Studies in Heritage Glazed Ceramics

On the origin of majolica azulejos production in Portugal

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PREFACE

Studies in Heritage Glazed Ceramics is published twice a year in English by *Laboratório Nacional de Engenharia Civil* (LNEC) and aims to offer researchers a choice peer-reviewed medium for scientific results pertaining to glazed ceramics in general with a particular emphasis on analytical investigation, conservation issues and historical studies and very specially welcoming to multidisciplinary research in the field.

LNEC is presently involved in Project FCT-AzuRe, funded by *Fundação para a Ciência e a Tecnologia* (FCT), the Portuguese Foundation for Science and Technology, and the first three numbers of Studies in Heritage Glazed Ceramics will be dedicated to research results on the origins and early evolution of the production of faience azulejos in Portugal within the scope of that Project.

In the first number, published in February 2019, seven articles covered historical data on the Flemish potter João de Góis, who established a workshop in Lisbon during the 1550s, and studied historically and analytically part of its known output from the mid-1560s to the early 1580s. In this second number the authors continue to explore the production of the workshop of João de Góis and his circle through a formerly unidentified panel or set of panels manufactured in the 1580s that once decorated *Igreja de São Roque* in Lisbon, a fragment of a tile retrieved from an archaeologic excavation, a very interesting panel recently uncovered in the Cathedral of Setúbal, tentatively dated to around 1590, and the panel with the heraldic symbol of Alcácer do Sal dated "1592". Advancing towards the end of the century, the studies deal for the first time with a foreign production: the Sevillian majolica tiles lining *Igreja de São Roque* in Lisbon, dated "1594" and "1596".

The third number of Studies in Heritage Glazed Ceramics will include a final set of papers within this research project. All individual papers are related and call upon each other to describe the inception and early diffusion of the production of majolica azulejos in Portugal. Such close connection advised a single panel of peer reviewers, so that their contributions would maintain a corresponding homogeneity of criteria. The editors are indebted to Professor Nuno Senos of *Universidade Nova de Lisboa* and to Doctor António dos Santos Silva of LNEC, both singularly experienced in the necessary fields, for having accepted the considerable task proposed by the full set of papers that will soon be concluded.

The Editors

SCOPE

Studies in Heritage Glazed Ceramics is dedicated to the results of scientific studies in the field with a particular emphasis on analytical results, conservation issues and historical studies and very specially to multidisciplinary research in the domain.

The contents will include:

- Archaeometry studies, namely the application of analytic methods to the identification of materials and the establishment of technologies, provenance or the setting of chronologies;
- The artistic and historical context of productions, materials and evolving technologies, as well as the origin, preparation and trade routes of pigments and other raw materials;
- Decay of glazed ceramics, techniques and materials for conservation;
- Other innovative research results in the field.

Study of a finding of 16th century azulejo panels at the Cathedral of Setúbal in Portugal

Alexandre Pais, João Manuel Mimoso, Pe. Rui Rosmaninho, Maria de Lurdes Esteves, Sílvia R. M. Pereira, Maria Augusta Antunes, Ana Margarida Cardoso, José Mirão

ABSTRACT

A series of disperse renaissance azulejos with designs outlined in blue against a yellow background, secluded by the basal wall of the altar of the *Igreja de Santa Maria da Graça*, Cathedral of Setúbal, near Lisbon, were recently unveiled. The azulejos were probably once part of a chapel lining that was removed, and some were re-applied here at an unknown date. They were spread without any concern whatsoever about continuity because they were not intended for visibility.

In this paper we attempt a partial digital reconstruction of the painting, showing that it includes the representation of two feminine winged figures, together with flowers and fruits. One of the figures is a young lady with butterfly wings, and the other an elderly woman with bird wings. Both have crowns, although of different sorts.

We also report the results of a first analytical study of the azulejos and discuss their technological and chronological placement in relation to other 16th century panels from the workshops of Lisbon.

RESUMO

Foi descoberto recentemente na Igreja de Santa Maria da Graça, Sé de Setúbal, um vasto conjunto de azulejos renascentistas com imagens delineadas a azul contra um fundo amarelo, que forram interiormente um murete frontal à base do altar, e que se encontram dispostos sem qualquer preocupação de continuidade. Os azulejos podem ter sido parte do revestimento de uma capela da própria igreja, de onde foram removidos numa data desconhecida e, posteriormente, reaplicados no local onde hoje se encontram, sem a preocupação de reconstituir, mesmo que parcialmente, a sequência da decoração.

Neste artigo, tentamos uma reconstituição fragmentária da pintura mostrando que ela inclui a representação de duas figuras femininas aladas, juntamente com flores e frutos. Uma das figuras é de uma mulher jovem, com asas de borboleta, e a outra de uma mulher idosa com asas de ave. Ambas ostentam coroas, embora de tipos diferentes.

Apresentamos também os resultados do estudo instrumental dos azulejos e discutimos a sua inserção tecnológica e cronológica na sua relação com outros painéis do século XVI atribuídos às oficinas de Lisboa.

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KEYWORDS: Renaissance majolica / Setúbal Cathedral / Portuguese azulejos / João de Góis

Acknowledgements

Our sincere thanks to all those who supported the sampling of azulejo panels and archaeologic findings, which contributed to the establishment of the characteristics defining the 16th century productions by the workshops of Lisbon, allowing to discuss the integration of the panel presently studied in a chronologic sequence.

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1. INTRODUCTION

The *Igreja de Santa Maria da Graça* is the cathedral of the old town of Setúbal (ca. 55 km SE of Lisbon). Recently, the local parish priest, Father Rui Rosmaninho, contacted the *Museu Nacional do Azulejo* because of some azulejos extant there. He also mentioned a curious application of odd azulejos lining a hidden wall of which he eventually sent a picture. This led to a major finding of rare 16th-century renaissance azulejos in Portugal: there, secluded by the altar, was a jigsaw puzzle of majolica tiles with images outlined in blue over a yellow background (Figure 1). Probably the azulejos were once part of the lining of a chapel, possibly at this very church, that was removed and 330 tiles and fragments were re-applied here at an unknown date. Their original emplacement remains obscure.

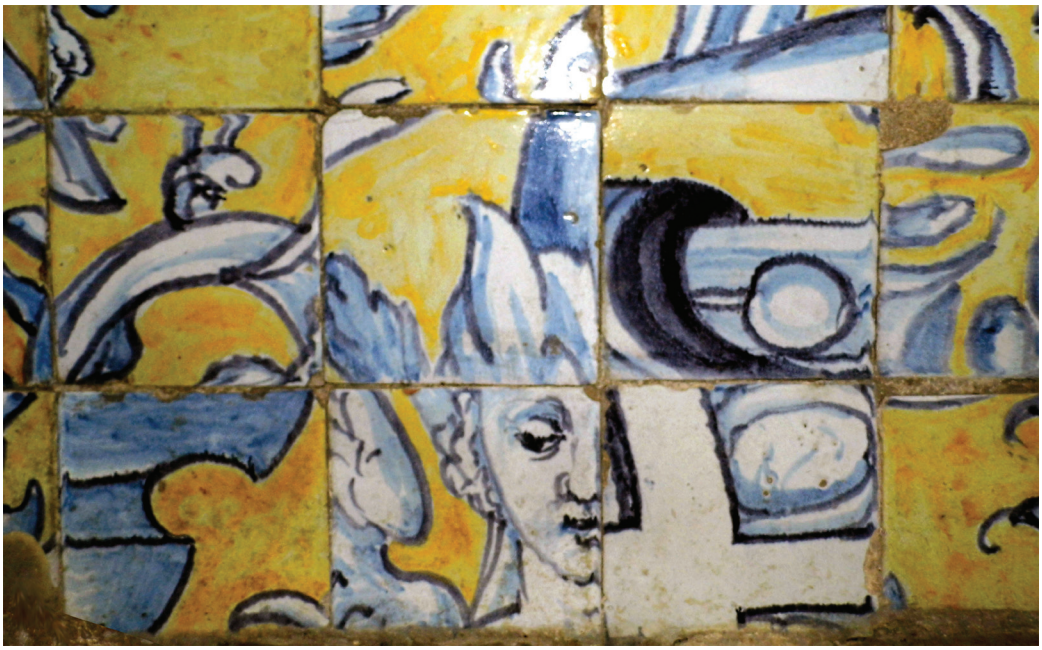

Figure 1. An aspect of the jigsaw puzzle as it was found at the Cathedral of Setúbal

In this paper, we report a partial reconstruction of some of the main motives of the dispersed azulejos, detail the information obtained from an analytical study of samples collected from the tiles and discuss their possible chronology and significance for the history of the early production of faience azulejos in Lisbon.

2. MACROSCOPIC STUDY OF THE AZULEJOS

A visual observation reveals immediately a number of technical issues that characterize these azulejos. The first, and maybe the most striking, is the seemingly poor filling power of the yellow background colour. While at *Capela de São Roque* in Lisbon [1] (also a 16th century production dated "1584" with motives painted in blue against a yellow background) the yellow areas are very homogeneous (right side of figure 4), here the painter did not obtain an acceptable degree of homogeneity (Figure 1). However, a closer look reveals that the problem actually stems more from the sparing use of the paint than

indeed from the maladroitness of the painter. While in *São Roque* the yellow was applied as a full colour, here it seems that the paint was too thin and there are conspicuous stroke markings, while locally there is a superimposition of two or more brush strokes that darken the colour (e.g. in areas of the tiles seen on the left side of figure 1).

Another noticeable issue resides in the frequent running of the blue outlines of the motives (recognizable in several of the azulejos depicted in figure 1). A similar issue was seen in the panel of the dog on the Gospel side of the *Capela de São Roque* lining [1] but in that case, the problem was not as striking as here.

The running of the dense outline paint shows clearly that the tiles were fired in a vertical position and the direction of the dribble indicates the side on which each azulejo so affected stood upright. Indeed, when that side is examined there can sometimes be seen remainders of two small clay rolls on which the tile stood, over firing (Figure 2). It is interesting to notice that the supporting rolls were of a clay that fired to a red colour, while the clay used for the biscuits fired to a lighter buff colour. The presence of the rolls remains discernible in the azulejos, and particularly the unevenness they caused to the side of the tile, leaving unsightly blemishes on the glaze that was never seen in other 16th century productions by the workshops of Lisbon.

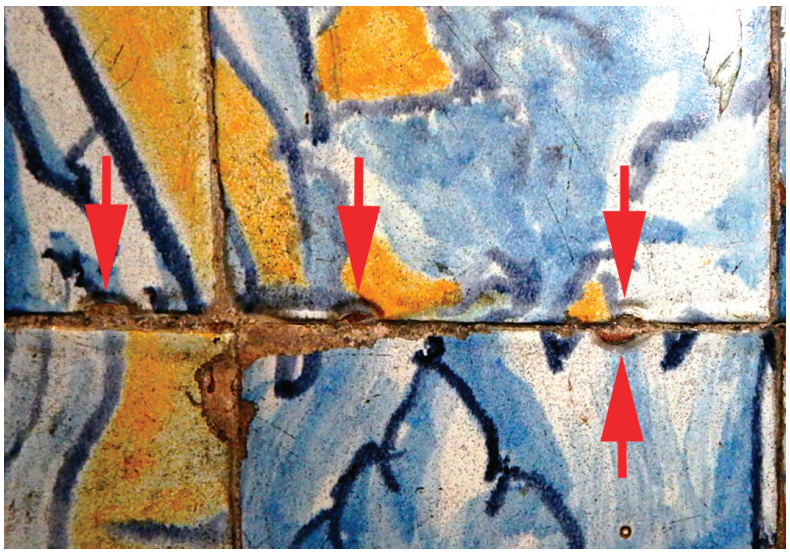

Figure 2. Remains of the clay rolls, under the lower edge, on which the tile rested over firing

3. HISTORICAL CONTEXT AND DIGITAL RESTITUTION OF THE PANELS

The church dedicated to *Santa Maria da Graça* seems to have been founded in 1248 [2]. Through the information obtained by a series of enquiries (called *visitações*) conducted during the 16th and 17th centuries, a possible chronology for the presence of the azulejos may be tentatively established. In 1533, an enquiry noted the bad conditions following an earthquake two years earlier [2]. The same enquiry mentions the widespread use of azulejos in the church, albeit at that time they could only be of the Hispano-Moresque

type, probably imported from Seville. In 1550-52 the church was demolished (*deribada*) and a new building started to be erected following an architectural program conceived by António Rodrigues [2]. The works were still proceeding in 1564/65 but the cathedral was almost finished, according to an enquiry from that period. An important information from this documentation refers that "The Church is finished and the floor will be paved with stone and the walls plastered" (*Ja ser acabada a Igreja mandar se haa lagear e acafear*) [3]. This means that there could be no azulejo panels before 1565. Most works were concluded by 1570, except the retables and parts of the towers [2].

We did not find any information pertaining to the lining with azulejos around this time but should they have been applied one possible location would be the *Capela do Santíssimo* (Chapel of the Holy Sacrament), located on the Gospel side of the transept and from 1586 under the tutelage of Diogo Salema, being the burial site for those of this family. Following an enquiry in 1611 by the *Ordem de Santiago* (the military Order of St. James) the church was described as "a large construction all in stone masonry, (faced) part in stonework, and part in azulejos." (*É uma casa grande, toda de pedra e cal, a parte de alvenaria, e a parte de cantaria, de azulejos*) [2]. The same description states "the *Capela do Santíssimo* has a sacristy, provided for by the Confraternity (of the Holy Sacrament) and the Salema family, well decorated in gold and blue, with its railing on the outside, a door on the west, and glass windows" (*a capela do Santíssimo Sacramento, sacristia, com provimento dos mordomos da confraria e dos Salemas, bem ornada, de ouro e azul, com suas grades por fora, com porta para o poente, com vidraças*) [2]. Putting together these two descriptions one can see that this very rich chapel could be a likely placement for the azulejos, with their painting in blue over a yellow background simulating gold.

The church was much damaged by the 1755 earthquake "being ruined in most parts, especially in the main chapel and the towers" (*ficando arruinada por muitas partes, principalmente na capella mor, e nas torres*) [2]. And this reference leads to another possible original location for the panels. In the enquiry of 1564/65, there is a reference to a burial of human remains in the altar apse [2], a privilege reserved to kings and very few others to whom such privilege (called *provisão régia*) was given. In this case the burial was related to the Cabedo family. Miguel de Cabedo had this exclusive privilege granted in 1565 by king D. Sebastião (1554-1578), because he proved that his mother was already buried in the main chapel of the former church that had been demolished and was under the patronage of his family. The royal privilege not only granted Miguel de Cabedo authorization to be buried in this most holy place in the church but also that his descendants could have a tomb in the main chapel provided he donated a silk garment the church needed. He died in 1577 and because there was a new provision by the king that no grave should be opened in the main chapel for burial purposes his widow had to ask royal permission for her husband to be buried there, arguing no new grave would be opened because his remains would be deposited in one that was already there. And so, in 1578 the king authorized his burial and that of his descendants [2].

For a coming argument it is important to understand who Miguel de Cabedo (1525-1577), also known as Miguel Cabedo de Vasconcellos, was (the following was sourced from [4]). His father was Jorge de Cabedo, ambassador in Paris, and one of his brothers, João Pinheiro, was present as a representative theologian of king D. Sebastião in the Council of Trent. Miguel de Cabedo studied in Bordeaux and then at the University of Toulouse where he developed his knowledge of jurisprudence. Subsequently his studies led him to the Universities of Orleans and Paris, and it was while he studied there (1547) that he made a translation from Old Greek to Latin of Aristophanes' (ca.446 BC - ca.386 BC)

comedy Plutus. He was called to the Portuguese royal court and had several important assignments among them the economical administration of Lisbon. He was so successful at this difficult task that when he died even the townspeople lamented his demise as Father of the People and outspoken defender of its liberty (*como Pay commum e acerrimo defensor da sua Liberdade*) [4, pp. 467]. Besides being a noted jurist, Miguel de Cabedo was also renowned for his classical culture and he was considered a remarkable Latinist poet. Among his celebrated works, the translation of Aristophanes' Plutus was maybe considered the most important. This play is a political satire and reflects that richness is bestowed randomly and not only to the virtuous and pious. Amid the characters of the play is the blind deity of richness, Plutus, and the she-deity of poverty, Penia.

The placement of the azulejos as we can see them today, secluded by a wall under the main altar, could be due to the rebuilding after the cataclysmic 1755 earthquake or else they could have been removed from the walls earlier and replaced by a different adornment. The question that is still without an answer is: what was their original placement? Believing they are from this church and noting they were expensive at the time [5], besides the already mentioned *Capela do Santíssimo*, they could also have been applied in the most important place in the church: its main chapel.

Can the motives that we perceive in these azulejos give us some suggestion of their purpose? We tried a digital reconstitution from what is left and assembled compositions with flowers and fruits (Figure 3) as well as two cornucopias of which the most complete is illustrated on the left side of figure 4 where it may be compared with one of the cornucopias at the *Capela de São Roque*, in Lisbon. Albeit less perfect, this cornucopia is not very different from São Roque's. If the purpose of the panels in *São Roque* was to create an illusory metal railing that simulates a protection for the chapel and where the symbols of the saint can be seen (the dog with a loaf in its mouth, on one side, and a pilgrim's staff, on the other) what could have been the motif for those in Setúbal? We cannot ascertain at the moment the number of original panels, but the presence of two feminine figures (Figure 5) and of also two cornucopias seems to indicate that the panels may have been two, either facing each other, or on both sides of some other feature. The cornucopia is a rather common decorative element in itself, but is also a symbol of the element Earth and of Prosperity, usually associated with deities that grant fortune, such as Plutus.

If what we have here is indeed the remains of two azulejo panels, they would be somewhat narrow and probably the key to understand them lies in the images of the two women, one young and the other old. One might see here an allegory related to time and the frailty of life (butterfly wings) and its briefness (bird wings), a subject that could easily be related with a mortuary chapel. If this interpretation is correct, and we must emphasize it is only a first hypothesis that only the rearrangement of the azulejos based on their backside markings may confirm, then both the main chapel and that of the *Santíssimo* would be appropriate locations. Although there are other chapels in the church that were meant for burials, only these two were made in the period that matches the aesthetics of the azulejos, the main chapel in 1578 and that of the *Santíssimo* in 1586. Another aspect that could support the idea of a more religious background for these panels is the fact that we have two seraphs or winged heads in this set, as well as a butterfly (Figure 6). Their presence seems to reinforce the idea that they could represent a kind of allegory to the frailty and swiftness of the human existence and to the thereafter of the soul.

But if we develop the idea that these panels could be used as decoration of the main chapel, then a relation with Miguel de Cabedo would be likely and the two women in figure 5 could represent Euthenia or Prosperity (the Young Lady) and Penia or Poverty

(the Old Lady), both aspects necessary to the balance of society according to the play *Plutus* that he translated. If this was the case, the representations were suitable for a renowned Latinist, as Miguel de Cabedo is known to have been, and if so a pattern in the commission of the first majolica azulejo panels in Lisbon could emerge: when we start to acknowledge the places with these specific azulejos, an important number of them can be associated to men with a solid classical background. Among them stands Brás de Albuquerque (1501-1581), responsible for the azulejos of *Quinta da Bacalhoa* (in Azeitão) and possibly for the azulejos in *Igreja da Graça* (in Lisbon), and Diogo d'Eça (1530-?) associated with *Quinta das Torres* (in Azeitão). Both estates are not far from Setúbal and are considered two of the most important renaissance sites in Portugal, also renowned for their azulejos from the same period.

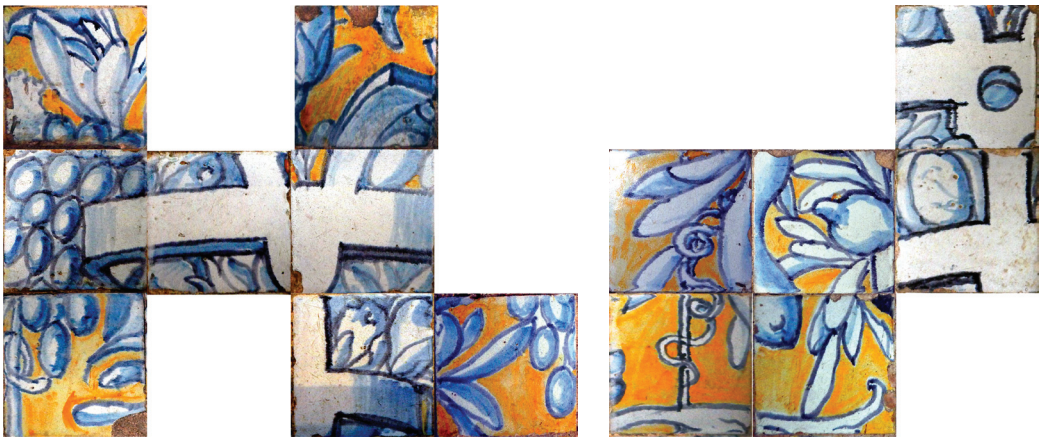

Figure 3. Partial reconstruction of two bundles of fruit

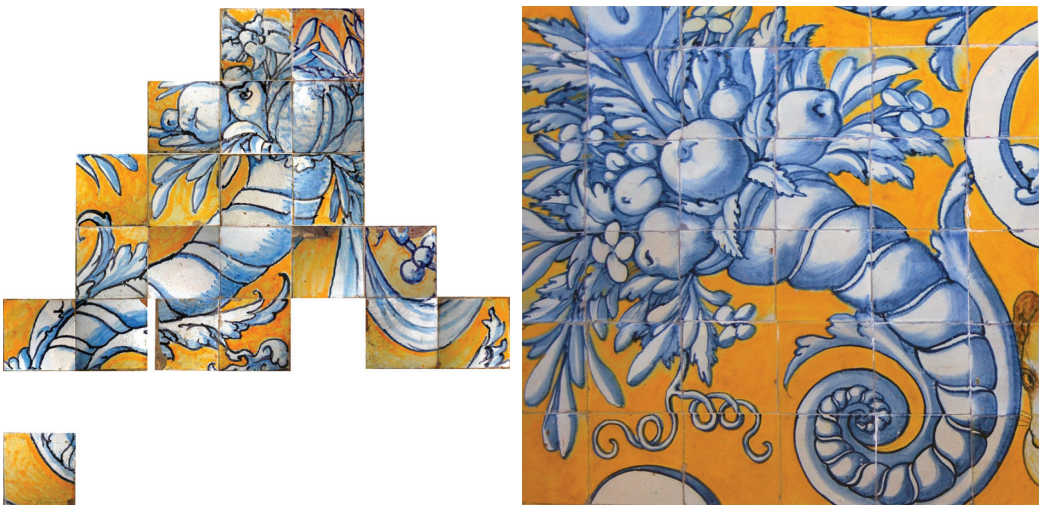

Figure 4. Partial reconstitution of a cornucopia from the tiles found at *Igreja Nossa Senhora da Graça* (left side) and comparison with a similar design at *Capela de São Roque*, in Lisbon (right side)

Figure 5. The two feminine figures (Young and Old Ladies) partially reconstructed from the disperse azulejos

Figure 6. Partial reconstruction of the two seraphs or winged heads, still faceless but the wings and the hair can be seen, and part of a butterfly in the azulejos found in Setúbal

If we consider the hypothesis of these azulejos having lined the *Capela do Santíssimo* - grounded in the fact that in 1611 there were azulejos in the church and this chapel was decorated in gold and blue, exactly the colours of the tiles - we must examine a possible connection with Diogo Salema who instituted the chapel as a burial place for him and his family about which he left precise testamentary instructions in 1586 [6, pp. 162]. The Salema family is connected with the nearby town of Alcácer do Sal and actually both towns were domains of the military *Ordem de Santiago*. There is also an azulejo panel in Alcácer do Sal dated 1592 and their chronology should not be too distant [7]. The purpose and original location of the Alcácer do Sal panel in also as yet unexplained but may be related to the Salema family [7], offering a second possible pattern for the occurrence of azulejo panels in both towns and a tempting research line to be tentatively explored in the future.

4. EXPERIMENTAL

4.1. Samples

The azulejos from the Cathedral of Setúbal were given the reference Az199. The full lining was photographed and the tiles were given individual reference codes. Fourteen samples (Az199/01 to Az199/14) were collected by removing small fractions, preferably of the glaze with biscuit attached, from areas previously damaged. The sampled areas were recorded but the images are not included here because the present amalgamation does not justify them. Table 1 collects information on the samples that were analysed.

Table 1. Samples from the renaissance azulejos of the Cathedral of Setúbal used in this study

Sample reference	Glaze colour
Az199/01	yellow
Az199/03	white
Az199/04	medium blue
Az199/07	white
Az199/08	yellow
Az199/10	white
Az199/11	yellow
Az199/12	medium blue
Az199/13	yellow
Az199/CH	mostly biscuit, with white and blue glaze attached

4.2. Analytical methodology

The azulejo samples were stabilized in resin, lapped and polished to obtain a cross-section for observation and analysis by scanning-electron microscopy coupled with an X-ray energy-dispersive spectrometer (SEM-EDS).

The optical acquisition of images of the sections was obtained with a Leica DFC295 digital camera coupled to a M205C stereomicroscope of the same brand.

SEM-EDS observations and analyses were made at the HERCULES Laboratory in Évora using a Hitachi S3700N SEM with a coupled Bruker XFlash 5010 EDS. The specimens were uncoated and the observations were made in backscattered electrons mode (BSE) in variable pressure mode at 40 Pa and at an accelerating voltage of 20.0 kV. The acquisition of X-ray spectra was done with the detector at ca. 10 mm working distance.

The selection of areas for EDS analysis avoided inclusions in the glaze or biscuit representing more than ca. 5% of the full area analysed. Whenever possible area sizes of ca. 200 x 200 μm for glazes and 500 x 500 μm for biscuits, or larger, were used but acceptable repeatability was verified in areas four times smaller. For comparison purposes, only the elements usually representing the major components were considered, excluding tin (Sn) in the glazes and lead (Pb) in the biscuits due to their variability with the area chosen (in the case of Sn in the glaze because of crystal aggregations and in the case of Pb in the biscuit because the content increases with proximity to the interface). The results of the EDS analyses were given in weight % of each element considered. The amount of oxygen was calculated through the remaining elements stoichiometry of their most commonly considered oxides and the results were normalized to 100%.

Principal Component Analysis (PCA) of EDS results was made using the SPSS© software platform by IBM Analytics.

4.3. Results

4.3.1. Morphological characteristics

Figure 7 illustrates microscopic images of two of the sample sections prepared. The colour of the biscuits varies from yellow-cream to buff. No coperta (a transparent glaze layer sprinkled on top of the painted glaze) was used over the painting.

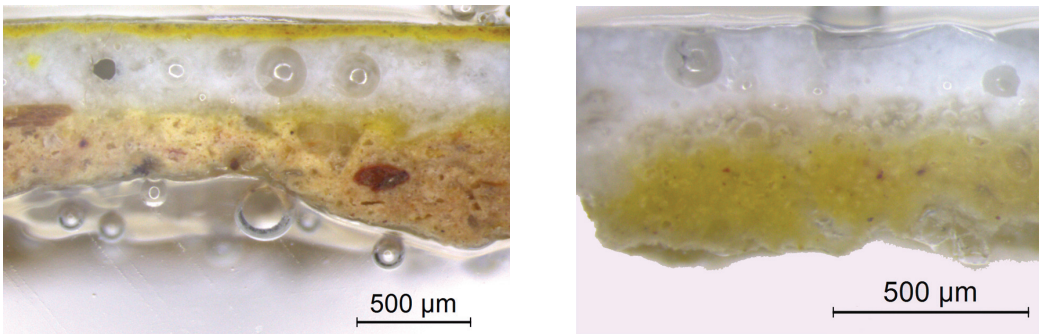

Figure 7. Prepared sections in optical microscopy - Az199/01 (left) and Az199/03 (right)

Figure 8 illustrates SEM images of samples Az199/01, Az199/10 and Az199/CH that exemplify the main micro-morphologic characteristics generally associated with the glazes of these azulejos: relatively few inclusions (grains of sand), occasionally none at all, and an interface glaze-biscuit with many crystals of neo-formation.

All the sections bearing both glaze and biscuit are morphologically similar.

