaic finds which were performed as a part of the author's doctoral research[1]. A diverse production technology was observed through the examination of gold glass sandwiched tesserae. This type was also in use beside the traditional gold glass tesserae containing thin, beaten gold foil between two hot fixed glass layers. The newly detected type of metallic glass tesserae have no gold foil, but gold particles and mercury are present between the glass support and the thin covering glass. The paper contains the details of the observation and mentions some other gilding techniques where mercury is present.

1 KÜRTÖSI 2016, 53–90.

HISTORICAL BACKGROUND

The Royal Basilica of Alba Regia/Székesfehérvár was founded by King Saint Stephen[2] in the medieval Hungarian Kingdom in 1018, after a successful Bulgarian offence. The highlighted city was a significant pilgrim station towards the Holy Land, and it was situated along the most important trade routes as well. The building became the prestigious burial place for three generations of the Royal family and also served for the crowning purposes during centuries.

All the following rulers had vibrant commercial and personal connections with the Venetian and also with the Byzantine court. An important marriage was realized in 1104 under the Kingdom of Coloman (1095–1116) between the Hungarian Piros-

2 The year of 1083 was the date of his canonisation under the reign of I. László (1077–1095).

Fig. 1: Two fragments with detail of female face derived from the mosaic of the former Royal basilica of Székesfehérvár. Now lost. Based on Fig. 49. In: DERCSÉNYI 1943, 135.

ka (widely known as Eirene[3]), and John II. Comnenus.[4]

It is seen that the mosaics – that are preserved only in excavated fragments - of the former Royal Basilica in Alba Regia/ Székesfehérvár were executed during this time, but the exact date is unknown. As the mosaic works in Constantinople was likely made by Greek craftsmen[5], maybe the Hungarian decoration was also realized by these foreign artists. The son of Eirene and John, Manuel Comnenus (1118–1180) placed the Hungarian Kingdom under Byzantine hegemony during the 12th century.[6] It is worth to note the existence of some written sources with descriptions of how the King of Rüms sent mosaic materials, tools and artisans for example to the Ummayad Caliph in Damascus, Syria[7] and he also gave orders to search for mosaic cubes in ruined cities.[8]

The basilica of Alba Regia burnt down several times. During the Ottoman conquest, the building was destroyed. Nowadays, only its ruins and the various findings indicate the former large-scale presence of the building.

EXCAVATIONS AND FINDS

The excavations of the site began in 1862 and were led by Imre Henszlmann, archaeologist. According to the findings the apse of the basilica was probably decorated by sumptuous figural mosaics dated to the 11th–12th century. These findings are significant because they are from the only wall mosaic from the Middles Ages in Hungary. They hide not only the know-how of making mosaics in this time, but include two fragments with details of a life-scale face[9], which show the former dimensions of the representation (Fig. 1).

In addition to the coloured mosaic stones, a large amount of gold tesserae were found, which indicate that the mosaic probably covered a wall or a vault, because fragile metal-foiled glass tesserae were generally not used for floor mosaics. The earliest examples of the use of gold tesserae so far date to the 1st

3 The Greek name means peace.

4 A wall mosaic depicting their marriage can be seen in the gallery of Hagia Sophia/Saint Sophia in Istanbul.

5 Also called Rüm/Rum, a term mainly used for Byzantine Greeks in the Muslim world in the territory of the Balkans and Anatolia. The word comes from the Byzantine Greeks' self-designation as'Romans'.

6 He led two offenses (1151–53, 1163–68) against the country, but he also made efforts towards the diplomatic annexation of Hungary.

7 Al-Walid I. (707–715)

8 References can be found in books of Arab geographers from the 9th–10th centuries.

9 Two fragments - as gifts for the Hungarian National Museum from canon János Pauer - disappeared later. Photo published in DERCSÉNYI 1943, 135. Fig. 49. Firstly mentioned in HENSZLMANN 1864, 90–91. published a drawing of the fragment with eye.

century CE[10]. Sparse appearances are known from the end of the 2nd century CE[11], albeit a few gold tesserae are inserted in the ornamental details of the Lod[12] floor mosaics dated to the end of the 3rd century CE. From the 4th century and onwards gold tesserae were more commonly used. A small number of gold tesserae also appear among the details of the figural floor mosaic finds from Nagyharsány, Hungary.

Fig. 2: Geometric detail from the mural mosaic of the former Royal Basilica of Alba Regia. The item contains two types of metallic tesserae. One of them is quite stable (cross in the middle), the tesserae which form the background all lost the metallic layer and the protective thin glass covering.

