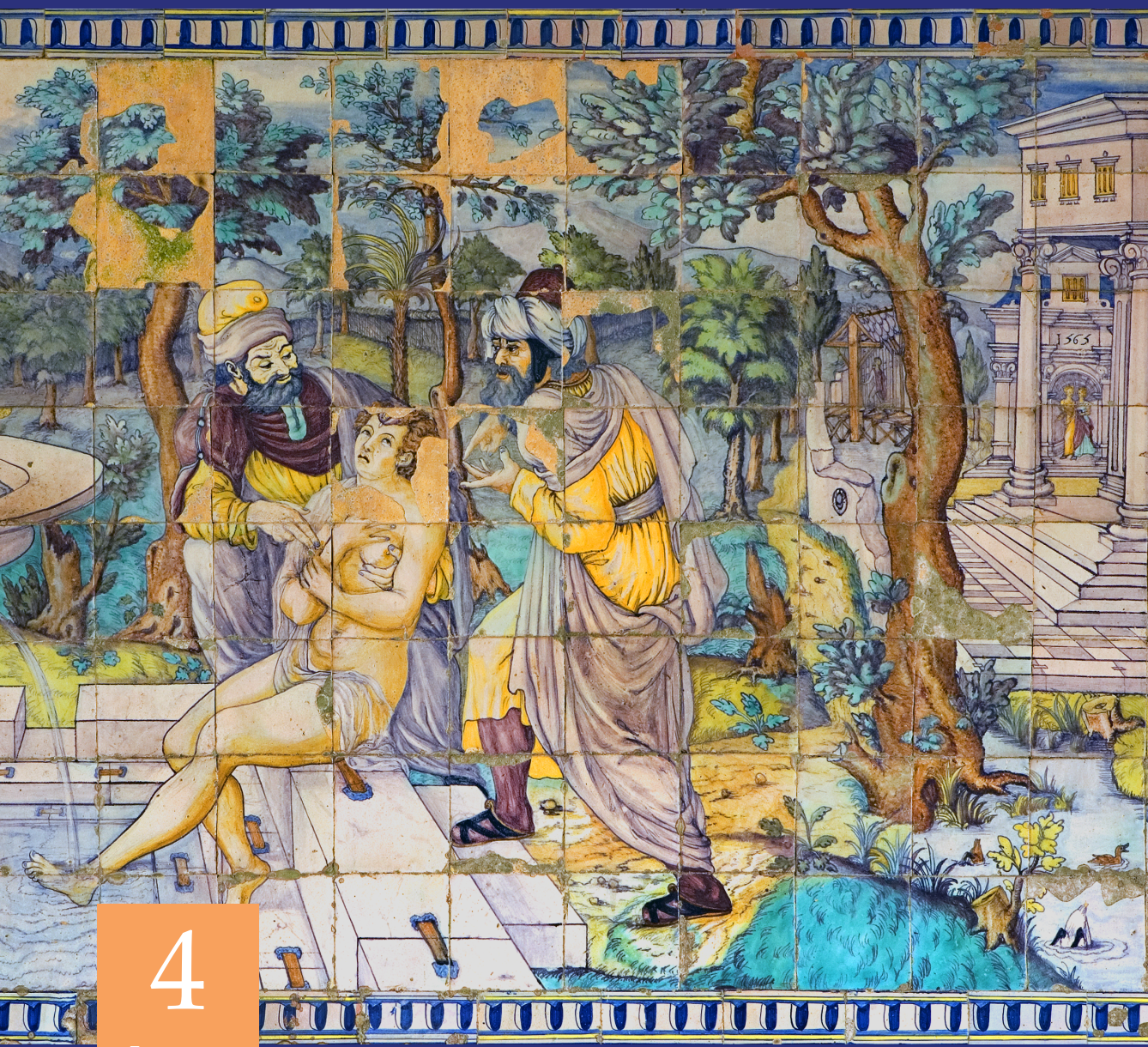
Studies in Heritage Glazed Ceramics

The majolica azulejo heritage of *Quinta da Bacalhôa*



4

January

2022

ISBN
978-972-49-2316-1

Special Series
Volume II

Studies in Heritage Glazed Ceramics

No. 4 | January 2022

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This number is published within the scope of the national infrastructure E-RIHS.pt funded by FCT, the Portuguese Foundation for Science and Technology.





Site: http://glazedceramics.lnec.pt/

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Graphic design: Helder David

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Setor de Divulgação Científica e Técnica
AV DO BRASIL 101 • 1700-066 LISBOA
e-mail: livraria@lnec.pt
www.lnec.pt

Publisher: LNEC
Collection: Studies in Heritage Glazed Ceramics
Series: SHGC 4
1st. edition: 2022
Printing: 200 copies

Descriptors: Azulejo / Historic heritage / Glazed ceramics / Manufacture / Physical-chemical characterization / PT
Descritores: Azulejo / Património histórico / Cerâmica vidrada / Fabrico / Caracterização físico-química / PT

CDU 691.833"16"(469)
691.434"16"(469)
ISBN 978-972-49-2316-1

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PREFACE

This is the second of a special series of four volumes of *Studies in Heritage Glazed Ceramics* dedicated to the renaissance majolica azulejo heritage of *Palácio e Quinta da Bacalhôa* in Azeitão, Portugal.

The azulejos of Bacalhôa have a legendary status in the studies of renaissance majolica in the Iberian Peninsula in general, because of their extraordinary variety and quality and the fact that its most mythical panel, representing the biblical episode of *Susanna and the Elders*, is dated "1565" – a chronology hardly compatible with the then-recent production of azulejos in Portugal. Several hypotheses were advanced over the years to cope with this seemingly impossibility, almost always involving Flemish potters immigrated to the Peninsula which the present study finally confirmed.