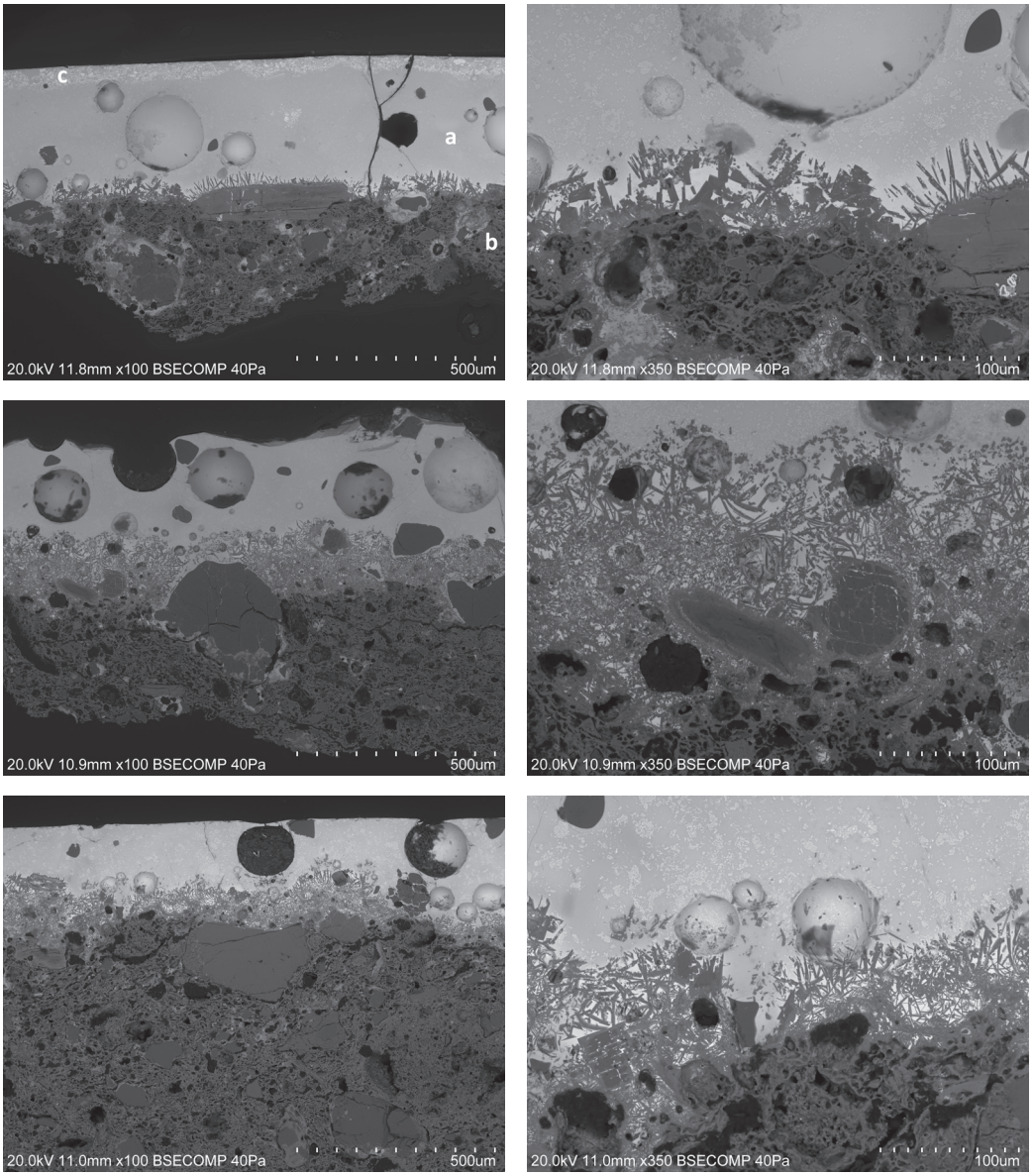

Figure 8. SEM images of samples Az199/01 (top), Az199/10 (middle) and Az199/CH (bottom) exemplifying the main micro-morphologic characteristics generally associated with the glazes of this panel (a – glaze; b – biscuit; c – yellow pigment)

4.3.2. Yellow pigment

A grain of yellow pigment from sample Az199/01 (left side of Figure 9) was analysed and the pigment found to be, not Naples yellow, but rather a tin-antimony-lead yellow as shown by the semi-quantification by EDS (Table 2) and spectral counterpart (right side of Figure 9). Besides the elements present in the matrix, the simultaneous high contents in Sn, Sb and Pb confirm the use of a tin yellow pigment (approximate proportions Sn:Sb are 1:2).

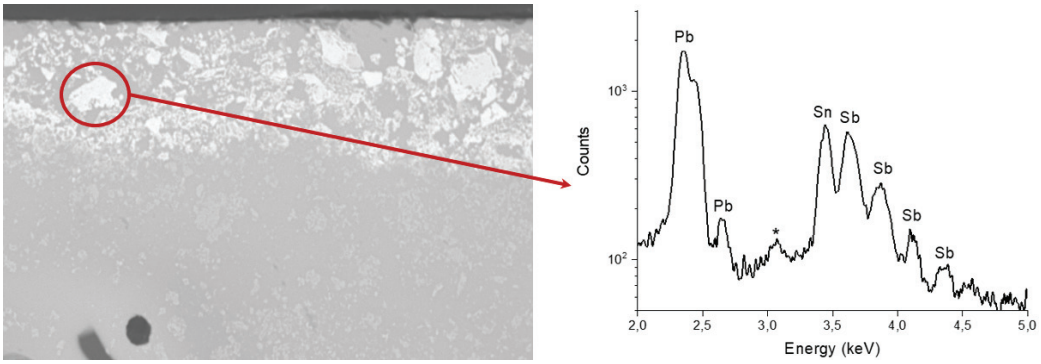

Figure 9. Selection of a grain of yellow pigment in Az199/01 (left side) and relevant part of the EDS spectrum of the yellow pigment in logarithmic scale confirming the presence of tin in the colour (the peak marked "*" is an artefact resulting from the analytic technology used)

Table 2. Semi-quantitative composition of a grain of yellow pigment in Az199/01 (wt.% of the elements normalized to 100%)

Az199/01	Al	Si	Fe	Sn	Sb	Pb	O
Yellow	0.34	2.23	0.69	9.11	18.14	53.78	15.71

4.3.3. Glaze composition

Table 3 includes the semi-quantitative results of analyses of the glazes by EDS in weight %. Sn was excluded for the reasons pointed out in section 4.2. The ratio between Si and Pb (the main components of the glaze) was determined and is also included in the table.

Table 3. Semi-quantitative composition of the glazes determined by SEM-EDS (weight of oxygen and main elements, excluding Sn, for comparative purposes normalized to 100%)

Samples	Na	Mg	Al	Si	K	Fe	Pb	O	Si/Pb
Az199/01	1.69	0.68	2.84	18.78	2.30	0.63	44.00	29.09	0.43
Az199/03	2.50	0.78	3.86	21.39	2.95	0.73	34.99	32.80	0.61
Az199/04	1.60	0.60	2.32	20.38	1.80	0.78	42.33	30.20	0.48
Az199/07	1.73	0.69	3.07	18.88	2.30	0.72	43.21	29.41	0.44
Az199/08	1.41	0.66	3.33	18.37	1.77	0.84	44.64	28.98	0.41
Az199/10	1.93	0.93	3.26	18.98	2.34	0.91	41.74	29.90	0.45
Az199/11	1.82	0.61	2.99	18.66	2.07	0.56	44.25	29.03	0.42
Az199/12	1.97	0.84	3.24	19.46	1.86	0.78	41.64	30.22	0.47
Az199/13	1.77	0.71	3.87	18.84	2.16	0.82	41.81	30.02	0.45
Az199/CH	0.78	0.72	3.46	21.51	2.23	0.97	38.17	32.15	0.56

4.3.4. Biscuit composition

Table 4 includes the semi-quantitative results of SEM-EDS analyses of the biscuits of which there was a sufficient area. The results refer to oxygen and eight other elements of higher content and particular interest for comparison purposes. Pb was detected in all cases but excluded for the reasons pointed in 4.2. The results are given in weight % and the table also includes the ratios between the main components of the biscuit - Ca and Si.

Table 4. Semi-quantitative composition of the biscuits determined by SEM-EDS (weight of the main elements corrected to 100%)

Samples	Na	Mg	Al	Si	K	Ca	Ti	Fe	O	Ca/Si
Az199/01	1.29	1.96	7.36	18.90	1.76	22.87	0.57	3.91	41.37	1.21
Az199/07	1.22	2.12	7.84	17.93	1.62	23.50	0.56	4.12	41.08	1.31
Az199/08	1.16	1.72	7.79	20.19	1.73	20.95	0.62	3.66	42.17	1.04
Az199/10	1.35	2.17	7.51	17.03	1.44	25.77	0.67	3.54	40.53	1.51
Az199/12	1.64	1.69	8.02	20.78	2.14	19.06	0.56	3.63	42.48	0.92
Az199/13	1.34	1.72	7.58	20.00	1.55	20.87	0.54	4.39	42.02	1.04
Az199/CH	1.39	1.46	8.68	20.92	2.27	18.17	0.61	3.75	42.74	0.87

4.4. Principal Component Analysis

4.4.1. Glazes

Figure 10 shows the results of a log-based PCA of the glazes considering the analytical results in Table 3, together with samples from known works used here for comparative purposes: *Igreja da Graça* (Graça I and Graça II corresponding to its two phases), the panel *Nossa Senhora da Vida*; *Capela de São Roque* [8] and the already mentioned panel from Alcácer do Sal [7], through a plot in the plane of the two first principal components (PC1 and PC2). PC1 explains 46% of the variation and is controlled in the positive sense mostly by the contents in Al, Si and K (possibly derived from the integration of quartz and potassium feldspars) and in the opposite sense by the content in Pb. PC2 explains 24% of the variation and is controlled in the positive sense mostly by the contents in Na and Mg and in the opposite sense mostly by the content in Fe (as seen in the loadings plot of Figure 11).

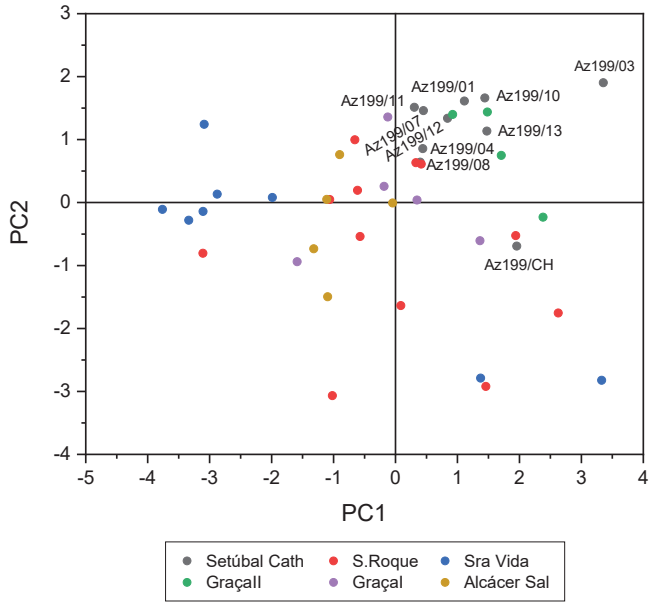

Figure 10. Score plot of the PCA of the glazes of Setúbal Cathedral (Az199) with other 16th century panels

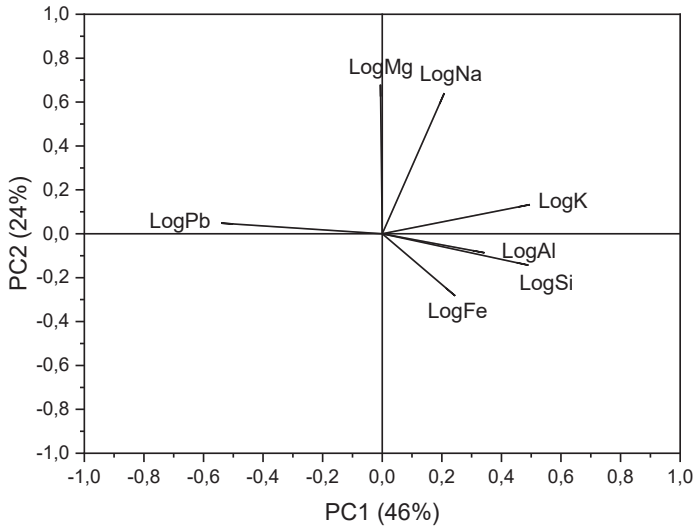

Figure 11. Loadings plot of the PCA of the glazes

4.4.2. Biscuits

Figure 12 shows the results of a log-based PCA of the biscuits of all samples, considering the analytical results in Table 4 together with the samples mentioned above, through a plot in the plane of PC1 and PC2. PC1 explains 42% of the variation and is controlled in

the positive sense by the contents in Al, Si and K and in the opposite sense mostly by the contents in Mg and Ca. Through PC1, the panels from Setubal, Graça II and Alcácer do Sal are separated from the remaining, meaning that they were probably produced from marls with higher contents in Mg and Ca. PC2 explains 26% of the variation and is controlled in the positive sense by the contents in Na, Mg, Al, Ti and Fe and in the opposite sense by the content in Si (Figure 13).

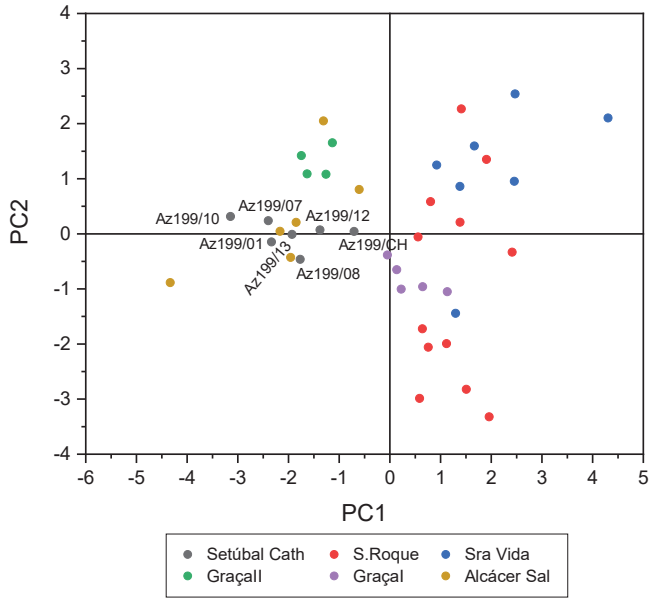

Figure 12. Score plot of the PCA of the biscuits of Setúbal Cathedral (Az199) with other 16th century panels

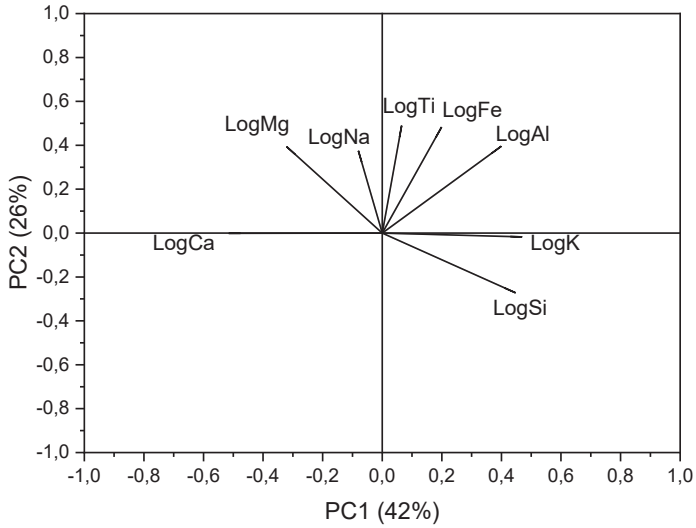

Figure 13. Loadings plot of the PCA of the biscuits

5. DISCUSSION

5.1. Technology

The SEM images of the glaze sections and their interfaces with the biscuits (Figure 8) can be compared with corresponding images of samples obtained from panels attributed to João de Góis or his circle [8]. The comparison strongly suggests a similar preparation of the components and a comparable firing practice, resulting in a few untransformed grains of sand often remaining in the glaze and a very noticeable growth of neo-formed feldspar crystals in the glaze-biscuit interface [9].

The use of the unusual Sn+Sb+Pb yellow pigment corresponds to what was already found in other panels stemming from the circle of João de Góis [8, pp. 129-130]. The same pigment was also found in the Alcácer do Sal panel [7].

Yet, and surprisingly given the aforementioned, a visual observation immediately reveals a general lack of quality in the azulejos under discussion, both as pertains to the manufacturing technique and the painting of the yellow background colour. The reason for this apparent contradiction cannot be presently affirmed but only hypothesized.

5.2. Clustering

The PCA of the glaze compositions (Figure 10) does not allow a clear separation of the Setúbal panel from other productions of the João de Góis circle, even though it points to a particular closeness to Graça II, the presumed second phase of the panels at *Igreja da Graça*, resulting from marginally higher contents in Na and K. However, the results presently available are not sufficient to affirm a clear individualization and, until more panels are studied and taken into account in the comparison, the glazes must all be considered similar regarding their composition.

The results of the PCA of the biscuits (Figure 12) is different and may help shed light on the chronology of Setúbal because it clearly separates it from panels presumed on firm grounds to have manufactured before 1585 (the first phase of *Igreja da Graça* – Graça I, the panel *Nossa Senhora da Vida* and the *Capela de São Roque* lining) [1; 8; 10] and groups it with the still undated second phase of *Igreja da Graça* (Graça II) and very closely with the Alcácer do Sal panel dated "1592".

6. CONCLUSION

The panels of the Cathedral of Setúbal are quite unique for their seemingly rather ordinary quality, particularly when compared with such technical and artistic achievements as the *Capela de São Roque* lining and the panel *Nossa Senhora da Vida* [1; 10]. It is tempting to allocate them to a still obscure time around 1560 and before the lining of *Igreja da Graça*, when João de Góis was learning and perfecting his trade. But are there firm grounds for such a proposition? There is a limit beyond which instrumental methods cannot, by themselves, be affirmative and a fair degree of assurance depends of the work of the historian, without which there is no solution in sight. The historical fact that the Cathedral of Setúbal was reconstructed and the work was not concluded before 1565

suggests that, if the azulejos were originally lining some part of the church, as they likely were, they should not pre-date the fine panels of *Igreja da Graça* and therefore cannot be an early work by João de Góis.

The recovery of the main motives (Figures 3-6) shows that the design now reconstructed was by no means ordinary. As mentioned before, the inhomogeneity of the yellow background painting that, more than anything else, imparts an impression of lesser quality, stems probably from the sparingly use of the paint, either because the pigment was very expensive, or because its stock was low. Therefore, it too may be unrelated to the quality of the output of the workshop. Finally, we come to the running of the blue colour and the vestigial presence of some clay rolls that supported the tiles during firing. These are, indeed, detrimental attributes but if the panel was not fired in the workshop itself, but rather at a kiln where faience from several producers was fired together, as it possibly was, then maybe the problems stem mostly from the work of those operating the kiln, not the potter's workshop. Still, we could expect a quality workshop to substitute by better replicas those tiles most affected by the running of the blue colour and particularly the single tile with the face of the Young Lady (see figure 5) in which the problem is very conspicuous.

Whatever the economic or technical limitations that resulted in the rather incongruous aspect of the panels of which the dispersed tiles found in Setúbal are just a part, and although the morphological and compositional similarities found in the glaze point to the technical circle of João de Góis, the shortcomings that were never seen in his known productions point to the early, unsure, steps of a different workshop, possibly started by one of his apprentices, rather than to a late production of his own. However, even if unlikely, it is within the realm of possibilities that the as yet undetermined departure or death of its master [11] may have left the workshop of João de Góis deprived of its full technological skill and artistry.

Can these azulejos represent a preliminary to the similar lining of *Capela de São Roque* dated "1584"? Analytics can dismiss such a hypothesis: the biscuits of *São Roque*, as those of Graça I and *Nossa Senhora da Vida*, are characterised by low Ca/Si ratios, typically under 0.50 [8, pp. 126] while here the ratio is typically over 0.90 (Table 4) and similar, namely, to the Alcácer do Sal panel dated "1592" [7]. Finally, we come to a likelier hypothesis: that the dispersed azulejos at the Cathedral of Setúbal are an attempt inspired by the lining of *Capela de São Roque*, tentatively copying its intricate floral designs, maybe heralding the beginnings of a workshop at some time after 1584.

Then, the Setúbal panel or panels should be datable to the late 1580s or to the 1590s. An attribution to this period may one day be confirmed by the finding of azulejo remains in their original emplacement or by documental evidence, but such a chronology would fit better a connection with Diogo Salema who was alive in 1586 [6, pp. 162] and the *Capela do Santíssimo*, than with Miguel de Cabedo, who died in 1577. And because Salema's exacting testamentary instructions drawn in 1586 [6, pp. 162] do not refer azulejo panels, the decision to order them would presumably have been made after that date, maybe after having seen the lining of *Capela de São Roque* in Lisbon.

The likelihood that a new workshop may have been established around this time, of which this panel or panels represents an early effort, to compete with that of João de Góis and/or of Francisco de Matos [1] is enticing and opens new prospects for the study of the production of faience azulejos in Lisbon as the 16th century was coming to a close.

BIBLIOGRAPHIC REFERENCES:

1. MIMOSO, J. et al. – *A research on the azulejo panels of the São Roque chapel in Lisbon* in Studies in Heritage Glazed Ceramics, No. 1, pp. 93-112, LNEC, Lisbon, February 2019. ISBN 978-972-49-2307-9.
2. NOÉ, P. et al. – *Santa Maria da Graça de Setúbal* at the national database for architectural heritage –SIPA.00002149, 2013. Available at: http://www.monumentos.gov.pt/Site/APP_PagesUser/SIPA.aspx?id=2149 (Acc. 09/2019).
3. ARCH. NAC. TORRE DO TOMBO, *Visitação a Setúbal efectuada por Estêvão de Brito, Comendador de Panóias e de Faro, e por Mestre Gaspar, Prior da Igreja de Santa Maria da Graça de Setúbal*, (1564/1565), in "Ordem de Santiago e Convento de Palmela, liv. 202" ref.: PT/TT/OSCP/B/003/00202.
4. MACHADO, D. – *Bibliotheca Lusitana, Historica, Critica, e Cronologica*, Vol. III (Miguel Cabedo de Vasconcellos in pp. 467-469), Oficina de Ignacio Rodrigues, Lisboa, 1752.
5. SENOS, N. – *Os lugares dos azulejos* in "From Flanders- the azulejos commissioned by D. Teodósio I, 5th Duke of Braganza (c. 1510-1563)", pp. 30-41, Museu Nacional do Azulejo & Fundação da Casa de Bragança, Lisboa, 2012.
6. NÓVOA, R. – *O Arquivo Gama Lobo Salema e a produção, gestão e usos dos arquivos de família nobre nos séculos XV-XVI*, PhD Thesis, Universidade Nova de Lisboa, 2016.
7. MIMOSO, J. et al. – *Instrumental study of the 16th century azulejo panel decorating a public fountain in Alcácer do Sal - Portugal* in Studies in Heritage Glazed Ceramics, No. 2, pp. 19-34, LNEC, Lisbon, November 2019. ISBN 978-972-49-2310-9.
8. MIMOSO, J. et al. – *A technical comparison of three renaissance azulejo panels from the workshops of Lisbon* in Studies in Heritage Glazed Ceramics, No. 1, pp. 113-132, LNEC, Lisbon, February 2019. ISBN 978-972-49-2307-9.
9. MOLERA, J. et al. – *Interactions between Clay Bodies and Lead Glazes*, Journal of the American Ceramic Society, May2001, Vol. 84, No. 5, pp. 1120-1128.
10. PAIS, A. et al. – *The 16th century azulejo panel called "de Nossa Senhora da Vida"* in Studies in Heritage Glazed Ceramics, No. 1, pp. 67-76, LNEC, Lisbon, February 2019. ISBN 978-972-49-2307-9.
11. PAIS, A. et al. – *The beginning of the production of majolica azulejos in Portugal – João and Filipe de Góis in 16th century Lisbon* in Studies in Heritage Glazed Ceramics, No. 1, pp. 1-23, LNEC, Lisbon, February 2019. ISBN 978-972-49-2307-9

Instrumental study of the 16th century azulejo panel decorating a public fountain in Alcácer do Sal - Portugal

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ABSTRACT

The public fountain at *Largo Prof. Dr. Francisco Gentil* in the town of Alcácer do Sal (65 km SE of Lisbon) is decorated with a square panel of 81 azulejos with a heraldic symbol of the Municipality. The panel is particularly important in the Portuguese context for bearing an inscribed date (1592), being the only Portuguese dated panel yet known from that decade. Another interesting feature is the text it bears: "SALATIA UBRS IMPERATORIA" referring to the Latin designation of the town in Roman times.

The panel has been generally considered of Portuguese manufacture by art historians and in this paper we report the results of an analytical study confirming that, indeed, it is a product of the workshops of Lisbon. Therefore, its micro-morphologic and compositional characteristics offer a chronologic anchor that may help to assign an approximate date to other azulejo panels or related archaeologic findings.

RESUMO

O fontanário no antigo Largo Prof. Dr. Francisco Gentil em Alcácer do Sal (65 km a sudeste de Lisboa) é decorado com um painel quadrado de 81 azulejos com um símbolo heráldico do Município. O painel é particularmente importante no contexto português por ter a data inscrita (1592), sendo o único até agora conhecido desta década. Outra característica interessante é o texto nele inscrito: "SALATIA UBRS IMPERATORIA" referindo-se à designação latina da cidade na época romana.

O painel tem sido geralmente considerado de fabricação portuguesa pelos historiadores de arte e neste trabalho relatamos os resultados de um estudo analítico do qual se conclui que, de facto, é um produto das oficinas de Lisboa. Assim, as suas características micro-morfológicas e composicionais oferecem uma âncora cronológica que pode ajudar a atribuir uma data aproximada a outros painéis azulejares ou a achados arqueológicos.

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KEYWORDS: Renaissance majolica / Alcácer do Sal azulejo heritage / João de Góis / Early Portuguese azulejos

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1. INTRODUCTION

The public fountain at *Largo Prof. Dr. Francisco Gentil* in the town of Alcácer do Sal (65 km SE of Lisbon) is decorated with a square panel of 81 azulejos with a heraldic symbol of the Municipality (Figure 1). Given the fact that its frame is not closed below, the panel may have been set over a pre-existing architectural structure, or else may be missing at least one lower azulejo row.

Generally considered of Portuguese manufacture [1; 2], the panel must have been originally better protected from the elements, as testifies the progression of its decay suffered over the last sixty years perceived by comparing the present condition with its condition ca. 1956 (Figure 1).

Figure 1. The panel in 2018 (top) and ca.1956 (colourised photo reproduced from [1])

The panel is particularly important in the Portuguese context for bearing an inscribed date: "1592", eight years after the signed and dated panel at *Capela de São Roque* in Lisbon [3]. It also bears the text "SALATIA UBRS IMPERATORIA" tentatively following the Latin designation "SALACIA IMPERATORIA URBS", the name of Alcácer do Sal in Roman times [4].

The date inscribed in the panel is separated in two parts by one of the symbolic castles and may also be transcribed as "IS / 92" instead of "15 / 92" because the graphic representation of the numerals changes, suggesting that the first two characters could also represent the letters "IS". The use of a dot over the numeral "1" is known in the field – at *Capela do Espírito Santo* in Évora, the panels of the Main Chapel are dated "1631" with both "1" numerals in the date superimposed by a dot [5, plate LVI]. However, here, there is a difference: the characters are purposely positioned to be separated in two groups of different calligraphy by the castle, suggesting a double entendre proposition on the observer representing, for instance, the initials of the workshop master or the person who commissioned the panel, while the date "92" may relate to an event of importance to the community of Alcácer or to whoever ordered the azulejos. In such case the panel may actually have been manufactured later than the date inscribed.

There is a general absence of references to this panel in terms of bibliography before the 20th century. However, reading an important collection of books published in 1873 about the history, chorography, heraldry, (etc.) of all the towns and villages of Portugal [6], there is a striking information regarding this particular municipality: "water is abundant in the whole region of Alcácer do Sal – however, inside the town proper there is no fountain!" (*É o termo da villa abundantíssimo de águas – mas dentro da villa não há fonte nenhuma!*). From this information we conclude that this fountain and its panel were not in place at their present site before circa 1873, the date when the book was published. This seems to be confirmed by the fact that the author makes a point of mentioning heraldic aspects and, although azulejos were so common that they were not considered worth mentioning in themselves, he would expectedly not go without noting a panel bearing the coat of arms of the town if it was publicly visible at its center. The first reference we found to the panel is in the second edition of Vergilio Correia's work on dated azulejos [7]. He does not mention any source, giving the impression that the panel was only recently identified. The notion of novelty is strengthened by the fact that he used a line drawing (dated "1921") of the panel for the cover. His list of dated azulejo panels was originally published in 1915, in a journal [8], but the panel was not mentioned at that time, even though the journal of the Archaeologist's Society, of which the author was a member, published frequent articles on Alcácer do Sal and its antiquities, the earliest and most complete of which in its first year of publication [9], and it is not likely that a panel of epigraphic interest would go unmentioned. Seemingly, the panel was applied at its present location between 1915 and 1921 but, unfortunately, none of the references yet found mentions its provenance.

Another interesting aspect that the author of the books published in 1873 mentions when describing the most important figures and events of the region is a reference to one Rui Salema (act.1537-1578). This nobleman built the Salema Manor that still stands not far from the fountain and, with his wife Catarina Sotomaior, is connected with the foundation of both the hospital in Alcácer do Sal and the Clarissa Convent of *Nossa Senhora de Aracoeli* [10, pp. 157-159]. Rui Salema had several brothers, one of which was Cristóvão Salema. Cristóvão Salema fathered Diogo Salema who in 1586 founded the second most important chapel in the Church of *Santa Maria da Graça* in Setúbal, the *Capela*

do Santíssimo [10, pp. 161-164]. The set of dispersed azulejos recently found in that church and tentatively dated to the late 1580s or 1590s may have been related with *Capela do Santíssimo* [11] and, if so, the Salema family could be involved in the purchase of both the Setúbal and the Alcácer do Sal panels. Rui Salema had died childless in 1578 but other members of the same family, whose name is connected with Alcácer do Sal since an early time, were active, including a cousin, João Salema, who returned from Ceuta precisely in 1592 [10, pp. 141-151].

On the other hand, the coincidence of family relations and the presence of early contemporaneous azulejo panels, maybe even from the same workshop, in both Setúbal and Alcácer do Sal, may well be fortuitous, but at least offers a starting point for a future investigation.

In this paper, we report the results of an analytical study of the Alcácer do Sal panel relating it with other 16th century azulejo panels by the workshops of Lisbon.

2. EXPERIMENTAL

2.1. Samples

The azulejo panel was given the reference Az334. Seven samples were carefully collected from the panel by removing small fractions, preferably of the glaze with biscuit attached, from areas already with previous damage. Each sample was identified with an alphanumerical code added to the panel reference (e.g. Az334/01). The sampling locations are shown in figure 2 and were intended to be representative of the whole panel.