Six fragments are displayed in the King St. Stephen Museum exhibition, but there are more (11 pieces) in storage. Some of them are preserved as mortar bed along with inserted tesserae, other fragments are without, but the surface of all the remained mortar finds were fresco-painted with red or black (grey) paint[13]. The bedding mortar is a whitish lime-based mortar[14] containing limestone grains as filler, but neither brick fragments, nor brick powder were present[15].

QUESTIONS

One of the mosaic fragments from the permanent exhibition of the King St. Stephen Museum representing a geometric motif contains two types of composite metallic tesserae (Fig. 2). Only traces of the metal layer can be observed on the surface of the slightly purplish translucent glass support of the tesserae which create / represent the which create the background. In the middle of the mosaic, a cross was made of gold glass tesserae possessing unaltered appearance and stable structure. Observation of the different state of preservation and deterioration processes of the two types of composite metallic tesserae drew attention to the particularity of the find and raised some interesting questions. Why is the firstly mentioned type more sensitive than the second? What are the causes of the quite distinct degradation processes? What are the essential differences between the two types of metallic tesserae?

ABOUT THE STRUCTURE OF GOLD-GLASS COMPOSITE TESSERAE IN GENERAL AND IN THE CONTEXT OF THIS STUDY

The earliest written mention of the art of making gold mosaics is related to the Lucca Manuscript dating to the 8th century CE,

10 NERI and VERITA 2013. Sparse finds are also known from ancient mosaics dating to the 2nd – 6th century.
11 BOSCHETTI 2011
12 Lod, Israel, http://www.lodmosaic.org/conservation-6.html (2014.05.14.)
13 According to the author's examination ((?), the pigments used were iron-based.
14 The general thickness is 1,8–2,5 cm.
15 According to the examination of the thin-sections made by the author. The mortar analyses and the specific stratigraphy can be found in the author's doctoral thesis.

Fig. 3: Among the finds there are a number of detached cartellini (thin covering glass). The fixing of the layers are not the traditional, the preparation method and temperature were probably quite different.

based on Greek tradition.[16] The precious metal sheets hammered to sensitive, extremely thin foils had to be adequately protected from both sides. The thin gold leaf is well protected between the applied two layers of glass.

The medieval masters working in the Royal Basilica of Alba Regia/Székesfehérvár distinguished two types of gold glass tesserae: The traditional type A is composed of three thermally fixed layers, i.e. a poured glass support, a layer of thin beaten gold leaf and a thin layer of blown glass as covering, called *cartellina*. Type B – as defined and tested by the author – consists of a poured glass support, a gold and mercury containing layer, and the *cartellina*. These two main types of gold tesserae can be found in the assemblage under discussion. The base glass of the first type (type A) - following the above-mentioned traditional structure - is translucent and yellow or green. The *cartellina* is completely colourless and transparent. The other type (B) consists of an inhomogeneous, translucent base glass in different shades of mostly purplish-brown and sometimes yellowish colour. Most of the few tesserae of this type are partially or completely detached from the mortar bed. The pale purple or yellowish hued *cartellini* and often the gold layer as well were detached from the glass support (Fig. 3).

The purplish hue of the *cartellina* can be intentional or unintentional; the artisans might have used the same material as that of the base glass or the colour is the outcome of chemical alteration by solarisation. In this case, the originally colourless glass is transformed by the oxidation of manganese and becomes pinkish. Manganese was one of the most commonly used decolourants, but it is not stable. It can be present in different oxidation states in the glass: Mn^{2+} gives a colourless glass, while Mn^{3+} can produce an intensively coloured glass. In some cases, a nearly identical chemical composition (with respect to the manganese) can result in differently coloured glass.[17]

The main result during the research was the detection of mercury among the components of the metal layer of the samples of type B, which indicates a different variation of producing gold tesserae, which is not mentioned in the ancient and medieval written sources.

16 675A, 675B in BURNAM 1920, 83–84.