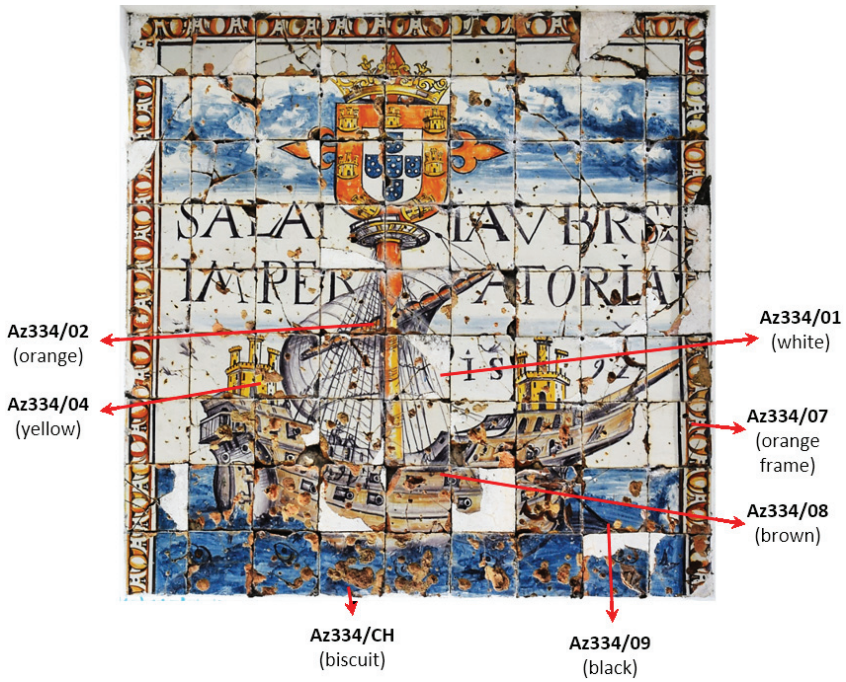

Figure 2. Sampling locations and sample references

2.2. Analytical methodology

The azulejo samples were stabilized in resin, lapped and polished to obtain a cross-section for observation and analysis by scanning-electron microscopy coupled with an X-ray energy-dispersive spectrometer (SEM-EDS).

The optical acquisition of images of the sections was obtained with a Leica DFC295 digital camera coupled to a M205C stereomicroscope of the same brand.

SEM-EDS observations and analyses were made at the HERCULES Laboratory in Évora using a Hitachi S3700N SEM with a coupled Bruker XFlash 5010 EDS. The specimens were uncoated and the observations were made in backscattered electrons mode (BSE) in variable pressure mode at 40 Pa and at an accelerating voltage of 20.0 kV. The acquisition of X-ray spectra was done with the detector at ca. 10 mm working distance.

The selection of areas for EDS analysis avoided inclusions in the glaze or biscuit representing more than ca. 5% of the full area analysed. Whenever possible area sizes of ca. 200 x 200 μm for glazes and 500 x 500 μm for biscuits, or larger, were used but acceptable repeatability was verified in areas four times smaller. For comparison purposes, only the elements usually representing the major components were considered, excluding tin (Sn) in the glazes and lead (Pb) in the biscuits due to their variability with the area chosen (in the case of Sn in the glaze because of crystal aggregations and in the case of Pb in the biscuit because the content increases with proximity to the interface). The results of the EDS analyses were given in weight % of each element considered.

Principal Component Analysis (PCA) of EDS results was made using the SPSS© software platform by IBM Analytics.

2.3. Results

2.3.1. Morphological characteristics

Figure 3 illustrates microscopic images of two of the sample sections prepared. All biscuits are of a buff colour. No *coperta* (a transparent glaze layer sprinkled on top of the painted glaze) was used over the painting.

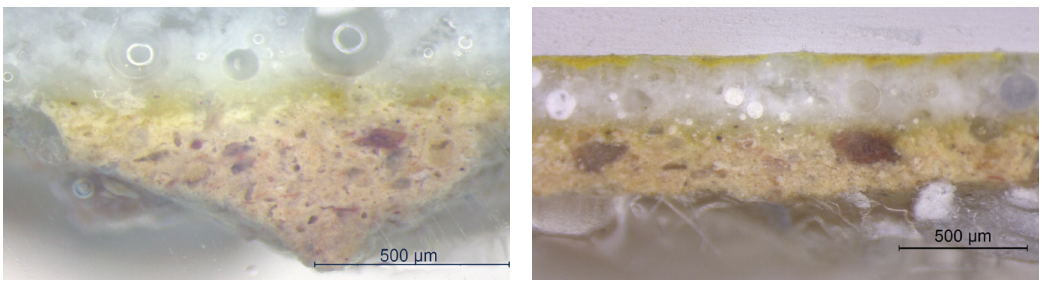

Figure 3. Prepared sections in optical microscopy – from left to right: Az334/01 and Az334/04

Figure 4 illustrates SEM images of samples Az334/01, Az334/07 and Az334/09 that exemplify the main micro-morphological characteristics generally associated with the glazes of this panel: relatively few inclusions, mostly large-sized grains of sand and rarer feldspars, and interface glaze-biscuit with many crystals of neoformation.

Both are distinguishing characteristics and the interfacial outgrowth is a particularly striking one that associates this panel with the productions of the circle of João de Góis [12].

All the sections bearing both glaze and biscuit are morphologically similar, although the density of the inclusions and of the interfacial crystals may vary.

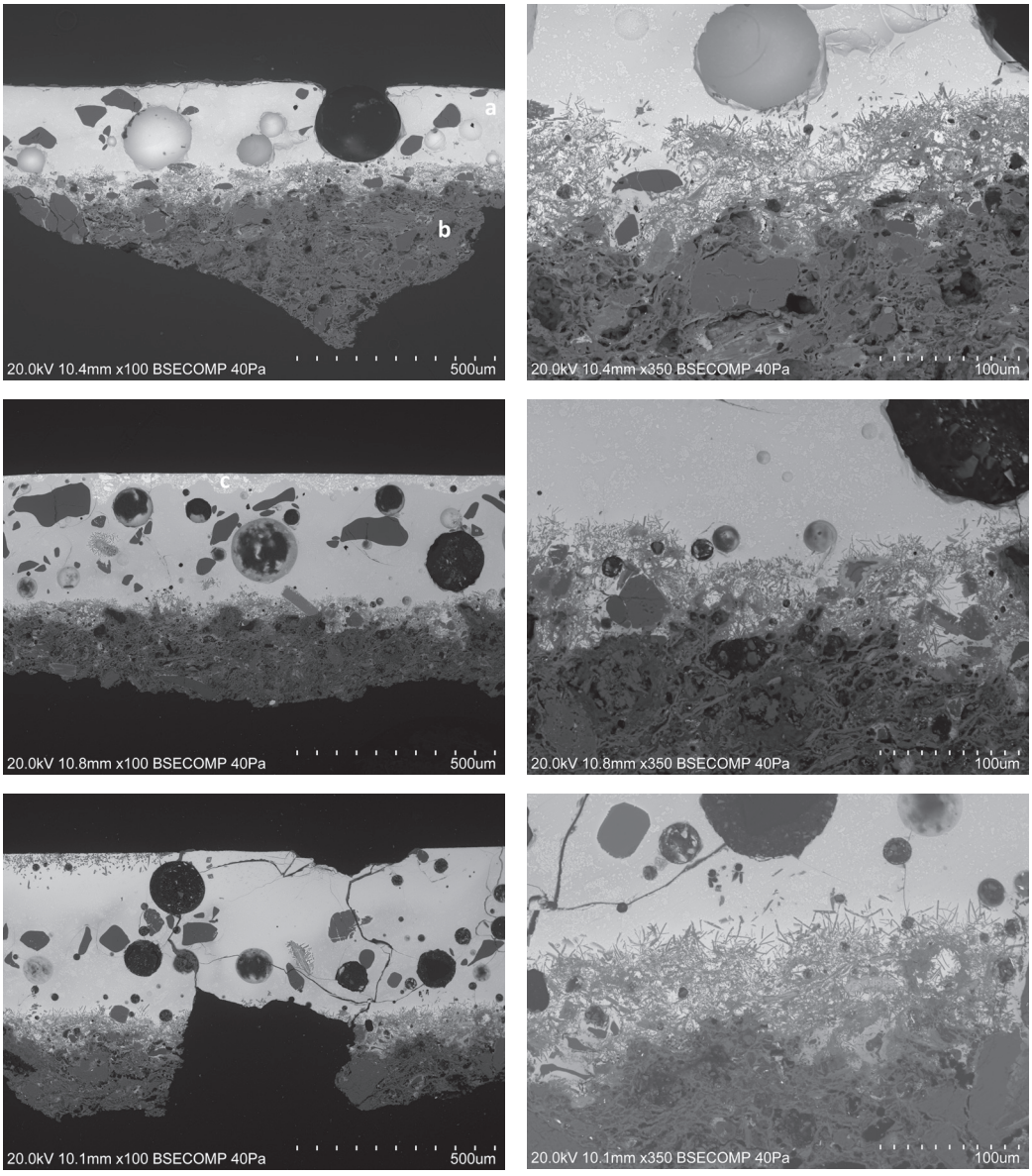

Figure 4. SEM images of samples Az334/01 (top), Az334/07 (middle) and Az334/09 (bottom) exemplifying the main micro-morphologic characteristics generally associated with the glazes and the interface glaze-biscuit of this panel (a – glaze; b – biscuit; c – orange pigment)

2.3.2. Glaze composition

Table 1 includes the semi-quantitative results of individual analyses of the glazes by EDS in weight %. Sn was excluded for the reasons pointed out in section 2.2. The amount of oxygen was calculated through the remaining elements stoichiometry of their most commonly considered oxides and the results were normalized to 100%. The ratio between Si and Pb (the main components of the glaze) was determined and is also included in the table.

Table 1. Semi-quantitative composition of the glazes determined by SEM-EDS (wt.% of oxygen and main elements, excluding Sn, for comparative purposes, corrected to 100%)

Samples	Na	Mg	Al	Si	K	Fe	Pb	O	Si/Pb
Az334/01	1.13	0.66	3.30	17.18	1.61	0.55	47.98	27.60	0.36
Az334/02	0.81	0.51	3.27	16.24	1.34	0.94	50.29	26.59	0.32
Az334/04	1.01	0.53	3.12	17.60	1.33	0.62	48.03	27.77	0.37
Az334/07	1.17	0.66	3.75	17.36	1.37	1.06	46.37	28.27	0.37

2.3.3. Biscuit composition

Table 2 includes the semi-quantitative results of individual analyses of the biscuits by EDS in weight %. The results refer to oxygen and eight other elements of higher content and particular interest for comparison purposes. Pb was detected in all cases but excluded for the reasons pointed in 2.2. The amount of oxygen was calculated through the remaining elements stoichiometry of their most commonly considered oxides and the results were normalized to 100%. The table also includes the ratios between the main components of the biscuit – Ca and Si.

Table 2. Semi-quantitative composition of the biscuits determined by SEM-EDS (wt.% of the main elements corrected to 100%)

Samples	Na	Mg	Al	Si	K	Ca	Ti	Fe	O	Ca/Si
Az334/01	1.08	2.26	7.98	19.11	1.83	21.13	0.60	4.25	41.77	1.11
Az334/02	1.06	2.45	7.15	15.66	1.46	28.80	0.47	3.25	39.69	1.84
Az334/04	1.50	1.93	7.86	20.53	1.86	20.23	0.52	3.21	42.36	0.99
Az334/07	1.40	4.33	8.62	19.94	2.64	15.34	0.82	4.17	42.73	0.77
Az334/09	1.52	3.98	8.65	20.96	4.57	13.62	0.57	3.27	42.87	0.65
Az334/CH	1.31	2.53	7.46	20.81	1.57	19.08	0.51	4.18	42.55	0.92

2.3.4. Yellow, orange, brown and black colours

A grain of yellow pigment from Az334/04 was analysed and the pigment found to be, not Naples yellow, but rather tin-antimony-lead yellow [12, pp. 129] as shown by the high contents in Sn, Sb and Pb observed in the EDS spectrum (Figure 5). The approximate proportion between Sn and Sb was found to be 1:2 in weight.

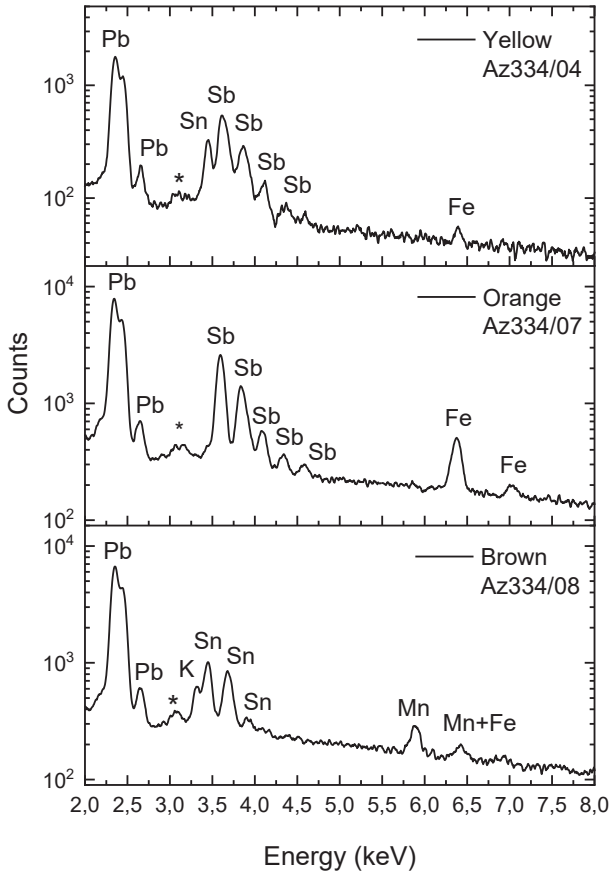

Figure 5. Partial SEM-EDS spectra of the pigments. From top to bottom: yellow (Az334/04), orange (Az334/07) and brown (Az334/08) – the peak marked "*" is an instrumental artefact

A grain of orange colour in Az334/07 was mapped by EDS (Figure 6) on the basis that it could either be a mixture of yellow pigment with iron oxide, or else an orange pigment, such as the one described by Piccolpasso [13]. The EDS colour-maps clearly show a coincidence of the occurrence of Fe and Sb in the grain areas, therefore indicating that an orange pigment was very likely used. The EDS spectrum of a single grain of the orange pigment is presented in figure 5 (approximate proportions Fe:Sb = 1:6).

The EDS analysis of the brown colour (Az334/08) showed that a manganese-based pigment was used (Figure 5).

A black colour sample (Az334/09) that includes a drawing outline was probed (Figure 7). The inclusions of grains of sand are limited to the lower part of the section, showing that

the colour was painted as a finely ground smalt, seen as a lighter whitish area in the SEM image of figure 7. The darker part of the optical image seemingly corresponds to the outline and in the SEM image small inclusions are clearly visible in it.

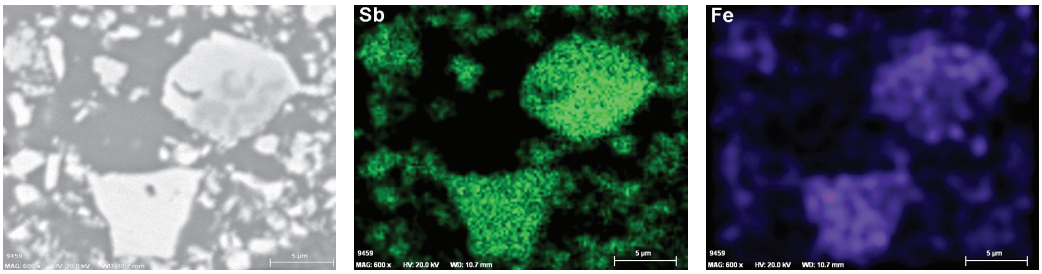

Figure 6. Selection of an area of orange colour (left side image) and elemental maps of Sb (centre image) and Fe (right side image) showing that areas of high content in both elements coincide with the grains of pigment

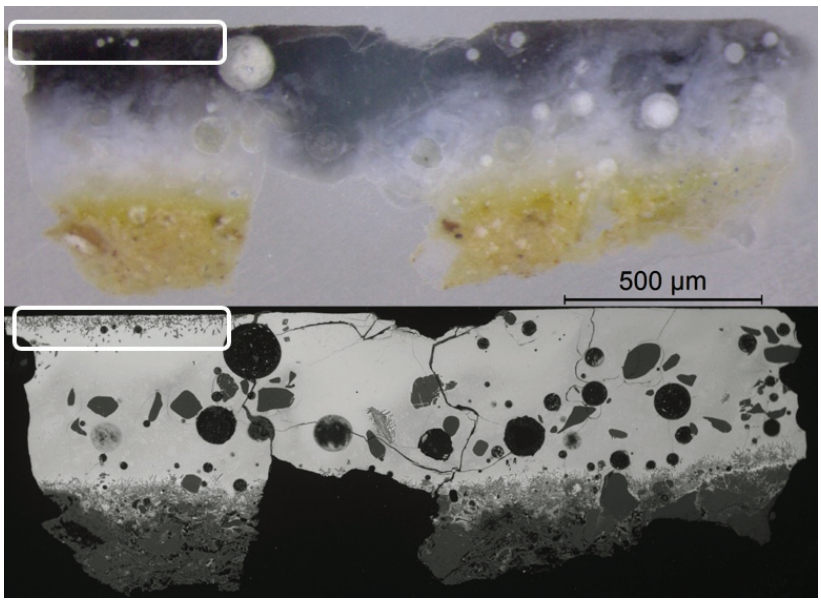

Figure 7. Sample Az334/09 in optical and scanning electron microscopy. The colour was painted as smalt and its darker part, seemingly an outline, is highlighted by the white rectangle

Figure 8 shows a detail of the area with the dark inclusions pointed out in figure 7 seen to be constituted by roundish particles and angular crystals. Figure 9 depicts a smaller area with elemental mapping by EDS (top images) and the EDS spectrum of the analysis of one of the dark crystal-like inclusions (bottom image), whose semi-quantitative composition is presented in table 3. Besides the elements present in the smalt, including the blue cobalt pigment and its associated elements (Ni and As), the simultaneous high contents in Si and Ca besides Mn, suggest, either the use of an unusual Ca-rich Mn mineral, or else, more likely, these inclusions are not purely pigmentary but derive from the addition of a particulate rich in Si and Ca to thicken the paint used on the outlines.

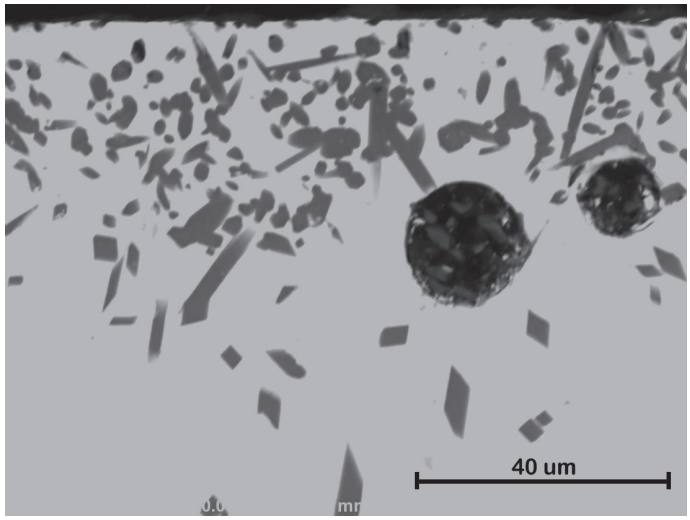

Figure 8. SEM image of a darker area of the colour in Az334/09 showing the geometry of the inclusions

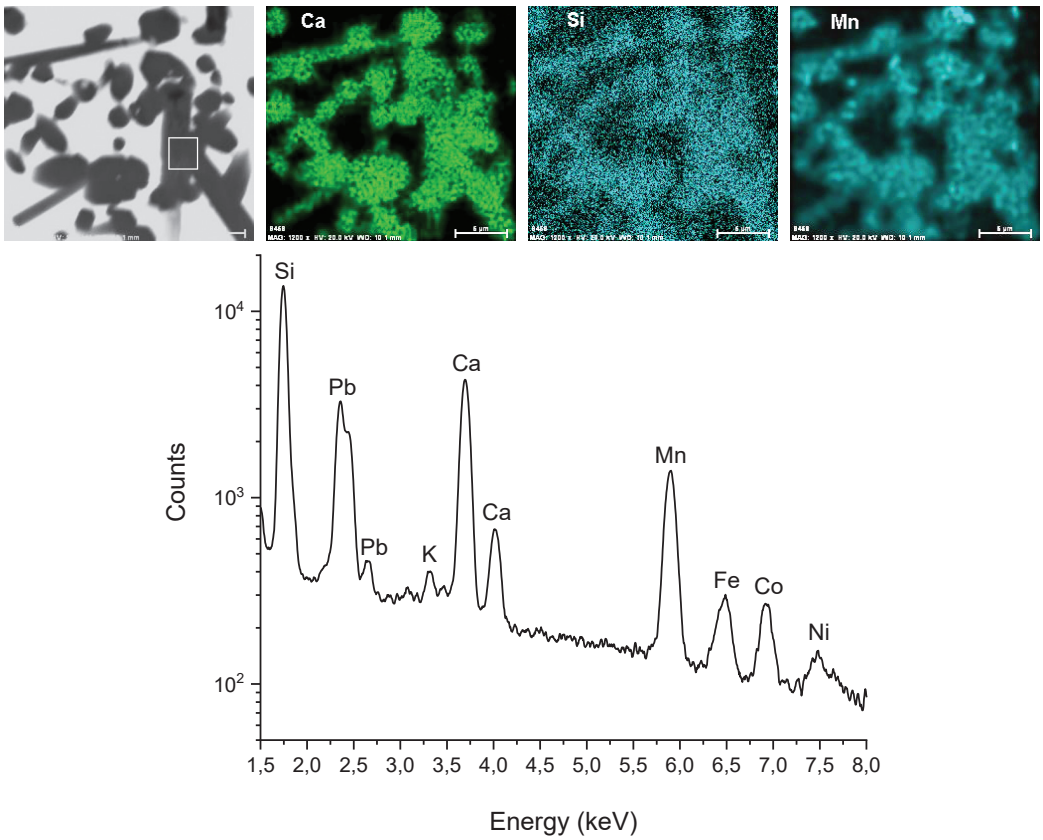

Figure 9. Selection of an area with inclusions (top - left) and elemental EDS maps of Ca, Si and Mn (top - from left to right) showing that the dark inclusions are rich in all those elements. Partial EDS spectrum (bottom) obtained in the analysis of a dark crystal-like inclusion (the area of analysis is highlighted in the top left image)

Table 3. Semi-quantitative composition of a dark inclusion in Az334/09 (wt.% of the main elements corrected to 100%).

Az334/09	Na	Mg	Al	Si	K	Ca	Mn	Fe	Co	Ni	As	Pb	O
Inclusion	0.52	0.38	1.12	18.62	0.67	14.59	9.02	0.45	1.71	0.69	1.13	17.30	33.78

2.4. Principal Component Analysis (PCA)

A log-based PCA was performed for the glazes and biscuits of all samples analysed, considering the results in tables 1 and 2, respectively, together with samples from works already known to be by the circle of João de Góis: *Igreja da Graça* (identified by the designations Graça I and Graça II), the panel *Nossa Senhora da Vida*, *Capela de São Roque* [12] to which were added the panels recently found in the Cathedral of Setúbal [11].

2.4.1. Glazes

Figure 10 shows the PCA results of the glazes, through a plot in the plane of the two first principal components (PC1 and PC2). PC1 explains 45% of the total variance in the data set and is controlled in the positive sense by the contents in Al, Si, K and Fe and in the opposite sense by the content in Pb. PC2 explains 25% of the variance and is controlled mostly by the contents in Na and Mg in the positive sense.

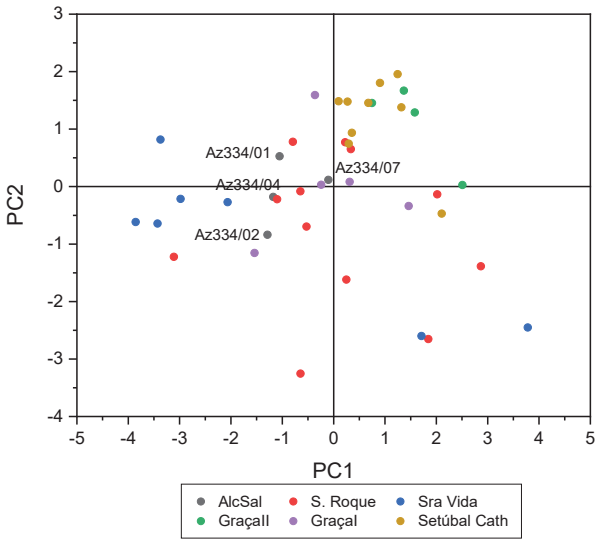

Figure 10. Score plot of the PCA of the glazes of Az334 (Alcácer do Sal) and other four 16th century panels

2.4.2. Biscuits

Figure 11 shows the PCA results of the biscuits, through a plot in the plane of the two first principal components (PC1 and PC2). PC1 explains 41% of the total variation and is controlled by Al, Si, and K in the positive sense and Mg and Ca in the opposite sense. PC2 explains 26% of the variation and is controlled in the positive sense by the contents in Na,

Mg, Al, Ti and Fe and in the negative sense by Si (as seen through figure 12 in which the loadings plot is represented as a vector graph).

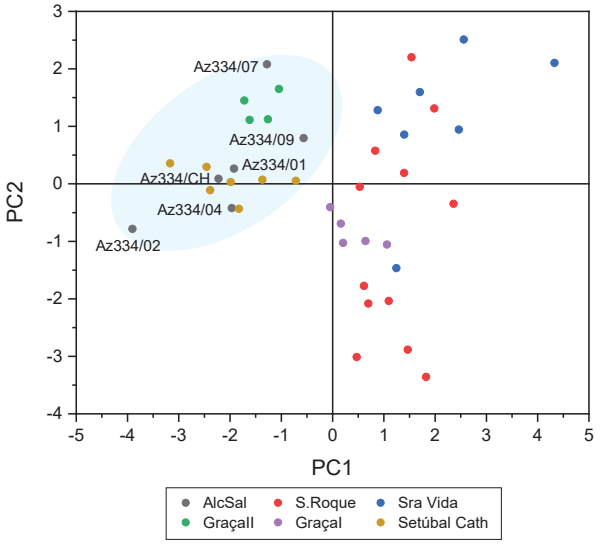

Figure 11. Score plot of the PCA of the biscuits of Az334 and other four 16th century panels

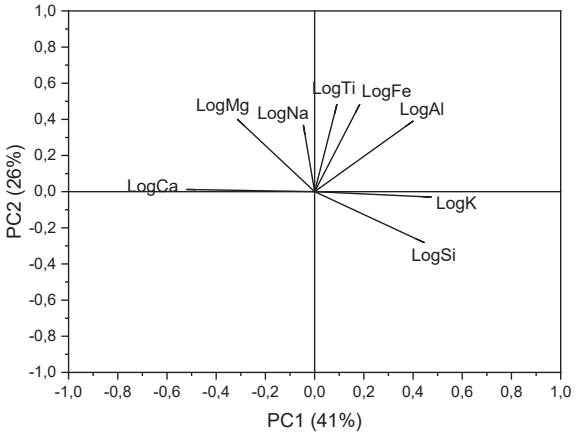

Figure 12. Loadings plot of the PCA of the biscuits

3. DISCUSSION

3.1. Technology

The SEM images of the glaze sections and their interfaces with the biscuits (Figure 4) depict morphologies compatible with the very distinctive configuration that characterizes the panels attributed to João de Góis or his circle [12] as well as with the panel recently identified at the Cathedral of Setúbal [11]. This similarity can be attributed to a comparable preparation of the raw materials and an analogous firing cycle, as was experimentally observed through the study of replicates [14]. In fact, such a close similarity points to a

possible firing of all these panels in the same kiln [12, p. 130], the same associated to João de Góis and his brother Filipe which was situated at the bottom of the Santa Catarina Hill [15, p. 19].

The use of a Sn+Sb+Pb yellow pigment and of a Fe+Sb+Pb orange pigment suggests purchases from abroad, possibly from Antwerp, where, seemingly, the light-yellow pigment was commonly used [16]. Such pigment was also used by João de Góis, e.g. in the *Nossa Senhora da Vida* panel [12, p. 129].

Inclusions rich in Mn, Si and Ca were found near the surface at the dark outlines, suggesting they may derive from the incorporation to the pigment of a mineral addition, following a technology akin to one already seen in other panels stemming from the circle of João de Góis [12, pps. 128-129].

3.2. Clustering

The PCA of the glazes (Figure 10) does not allow a clear clustering: samples from the Alcácer do Sal panel are intermixed with samples from *Capela de São Roque* which, on their side, are intermixed with others. Although the distribution is not random (the Alcácer do Sal samples are concentrated near the centre of the plot) no clear clustering can be proposed and, at least until more results become available, all the glazes should be considered similar.

However, the PCA of the biscuits (Figure 11) offers a completely different vision of the possible relations between the panels. Two clusters may be separated resourcing only to PC1. One group, set on the positive side of PC1, includes the *Nossa Senhora da Vida* panel, the lining of *Capela de São Roque* and what we believe is the earliest phase of *Igreja da Graça* – identified here by "Graça I" [see also 12, p. 127], corresponding to biscuits with a lower Ca/Si ratio and higher contents in Al and K. Most interestingly, the second cluster, nearly corresponding to the top-left quadrant of the plot (highlighted in blue in figure 11), includes the Alcácer do Sal panel, the panel from the Cathedral of Setúbal [11], but also the second phase of *Igreja da Graça* – identified here by "Graça II" – [see also 12, p. 127], whose biscuit compositions are akin mainly by their higher content in Ca, suggesting a chronologic separation from panels whose biscuits are plotted on the positive side of PC1.

4. CONCLUSION

We consider very relevant the fact that the glaze of this panel, dated "1592", has a micro-morphology and a composition similar to other panels attributable to the circle of João de Góis. The morphological characteristics indicate the panel was fired using a cycle very similar to the unusual cycle used by João de Góis presumably since at least the 1560s, even though the biscuits were now, in 1592, much richer in calcium than before. The fact that the painting of the Alcácer do Sal panel made use of rather uncommon yellow and orange pigments such as those also used by João de Góis and his circle, also strongly suggests a technical connection between them all.

The different biscuit compositions when compared with presumably older panels such as *Igreja da Graça* I, *Nossa Senhora da Vida* and *Capela de São Roque* [12] suggests that, either a different clay source was now used, or a depth of the clay pits was attained at which the composition was much richer in calcium. In any case, the compositional similarity within

a biscuit cluster suggests an approximate chronology of the productions included in it. The fact that Alcácer do Sal is dated "1592" and its biscuit clusters closely with Cathedral of Setúbal and then, less closely, with *Igreja da Graça* II suggests that the chronology of both those two other works, particularly the chronology of the panels recently unveiled at the Cathedral of Setúbal, should be not too distant from 1592.

It is interesting to mention in this respect that Pais et al. [15, pp. 19] have tentatively identified the kiln used by João de Góis, his brother Filipe, and probably several other workshop masters firing glazed pottery, as the edification with chimneys seen in an old map at the bottom of the Santa Catarina hill in Lisbon (Figure 13). On July 21, 1597 there was a catastrophic collapse of part of the Santa Catarina and Chagas hills towards the river destroying three whole streets and the *Cais das Negras* (Black Womens' Wharf) on the river, which were entirely buried with earth and debris [17]. The location of *Cais das Negras* is unknown but archaeologist Alexandra Gomes, who researched the ancient wharfs in that section of the river [18], suggests that it may be a structure dimly seen in Georg Braun's map [19] exactly in front of the edification that may have been the kiln - figure 13. If that was the case, the kiln was destroyed in 1597 and, in fact, we have not yet seen any azulejos firmly assigned to the 17th century that were fired using a cycle resulting in the same interfacial morphology…

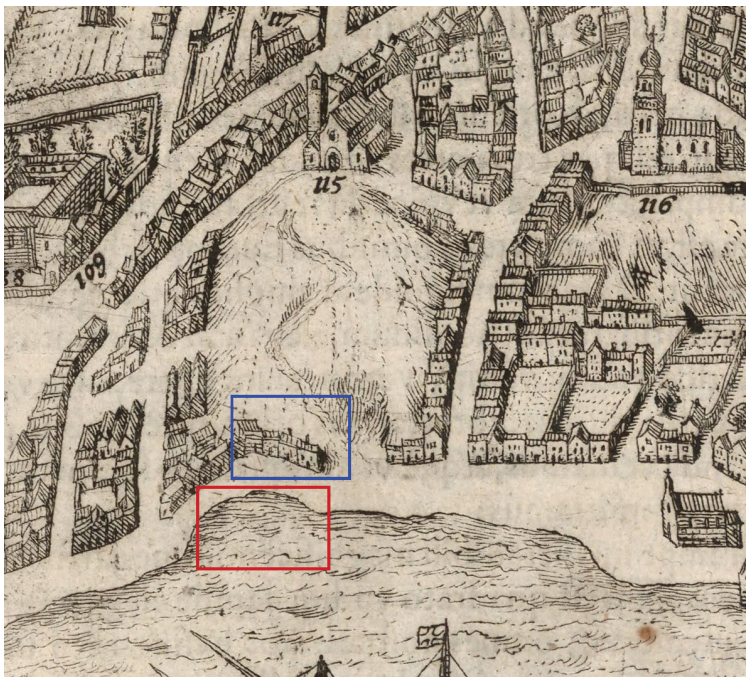

Figure 13. The Santa Catarina and the Chagas hills (115 & 116 in the image above) that collapsed on the night of July 21, 1597 forming the rift where today runs the *Elevador da Bica* tramway. The edification presumed to house the kiln used by the De Góis brothers is indicated by the blue rectangle, while the area of the wharf buried by the collapse is indicated by the red rectangle

This work exemplifies the sort of information that may derive from the study of a chronologic anchor, a dated azulejo panel, and its comparison with other panels to which, previously, no date could be assigned on documentary evidence with some degree of

certainty. Much is still expectable from comparative studies based on glazed ceramics for which date, authorship or any other useful historical information is known.

BIBLIOGRAPHIC REFERENCES:

1. SANTOS, R. – *O azulejo em Portugal*, Editorial Sul, pp. 64, Lisboa, 1957.
2. MECO, J. – *O azulejo em Portugal*, Publicações Alfa, pp. 198, Lisboa, 1993.
3. MIMOSO, J. et al. – *A research on the azulejo panels of the São Roque chapel* in Lisbon in Studies in Heritage Glazed Ceramics, No. 1, pp. 103-112, LNEC, Lisbon, February 2019. ISBN 978-972-49-2307-9.
4. ENCARNAÇÃO, J. d' – *Salacia Imperatoria Urbs* in Arqueología Iberoamericana, Nº 18, pp. 15-24, 1989.
5. SANTOS SIMÕES, J.M. – *Azulejaria em Portugal no século XVII - Tomo II – Elenco*. 2ª edição. Fundação Calouste Gulbenkian, plate LVI, Lisboa, 1997.
6. PINHO LEAL, A.S. – *Portugal Antigo e Moderno. Diccionario Geographico, Estatistico, Chorographico, Heraldico, Historico, Biographico e Etymologico de todas as Cidades, Villas e Freguezias de Portugal e de grande numero de aldeias*, Volume primeiro, pp. 56-61, Livraria Editora de Mattos Moreira & Companhia, Lisboa, 1873.
7. CORREIA, V. – *Azulejos datados*, 2nd edition, pp. 8, Imprensa Libânio da Silva, Lisbon, 1922.
8. CORREIA, V. – *Azulejos datados* in O Archeologo Portugues, Vol.XX, pp. 162-210, Lisbon, 1915.
9. VASCONCELLOS, J. L. de. – *Excursão archeologica a Alcacer-do-Sal* in O Archeologo Portugues, Vol.I, No. 3, pp. 5-92, Lisbon, 1895.
10. NÓVOA, R. – *O Arquivo Gama Lobo Salema e a produção, gestão e usos dos arquivos de família nobre nos séculos XV-XVI*, PhD Thesis, Universidade Nova de Lisboa, 2016.
11. PAIS, A. et al. – *Study of a finding of 16th century azulejo panels at the Cathedral of Setúbal in Portugal* in Studies in Heritage Glazed Ceramics, No. 2, pp. 1-18, LNEC, Lisbon, November 2019. ISBN 978-972-49-2310-9.
12. MIMOSO, J. et al. – *A technical comparison of three renaissance azulejo panels from the workshops of Lisbon* in Studies in Heritage Glazed Ceramics, No. 1, pp. 113-132, LNEC, Lisbon, February 2019. ISBN 978-972-49-2307-9.
13. PICCOLPASSO, C. – *The three books of the potter's art*, transl. and ed. R.Lighitbown & A. Caiger-Smith, pp. 77 of the translation on the colours of the Marches, London, 1980.
14. PEREIRA, S. et al. – *Influence of the production technology on the morphological characteristics of azulejos* in Proc. Int. Conf. Glazed Ceramics in Cultural Heritage (GlazeArt 2018), pp. 140-149, LNEC, Lisbon, October 29-30, 2018.
15. PAIS, A. et al. – *The beginning of the production of majolica azulejos in Portugal – João and Filipe de Góis in 16th century Lisbon* in Studies in Heritage Glazed Ceramics, No. 1, pp. 1-23, LNEC, Lisbon, February 2019. ISBN 978-972-49-2307-9.
16. MIMOSO, J. et al. – *Analytical study of tiles of presumed Flemish origin from the Palace of the Dukes of Braganza in Vila Viçosa* in "From Flanders. The azulejos commissioned by D.Teodósio I, 5th Duke of Braganza, pp. 68-69, Museu Nacional do Azulejo & Fundação da Casa de Bragança, Lisbon, 2012.
17. OLIVEIRA, E. – *Elementos para a história do Município de Lisboa*, Vol. XVI, pp. 138, Câmara Municipal de Lisboa, 1908.
18. GOMES, A. – *Os "caes" do sítio da Boavista no século XVIII - estudo arqueológico de estruturas portuárias*, MSc disseration, Universidade Nova de Lisboa, 2014.
19. BRAUN, G. – *Civitates Orbis Terrarum*, Vol.V, Amesterdam, Holland, ca.1598.

16th century azulejos excavated in Lisbon: a tile with arabesque designs found at *Terraços do Carmo*

João Manuel Mimoso, Alexandre Pais, António Marques, Maria de Lurdes Esteves, Sílvia R. M. Pereira, Maria Augusta Antunes, Ana Margarida Cardoso, António Candeias

ABSTRACT

Counter to the notion that the production of azulejos in Portugal during the 16th century was scant, recent excavations are bringing to light shards that point to the opposite. The variety of fragments recovered from the ground will need many years of study to return a clear notion of what actually was produced at the time.

In some instances, we come across particularly interesting shards which are in a condition good enough to allow attribution based on previous research. A recent excavation at an area once part of the grounds of the ancient *Convento do Carmo* (Carmo Convent) recovered a large fragment that offers stylistically an immediate connection with productions of Antwerp. This paper includes the results of an analytical research of that fragment and discusses its provenance, significance and likely chronology.

RESUMO

Contrariando a noção de que a produção de azulejos em Portugal durante o século XVI era escassa, escavações recentes têm trazido à luz fragmentos que apontam para o oposto. A variedade de fragmentos recuperados do solo precisará de muitos anos de estudo para oferecer uma noção clara do que realmente foi produzido na época. Por vezes, deparamo-nos com casos particularmente interessantes e que se encontram numa condição suficientemente boa para poderem ser estudados.

Numa escavação recente, na envolvente do antigo Convento do Carmo, em Lisboa, foi recuperado um importante fragmento de um azulejo que sugere a nível estilístico uma ligação imediata a produções pouco divulgadas de Antuérpia. Este artigo inclui os resultados de um estudo analítico desse fragmento e discute a sua proveniência, significado e provável cronologia.

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KEYWORDS: Renaissance majolica / Archaeology of Largo do Carmo in Lisbon / / Portuguese azulejos / João de Góis / Renaissance tiles from Antwerp

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1. INTRODUCTION

Between 2013 and 2015, during the archaeological work carried out at an area once part of the grounds of the ancient *Convento do Carmo* in Lisbon[1], a vast collection of tile fragments was recovered, which, in most cases, must have been once part of the internal arrangement of this important Lisbon convent. One of the fragments (Figure 1) caught our attention because a substantial part of a single tile had been preserved in good condition and because we recognized the sort of pattern it depicted from azulejos related with the productions of Antwerp [1-3] but which was, until now, unknown from the workshops of Lisbon.

The construction of *Convento do Carmo* started in 1389. Throughout its existence it had successive phases of new construction and reconstruction, either for natural reasons (as would have been the case of the 1531 and 1755 earthquakes) or because of new edifications within its old fence, also known as *Terraços do Carmo* [4].

Although other major works are documented in this area, as well as, at an earlier period, inside the building, in the case of the shard under study[2] (Figure 1) the context where it was found resulted from the remobilization of the land, on the occasion of the construction of the *Ordem Terceira do Carmo* Hospital, between 1703 and 1706, which collapsed completely during the 1755 quake. In association with the present fragment, a vast and important set of earthenware, majolica, porcelain and glass (as well as other archaeological materials) that chronologically point to the second half of the 16th and to the 17th centuries was also exhumed, constituting a coherent and well defined unity, which still needs to be studied in detail.

Therefore, it is believed that this tile would be part of an order made at the end of the 16th century, for the decoration of some internal space of the current building, or of some new construction that is known to have been erected during this period, such as the designated "New Dormitory", built between 1571 and 1582. In fact, according to Frei José Pereira de Santa Anna's description of the *cenobium* towards the middle of the 18th century, there are numerous references to the existence of tile panels on the walls of the building's various dependencies and worship spaces [5].

Tiles with related patterns have been reported by C. Dumortier [1], F. Caignie [2] and M. Archer [3] from the workshops of Antwerp. Dumortier connects these designs with Francesco di Pellegrino's book *La fleur de la science de pourtraicture* where his exotic patterns are collected and which was published in Paris in 1530 and republished in Antwerp in 1543 by Cornelis Bos as *Livre des Moresques*. Figure 2 illustrates two plates from the original edition, showing how the decoration of the azulejo may be assembled from simpler designs extracted from the plates. It is interesting to note that in the Flemish productions the design corresponding here to the stepped blue ribbon is usually made up of two, three or even four parallel thin lines. Here the ribbon is a single, thick, continuity after the suggestion in the plate illustrated, resulting in a pattern much easier to paint. The full lining, maybe a low sill, could have been made of a repetitive fleuron with a module of four tiles, or else be constituted by a more complex sequence as suggested by any of the plates in figure 2.

1 The archaeological work was part of the implementation of an urban regeneration project by Architect Álvaro Siza Vieira.

2 Exhumed from the Stratigraphic Unit 146.

Figure 1. A large fragment from a single tile (ca. 13 cm across) recovered from the ground at *Largo do Carmo* in Lisbon (the arrow indicates the sampling point)

This paper further includes the results of an analytical research of the fragment towards an attempt to determine its provenance and possible chronology.

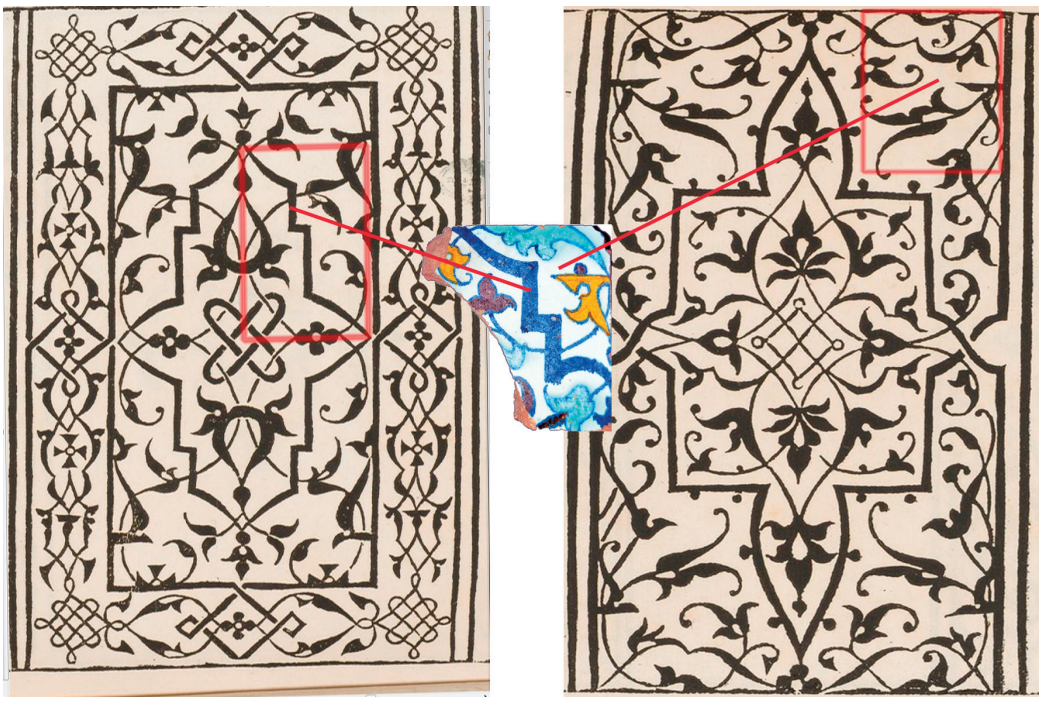

Figure 2. Two designs of arabesques (plates XII and XVIII) from *La fleur de la science de pourtraicture* showing how the pattern used in the azulejo may be composed from sketches adapted from the book (source of the images: gallica.bnf.fr / Bibliothèque Nationale de France)

2. EXPERIMENTAL

2.1. Sampling and methodology

The tile was sampled at the point indicated by the red arrow in figure 1, allowing the acquisition of a scale of white faience with blue and yellow colours. The sample (with the reference Az327) was stabilized in resin, lapped and polished to obtain a cross-section for observation and analysis by scanning-electron microscopy coupled with an X-ray energy-dispersive spectrometer (SEM-EDS).

The optical acquisition of images of the sections was obtained with a Leica DFC295 digital camera coupled to a M205C stereomicroscope of the same brand.

SEM-EDS observations and analyses were made at the HERCULES Laboratory in Évora using a Hitachi S3700N SEM with a coupled Bruker XFlash 5010 EDS. The specimen was uncoated and the observations were made in backscattered electrons mode (BSE) in variable pressure mode at 40 Pa and at an accelerating voltage of 20.0 kV. The acquisition of X-ray spectra was done with the detector at ca. 10 mm working distance.

The selection of areas for EDS analysis avoided inclusions in the glaze or biscuit representing more than ca. 5% of the full area analyzed. Whenever possible area sizes of at least ca. 200 x 200 μm for glazes and 500 x 500 μm for biscuits were used but acceptable repeatability was verified in areas four times smaller. For comparison purposes, only the elements usually representing the major components were considered, excluding tin (Sn) in the glaze and lead (Pb) in the biscuit due to their variability with the area chosen (in the case of Sn in the glaze because of crystal aggregations and in the case of Pb in the biscuit because the content increases with proximity to the interface). The results of the EDS analyses are given in weight % of each element considered.

Principal Component Analysis (PCA) of EDS results was made using the SPSS© software platform by IBM Analytics.

2.2. Results

2.2.1. Morphological characteristics

Figure 3 illustrates a microscopic image of the section of the sample after preparation, compared to a SEM image of the same general area. Although some hair-thin microcracks are apparent in the glaze, including around the sand inclusions, the gas bubbles are still empty, meaning that the lixiviation of the components of the glaze has not yet started in a noticeably manner (otherwise the bubbles would not be clean inside, because of deposition) and therefore the results of analyses of the glaze should not be particularly affected by the long burial. No *coperta* (a transparent glaze layer sprinkled on top of the painted glaze) was used over the painting.

Figure 4 illustrates SEM images of the sample under study in which it is noticeable that the glaze is rather devoid of inclusions except for a few grains of sand, and that its interface with the biscuit has conspicuous outgrowths of individualized crystals formed over the firing cycle.

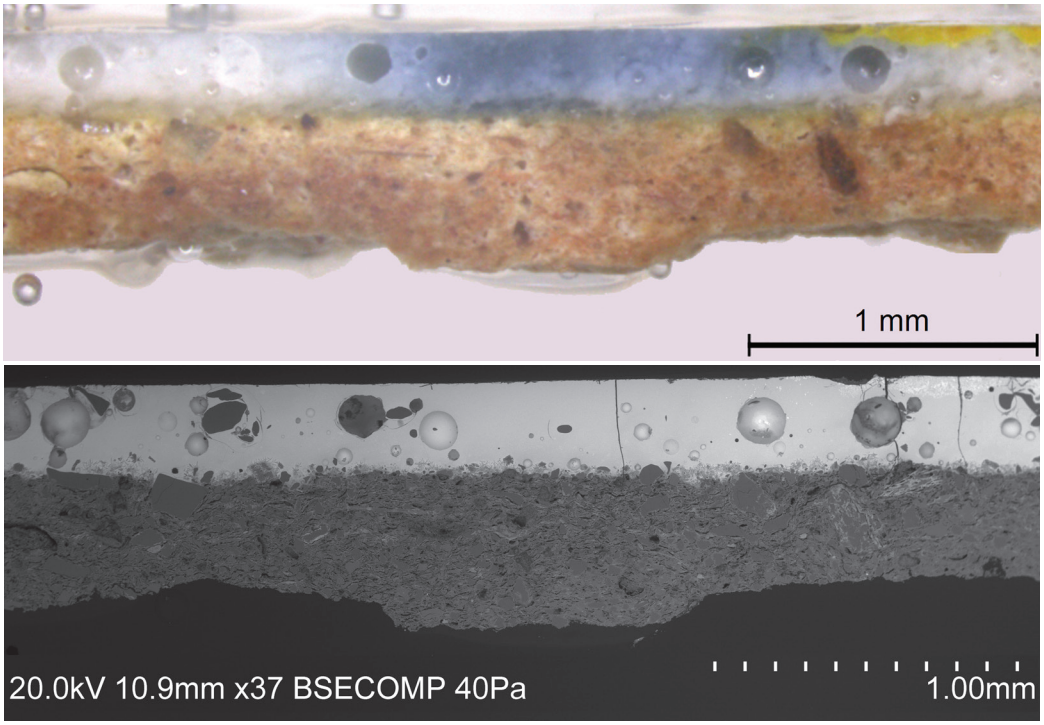

Figure 3. Paired images of sample Az327 in optical microscopy (top) and scanning electron microscopy (bottom)

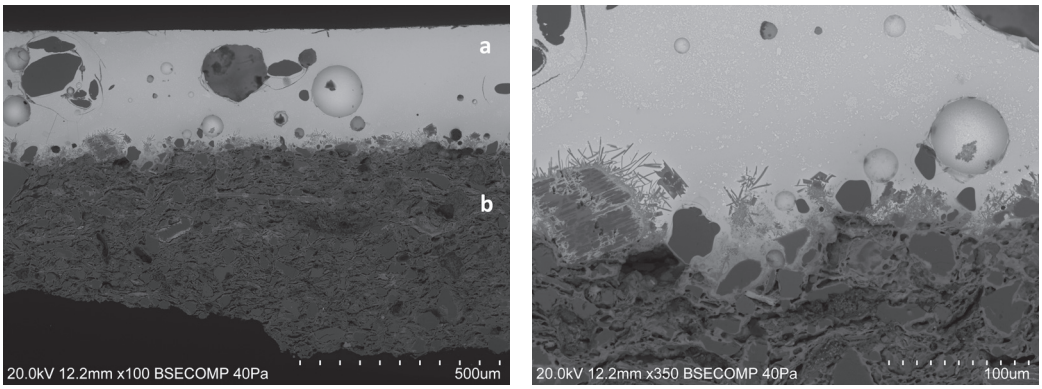

Figure 4. SEM images of sample Az327 depicting the main micro-morphologic characteristics of the tile (a – glaze; b – biscuit)

2.2.2. Glaze composition

Table 1 includes the semi-quantitative results of the sectional analysis of the glaze by EDS in weight %. Eight different areas of the glaze were analyzed and the values of the averages and standard deviations were also determined. Sn was excluded for the reason pointed out in section 2.1. The amount of oxygen was calculated through the remaining elements stoichiometry of their most commonly considered oxides and the results were normalized to 100%. The ratio between Si and Pb (the main components of the glaze) was calculated and is included in the table.

Table 1. Semi-quantitative composition of the glaze of sample Az327 determined by SEM-EDS (wt.% of oxygen and main elements, excluding Sn, normalized to 100%)

Determination nr.	Na	Mg	Al	Si	K	Fe	Pb	O	Si/Pb
1	1.20	0.72	3.22	18.05	1.57	0.92	45.75	28.57	0.39
2	1.10	0.65	3.57	17.98	1.54	1.01	45.42	28.73	0.40
3	1.07	0.59	3.98	18.37	1.55	1.23	43.75	29.45	0.42
4	1.03	0.45	2.73	17.83	1.41	0.63	48.25	27.68	0.37
5	1.13	0.60	3.01	17.79	1.48	0.81	47.14	28.03	0.38
6	1.08	0.56	2.56	17.46	1.24	0.78	49.01	27.29	0.36
7	0.91	0.61	2.31	17.56	1.18	1.23	48.88	27.32	0.36
8	0.95	0.74	2.45	17.31	1.22	0.82	49.37	27.14	0.35
Average	1.06	0.61	2.98	17.79	1.40	0.93	47.20	28.03	0.38
St. Deviation	0.09	0.09	0.58	0.34	0.16	0.22	2.04	0.83	0.02

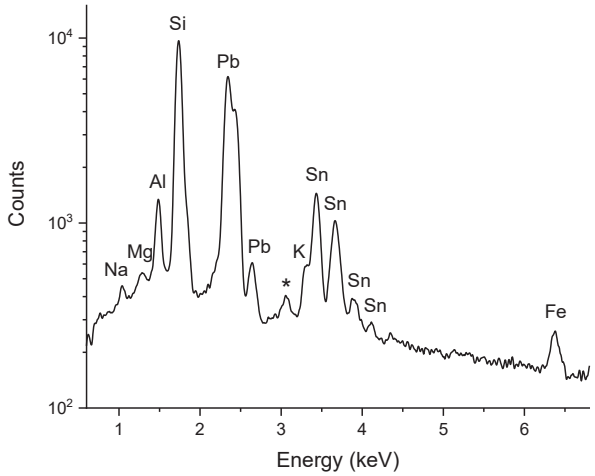

Figure 5. Relevant part of the analytic spectrum of the glaze of Az327 obtained by SEM-EDS (the peak marked "*" is an artefact)

2.2.3. Biscuit composition

Table 2 includes the semi-quantitative results of the EDS analysis, in weight %, of four different sectional areas of the biscuit. Pb was excluded for the reason pointed out in section 2.1. The amount of oxygen was calculated through the remaining elements stoichiometry of their most commonly considered oxides and the results were normalized to 100%. The ratio between Ca and Si (the main components of the biscuit) was determined and is included in the table as well as the averages per element and the corresponding standard deviations.

Table 2. Semi-quantitative composition of the biscuits of sample Az327 determined by SEM-EDS (wt.% of the main elements corrected to 100%)

Determination nr.	Na	Mg	Al	Si	K	Ca	Ti	Fe	O	Ca/Si
1	1.12	1.19	8.20	29.32	2.94	6.80	0.60	2.96	46.86	0.23
2	1.05	1.26	8.13	27.34	2.70	9.18	0.88	3.56	45.90	0.34
3	1.16	1.32	8.78	27.09	3.38	8.19	0.71	3.48	45.88	0.30
4	1.12	1.25	8.28	25.13	2.65	12.49	0.79	3.51	44.78	0.50
Average	1.11	1.26	8.35	27.22	2.92	9.16	0.75	3.38	45.86	0.34
St. Deviation	0.04	0.05	0.30	1.71	0.33	2.42	0.12	0.28	0.85	0.11

2.2.4. Yellow pigment

A grain of yellow pigment (left side of figure 6) was analysed and the pigment found to be, not Naples yellow, but rather tin-antimony-lead yellow [6] as shown by the semi-quantification by EDS (Table 3) and spectral counterpart (right side of figure 6). Discounting the elements present in the matrix, the simultaneous high contents in Sn, Sb and Pb confirm the use of a tin yellow pigment, with an approximate ratio between Sn and Sb of 1:2.8.

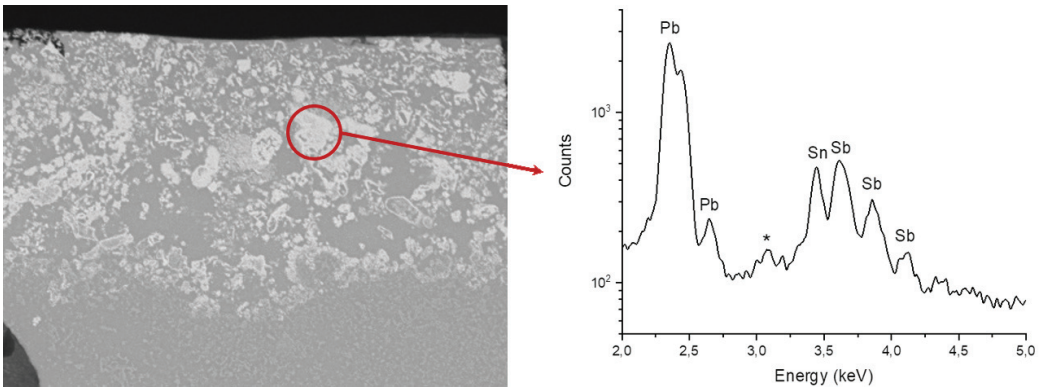

Figure 6. SEM image showing the selection of a grain of yellow pigment (left side); and relevant part of the EDS spectrum of the yellow pigment in logarithmic scale confirming the substantial presence of tin in it (the peak marked "*" is an artefact)

Table 3. Semi-quantitative composition of a grain of yellow pigment (wt.% of the elements normalized to 100% in the same conditions as before).

Az334/04	Al	Si	Fe	Sn	Sb	Pb	O
Yellow	0.57	7.58	0.83	4.58	12.70	54.61	19.13

3. DISCUSSION

3.1. Technology

Figure 7 illustrates SEM images of the sample under study compared with 16th century Portuguese azulejos from *Igreja da Graça* in Lisbon (identified by the sample reference Az013/L1) [7] and the panel *Nossa Senhora da Vida* (Az032/01) [8]. In all samples, it can be noticed the same general glaze morphology, characterized by few inclusions, mostly grains of sand, and outgrowths of neo-formed crystals in the glaze-biscuit interface.