17 VERITA, SANTOPADRE and DE PALMA 2016, 14.

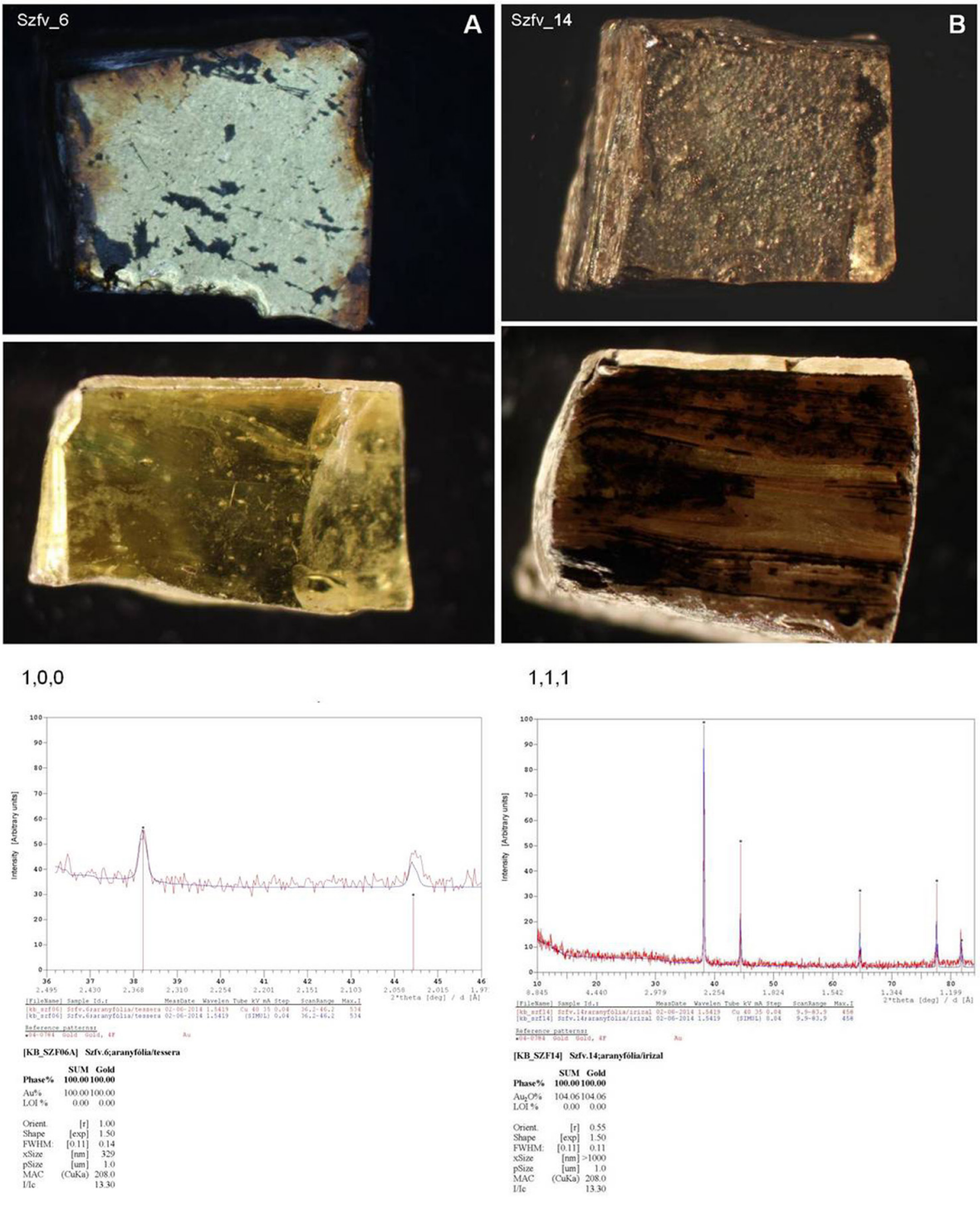

Fig. 4: Surfaces and cross-sections of the samples. XRD examination revealed that the "A" (Szfv6) and "B"-type (Szfv14) metallic tesserae have different crystallographic orientation. This phenomenon indicates that the "A"- type (1,0,0) is a metal (gold) foil, while the "B"-type (1,1,1) cannot be a foil, but that another gilding technique was employed. The different thickness and appearance of the cartellini is quite visible.