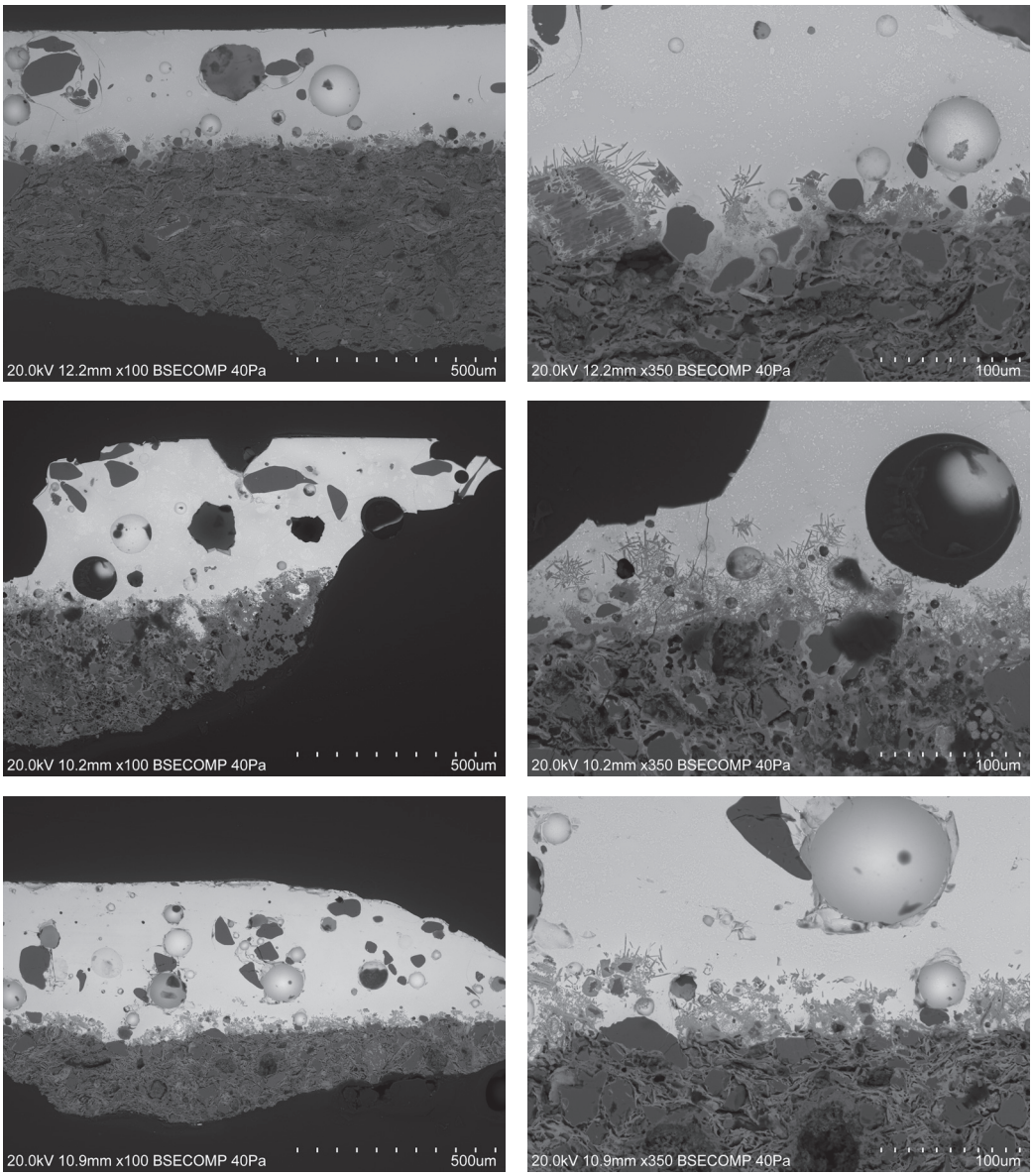

Figure 7. SEM images of the sample under study Az327 (top) compared to *Igreja da Graça* Az013/L1 (middle) and *Nossa Senhora da Vida* Az032/01 (bottom)

On the other hand, the glaze morphology of Az327 is very different from Antwerp tiles which are almost devoid of interfacial outgrowths at the scale studied [9]. For the same reason, it is also different from Portuguese 17th century tiles [9] and from Seville majolica productions - see also [10]. As an example, in figure 8, are presented SEM images of the glazes of samples from Antwerp (Az031/A), Portuguese 17th century (Az024/00) and Seville (Az040/02) glazed tiles.

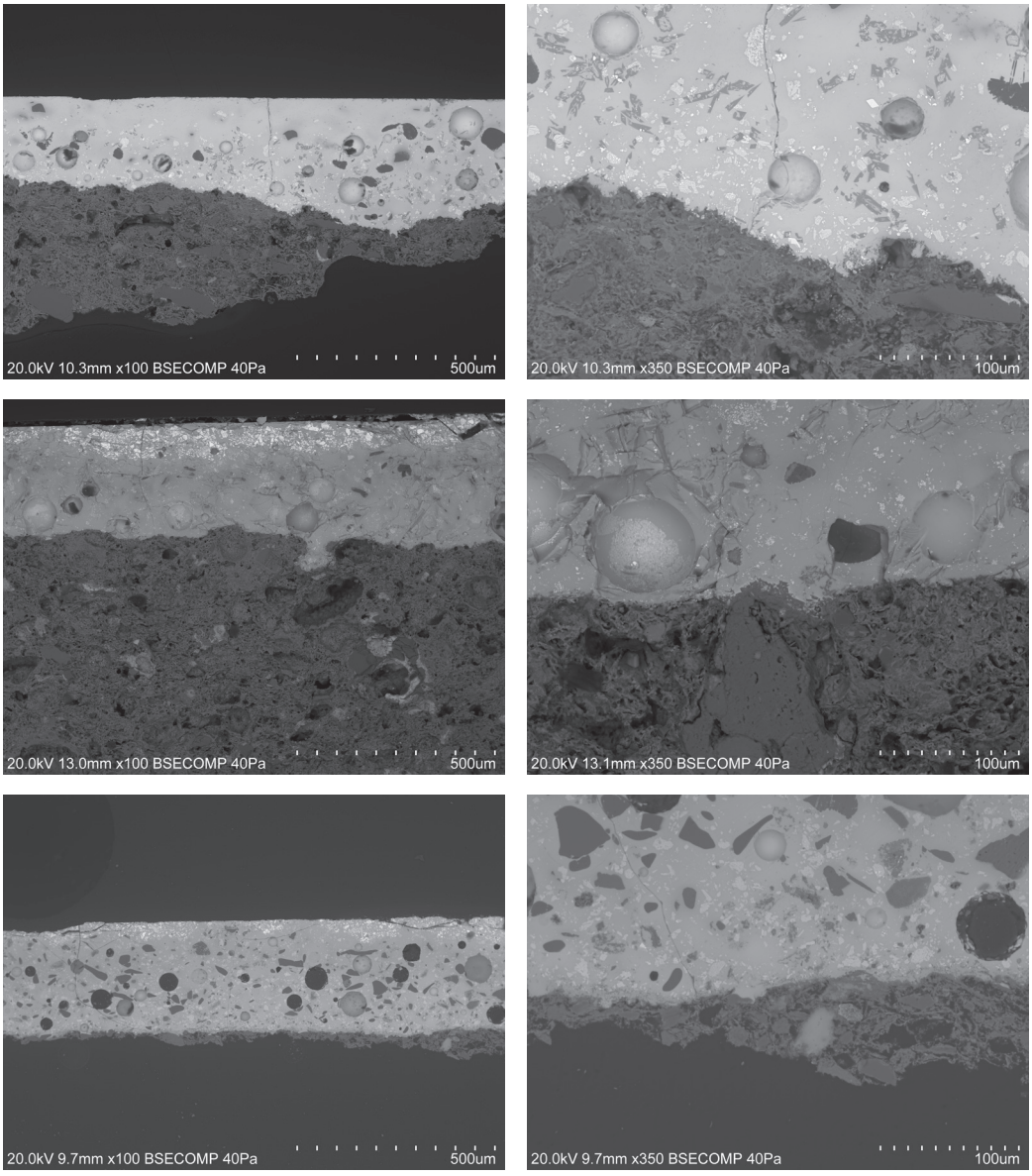

Figure 8. SEM images of samples Az031/A ca. 1560 from the productions of Antwerp (top), Az024/00 from the 17th century productions of Lisbon (middle), and Az040/02 from Seville ca. 1580 (bottom)

The interfacial crystalline development is a very important distinguishing characteristic of 16th century Portuguese azulejos manufactured by the workshops of Lisbon [11] derived from a peculiar firing cycle, as was experimentally observed by the study of replicates [12]. The use of the unusual Sn+Sb+Pb yellow pigment has also been found in other panels stemming from the circle of João de Góis [11, pp. 129].

Therefore, as respects the micro-morphology and the use of a tin-antimony-lead yellow, the tile under study can be clustered with the productions of the João de Góis circle.

3.2. Glaze

In figure 9 are presented the results of a log-based PCA of the glaze of sample Az327, considering the analytical results in table 1, together with samples from *Igreja da Graça* (identified by the code Az013) [7; 11], the panel *Nossa Senhora da Vida* (identified by the code Az032) [11], as well as samples from Antwerp (Az030/01, Az031 [9] and Az311/02), Portuguese 17th century (Az024/00, Az100/02, Az052, Az198/AR2 and Az197/01) [9] and Seville 16th to early 17th centuries (Az040/01, Az192b+r, Az306/01, Az338/01 and Az345/04) [to be published]. The plot depicts a projection in the plane of the two principal components, PC1 and PC2. PC1 explains 49% of the variation and is controlled in the positive sense by the contents in Na, Si and K, and in the opposite sense by the content in Pb. PC2 explains 22% of the variation and is controlled in the positive sense by the contents in Na, Mg and Pb and in the opposite sense by the content in Al.

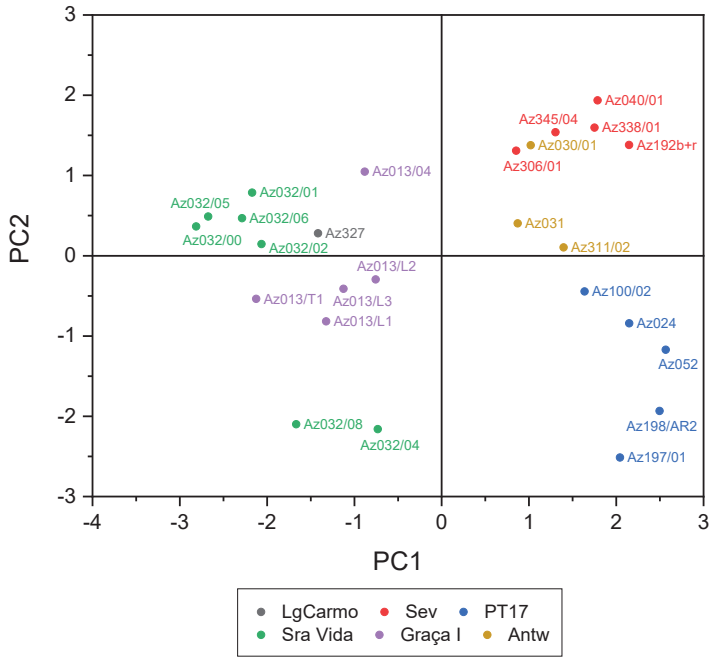

Figure 9. Score plot of the PCA of the glazes of: the shard under study (Az327- LgCarmo); Portuguese 16th century panels by João de Góis (Graça I and the panel *Nossa Senhora da Vida* - Sra Vida); Antwerp ca. 1560 (Antw); Portuguese 17th century (PT17) and early Seville majolica azulejos (Sev)

In a previous comparative study [9], we have shown that the composition of the glazes is a particularly important differentiating characteristic of 16th century Portuguese azulejos, which are distinguishable from other productions by their simultaneous low contents in Na and K. The PCA analysis shows that, in this respect, Az327 fits within such productions.

The direct comparison of spectra typical of the different productions (Figure 10) also confirms that the pattern of the spectrum of Az327, with simultaneously low peaks of Na, Mg and K and a relatively high peak of Pb, is only similar to the 16th century Portuguese productions, here represented by sample Az013/L2.

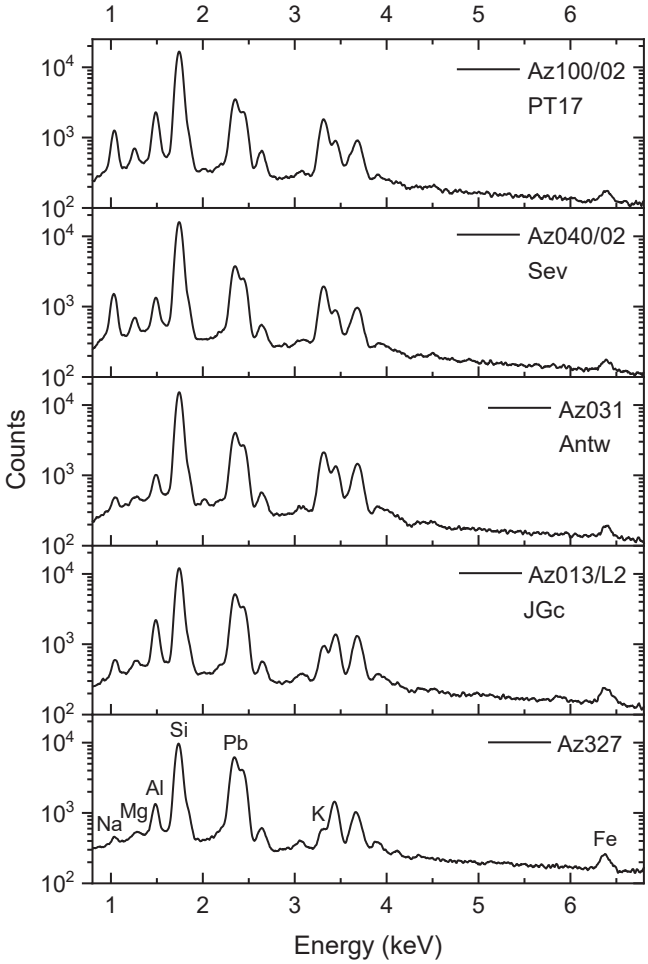

Figure 10. EDS spectra of the glazes of the shard under study (Az327), Portuguese 16th century sample of a panel by João de Góis (Az013/L2), Antwerp (Az031), Seville (Az040/02) and Portuguese 17th century (Az100/02) azulejos

3.3. Biscuit

Figure 11 shows the results of a log-based PCA of the biscuit of Az327 through a plot in the plane of the first two principal components (PC1 and PC2) considering the analytical

results in table 2, together with samples from the same tiles used for the PCA of the glazes. PC1 explains 58% of the variation and is controlled in the positive sense by the contents in Al, Si, K and Fe and in the opposite sense by the contents in Mg and Ca. PC2 explains 17% of the variation and is controlled in the positive sense, in varying degrees, by the contents in Na, Al and Fe, while the opposite sense is controlled by the content in Si (as shown by the loadings plot depicted in vector form in figure 12).

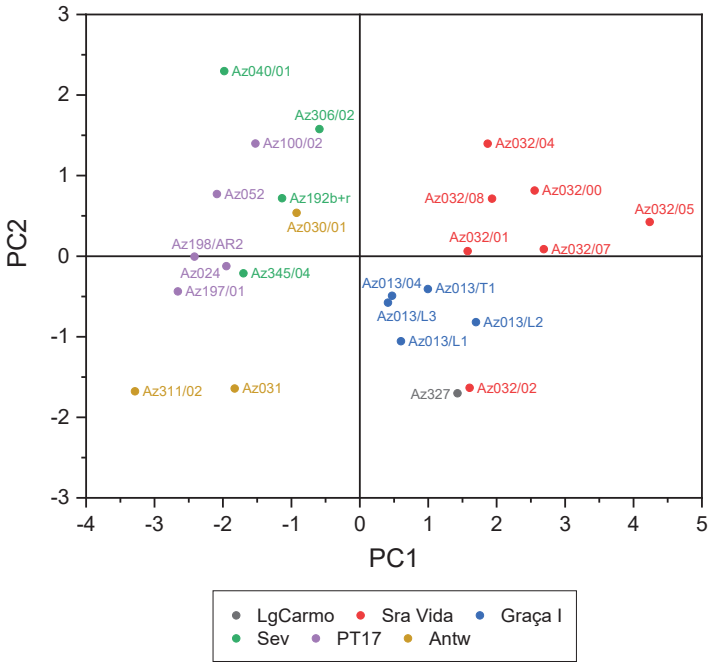

Figure 11. Score plot of the PCA of the biscuits of: the shard under study (Az327- LgCarmo); Portuguese 16th century panels by João de Góis (Graça I and the panel *Nossa Senhora da Vida* - Sra Vida); Antwerp (Antw); Portuguese 17th century (PT17); and Seville (Sev)

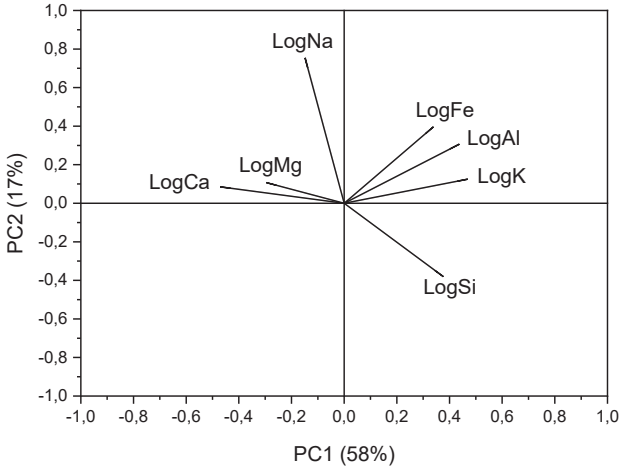

Figure 12. Loadings plot of the PCA analysis of the biscuits

The result shows that, as in the case of the glazes, Az327 is compatible with known productions of João de Góis, particularly with Graça I, the first phase of *Igreja da Graça*, presumably dated 1560–70, and to a lesser degree with the panel *Nossa Senhora da Vida*, dated ca. 1580 [11].

4. CONCLUSION

The micro-morphology and compositional results indicate that the tile is a 16th century production by the workshops of Lisbon. They further suggest that the tile is a production of the workshop of João de Góis tentatively datable from the 1560s to the early 1580s. Although the attribution to the workshops of Lisbon is well supported by the distinctive morphology, the comparative position of Az327 must be considered with caution because, contrarily to the panels with which it was compared, only a single tile fragment is available. Furthermore, a long burial in a damp environment may alter the composition. However, as referred above, the sample under study did not present any visible signs of degradation and so it was very likely buried in a relatively dry place.

The arabesques pattern was probably inspired by prints published in Antwerp, possibly the *Livre des Moresques* published by Cornelis Bos in 1543, although it is not an exact copy of any pattern in the book (for the original published in Paris in 1530 see [13]). The composition preserved in the fragment suggests a fleuron of four tiles that formed a repeating pattern, probably for parietal lining.

The study presented shows that, once a background of data is established for comparative purposes, important conclusions bearing on the early production of azulejos in Portugal may be drawn from a single excavated fragment.

BIBLIOGRAPHIC REFERENCES

1. DUMORTIER, C. – *Céramique de la Renaissance à Anvers: de Venise à Delft*, Éditions Racine, pp. 189-190, Bruxelles, 2002.
2. CAIGNIE, F. et al. – *Carreaux en majolique anversoise dans le château de Pierre-Ernest de Mansfeld à Luxembourg* in Archaeologia Mosellana, 8, pp. 253, figure 15a, 2012. Available at: http://www.tegels-uit-antwerpen.be
3. ARCHER, M. & WILSON, T. – *Antwerp majolica tiles at Firle Place* in Keramos, Vol. 210, figure 17, October 2010. Available at: https://firle.com/antwerp-maiolica-tiles-firle-place/
4. MARQUES, A. & BASTOS, M. A. – *Subsídios arqueológicos para a História da Igreja do Convento do Carmo (Lisboa)* in Arnaud, J.M.; Martins, A.; Neves C. (eds.) Arqueologia em Portugal. 150 anos, pp. 1091-110, Associação dos Arqueólogos Portugueses, Lisboa, 2013.
5. SANTA ANNA, J. – *Chronica dos Carmelitas da Antiga, e Regular Observancia nos Reynos de Portugal, Algarves, e seus Dominios*, Tomo I, Oficina dos Herdeiros de Antonio Pedrozo Galram, Lisboa, 1745.
6. SECCARONI, C. – *Giallorino- Storia dei pigmenti gialli di natura sintetica*, De Luca Editori D'Arte, chapters 10 & 11, Roma, 2006.
7. PAIS, A. et al. – *Study of the azulejo panels in Graça Church signed by João de Góis* in Studies in Heritage Glazed Ceramics, No. 1, pp. 47-66, LNEC, Lisbon, February 2019. ISBN 978-972-49-2307-9.

8. MIMOSO, J. et al. – *Analytical study of the 16th century azulejo panel "Nossa Senhora da Vida" and related archaeologic findings* in Studies in Heritage Glazed Ceramics, No. 1, pp. 77-92, LNEC, Lisbon, February 2019. ISBN 978-972-49-2307-9.

9. MIMOSO, J. et al. – *A comparison of the earliest faience tiles produced in Lisbon with earlier and later types* in Studies in Heritage Glazed Ceramics, No. 1, pp. 25-45, LNEC, Lisbon, February 2019. ISBN 978-972-49-2307-9.

10. PAIS, A. et al. – *The many questions raised by the 16th century Sevillian azulejos in Igreja de São Roque in Lisbon* in Studies in Heritage Glazed Ceramics, No. 2, pp. 51-72, LNEC, Lisbon, November 2019. ISBN 978-972-49-2310-9.

11. MIMOSO, J. et al. – *A technical comparison of three renaissance azulejo panels from the workshops of Lisbon* in Studies in Heritage Glazed Ceramics, No. 1, pp. 113-132, LNEC, Lisbon, February 2019. ISBN 978-972-49-2307-9.

12. PEREIRA, S. et al. – *Influence of the production technology on the morphological characteristics of azulejos* in Proc. Int. Conf. Glazed Ceramics in Cultural Heritage (GlazeArt 2018), pp. 140-149, LNEC, Lisbon, October 29-30, 2018.

13. DI PELLEGRINO, F. – *La fleur de la science de pourtraicture (et patrons de broderie facon arabicque et ytalique)*, Paris, 1530. Available at: https://gallica.bnf.fr/ark:/12148/bpt6k857536m

The many questions raised by the 16th century Sevillian azulejos in *Igreja de São Roque* in Lisbon

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ABSTRACT

There are, in the interior of *Igreja de São Roque* (St. Roch Church), in Lisbon, linings of azulejos attributed to the productions of Seville. They form two very distinct groups of panels: one, with tiles painted over a yellow background, is in the nave, near the entrance to the church; while a second group, with tiles painted over a white background, is set in the transept, against a lining of *punta de clavo* patterned tiles.

In this paper, the authors identify the sets that make up each group, point to their peculiarities, present the results of an analytical study and discuss their possible common provenance and chronology. It is also wondered: why buy from Seville what could be acquired in Lisbon?

RESUMO

O interior da nave da Igreja de São Roque, em Lisboa, é rico em revestimentos azulejares. Além dos painéis da Capela de São Roque, os conjuntos mais referidos são os atribuídos a produção sevilhana que se encontram nas arcarias da nave, antes das capelas, e na zona do transepto, formando dois grupos distintos.

Neste trabalho, identificamos os conjuntos, apontamos algumas particularidades e apresentamos os resultados do estudo analítico com base no qual se discute a possível proveniência comum e cronologias aproximadas. Também se questiona a razão da compra em Sevilha do que aparentemente poderia ter sido adquirido em Lisboa.

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KEYWORDS: Renaissance majolica / Igreja de São Roque em Lisboa / 16th century Sevillian azulejos / Jesuitic churches

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1. INTRODUCTION

Figure 1. 1a (top) The two tiled arches on the Epistle side of the nave; 1b (bottom) the corresponding arches on the Gospel side

In the interior of *Igreja de São Roque* (St. Roch Church) in Lisbon, the arches under the elevated choir are lined with azulejo panels in striking colours: orange, blue, green, often over a finely applied yellow background (Figure 1). These colourful linings can be divided in three separate sets: a lower set, covering the pillars, has yellow oval medallions depicting imagery of the so-called *Arma Christi*, objects associated with the Passion of Jesus (left side of figure 2); an upper set, which continues the pillar panels over the spandrels, has very similar yellow oval medallions with Christian symbology (right side of figure 2); finally a set lining the tympanums has a radial decoration and a central oval medallion within a frame different from the rest, with Christian symbols or a Latin epithet (Figure 3). The palette of all these sets is similar but the design of this third set is rather simple when compared to the others and it may correspond to a different order. Besides these, there are also linings with the so-called *punta de clavo* patterns over the double arches and in the blind archways (Figure 1).

Figure 2. Some of the panels on the nave of *Igreja de São Roque*, near the entrance: over the pillars, with symbols associated with the Passion – in this case the knife of Peter cutting the ear of Malchus (left side); and over one of the spandrels with the Christogram "IHS" (right side)

All these linings have been attributed, on strong grounds of artistic similitude, to the workshops of Seville by several authors who studied them as an art history object. A review of such contributions may be found in a recent work by M. Almeida & E. Fernandes [1].

A close inspection of those panels reveals a number of interrupted yellow designs and intermixed tiles as in figure 1a (central and right-side spandrels). The blemishes may, in

part, be a consequence of the 1755 earthquake that ravaged Lisbon but seem to have been mostly caused by the fastening of large illumination fixtures that are seen in pictures taken ca. 1956 [2, plate 40] and were removed at a later date. Some of these intermixed azulejos are obviously connected with the Seville panels but others are totally different and have been addressed by us in another paper [3].

Figure 3. A tympanum panel

Figure 4. The two sorts of panels set against linings of *punta de clavo* patterned tiles on the end walls of the transept of *Igreja de São Roque*. The shape of the corner panel on the left side of the figure shows that it was specifically designed for this particular spot on top of the transept

Another group of panels that is relevant to this article is to be found on the walls of the transept: square and triangular panels with rather naïvely sketched figures over a white background, set against a lining of the same *punta de clavo* tiles seen associated to the arches near the entrance (Figure 4).

In this paper, we highlight some peculiarities of those interesting panels, discuss their historical context, propose their original distribution in the nave, and present the results of an analytical study, comparing them to other productions of known provenance.

2. OBSERVATIONS ON THE TILES AND THEIR HISTORICAL CONTEXT

The pillar panels, of which one is illustrated on the left side of figure 2, are seemingly dated "1594" on the Gospel side of the nave – the painter resourced to the representation of the dice with which the soldiers cast lots for Jesus' seamless robe by including the unlikely number nine in one of the dice faces. The three visible faces of that die read clockwise "594" and the frontal faces of the three dices represented also read"594" in the same sense (Figure 5). The upper linings are also twice dated "1596" (Figure 6) but, as will be seen, one of those dates may be misplaced.

On the Gospel side of the nave, a medallion depicts the "AM" Marian monogram (*Auspice Maria* or "under the protection of Mary") with an overline indicating scribal abbreviation (left side of figure 6). The medallion bears the date "1596" but is incomplete. On the Epistle side the date is preceded by a Latin sentence – R(E)GNI COELORVM (of the Kingdom of Heavens) – right side of figure 6.

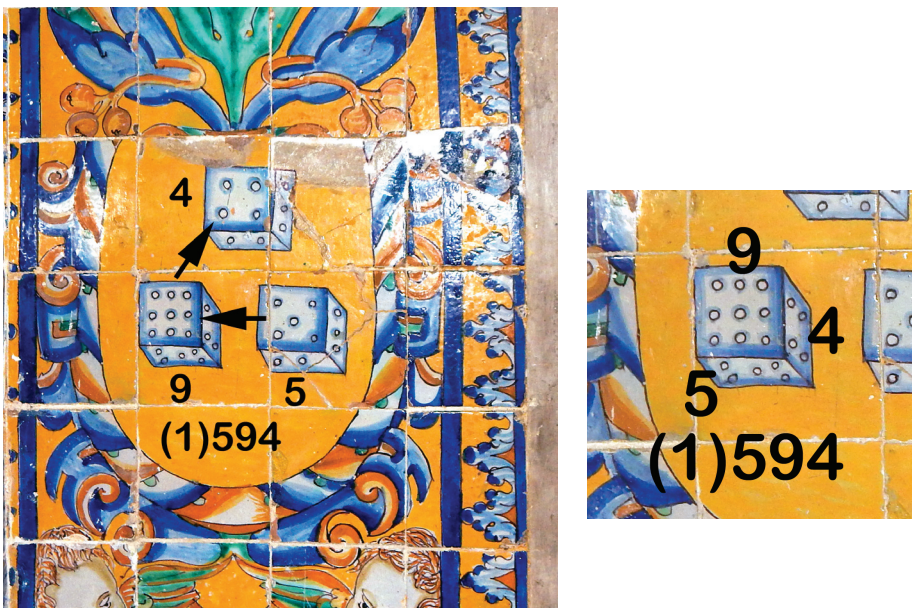

Figure 5. In all likelihood a representation of the date "1594" using the dice on a pillar panel on the Gospel side of the nave

Figure 6. Incomplete medallion with the *Auspice Maria* monogram on the Gospel side and the other dated medallion on a tympanum on the side of the Epistle

These azulejos pose many questions, such as: how many panels were there originally? And: why were they commissioned to Spanish potters? An important key to clarify the first issue lies in the tiles once part of similar panels and now kept crated, in storage at the local Museum (*Museu de São Roque*). Considering the markings on their backs, one can see that besides the numeral necessary for setting each panel properly on the wall, there is a code aimed at indicating the individual panel of which the tile was a part [4] – see figures 7d, f. From these codes (A, B, C, c, D, d, E, G, Y) the number of panels represented in the storage crates can be established and thus at least nine upper medallions and four pillar panels were identified, presumably all once bearing *Arma Christi*. A further code (O) is so scarce that it could not be established to which sort of panel it belonged.

Another aspect is related to the occurrence of two different sorts of oval borders in the medallions, a "broad" one made up of rolls in two shades of blue and orange (as in figure 2) and a "narrow" one made up mostly of blue pearls on a white background (as in figure 3 and on the right side of figure 6). The broad oval border is associated with medallions on the pillar panels and the corresponding panels on the spandrels, some with the Christogram IHS (*Iesus Hominum Salvator*) of which there are in the church two sets correctly assembled plus a third one in an area of mixed azulejos (Figures 1a and 1b) and the incomplete medallion with the AM monogram. The narrow oval border is exclusively associated with medallions set on the tympanums with the representation of the cross and the pair of keys of Saint Peter (Figure 3) or bearing the *Regni Coelorum* epithet that may be seen on the right side of figure 6 (in which two pieces of broad oval border result from restoration attempts with parts of other tiles). The occurrence of two different oval borders suggests an association between the pillar and the spandrel panels and enhances the contrast with the tympanum panels.

From the azulejos in storage, it could be established that there were at least three more medallion panels with a broad border as in the IHS panel of figure 2 (coded C, D, E) but it is not possible to define at this time what were the motives inside. Another azulejo with this same medallion in which the tip of the "S" is recognizable had a code that could not be read (Figures 7a, b). Also found in the crates were parts of at least four medallions with a narrow border that had the cross and the pair of keys of Saint Peter, similar to

those seen at the church (as in figure 3). These have the codes A, B, E and G (Figures 7 c, d). Two more groups belonging to panels with medallions of the same type were coded C, D but these did not include tiles allowing the determination of the motives in their interior.

As for the very interesting lower pillar panels (as in figures 2 and 5), remains of four similar panels with legible codes (B, C, G and Y) were identified in storage. It was possible to establish in three of them the presence of more *Arma Christi*: a sponge, of which there were seemingly two in the set - one for the vinegar and one for the gall (code G34, figures 7e, f); the flagellation column and the whip (code B- figure 7g) and some ribbons (code Y). Also, with a code that could not be read, two azulejos from a fifth pillar medallion that had a cross with the *Titulus Crucis* INRI (*Iesus Nazarenus Rex Iudaeorum*) – figure 7h.

The fact that there are medallions coded "C", "D", "E" and "G" both with narrow and broad oval borders (as exemplified in figures 7c, d – code G, keys in a narrow border medallion, and 7e, f – code "G" broad border) suggests that those two types were delivered and applied at different times. This remark agrees with the presence of two dates on the panels (1594 and 1596) and it is important to note that the association of the date "1596" with both the broad and the narrow ovals (Figure 6) may be misleading. Indeed, the dates are contained in a single tile and the tiles in many medallions have been mixed, particularly near the entrance on the Gospel side (Figure 1b). Therefore, without accessing the backside codes it is not possible to assert whether, in particular, the dated tile associated with the "AM" monogram is correctly posed.

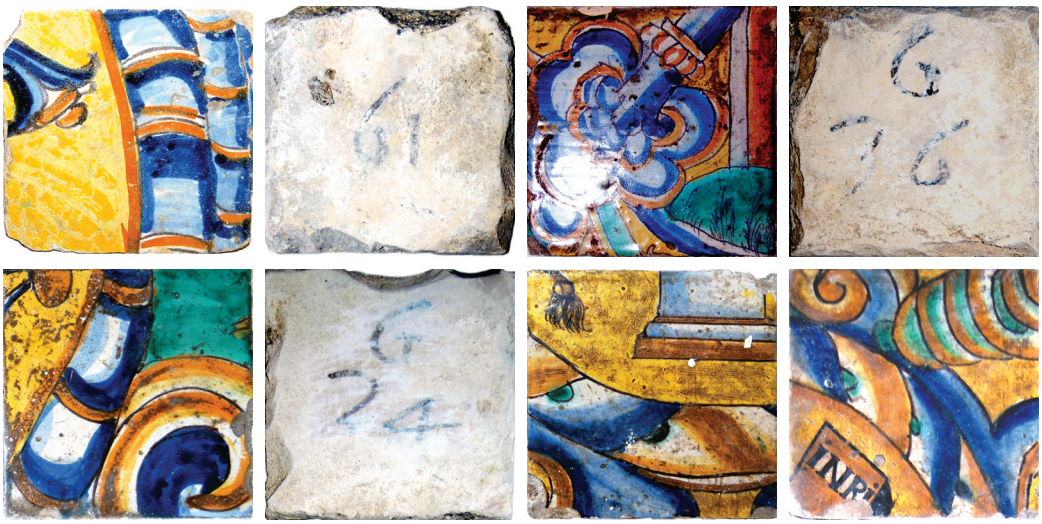

Figure 7. From left to right and top to bottom: 7a, b - front and back of a tile from a *IHS* medallion with a broad oval border, coded ?61; 7c, d - front and back of a tile from a narrow bordered medallion with the keys of St. Peter coded "G36"; 7e, f - front and back of a tile with a sponge coded G24; 7g, h - tiles in storage with two more *Arma Christi*

Considering the panels to which the tiles in storage belonged together with those still on the walls, it is possible an estimation of their original number. Therefore, there should have originally been at least nine spandrel panel medallions, possibly ten or more. The pillar panels would have been at least eleven. As for the narrow oval medallions of the tympanums, their number can be estimated in at least seven with the cross and the keys

and two with the *Regni Coelorum* text. With this information in mind it is possible to have a clearer idea of the area once occupied by the full lining.

Igreja de São Roque started being erected in 1565/1566, after the demolition of part of a primitive chapel. Due to revisions in the project and other problems, the construction of the definitive ceiling only started in 1585, although the church was open for worship since 1573 [5].

A dated mention to an application of azulejos in the nave has not yet been found, but the year 1596 is connected to an important event involving reconstruction and new decoration inside the church. In 1587, a very important group of relics was donated to this church by Juan de Borja y Castro, son of the then Principal of the Company (Francis Borgia, later canonized) and secretary of the Holy Roman Empress Maria of Austria. The document of donation was made at the Monastery of Escorial and the relics arrived in Lisbon on October 27, 1587 amidst great festivities [6, p. 119]. The importance of this donation (even today this is considered one of the most significant sets of catholic relics in Portugal) brought forth the need to enlarge the area where the relics would be laid, near the Main Altar. The area was expanded and received the relics in 1596. It is likely that it was at this instance that the whole transept was lined with *punta de clavo* azulejos and decorative panels (as in figure 4), presumably also made in Seville. What is known for certain is that in 1596 work on the transept and decoration of the area was completed at a cost of 4,500 Portuguese *cruzados* [5, p. 358]. Coincidently, or probably not, this is the date also inscribed in the medallions near the entrance (Figure 6). Since the changes to the interiors were made between 1587 and 1596 to receive the relics, and the area lined with azulejos was extensive indeed, it seems likely that several orders and deliveries were made and therefore the imprint of two dates within the period (1594 and 1596) does not seem out of line.

In 1599 "three chapels were gilded and decorated" (*douraram-se e ornaram-se três capelas da igreja*) [5, p. 357] works that seem to mark the completion of the Church which, at this time, had only four side chapels, one of them the *Capela de São Roque* (Chapel of St. Roch). These four chapels were those nearer to the Main Chapel, while the remaining nave area close to the entrance had "some niches with burnished stone, very well decorated and tiled with azulejos and in them the confessionals" (*huns nichos, de pedraria burnida, muy bem ornados, & azulejados, & nelles seus confissionarios*) [6, p. 113]. All this was removed when it was decided to erect in this area four more chapels. Balthazar Telles writing in the 1640s says that the transformation had been completed not much earlier [6, p. 113] and Rui Lobo, sourcing another author, mentions that one of the new chapels was established in 1623 [7, p. 250] from which one may safely assume a date for the demolition of the niches in the late 1610s or early 1620s. This raises the question: could the azulejos now crated be what remains of those formerly used to decorate the demolished confessionals?

When Balthazar Telles mentions the demolished niches, he adds: "over the confessionals laid balconies with large windows to the church where there was space to hear the sermons and other worship services" (*por sima dos confissionarios corriam tribunas com janellas muy largas pera a Igreja, nas quaes havia commodo pera assistir às prégaçoens & mais officio s divinos…*) [6, p. 113]. Having in mind that the structural skeleton of *Igreja de São Roque* follows a fixed module (ca. 6.56 m) which determines the span of the chapel arches, it may be remarked that the length of the tiled area seen in figure 1 (ca. 6.20 m) fits into this module. Then, one can hypothesize that before 1620 this double-arch structure was repeated where the new chapels were erected afterwards and if the balconies ran over the confessionals, then there would likely have been four confessionals on each side, decorated with azulejos, as testified by Balthazar Telles.

One hypothetical arrangement is illustrated in figure 8[1], supposing that the azulejo lining extended beyond the two remaining arches on each side of the nave ("St" in figure 8). If this was the case, then, except for the rearrangements and substitutions of some tiles, those panels that remain today are applied exactly where they originally were and their azulejos must have codes that are not represented in the crates. This arrangement, or any of the alternative dispositions, will set the number of original panels and that number may later be compared with the codes on the backside of the azulejos still on the walls if those are one day removed to be orderly reapplied. Maybe the interior of the niches was also decorated with azulejos, and these could be the *punta de clavo* tiles that were re-used at a later time e.g. in the blind archways near the entrance and in the interior of the first chapel on the side of the Gospel (dedicated to St. Anthony) which was built after the niches were demolished.

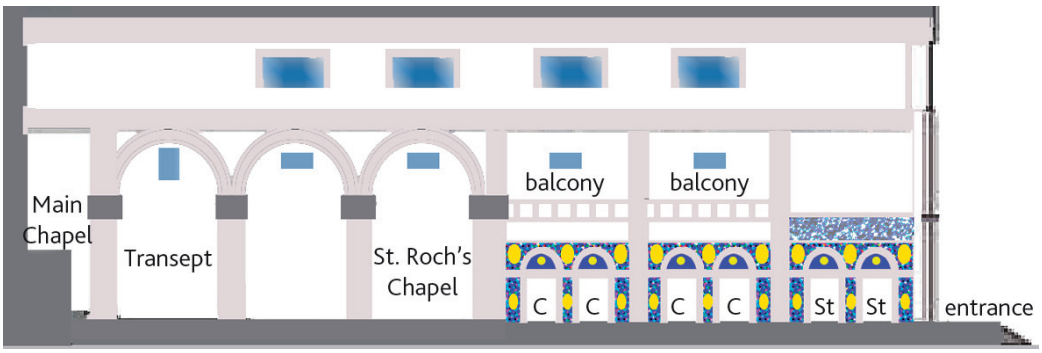

Figure 8. Hypothetical configuration of the church interior before 1620 with the tiled confessionals (C) and the balconies running over them – the two arches that still stand today (St) could erstwhile be passageways to the stairs leading to the balconies – see also [7, fig. 11]. If this configuration was replicated on the other side of the church, there would have been 18 pillar panels in the whole, 12 tympanum panels with their medallions and 18 spandrel medallions between the arches. Other configurations, e.g. with only four tiled arches, would lead to less azulejo panels

Another possibility, but less likely, would be that these azulejo sets were originally intended for the cloister of the convent (*Casa Professa*) near the church, where the *Arma Christi* could be associated with the procession of the *Via Sacra*. However, the symbols present in the upper panels seem more suited to the church and with the information regarding the presence of confessionals they appear to make sense, promising redemption after the sacrament of confession. One other aspect that gives strength to the idea that the colourful azulejo panels once decorated the niches of the confessionals is the fact that when writing in the decade of 1640, Balthazar Telles still alludes to the azulejos and to the area where they were used, although at this point their original placement was already a memory. Nevertheless, they seemed to be worthy of mention by this author who somewhat laments the alterations when he writes, referring to the niches with the azulejos and the balconies: "all that was there was demolished, not so much to improve

1 The arrangement supposes that the pulpits were not integrated into the walls, as they are today. The balconies would have windows, as can still be seen today in the Jesuit *Igreja do Espírito Santo*, in Évora, and the arrangement of the top windows was suggested by external signs that point to a different setup than today's, also noted by Rui Lobo on his proposed reconstruction [7, p. 251].

the area (because some liked it better as it was before) but to strengthen the walls of the church with the structure of the new chapels" (*tudo isto se desfez por causa das quatro capellas que de novo aly fabricámos; nam tanto com intento de melhorar & ornar a Igreja (pois alguns a julgavam d'antes por mais engraçada) quanto por rezam de acrecentar este novo repuxo das capellas às paredes da Igreja*) [6, p. 113].

While dealing with the symbology in the Sevillian azulejos, there is a striking feature worth of special mention: the *Auspice Maria* monogram, seen on the left side of figure 6. Writing in 1907, José Queirós mentioned it as follows "Entering [the church] on the right side the inscription: REGNI CELORUM and the date; on the wall opposite, the same date preceded by the monogrammed letters AM. Are these the initials of the painter [...] or the monogram of the Virgin Mary? The same monogram can also be seen on the right side of the entrance, but now without the date […]." (*Entrando, á direita, a inscripção: REGNI CELORUM, e a data; na parede opposta, a mesma data antecedida das letras AM, em monogramma. Representarão estas letras o nome e appellido d'algum pintor […] ou o monogramma da Virgem Maria? É certo que este monograma se encontra á direita da entrada, mas sem a data […].*) [8, pps 248-249]. Queirós was not the only author to consider that this could be a signing monogram of the artist or workshop master. However, the religious meaning of the "AM" monogram is well established. The mark over the letters may cast doubts on its true nature but it should be pointed out that in the 16th and 17th centuries the Jesuits adopted similar (albeit less ornate) overline marks over religious monograms to indicate a scribal abbreviation. In the frontispiece of many early editions of Ignatius de Loyola's *Spiritual Exercises* the overline with a half circle at the middle is used over the IHS monogram (see for instance the first edition, published in Rome in 1548 by Antonio Bladio), while in the frontispiece of the 1635 Flemish edition by Johannes Meursius, the same overline is used over a "MA" monogram. There is, however, an argument that may resolve all doubts and it stems from the sheer size of the monogram: no potter working for the Jesuits would certainly dare occupy half a medallion devoted to religious symbolism with his own signature! Queirós' information that there was a pair of A.M. monograms on both sides of the entrance suggests an assertion to those coming in, and gives weight to the hypothesis that these tiled arches are relics of the original extended lining and not a later re-application. Still, one question subsists: what was represented on the other half of the surviving AM medallion?

There is one last aspect, certainly the most relevant as pertains the history of the early production of azulejos in Portugal, and one of the reasons for our interest in these panels at this time when we are studying Portuguese productions at the end of the 16th century. The question is: why commission those azulejos to Seville instead of to local manufacturers, as had been done earlier for the very same church [3; 9]? One simple answer could be that the workshops or the painters that had produced masterpieces such as the lining of *Capela de São Roque*, dated "1584", were no longer active and the productions in the 1590s, maybe exemplified by the panels at the Cathedral of Setúbal [10], did not meet strict quality requirements by the Jesuits for the church of their seat in Portugal. A detail that may support this assumption is that there was a shift in the manufacture of azulejos in Lisbon that seemingly occurred at about this time. Thenceforward a new glaze formulation and a different firing cycle would be used [11], as if the earlier 16th century workshop or workshops of Lisbon had all gone out of business or else recognized that their technology was by then unsuited to compete with Spanish productions and felt the need to upgrade their procedures. Another simple alternative hypothesis is that the workshop(s) of Lisbon did not have the necessary output for such a large commission to be delivered in a relatively short time. Júlio Parra counted the Sevillian tiles inside the

church and he concluded that there are around 10,000 *punta de clavo* tiles and associated patterns and panels (as in figure 4) in the nave and the transept [12]. For a comparison, the lining of *Capela de São Roque* comprises only ca. 1,200 tiles [12]. There is not, at present, enough data to verify or reject any of these hypotheses.

A third possibility is related with a political aspect. At this time, the king of Spain also occupied the throne of Portugal and, as mentioned before, a very important group of relics was donated to this church and transferred from Spain in 1587. It is possible that the priests of the Society of Jesus (with headquarters in Rome but rooted in Spain) thought it suitable, after such a donation, to commission the azulejos to Sevillian workshops that had also supplied with similar linings convents such as *Santa Inés* (with the same *punta de clavo* and associated patterns – left side of figure 9) and *Santa Paula* (with grotesque designs painted over a yellow background – right side of figure 9) in Seville, disregarding in the process the possibility to order the azulejos from the workshops of Lisbon for no other particular reason.

Figure 9. *Punta de clavo* and associated patterns in *Convento de Santa Inés* (Seville) similar to azulejos at *Igreja de São Roque* (left side); panel with grotesques in *Convento de Santa Clara* (Seville) painted on a yellow background with the same palette as used in *Igreja de São Roque*, of which the combination of the two hues of blue is particularly characteristic (right side)

3. EXPERIMENTAL

3.1. Samples

The yellow, orange and blue panels near the entrance to the church (Figure 1) were given the reference Az333, the square panels on the transept (Figure 4) were coded Az309 and the *punta de clavo* patterned tiles at the same location were referenced as Az310. A total of eight samples were collected by removing small fractions, preferably of the glaze with biscuit attached, usually from areas already with previous damage. Each sample was identified with an alphanumerical code added to the panel reference (see table 1) and the sampling points are shown in figure 10.

Table 1 Samples collected from the azulejos of *Igreja de São Roque* attributed to the workshops of Seville

Sample reference	Location	Colour of the sampling point
Az333/01	Tympanum church entrance	yellow
Az333/02	Arch spandrel church entrance	yellow + purple outline
Az333/04	Arch spandrel church entrance	dark blue + dark outline
Az333/05	Crated single tile	orange
Az309/01	Transept (square panel)	yellow
Az309/02	Transept (square panel)	orange
Az309/03	Transept (square panel)	dark blue
Az310/01	Transept (*punta de clavo*)	white

Figure 10. Location of the sampling points

3.2. Analytical methodology

The azulejo samples were stabilized in resin, lapped and polished to obtain a cross-section for observation and analysis by scanning-electron microscopy coupled with an X-ray energy-dispersive spectrometer (SEM-EDS).

The optical acquisition of images of the sections was obtained with a Leica DFC295 digital camera coupled to a M205C stereomicroscope of the same brand.

SEM-EDS observations and analyses were made at the HERCULES Laboratory in Évora using a Hitachi S3700N SEM with a coupled Bruker XFlash 5010 EDS. The specimens were uncoated and the observations were made in backscattered electrons mode (BSE) in variable pressure mode at 40 Pa and at an accelerating voltage of 20.0 kV. The acquisition of X-ray spectra was done with the detector at ca. 10 mm working distance.

The selection of areas for EDS analysis avoided inclusions in the glaze or biscuit representing more than ca. 5% of the full area analysed. Whenever possible area sizes of ca. 200 x 200 μm for glazes and 500 x 500 μm for biscuits, or larger, were used but acceptable repeatability was verified in areas four times smaller. For comparison purposes, only the elements usually representing the major components were considered, excluding tin (Sn) in the glazes and lead (Pb) in the biscuits due to their variability with the area chosen (in the case of Sn in the glaze because of crystal aggregations and in the case of Pb in the biscuit because the content increases with proximity to the interface). The results of the EDS analyses were given in weight % of each element considered.

3.3. Results

3.3.1. Glaze morphology

Figure 11 illustrates microscopic images of two of the sample sections prepared. The colour of the biscuits varies but is never red or brown, as happens in many 16th century azulejos manufactured in Lisbon [e.g. 3]. No *coperta* (a transparent glaze layer sprinkled on top of the painted glaze) was used over the yellow painting.

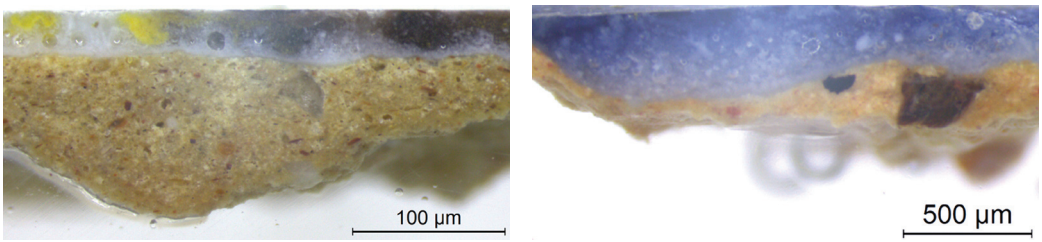

Figure 11. Prepared sections in optical microscopy - left to right: Az333/02 and Az309/03

Figure 12 illustrates SEM images of five samples that exemplify the main micro-morphologic characteristics associated with the glazes of these azulejos. The development of the interface is limited and often made up (at this scale) of detached crystals in the midst of the glaze.

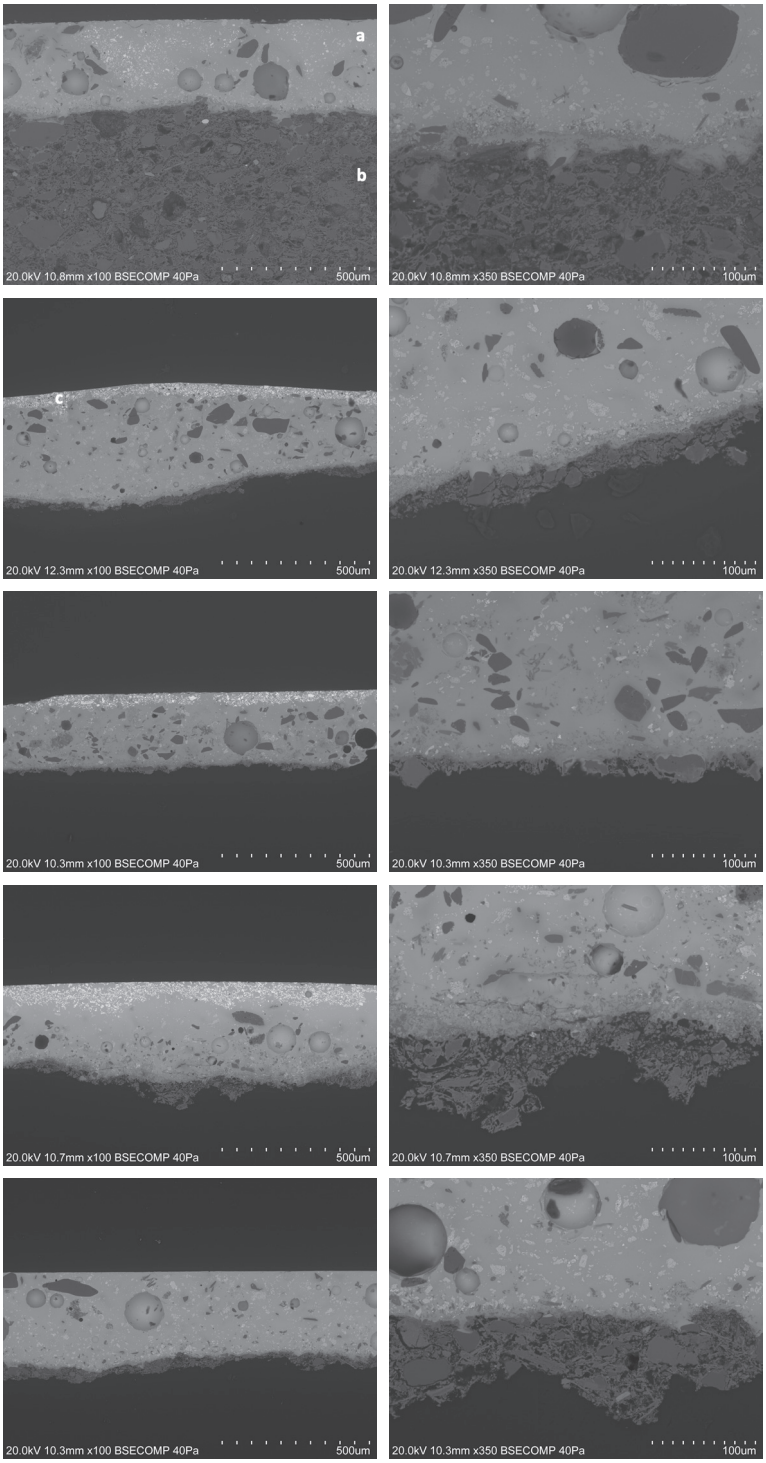

Figure 12. SEM images of the glaze and glaze-biscuit interface - from top to bottom: Az333/02; Az333/05; Az309/01; Az309/02 and Az310/01, exemplifying the main micro-morphologic characteristics generally associated with the glazes of the tiles under study (a – glaze; b – biscuit; c – orange pigment)

3.3.2. Glaze composition

Table 2 includes the semi-quantitative results of analyses of the glazes by EDS in weight %. Sn was excluded for the reasons pointed out in section 3.2. Ca was detected in all glazes but was left out of the quantification because of a possible confusion with Sn, due to the overlap of peaks. The amount of oxygen was calculated through the remaining elements stoichiometry of their most commonly considered oxides and the results were normalized to 100%. The ratio between Si and Pb (main components of the glaze) was determined and is also included in the table, together with averages and standard deviations.

Table 2. Semi-quantitative composition of the glazes determined by SEM-EDS (wt.% of oxygen and main elements, excluding Sn and Ca, for comparative purposes, normalized to 100%)

Samples	Na	Mg	Al	Si	K	Fe	Zn	Pb	O	Si/Pb
Az333/01	1.73	1.17	2.75	23.98	5.02	0.86	1.24	28.22	35.02	0.85
Az333/02	2.49	0.67	2.39	24.40	4.55	2.20	0.60	27.32	35.37	0.89
Az333/04	3.71	1.01	1.96	24.80	3.66	0.78	N.D.	28.82	35.26	0.86
Az333/05	3.11	0.88	2.08	24.31	4.89	0.69	N.D.	29.29	34.76	0.83
Az309/02	2.84	1.22	1.99	23.26	4.05	1.87	N.D.	30.71	34.07	0.76
Az309/03	3.46	0.73	1.93	24.45	5.18	2.47	N.D.	26.36	35.42	0.93
Az310/01	1.90	1.19	1.74	25.11	4.94	0.87	0.62	28.31	35.32	0.89
AVERAGE	2.75	0.98	2.12	24.33	4.61	1.39	-	28.43	35.03	0.86
StDev	0.75	0.23	0.34	0.59	0.56	0.76	-	1.39	0.48	0.05

N.D.= not detected

3.3.3. Biscuit composition

Table 3 includes the semi-quantitative results of EDS analyses of the biscuits of which there was a sufficient area (the biscuit area of Az309/03 available for analysis was curtailed by a large inclusion). The results refer to oxygen and eight other elements of higher content and particular interest for comparison purposes. Pb was detected but excluded for the reasons pointed in 3.2. The results are given in wt.% and were corrected to 100%. The table also includes the ratios between Ca and Si, the main components of the biscuit, as well as the averages and standard deviations.

Table 3. Semi-quantitative composition of the biscuits determined by SEM-EDS (wt.% of the main elements normalized to 100%)

Samples	Na	Mg	Al	Si	K	Ca	Ti	Fe	O	Ca/Si
Az333/01	1.95	2.98	7.58	20.17	1.33	19.36	0.47	3.83	42.32	0.96
Az333/02	1.70	2.60	7.51	20.96	1.90	18.45	0.53	3.75	42.59	0.88
Az333/05	2.34	2.91	7.76	21.03	2.59	16.83	1.08	2.74	42.73	0.80
Az309/03	2.88	3.11	9.94	20.79	2.50	12.35	0.75	4.30	43.37	0.59
Az310/01	2.69	3.28	8.31	20.39	1.51	17.12	0.52	3.48	42.70	0.84
AVERAGE	2.31	2.98	8.22	20.67	1.97	16.82	0.67	3.62	42.74	0.81
StDev	0.49	0.25	1.01	0.37	0.57	2.70	0.25	0.57	0.39	0.14

4. DISCUSSION

4.1. Technology

The images of figure 12 show that, morphologically, nothing strikingly different separates the samples between them and, particularly, the interface testifies to similar firing cycles, significantly different from the firing cycle used in Lisbon in the 16th century that was characterized by an overgrowth of interfacial crystals [11].

The composition of the glazes testifies to, in average, relatively higher contents of Na and K when compared to their 16th century counterparts by the workshops of Lisbon [see 11, table 2].

4.2. Analysis of the EDS spectra

Comparing the semi-quantitative results of the EDS analyses in tables 2 and 3, none of the samples is strikingly dissimilar. It is relevant to point out that zinc (Zn) was detected in the glaze of some samples, but not in others. Zinc was never clearly detected in the white glaze of Portuguese azulejos of the 16th century that we have studied so far. If, later, we confirm that zinc is consistently found in the composition of some Sevillian glazes, its presence may be important as a marker of provenance.

A more substantive discussion of the results obtained is hampered by the fact that there is not, yet, a comparable data collection of analytical results pertaining to the glazes of 16th century faience azulejos produced by the Spanish workshops. A recent study by

Laurence de Viguerie et al. [13] relied on energy-dispersive X-Ray Fluorescence (XRF) semi-quantification, obtained with a portable unit, and the results are not directly comparable to ours. Indeed, the authors point to the need for complementary results obtained also from a study based on cross sections, as we are pursuing. Our own results for Hispano-Moresque tiles [11] would be comparable; however the technology of faience glazes is different from the Hispano-Moresque and possible similarities in the morphology or composition of the glazes are not conclusive. On the other hand, a direct comparison of the EDS spectra of the glazes of different samples often shows in a quite clear way the main dissimilarities between samples of different productions [14].

Figure 13 compares the spectrum of the glaze of sample Az333/01 with the spectrum of a sample from the Alcácer do Sal panel (Az334/01) manufactured by the workshops of Lisbon and dated "1592" [15]. The spectra were normalised through the Si peak. Since the area of the peaks is, for each element, proportional to its content, it is obvious that the two compositions are quite different pertaining important elements such as Na, Mg, Pb, K and, in this particular sample, also Zn. Ca in the glaze was detected but not quantified, as mentioned above. Yet, its presence is recognizable in sample Az333/01, as shown by the higher relative intensity of the Sn Lβ + Ca Kα overlapping peaks compared to the Sn Lα peak. The relatively high Ca content in these glazes may also be valuable for future provenance studies.

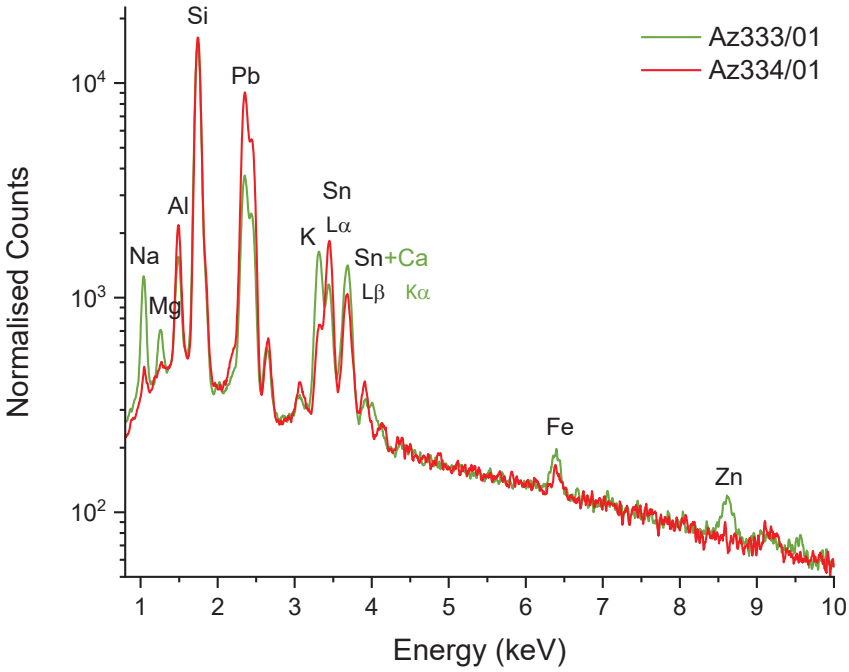

Figure 13. Comparison in the range 0-10 keV of the spectral results of the EDS analyses of the glazes of a sample from the 1592 Alcácer do Sal panel - Az334/01 (red) with Az333/01 (green)

Having established the spectral counterpart of compositional differences, figure 14 now shows the spectral counterpart of similarities by comparing the glaze of Az333/01 with Az309/03 and Az310/01.