Handheld ED XRF analysis of Székesfehérvár (Szfv) metal foiled tesserae (%)														
Sample ident		Colour of glass support	S	K	Ca	Ti	Mn	Fe	Ni	Cu	Zn	Ag	Au	Hg
Szfv14 glass	light purple translucent glass		0,075	**2,642**	**4,99**	0,088	1,451	0,546	0,004	0,008	0,003	<LOD	0,002	<LOD
Szfv14 metal	metal foil	light purple translucent	0,148	1,028	0,61	0,055	**33,207**	**11,153**	**0,167**	**0,215**	**0,414**	**0,387**	**16,949**	**0,97**
Szfv17 metal	metal foil	yellowish translucent	0,457	0,738	0,893	0,077	**6,382**	**1,385**	0,015	**0,031**	0,031	**0,006**	**0,717**	**0,048**
Szfv17 metal	metal foil reverse side	yellowish translucent	0,185	1,039	2,077	0,034	2,954	0,873	0,011	0,017	0,018	0,004	0,103	<LOD
Szfv15 metal	metal foil	light purple translucent	0,527	**1,673**	**2,397**	0,089	0,937	0,597	0,007	0,006	0,008	0,004	**0,131**	**0,008**
Szfv06 metal	metal foil covered by glass (cartellina)	yellowish translucent	0,075	**2,474**	**5,439**	0,191	1,383	0,892	<LOD	0,002	0,002	0,016	0,065	<LOD
Szfv06 glass	yellowish translucent glass		0,065	**2,359**	**5,025**	0,174	1,275	0,825	<LOD	0,002	0,004	0,002	0,003	<LOD
Szfv04 glass	deep purple glass (controll)		<LOD	**2,109**	**2,606**	0,209	**2,618**	**1,858**	0,007	0,01	0,015	<LOD	<LOD	<LOD
SiO standard			<LOD	0,009	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

Fig. 5: Portable ED-XRF analyses of some representative metallic samples from Székesfehérvár. Measurements were performed by István Sajó, (PTE-SZKK).

After the microscopic and micro-chemical analyses XRD and portable XRF [18] measurements were performed. The XRD examination shows that A-type (Szfv6) and B-type (Szfv14) metallic tesserae have different crystallographic orientations. The results indicate that the middle layer of the A- type tesserae – with an orientation of (1,0,0) - is a metal (gold) foil, while that of the B-type tesserae - with an orientation of (1,1,1) – is not a foil, but provides evidence for another kind of gilding technique. A difference in thickness and appearance of the *cartellini of the two types* was also notable (Fig. 4). Also the presence of the mercury implies that another gilding technique was used to make the B-type tesserae (Fig. 5).

Mercury is known to have been used in gilding: In one case, mercury was used as an adhesive, a process known in the literature as cold mercury gilding. The other option is amalgam gilding, where gold powder is mixed with liquid mercury. When applying sufficient heat, the excess mercury, which is the supporting matrix of gold, evaporates. However, it is important to note that this method was generally not used to produce mosaic *lingua* and tesserae (there is no mention of it), but it was a common technique for gilding various metal objects.

At first sight, the at first sight silvery-looking tesserae were originally gold-coloured and gold is the main component of their alloy. The alteration is a reference to the nature of the metal alloy and to the general nature of the manufacturing process. Gold is basically insensitive to atmospheric effects, but the degree of its purity can lead to different behaviour patterns alteration phenomena. The type, quality and quantity of additives can also affect the appearance and properties of gold. It is also mentioned that the character of gold foil has no alteration in contact with nitric mercury oxide, while the colour of a non-genuine moisturized mercury solution first become