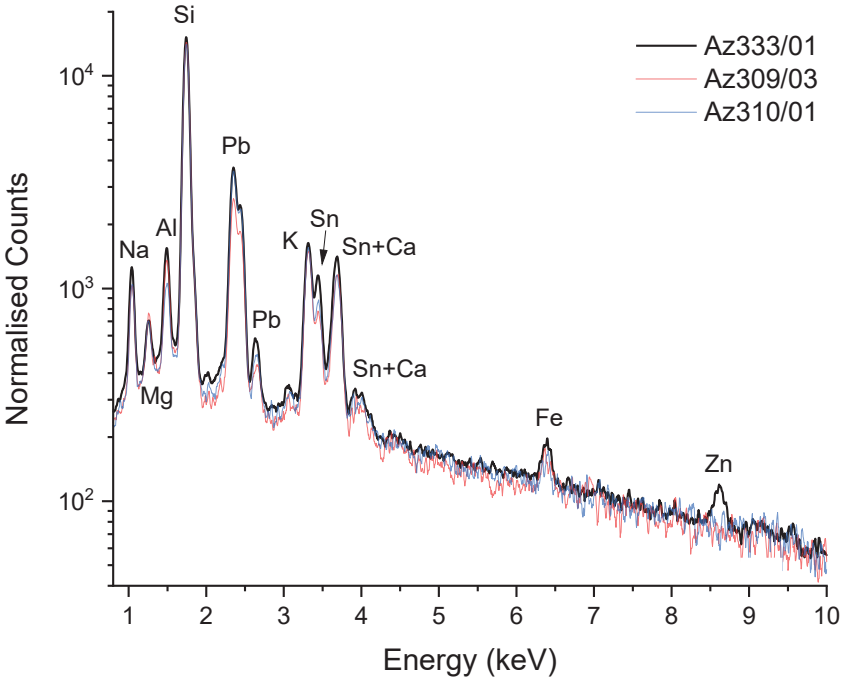

Figure 14. Comparison in the range 0-10 keV of the spectral results of the EDS analysis of the glazes of Az333/01 (black) with Az309/03 (red) and Az310/01 (blue)

The juxtaposition of the spectra illustrates quite clearly the similarity between the glazes of the samples taken from the different panels studied, as well as the conspicuous differences when compared to a Portuguese panel from the same decade.

Although the composition of faience glazes is not wholly comparable to Hispano-Moresque glazes, the composition of the biscuits is independent of the glaze type and may therefore be compared. The composition of the biscuits of the panels studied as pertains major elements with contents > 0.5 wt.% (Table 3) may be compared with the composition of other productions including Sevillian Hispano-Moresque tiles that we have analysed with the same instrumental means and published in the past [11]. Table 4 includes the comparison, showing clearly that the average values in table 3 only fit the Hispano-Moresque biscuits, pointing to a Sevillian provenance and suggesting that, notwithstanding the different chronologies, the geologic source of the clays was the same.

Table 4. Comparison of average biscuit compositions from table 3 with averages and 90% confidence intervals for Hispano-Moresque, Circle of João de Góis (Lisbon 16th century) and Portuguese azulejos from the 17th century (adapted from [11])

Samples	Na	Mg	Al	Si	K	Ca	Ti	Fe	O	Ca/Si
Average Az 333, 309 & 310	2.31	2.98	8.22	20.67	1.97	16.82	0.67	3.62	-	0.81
Hispano-Moresque	2.0±0.7	3.8±1.9	7.3±0.3	21.8±1.8	1.7±0.3	16.5±2.7	N.D.	3.8±0.6	-	0.8±0.2
João de Gois circle	1.3±0.1	1.6±0.3	8.6±1.0	26.9±1.6	2.9±0.5	8.8±1.2	N.D.	4.2±1.1	-	0.3±0.0
Portugal 17th cent.	1.4±0.2	1.9±0.3	6.6±0.5	17.9±1.2	1.5±0.4	26.5±2.7	N.D.	3.7±0.6	-	1.5±0.2

N.D. – not determined

5. CONCLUSIVE REMARKS

The morphological and analytical comparisons have shown a remarkable similarity between all samples analysed and made clear that they are different from Portuguese 16th century productions.

The micro-morphology and the glaze compositions cluster all tiles addressed by this study together, as products of basically the same technology, as could be expected from a single workshop or workshops from the same town, working based on the same technological parameters. If any of the types tested can be attributed to Seville on grounds of artistic similitude, as has been done by several authors referring to the panels set near the entrance (Figure 1), then all the other panels and the *punta de clavo* lining sampled from the transept are also attributable to the same provenance, despite the differences in colour and design. The similarity of the composition of the biscuits as pertains major elements with the composition of Hispano-Moresque tiles attributed to the workshops of Seville supports a common geographical provenance.

Nothing in the analytic results indicates that the productions represented were chronologically spread in a significant manner - the striking similitude suggests that the chronology of all the tiles sampled and tested is not very different, supporting a common date in the 1590s.

This result may be relevant to the history of the first half century of faience azulejo production in Portugal: if in 1584 there was a workshop able to supply the linings of *Capela de São Roque* [9], why was it necessary to order a somewhat simpler set from Seville only ten years later? The colours of the Sevillian tiles are superb; however the sketch of figures is far inferior to what can still be seen in *Capela de São Roque*. Considering the possibilities hypothesized at the end of section 2 above, we think it likely that the workshop that produced the lining of *Capela de São Roque* was no longer active, at least under the same master and with the same artists, and whatever was available at the time was considered unreliable in terms of colour, homogeneity of the product or output capacity. Those responsible for the commission likely believed, probably supported by a direct knowledge of the Spanish productions [2, p. 64] that they would be better served by the workshops of Seville than by those of Lisbon and, in fact, they could be assured simply by visiting religious houses in Seville where they could verify the quality of the

products and, as in a catalogue, order linings and panels similar to what they saw there (Figure 9).

The analytic results coincide with the historians' opinions on an attribution to the workshops of Seville, possibly to a single workshop… but to which workshop? We left a remark on authorship to the end. Alfonso Pleguezuelo[2] is of the opinion that the panels are a product of the workshop of Juan and Hernando Valladares about whom he writes: "A family named Valladares monopolizes the production of Sevillian azulejos in the last years of the 16th century and during the first decades of the 17th. (…) We know nothing of the work of Juan, the founder of the saga, but we know more of the works of his son Hernando, who married in 1595. (… The Valladares workshop) increased the use of repetition patterns of textile inspiration. A pattern which was disseminated from the last years of the 16th century was the *punta de clavo*, also produced in other peninsular pottery centres"(*Una familia de apellido Valladares monopoliza la producción de azulejos sevillanos en los últimos años del siglo XVI y durante las primeras décadas del XVII (...). Nada sabemos de la obra de Juan, el iniciador de la saga, pero son más abundantes los datos de la obra de su hijo Hernando, que se casa en 1595. (... La oficina de Valladares) aumenta los motivos de repetición de carácter textil. Uno de los que se difunden desde los últimos años del siglo XVI es el de punta de clavo que también se emplea en otros centros peninsulares.*) [16, pp. 368-369]. The name "Valadares" has a toponymical origin in the border between Portugal and Spanish Galicia [17, p. 717] although it was certainly adopted by other families in the Peninsula. Still, it is a rather uncommon name and it is curious to note that, at the time when the panels were ordered and produced, one of the Jesuit priests was the Portuguese Manuel de Valadares, born in Pombal, near Coimbra, who joined the Company in 1553, when Ignatius of Loyola (1491-1556) was still alive. Valadares served most of his life in India and died in Cochin in 1598 [17, p. 720]. The matching family names may well be casual, but this interesting aspect leads us to raise a number of questions. Can Juan Valladares, whose origins are unclear, be connected with Portugal? Can a possible family relation in the Company of Jesus be at the origin of this extraordinarily large order for their church in Lisbon? And most important of all: can his workshop be related with the shift in the Portuguese production of azulejos that aligned the glaze compositions and firing cycles with Sevillian productions and seemingly occurred around the turn of the century [11, and results to be published]? The Sevillian panels in São Roque were studied at this time, when we are addressing the productions of Lisbon in the 1580s and 1590s, also because of possible implications in the technical evolution of the manufacture of azulejos in Portugal.

We attempted to explain a number of questions connected to this lining, but in the end raised more new interrogations. Their considerable potential for future research is what makes these panels so very interesting.

BIBLIOGRAPHIC REFERENCES:

1. ALMEIDA, M. & FERNANDES, E. – *Os azulejos das arcadas sob o coro da igreja de São Roque (Lisboa)* in Arqueologia & História, Vol. 66-67, pp. 123-136, Associação dos Arqueólogos Portugueses, Lisbon, 2015.
2. SANTOS, R. dos – *O azulejo em Portugal*, Editorial Sul, Lisbon, 1957.

2 Professor at the University of Seville (ret.) and noted Spanish researcher in the field.

3. MIMOSO, J. et al. – *Debris of greatness – research on the remains of 16th century Portuguese azulejo panels at Igreja de São Roque* in Lisbon in Studies in Heritage Glazed Ceramics, No. 2, pp. 73-90, LNEC, Lisbon, November 2019. ISBN 978-972-49-2310-9.
4. PAIS, A. et al. – *Os códigos ocultos - informação presente no tardoz dos azulejos (Hidden codes - the information on the backside of azulejos)* in Proc. Int. Conf. Glazed Ceramics in Architectural Heritage (GlazeArch 2015), pp. 347-355, LNEC, Lisbon, 02-03 July 2015.
5. LEITE, S. – *Novos documentos sobre Francisco Dias, Mestre das obras de S. Roque em Lisboa. Arquitecto da Companhia de Jesus no Brasil*, in Archivum Historicum Societatis Iesus, Extractus vol. XXII, pp. 352-366, Institutum Historicum, Rome, Italy, 1953.
6. TELLES, B. – *Chronica da Companhia de Iesu da Província de Portugal*, Volume II, Cap. XXVI, pp. 113 & Cap. XXVII, pp. 117-119, Paulo Craesbeck, Lisbon, 1647.
7. LOBO, R. – *A arquitectura das primeiras igrejas jesuítas em Portugal: São Roque de Lisboa e Espírito Santo de Évora - confessionários, púlpitos e tribunas* in La Compañía de Jesús y las Artes- nuevas perspectivas de investigación, pp. 233-257, Universidad de Zaragoza, Spain, 2014.
8. QUEIROZ, J. – *Ceramica Portugueza*, Typographia do Anuria Commercial, Lisbon, 1907.
9. MIMOSO, J. et al. – *A research on the azulejo panels of the São Roque chapel in Lisbon* in Studies in Heritage Glazed Ceramics, No. 1, pp. 93-112, LNEC, Lisbon, February 2019. ISBN 978-972-49-2307-9.
10. PAIS, A et al. – *Study of a finding of 16th century azulejo panels at the Cathedral of Setúbal in Portugal* in Studies in Heritage Glazed Ceramics, No. 2, pp. 1-18, LNEC, Lisbon, November 2019. ISBN 978-972-49-2310-9.
11. MIMOSO, J. et al. – *A comparison of the earliest faience tiles produced in Lisbon with earlier and later types* in Studies in Heritage Glazed Ceramics, No. 1, pp. 25-45, LNEC, Lisbon, February 2019. ISBN 978-972-49-2307-9.
12. PARRA, J. – *Azulejos - painéis do século XVI ao século XX*, pp. 26-30, Museu de São Roque, Lisbon, 1994.
13. VIGUERIE, l. et al. – *Technological evolution of ceramic glazes in the renaissance: in situ analysis of tiles in the Alcazar (Seville, Spain)* in Journal of the American Ceramic Society, Volume 102, Issue 3, 2019.
14. MIMOSO, J. et al. – *On the use of glaze and ceramic body analytical spectra in heritage azulejos as beacons of provenance* in Proc. Int. Conf. Glazed Ceramics in Cultural Heritage (GlazeArt 2018), pp. 439-450, LNEC, Lisbon October 29-30, 2018.
15. MIMOSO, J. et al. – *Instrumental study of the 16th century azulejo panel decorating a public fountain in Alcácer do Sal - Portugal* in Studies in Heritage Glazed Ceramics, No. 2, pp. 19-34, LNEC, Lisbon, November 2019. ISBN 978-972-49-2310-9.
16. PLEGUEZUELO, A. – *Cerámica de Sevilla (1248-1841)* in SUMMA ARTIS - Cerámica Española, pp. 345-386, Espasa Calpe S.A., Madrid, Spain, 1997.
17. AUCT. – *Grande Enciclopédia Portuguesa e Brasileira* Vol. XXIII, Editorial Enciclopédia, Lisboa, 1960.

Debris of greatness – research on the remains of 16th century Portuguese azulejo panels at *Igreja de São Roque* in Lisbon

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ABSTRACT

In the interior of *Igreja de São Roque* (Saint Roch Church) in Lisbon, on both sides of the nave near the entrance, an inspection of the tile linings promptly reveals a potpourri of azulejos hastily intermixed with the otherwise orderly panels bought from Seville in the late 16th century. Some of these azulejos are obviously connected with the Seville panels but others are very different.

In this paper, we present the results of a first study concerning those odd dispersed azulejos on the walls of the lower nave of *São Roque* and discuss their origin, significance and chronology.

RESUMO

No interior da Igreja de São Roque, em Lisboa, em ambos os lados da nave, perto da entrada, a observação do revestimento azulejar rapidamente revela uma miscelânea de azulejos encaixados de forma descontínua nos painéis sevilhanos datados de finais do séc. XVI. Alguns destes azulejos dispersos são obviamente parte das encomendas feitas a Sevilha na última década do século XVI, mas outros são totalmente diferentes.

Neste artigo, apresentam-se os resultados do primeiro estudo destes misteriosos azulejos dispersos nas paredes da nave inferior de São Roque, discutindo-se a sua origem, significado e cronologia.

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KEYWORDS: Renaissance majolica / Igreja de São Roque em Lisboa / Portuguese azulejos / / João de Góis

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1. INTRODUCTION

In the interior of *Igreja de São Roque* (Saint Roch Church) in Lisbon, on both sides of the nave near the entrance, an inspection of the tile linings promptly reveals a potpourri of azulejos intermixed with the otherwise orderly panels reputedly bought from Seville [1] in the late 16th century (Figure 1). Some of these azulejos are visibly connected with the Seville panels [1] but others are aesthetically different. The fact has been mentioned (e.g. by Pais [2]) yet they were never, to our knowledge, specifically studied.

Figure 1. An arch spandrel orderly lined with Sevillian azulejos (left side) compared to another with intermixed azulejos (right side) – the tiles referred to in this paper are within the area outlined in red

A close examination identified 51 whole tiles and fragments applied to the walls potentially from the same set. Besides these, the *Museu de São Roque* (Saint Roch Museum) keeps in storage a number of single azulejos amidst which seven other related units were identified. Therefore, there are, in the whole, 58 azulejos or fragments that may be related to one or more figurative panels that were lost. Figure 2 illustrates fifteen tiles from this mysterious set.

In this paper, we report the results of a study of the disperse azulejos, discuss what they represented and where they were originally applied. We also detail the information obtained from an analytical study of samples collected from the tiles, and discuss their possible chronology and integration into the production of their time.

Figure 2. Tiles from the dispersed set of azulejos at *São Roque*. From left to right and top to bottom: first row - 2a) part of an arm, branch of a bush and a halo; 2b) a foot; 2c) part of a fur vest (?); 2d) part of a letter (T) and the numeral "3"; 2e) a cloud with the sun (?) behind; second row - 2f) a tile depicting part of a frame made of ovals; 2g) part of a tree trunk with leaves; 2h, i, j) leaves, fruit and a flower; third row - 2k, l) representation of a precious tissue; 2m) part of a piece of furniture; 2n) decorative motives on furniture, simulating gold and 2o) a complex corner (?)

2. OBSERVATIONS ON THE TILES AND HISTORICAL CONTEXT

Although it is difficult to securely establish whether this set of *circa* 60 azulejos belonged to a single or to multiple panels and what was its iconography, some propositions can nevertheless be advanced. The presence of one azulejo where an arm can be seen over what seems to be a halo (Figure 2a) and another one with the writing "T:3" (Figure 2d) suggests a representation of the Baptism of Christ. The subject is addressed in the New Testament by three of the Evangelists (Mark, Lucas and Matthew), and Matthew refers to this event in the 3rd chapter of his Gospel (Mt: 3, 13-17). Having this in mind, we may have what seems to be part of a mention to the Gospel of Matthew referring to this narrative and the arm of Saint John the Baptist pouring water over the haloed head of Jesus. Furthermore, the tile in figure 2c could represent part of the lamb skin the Baptist used on his shoulders. Several other azulejos suggest a scene taking place in the open air, with trees and fruits, and also a bare foot on the grass, all elements that could be associated with the same scene. Although we do not actually have a representative set of azulejos to have a fair notion of the scene in the panel, it can be hypothesised that it might be something similar to the print by Abraham de Bruyn, after Gerard van Gröningen, dated 1583 (Figure 3).

Examining the figurative azulejos that are in storage we found that the backs were rather unusually marked by writing with white glaze (Figure 4). Besides a sequential number

at the centre, there is a symbol on top and, sometimes, other symbols are apparent below the number. The numerals are similar to one reported by José Queiroz from the back of a tile from *Capela de São Roque* [3, p. 111].

Figure 3. On the left side the print (source: Rijksmuseum ref. RP-P-1906-2170) and on the right side with six azulejos that could fit the representation

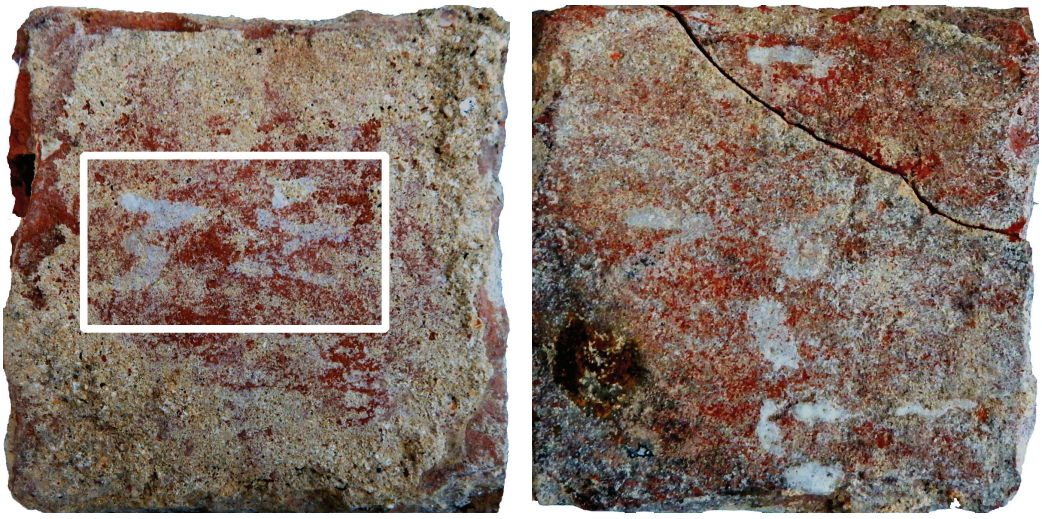

Figure 4. From left to right: 4a) back of a tile on which a sequential positioning marking "32" is clearly visible while a further marking below (2?) is barely perceivable; 4b) back of a different tile with a numeral "2(?)6" in the middle, a horizontal line on top and, seemingly, more markings below (the colour was enhanced on both tiles)

If it is accepted that there once was a panel depicting the Baptism of Jesus, where would it have been located in the Church, and when was it made? The second part of the question is easier to answer, because *Igreja de São Roque* was erected between 1565 and 1573 when it was opened for worship albeit not yet quite finished [4]. The works continued in 1577 and the finishing of the interiors was mostly done in 1584-1586 [4]. The azulejos lining *Capela de São Roque*, inside the church, are precisely dated "1584" and this panel possibly depicting the Baptism of Jesus may have been made around the same time. The consecration of each of the four side chapels of the church that existed at this time is known and one of them was to the *Espírito Santo* (the Holy Ghost). Baltasar Telles mentions this chapel, identifying its patrons [5, pp. 123-124], but does not detail its decoration, nor does the unknown author of the description of the Church, *circa* 1706-1708 [6], who considers it "humble" presumably because it did not have any painted retable that they would consider remarkable. In 1749 this chapel was demolished and replaced by the lavish *Capela de São João Baptista* (Chapel of John the Baptist) commissioned in Italy by King D. João V and delivered as a self-contained fully decorated unit. Could an azulejo panel depicting the Baptism of Jesus have formerly been there? If so, how would such a panel have fitted in a space consecrated to the Holy Ghost?

The Holy Ghost is mentioned three times in the New Testament: connected to the Annunciation (Luke: 1, 35); in connection precisely with the Baptism of Jesus and, finally, the Descent of the Holy Spirit, in connection with the Christian holy day of Pentecost (Luke: 24, 49 and Acts 2:1–31). Of all these references, the most important one in terms of representation and symbolism is probably the Baptism, when the Holy Ghost was visible; in all the other events, the presence was felt but remained unseen. If there was a second azulejo panel with the same invocation in this chapel one might suggest that the image could be of the Annunciation and that the azulejos in figure 2 which have an image of a textile with a Greek motif could be related to such a scene.

As far as we know there is no mention of azulejos related to the chapel while it was consecrated to the Holy Ghost. Nevertheless, it is worth noting that the chapel dedicated to Saint Roch, on the other side of the nave, is lined with an extraordinary set of azulejos signed "Francisco de Matos" and dated "1584" and it too was never even considered worth mentioning by those who described the church. Therefore, the authors of the two books referred above [5; 6] were seemingly not interested in azulejos or maybe even prejudiced against an art medium that competed with painting on wood, canvas or frescoes, but one may always hope that another more comprehensive source will someday be found.

3. EXPERIMENTAL

3.1. Samples

The dispersed azulejos of *Igreja de São Roque* were given the reference Az307. Nine samples were collected by removing small fractions, preferably of the glaze with biscuit attached, from areas already with previous damage. Figure 5 exemplifies the sample areas. Each sample was identified with an alphanumerical code added to the panel reference (see table 1).

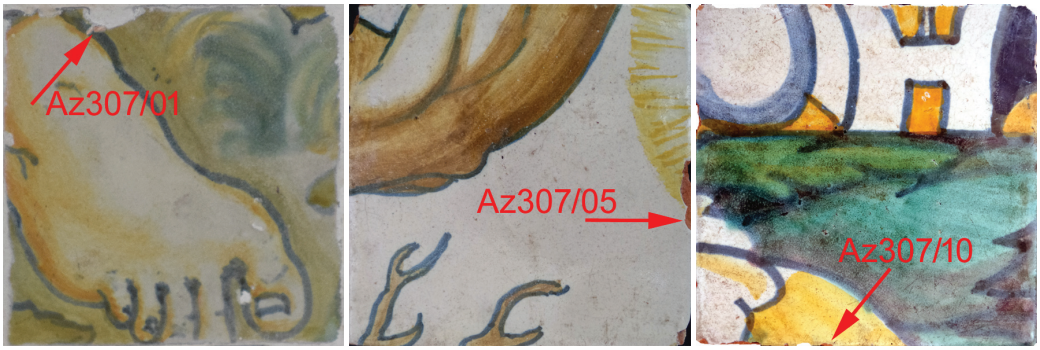

Figure 5. Sampling points – from left to right: Az307/01, Az307/05 and Az307/10

Table 1. Samples collected for microscopic and chemical analysis

Sample reference	Tile	Colour of the sampling point
Az307/01	integrated in the wall depicting one foot dark outline	dark greenish outline
Az307/03	integrated in the wall depicting a textile	white
Az307/04	integrated in the wall depicting part of a letter (T) and numeral (3)	white
Az307/05	integrated in the wall depicting part of an arm, branches of a bush and a halo	white
Az307/06	stored single tile decorated with yellow and blue motifs	blue
Az307/08	stored single tile decorated with green and blue motifs	white
Az307/09	stored single tile decorated in blue on white	white
Az307/10	stored single tile depicting part of a frame made of ovals	lemon yellow
Az307/13	stored single tile decorated with yellow, orange, blue and purple drawings	purple

3.2. Analytical methodology

The azulejo samples were stabilized in resin, lapped and polished to obtain a cross-section for observation and analysis by scanning-electron microscopy coupled with an X-ray energy-dispersive spectrometer (SEM-EDS).

The optical acquisition of images of the sections was obtained with a Leica DFC295 digital camera coupled to a M205C stereomicroscope of the same brand.

SEM-EDS observations and analyses were made at the HERCULES Laboratory in Évora using a Hitachi S3700N SEM with a coupled Bruker XFlash 5010 EDS. The specimens

were uncoated and the observations were made in backscattered electrons mode (BSE) in variable pressure mode at 40 Pa and at an accelerating voltage of 20.0 kV. The acquisition of X-ray spectra was done with the detector at ca. 10 mm working distance.

The selection of areas for EDS analysis avoided inclusions in the glaze or biscuit representing more than ca. 5% of the full area analysed. Whenever possible area sizes of ca. 200 x 200 μm for glazes and 500 x 500 μm for biscuits, or larger, were used but acceptable repeatability was verified in areas four times smaller. For comparison purposes, only the elements usually representing the major components were considered, excluding tin (Sn) in the glazes and lead (Pb) in the biscuits due to their variability with the area chosen (in the case of Sn in the glaze because of crystal aggregations and in the case of Pb in the biscuit because the content increases with proximity to the interface). The results of the EDS analyses were given in weight % of each element considered.

Principal Component Analysis (PCA) of EDS results was made using the SPSS© software platform by IBM Analytics.

3.3. Results

3.3.1. Morphological characteristics

Figure 6 illustrates microscopic images of two of the sample sections prepared. There are at least two different biscuit colours: buff (left side of figure 6) and red/brown (right side of figure 6). No *coperta* (a transparent glaze layer sprinkled on top of the painted glaze) was used over the painting.

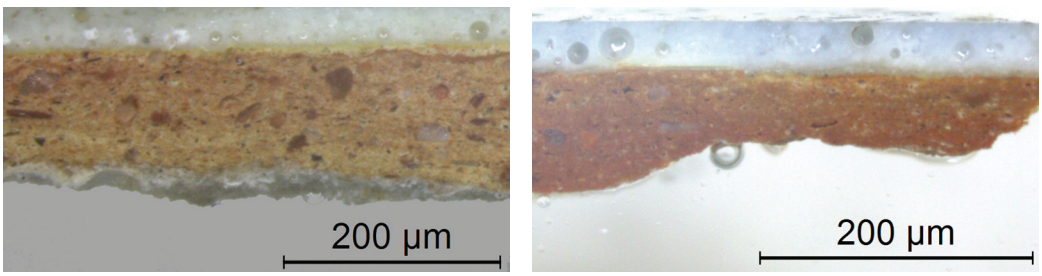

Figure 6. Prepared sections in optical microscopy - left to right: Az307/03 and Az307/06

Figure 7 illustrates SEM images of samples Az307/01, Az307/05, Az307/09 and Az307/13 that exemplify the variability of the main micro-morphologic characteristics associated with the glazes of these azulejos: relatively few inclusions, the most conspicuous of which are grains of sand, and an interface glaze-biscuit with a fair amount of individualized crystals of neoformation.

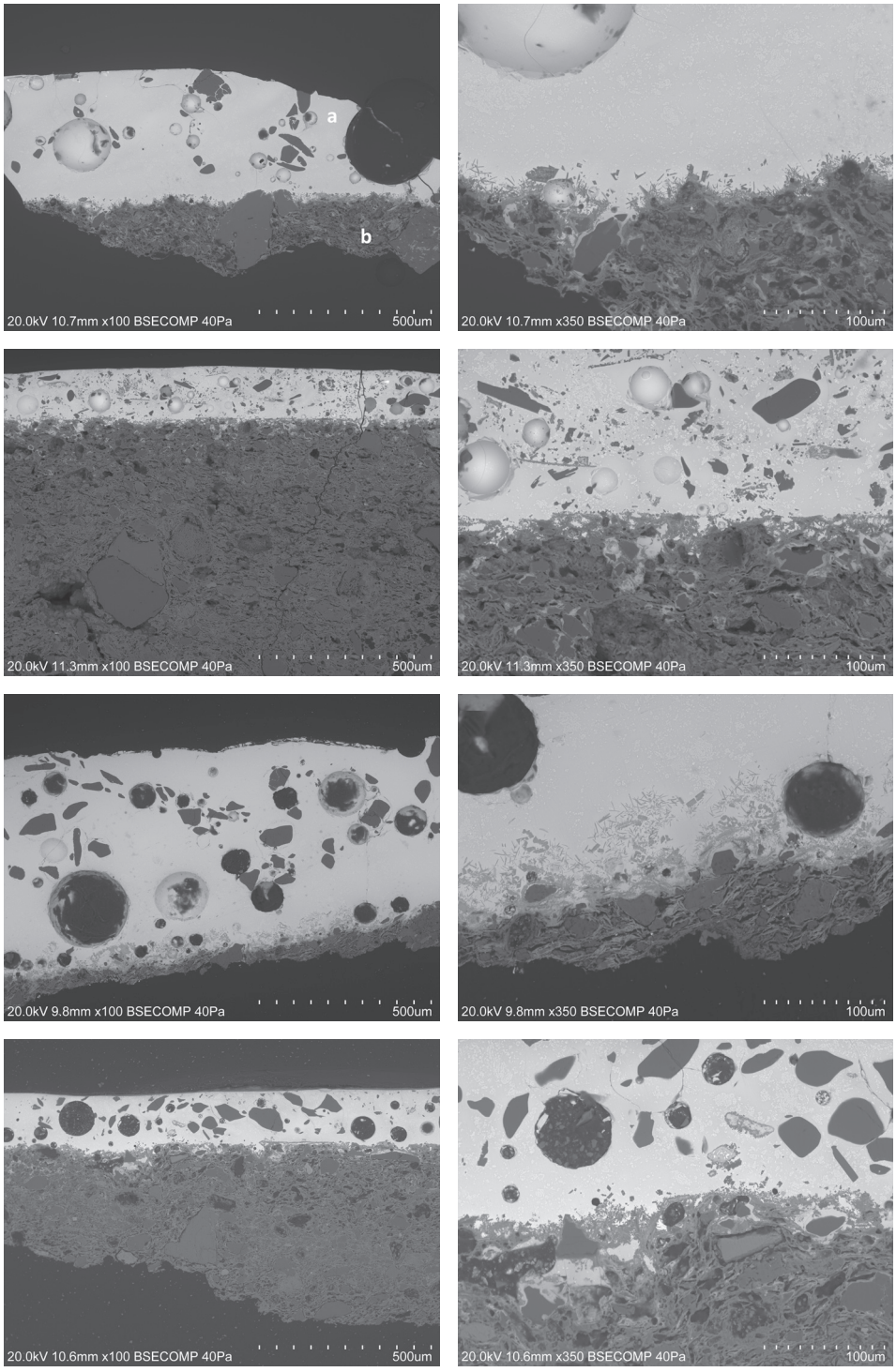

Figure 7. SEM images of samples (from top to bottom): Az307/01, Az307/05; Az307/09 and Az307/13, exemplifying the main micro-morphologic characteristics generally associated with the glazes of this panel (left side) and biscuit-glaze interfaces (right side) (a – glaze; b – biscuit)

3.3.2. Glaze composition

Table 2 includes the semi-quantitative results of analyses of the glazes by EDS in weight %. Sn was excluded for the reasons pointed out in section 3.2. The amount of oxygen was calculated through the remaining elements stoichiometry of their most commonly considered oxides and the results were normalized to 100%. The ratio between Si and Pb (the main components of the glaze) was determined and is also included in the table, as well as the averages and standard deviations.

Table 2. Semi-quantitative composition of the glazes determined by SEM-EDS (wt.% of oxygen and seven main elements of particular interest, excluding Sn, for comparative purposes, normalised to 100%)

Samples	Na	Mg	Al	Si	K	Fe	Pb	O	Si/Pb
Az307/01	1.05	0.37	2.61	18.70	1.78	0.67	46.36	28.47	0.40
Az307/03	0.91	0.40	2.99	17.81	1.48	0.73	47.85	27.84	0.37
Az307/04	1.49	0.50	3.22	21.50	3.49	0.81	36.87	32.12	0.58
Az307/05	1.54	0.60	2.69	17.56	3.78	1.04	44.77	28.01	0.39
Az307/06	0.92	0.44	2.75	17.29	1.13	0.59	49.82	27.07	0.35
Az307/08	0.83	0.42	3.97	18.25	1.33	0.81	45.36	29.02	0.40
Az307/09	0.78	0.38	3.48	16.24	0.82	0.73	51.03	26.54	0.32
Az307/10	1.17	0.53	2.82	19.08	1.60	0.69	45.01	29.10	0.42
Az307/13	1.24	0.58	3.27	19.14	2.26	0.83	43.00	29.67	0.45
Average	1.10	0.47	3.09	18.40	1.96	0.77	45.56	28.65	0.41
STDev	0.28	0.09	0.44	1.49	1.03	0.13	4.14	1.64	0.08

3.3.3. Biscuit composition

Table 3 includes the semi-quantitative results of EDS analyses of the biscuits of which there was a sufficient area. The results refer to oxygen (calculated through the remaining elements stoichiometry of their most commonly considered oxides) and eight other elements of higher content and particular interest for comparison purposes. Pb was detected in all cases but excluded for the reasons pointed in 3.2. The results are given in wt.% and were corrected to 100%. The table also includes the ratio between the main components of the biscuit, Ca and Si, as well as the averages and standard deviations.

Table 3. Semi-quantitative composition of the biscuits determined by SEM-EDS (wt.% of the main elements normalised to 100%)

Samples	Na	Mg	Al	Si	K	Ca	Ti	Fe	O	Ca/Si
Az307/03	1.56	1.20	8.81	22.44	2.65	14.39	0.75	4.67	43.53	0.64
Az307/04	1.44	1.46	9.25	22.85	2.37	13.53	0.65	4.48	43.96	0.59
Az307/05	1.52	1.43	8.57	22.99	3.62	13.73	0.56	3.99	43.59	0.60
Az307/06	1.33	1.38	9.63	27.98	3.24	4.70	0.64	4.40	46.68	0.17
Az307/08	1.24	1.37	9.68	25.67	3.19	8.46	0.76	4.13	45.50	0.33
Az307/09	1.56	1.66	11.04	25.11	4.02	6.27	0.86	3.86	45.62	0.25
Az307/13	1.09	1.51	9.31	20.21	2.87	17.28	0.99	4.14	42.60	0.85
Average	1.39	1.43	9.47	23.89	3.14	11.19	0.74	4.24	44.50	0.49
STDev	0.18	0.14	0.80	2.55	0.55	4.71	0.15	0.29	1.45	0.25

4. DISCUSSION

4.1. Technology

The SEM images of the glaze sections and their interfaces with the biscuits can be compared with corresponding images of samples obtained from panels attributed to João de Góis or his circle [7], e.g. the *Nossa Senhora da Vida* panel (Figure 8), confirming that they are similar, which suggests the use of an analogous glaze preparation and a comparable firing cycle, as was experimentally observed through the study of replicates [8]. In fact, such a close similarity points to a probable firing of all these panels in the same kiln [7, p. 130], possibly the same mentioned in relation with João de Góis and his brother Filipe that was situated at the bottom of the Santa Catarina Hill [9, p. 19].

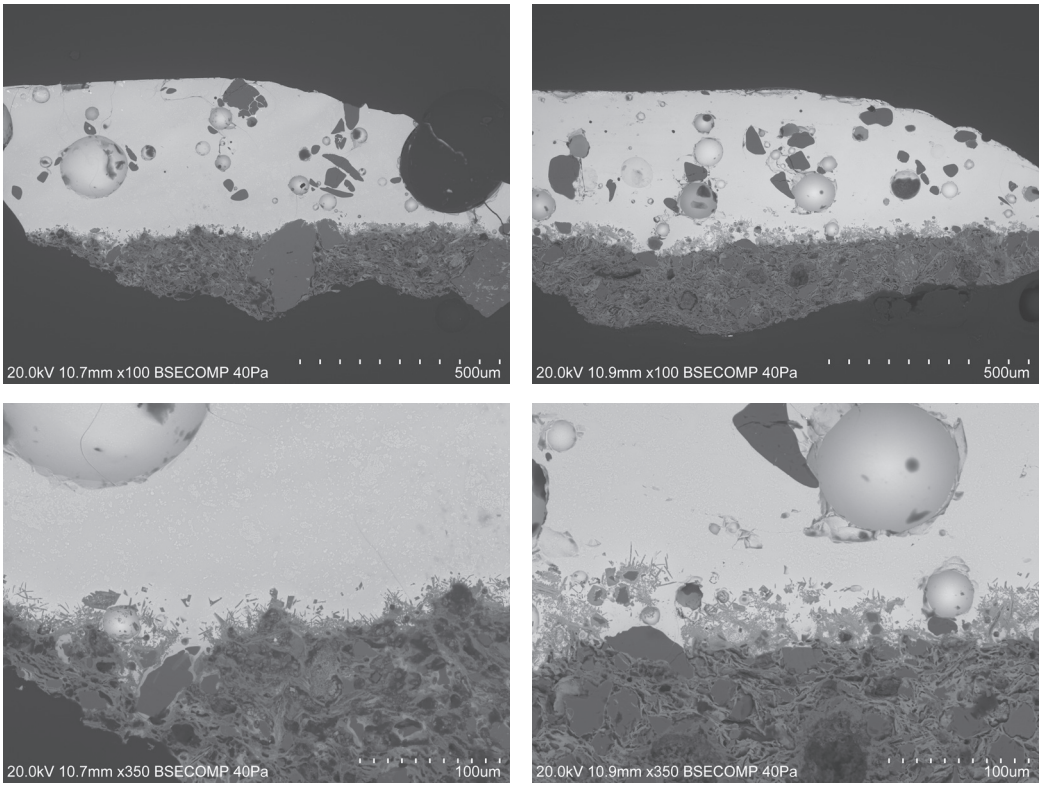

Figure 8. Morphologic comparison between Az307/01 (glaze and interface - left side) and a sample of the *Nossa Senhora da Vida* panel, Az032/01 (glaze and interface - right side)

Therefore, as respects micro-morphology (partially derived from an unusual firing technique) the tiles under study are similar to other productions of the João de Góis circle [7].

4.2. Glazes

Figure 9 shows the results of a log-based PCA of the glazes considering the analytical results in table 2, together with samples from previous studies, used here for comparative purposes: first phase of *Igreja da Graça* (identified by the designation Graça I) [10], the panel *Nossa Senhora da Vida* formerly from *Igreja de Santo André* [11], the lining of *Capela de São Roque* [12] and the Sevillian azulejos from this same church [1]. The plot depicts a projection in the plane of the two principal components, P1 and P2. In fFigure 10 is presented the loadings plot showing the contribution of each element to PC1 and PC2. PC1 explains 60% of the variation and is controlled in the positive sense by the contents in Na, Mg, Si, K and Fe, and in the opposite sense by the contents in Al and Pb. PC2 explains 20% of the variation and is controlled in the positive sense mostly by the contents in Al, Si and Fe and in the opposite sense mostly by the contents in Na and Mg.

As can be seen from figure 9, the present samples cluster together with samples from Graça I, the first phase of *Igreja da Graça*, the panel *Nossa Senhora da Vida* and the lining of *Capela de São Roque*, in this same church, all productions of the circle of João de Góis. On the other side, they are clustered far away from the Sevillian azulejos also from *Igreja de São Roque*.

Table 4 further compares the average elemental contents in the glazes of the azulejos presently studied (Az307) with the same for the panel *Nossa Senhora da Vida* (determined from [11, table 2] and the lining of *Capela de São Roque* – determined from the results for the panels of the dog and of the cardinal in [12, table 2]. The results demonstrate that the glazes are very similar.

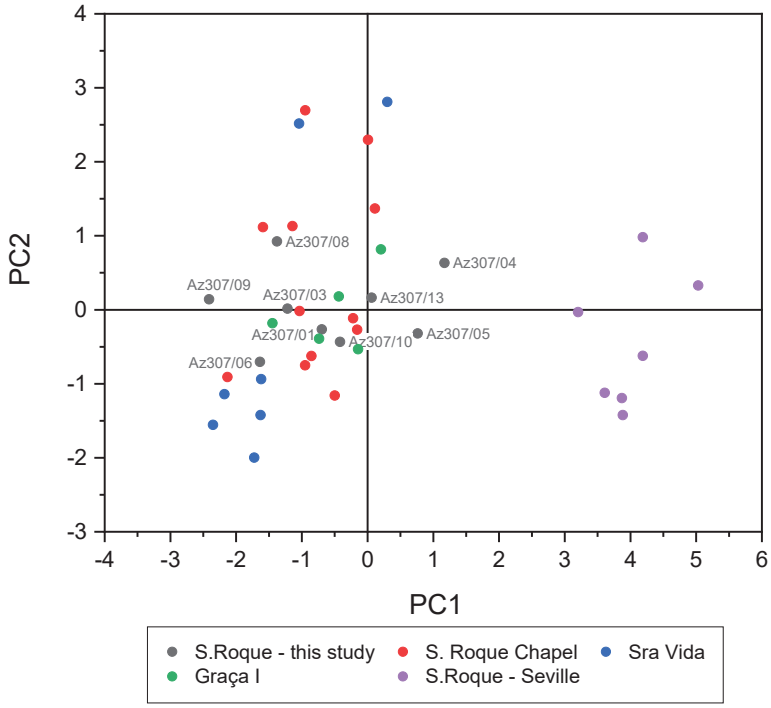

Figure 9. Score plot of the PCA of the glazes of Az307 (black) with other 16th century panels

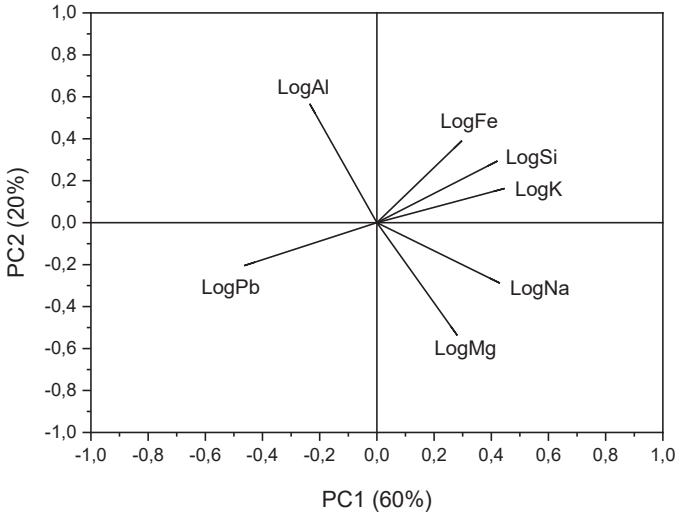

Figure 10. Loadings plot of the PCA of the glazes

Table 4. Comparison of average elemental contents and Si/Pb ratio in the glazes of Az307, the panel *Nossa Senhora da Vida* and the lining of *Capela de São Roque*

Az307	Na	Mg	Al	Si	K	Fe	Pb	O	Si/Pb
AVERAGE	1.10	0.47	3.09	18.40	1.96	0.77	45.56	28.65	0.41
STDev	0.28	0.09	0.44	1.49	1.03	0.13	4.14	1.64	0.08

N. S. da Vida	Na	Mg	Al	Si	K	Fe	Pb	O	Si/Pb
AVERAGE	0.92	0.48	2.98	17.33	1.25	0.78	48.87	27.39	0.38
STDev	0.24	0.20	0.71	3.47	0.66	0.20	8.50	3.91	0.17

Capela S. Roque	Na	Mg	Al	Si	K	Fe	Pb	O	Si/Pb
AVERAGE	0.98	0.46	3.21	18.76	1.74	0.82	44.98	29.05	0.42
STDev	0.19	0.22	0.67	1.32	0.50	0.24	3.92	1.70	0.07

4.3. Biscuits

Figure 11 shows the results of a log-based PCA of the biscuits of all samples, considering the analytical results in table 3, together with the same samples used for the glazes. PC1 explains 43% of the variation and is controlled in the positive sense by the contents in Na, Mg and Ca and in the opposite sense mostly by the contents in Si and K. PC2 explains 29% of the variation and is controlled in the positive sense by the contents in Al, Fe and Ti, and in the opposite sense mostly by the content in Si (Figure 12).

As for the glazes, the PC1 vs. PC2 plot of the biscuits (Figure 11) shows that the Az307 samples are clustered together with samples from the João de Góis circle (*Nossa Senhora da Vida* and, partially, *Capela de São Roque*), while the samples from the Sevillian panels and linings form a different and well separated group.

It is of some interest to remark that the biscuits of those tiles that are in storage and that, therefore, could be examined from both sides are of a very unusual deep red/brown colour similar to tiles from the *Nossa Senhora da Vida* panel that we have examined. The biscuit is very hard and its thickness (ca. 13 mm) is small for the time but adequate given the hardness of the material. In this particular case, the colour and hardness are important distinguishing characteristics that, even in the case of archaeologic shards, can point macroscopically to a common provenance.

Table 5 further compares the average elemental contents in the biscuits of the azulejos presently studied (Az307) with the same for the panel *Nossa Senhora da Vida* – determined from [11, table 3]; and the lining of *Capela de São Roque*, determined from the results for the panels of the dog and of the cardinal in [12, table 3]. The results demonstrate the

similarity of the biscuits – only the rates Ca/Si are somewhat higher than the other two because of a few samples with higher Ca contents, as seen in table 3, but still the results are compatible and the Ca/Si ratio is much lower than e.g. for Sevillian tiles of the period or Portuguese 17th century azulejos [see e.g. 1, table 4].

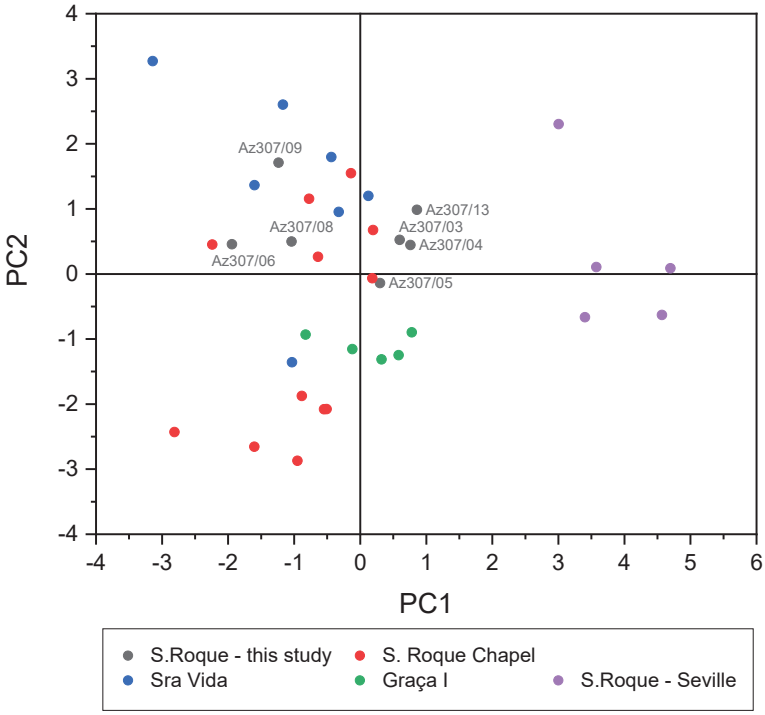

Figure 11. Score plot of the PCA of the biscuits of Az307 (grey) with other 16th century panels

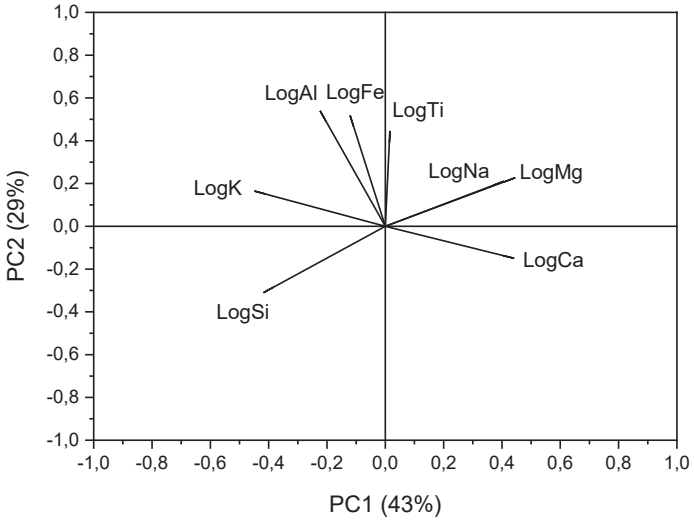

Figure 12. Loadings plot of the PCA of the biscuits

Table 5. Comparison of average elemental contents and Ca/Si ratio in the biscuits of Az307, the panel *Nossa Senhora da Vida* and the lining of *Capela de São Roque*

Az307	Na	Mg	Al	Si	K	Ca	Ti	Fe	O	Ca/Si
AVERAGE	1.39	1.43	9.47	23.89	3.14	11.19	0.74	4.24	44.50	0.49
STDev	0.18	0.14	0.80	2.55	0.55	4.71	0.15	0.29	1.45	0.25

N. S. da Vida	Na	Mg	Al	Si	K	Ca	Ti	Fe	O	Ca/Si
AVERAGE	1.34	1.68	10.11	24.97	3.48	7.36	0.70	5.05	45.31	0.30
STDev	0.23	0.25	1.28	1.82	0.60	2.71	0.26	0.80	0.94	0.12

Capela S. Roque	Na	Mg	Al	Si	K	Ca	Ti	Fe	O	Ca/Si
AVERAGE	1.29	1.34	8.68	26.53	3.30	9.00	0.65	3.67	45.55	0.35
STDev	0.30	024	0.83	2.16	0.66	2.02	0.40	0.67	0.91	0.10

5. CONCLUDING REMARKS

From the micro-morphology and compositional results, there is evidence that the panel or panels represented by the tiles grouped under Az307 are a product of the circle of João de Góis, maybe of his own workshop, with a chronology not far from the panel *Nossa Senhora da Vida* and the lining of *Capela de São Roque*. Even if the tiles available are few, some remarkable similarities can still be pointed (Figure 13).

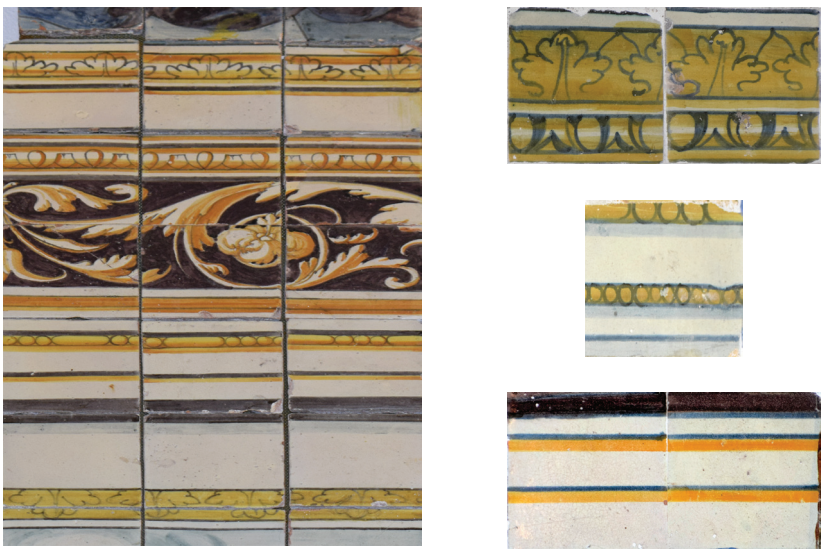

Figure 13. Occurrence of similar decorative elements in the panel *Nossa Senhora da Vida* (left side) and the dispersed azulejos in *São Roque* (right side), often simulating stonework

Another interesting aspect is that, even though the dispersed azulejos are few, several panels seem to be represented. This is suggested by the several patterns that once may have framed individual panels (Figure 14).

Figure14. Parts of different frames of panels conserved in the dispersed remaining azulejos

If the dispersed azulejos represent several panels, one of them likely illustrates the Baptism of Jesus by John the Baptist. If such representation depicted the Holy Ghost as a dove, as it almost always does, the panel would befit the former Chapel of the Holy Ghost, replaced in 1749 by the present Chapel of St. John the Baptist. If we look today into this chapel in *Igreja de São Roque* and consider the finely made paint-like mosaic panels that decorate its walls, we shall see on the end wall the Baptism of Jesus, on the right hand side an Annunciation, and on the left the Descent of the Holy Spirit… exactly the three instances when, according to the New Testament, the Holy Ghost was perceived. The chapel called "of St. John the Baptist", to honour one of the patronym saints of King John V who had it made in Italy and offered it to the church, actually conserves the memory of the original dedication. We will not, then, risk much in hypothesizing that three azulejo panels (or compound azulejo retables similar to *Nossa Senhora da Vida*) could have once decorated the same three walls, one representing the Baptism of Jesus, one the Annunciation (also suggested by the few remaining tiles depicting what seems to be a rich mantle fit for Archangel Gabriel, and a piece of furniture) and one the Descent during the Pentecost. Maybe the full order was never completed because João de Góis may have left Lisbon around this time [9, p. 21].

What happened to the other tiles? Seemingly they were not carried to another location for re-applying, else nothing would have remained and particularly not parts of the body of John the Baptist. A simple explanation could be that the tiles were broken and buried, but there is a more tantalizing possibility: that the missing tiles may actually still be lining the walls beneath the rich decoration of the Chapel of John the Baptist. Tiles pasted on the walls do not increase appreciably their thickness (ca. 15 mm in this case) and if the previous walls were kept, then the old panels may still be there, hidden by the new walls in the same manner as part of the lining of *Capela de São Roque* was preserved hidden by a painting [3, pp. 103-115]. Existing imaging techniques can clarify the issue and, who knows, if the azulejos are still there, they may one day be retrieved. In the meantime, we may conjecture their splendour from the meagre but still impressive debris whose study this paper presented.

BIBLIOGRAPHIC REFERENCES

1. PAIS, A. et al. – *The many questions raised by the 16th century Sevillian azulejos in Igreja de São Roque in Lisbon* in Studies in Heritage Glazed Ceramics, No. 2, pp. 51-72, LNEC, Lisbon, November 2019. ISBN 978-972-49-2310-9.

2. PAIS, A. – *O espólio azulejar nos palácios e conventos da Misericórdia de Lisboa* in Património Arquitectónico – Santa Casa da Misericórdia de Lisboa, Vol. I, Museu de São Roque, pp. 136-161, Lisbon, 2006.
3. QUEIROZ, J. – *Olarias do Monte Sinay*. Typographia Castro Irmão, Lisbon, 1913.
4. LEITE, S. – *Novos documentos sobre Francisco Dias, mestre das obras de S. Roque em Lisboa. Arquitecto da Companhia de Jesus no Brasil* in Archivum Historicum Societatis Iesus, Extractus vol. XXII, pp. 352-366, Institutum Historicum, Rome, Italy, 1953.
5. TELLES, B. – *Chronica da Companhia de Iesu, na Provincia de Portugal; e do que fizeram, nas conquistas d'este reyno, os religiosos, que na mesma provincia entràram, nos annos em que viveo S. Ignacio de Loyola, nosso fundador*, Vol. II, pp. 108-126, Paulo Craesbeeck, Lisbon, 1645.
6. AUCT. – *História dos mosteiros, conventos e casas religiosas de Lisboa na qual se dá notícia da fundação e fundadores das instituições religiosas, igrejas, capelas e irmandades desta cidade*, Vol. I, pp. 228-263, Câmara Municipal de Lisboa, Lisbon, 1950.
7. MIMOSO, J. et al. – *A technical comparison of three renaissance azulejo panels from the workshops of Lisbon* in Studies in Heritage Glazed Ceramics, No. 1, pp. 113-132, LNEC, Lisbon, February 2019. ISBN 978-972-49-2307-9.
8. PEREIRA, S. et al. – *Influence of the production technology on the morphological characteristics of azulejos* in Proc. Int. Conf. Glazed Ceramics in Cultural Heritage (GlazeArt 2018), pp. 140-149, LNEC, Lisbon, October 29-30, 2018.
9. PAIS, A. et al. – *The beginning of the production of majolica azulejos in Portugal – João and Filipe de Góis in 16th century Lisbon* in Studies in Heritage Glazed Ceramics, No. 1, pp. 1-23, LNEC, Lisbon, February 2019. ISBN 978-972-49-2307-9.
10. PAIS, A. et al. – *Study of the azulejo panels in Graça Church signed by João de Góis* in Studies in Heritage Glazed Ceramics, No. 1, pp. 47-66, LNEC, Lisbon, February 2019. ISBN 978-972-49-2307-9.
11. MIMOSO, J. et al. – *Analytical study of the 16th century azulejo panel "Nossa Senhora da Vida" and related archaeologic findings* in Studies in Heritage Glazed Ceramics, No. 1, pp. 77-92, LNEC, Lisbon, February 2019. ISBN 978-972-49-2307-9.
12. MIMOSO, J. et al. – *A research on the azulejo panels of the São Roque chapel in Lisbon* in Studies in Heritage Glazed Ceramics, No. 1, pp. 93-112, LNEC, Lisbon, February 2019. ISBN 978-972-49-2307-9.

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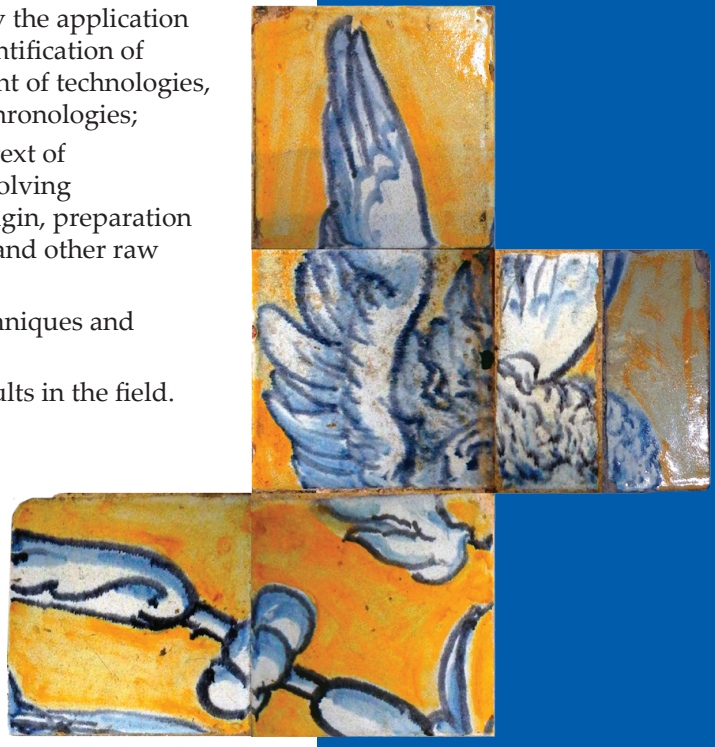

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