18 Measured by István Sajó (PTE-SZKK)

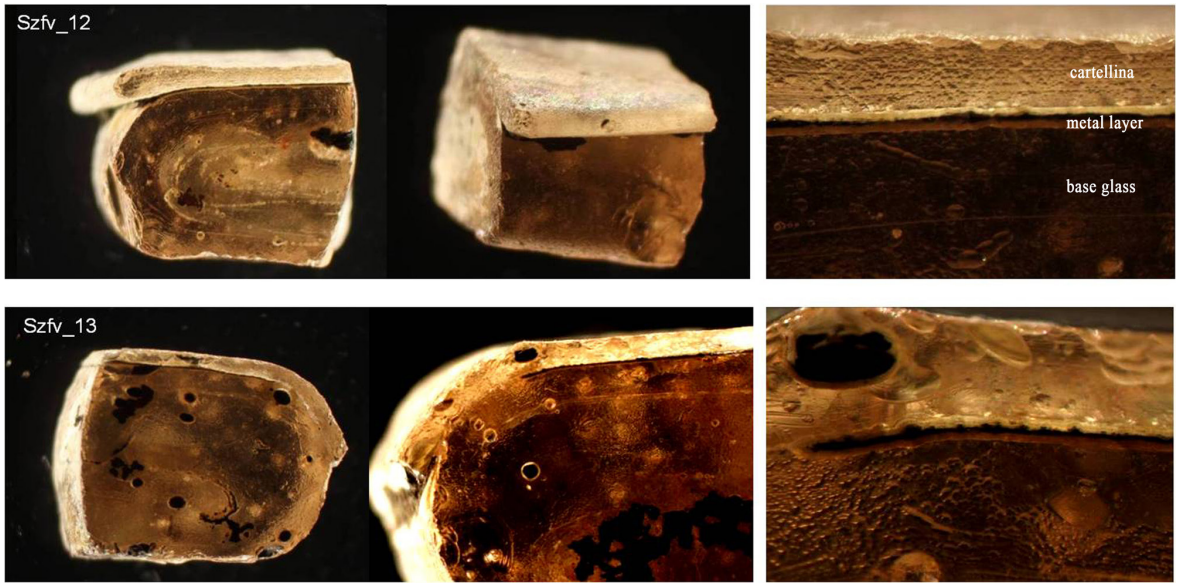

Fig. 6: The rounded edges of the molten glass supports can be seen along with the covering glass sheets which delicately follow the shape of the supports. These two layers are to protect the metal layer in between. The composite tesserae were most likely made at the same time, and the gilding cannot be the result of any contemporary restoration. (samples Szfv12, Szfv13)

white, then turn to dark gray[19]. Not only gold foiled tesserae were used in Székesfehérvár, according to "B" type gold it is presumed that the low-purity raw material and the applied technology can be responsible for the alteration phenomena.

ABOUT SIGNIFICANCE OF THE FINDS

The archaeological assemblage contains a large percentage of the detached thin covering glass sheets, that are evidence of a different manufacturing technique. The possibility of an early restoration was also occured, but all the above mentioned details are in contradiction with this hypotesis. There are mosaic tesserae among the finds, that allow to trace the contemporaneous production of gold sandwich tesserae for the direct use. On these examples, we can observe the rounded edges or rims of the supporting glass along with the thin layer of the glass on the metal which is in between. The thin covering glass layer is spread on the substrate, and follows the shape of the edges of the support. These examples can be the evidence of originality, the contemporaneous and entire creation of the tesserae, and exclude the possibility of re-gilding, which could refer to a later restoration (Fig. 6). The habitus of tesserae described above survived not only as sparse finds but also embedded in the original painted mortar, which are evidence that they were - no doubt - used during the works, when the mosaic was originally created.

This observation is of great significance, because it provides new information for understanding the production techniques of gold sandwich tesserae and it is important, because the perception of the different deterioration processes have drawn attention to the curiosity of the material, which can be stated unique at this moment.

19 HEBING 1997, 26.

MERCURY GILDING TECHNIQUES

Cold mercury gilding

The components are: Kilermeni (Armenian bolus), ochre from Constantinople, Lampezi (red lead = minium (PbO)), Cinnabar (HgS), mercury, egg white, ash of paper. The mixture of the above-mentioned components functions as a glue for the gold foil.

Amalgam gilding

Powder or a fragment of gold is mixed with liquid mercury, the mixture is then applied on the surface and is heated up to 400 °C, so that the mercury can evaporate.

Powder gilding

Gold powder is mixed with an organic binder, then painted on the surface. After this, the binder is let to evaporate by heat. This kind of gilding is known from twelfth-century Iran and was used on glass objects.

Vermeil[20]

The term has a French origin, meaning "red". The term refers to a certain type of gilding technique mainly used on metal objects. It gives a warm, "rosy" shade to the gold. The process was commonly used to gild silver and bronze. During the vermeil gilding process the object was dipped first into a hot gold-mercury amalgam and then into cold water. The result is a reddish-hued gold coating. Other expressions for the Vermeil technique are "*Argent dore*", "*Silver gilt*". Its first mention is known from 1316. The exact technology is disputed; it is possible that powdered mercury ores was used because it is reddish instead of the silvery liquid mercury itself. It might also have been necessary to prepare the surface of the objects before application.

20 THORN 2009, 8.

Summary

The research proved that the finds of the Székesfehérvár mosaic reflect of Byzantine origin in all respects. Important result of the work to put the intact assemblage in international context by the investigation of technology applied. The medieval masters working in the Royal Basilica in Alba Regia distinguished between the traditional gold tesserae and gold mosaic version type B. The main result is the detection of the mercury, which indicates a different variation of producing gold tesserae not to be mentioned in the written sources.

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