The first volume of the series dedicated to Bacalhôa, issued in December 2021, published three papers that established the pillars supporting the subsequent detailed study of the panels and patterned tiles: a study of the estate, locating its 16th century majolica azulejos; a study of the career and productions of Jan Floris de Vriendt of Antwerp (known in Spain as *Juan Flores*) who, according to the results, was likely the main potter, painter and pattern designer connected with the lining of Bacalhôa with majolica azulejos around 1565; and finally a systematization of the main types of 16th century majolica azulejos still extant in the Palace, the Pleasure House by the lake and the garden. That first volume was complemented by a study of the panels and tiles that, according to the previous results, had been manufactured in Talavera (Spain) and imported to Portugal, probably the earliest painted majolica to be applied at Bacalhôa.

This second volume of the series starts the presentation of the research results connected to panels and patterned tiles that were mostly produced in Portugal. The four articles cover in detail: the central room of the Pleasure House, where *Susanna and the Elders* is applied; the five panels of the *Loggia of the River Gods*; the very interesting and often belittled *Rape of Europa*; and the according to our knowledge until now unpublished floor of the oratory of the *piano nobile* of the Palace.

The scientific production stands on several pillars, one of them the peer-reviewers of the authors' papers, whose names are often unknown but whose importance in the final output is singular. The editors wish to heartily thank the reviewers for this number: Doctor Alexandre Nobre Pais, Director of *Museu Nacional do Azulejo* and Doctor António dos Santos Silva of *Laboratório Nacional de Engenharia Civil* (LNEC) who have graciously accepted the hardship of the revisions.

Two more numbers of the journal dedicated to the azulejo heritage of Bacalhôa, with four new research papers in each, are expected to be published over the next 12 months.

LNEC thus presents No. 4 of *Studies in Heritage Glazed Ceramics*. Its 108 pages condense an important part of the results obtained over 20 months of multidisciplinary research, as befits the aims of this journal, aiming to clarify the early diffusion of majolica azulejos in Portugal.

The Editors

EDITORS

João Manuel Mimoso (LNEC), Alexandre Nobre Pais (MNAz), José Delgado Rodrigues (LNEC) & Sílvia R. M. Pereira (HERCULES & LNEC)

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.

The 16th century majolica azulejo heritage of *Quinta da Bacalhôa*: the central room of the Pleasure House

Alfonso Pleguezuelo, João Manuel Mimoso, Maria Augusta Antunes, Sílvia Pereira, Álvaro Silva

ABSTRACT

The Pleasure House by the lake in the Bacalhôa estate is quite unique for its five successive rooms tiled from the floor to the ceiling with 16th century azulejos. Its pinnacle is the central room, wholly lined with majolica tiles, from which stand out three figurative panels. One of these panels, representing the biblical episode of Susanna surprised at her bath and dated "1565", is the only one that survived basically intact in the room.

The whole lining is constituted, besides the three panels with their frame tiles, by the patterned tiles that clad the walls and by the two-tile high continuous skirting, interrupted only by the doors.

The present paper examines the panels and the remaining elements of the lining from the iconographical, stylistic and technical points of view to support a conclusion on their provenance and authorship.

RESUMO

A Casa de Prazer junto ao lago da Quinta da Bacalhôa é única pelas suas cinco divisões revestidas do pavimento até ao tecto com azulejos do século XVI. O ápice é a sala central, totalmente forrada a azulejos de faiança, da qual se destacam três painéis figurativos. Um desses painéis, que representa o episódio bíblico de Susana surpreendida no banho e datado de "1565", é o único que sobreviveu praticamente intacto.

Além dos três painéis com as suas molduras, o revestimento é completado pelos azulejos de padrão renascentista que cobrem as paredes e pelo rodapé contínuo, com dois azulejos de altura, interrompido apenas pelas portas.

O presente artigo examina os painéis e os restantes elementos do revestimento do ponto de vista iconográfico, estilístico e técnico para fundamentar uma conclusão sobre a sua proveniência e autoria.

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KEYWORDS: Renaissance majolica; Azulejos; Palace of Bacalhôa; João de Góis; Jan Floris; Juan Flores

Acknowledgements

We are thankful to Mr. Joe Berardo and to Mr. Renato Berardo, who authorised the sampling of the unique azulejo heritage of *Palácio e Quinta da Bacalhôa*; and to *Associação de Colecções | The Berardo Collection* and *Bacalhôa Vinhos de Portugal* for their support to this project.

Sections 1 and 2 translated from the Spanish by Judith Wilcock.

Instrumental research conducted at *Laboratório Nacional de Engenharia Civil* (LNEC) within the scope of the national infrastructure E-RIHS.pt funded by FCT, the Portuguese Foundation for Science and Technology. LNEC Research Project 0202/1101/19014.

How to cite

PLEGUEZUELO, A. et al. – *The 16th century majolica azulejo heritage of Quinta da Bacalhôa: the central room of the Pleasure House* in Studies in Heritage Glazed Ceramics No. 4, LNEC, Lisbon, 2021, pp. 1-34.

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1. INTRODUCTION

> *… how rare and delightful it would be to clad the walls of a study or a garden portico, or another room with such work. For if an azulejo panel or wall in Spain is a great adornment for a chamber... how much greater it would be to have all the walls lined with azulejos forming the pleasant design of a poem or famous story on fine encaustic from Faenza or Pisa.* [1: fol. 37]

The above words come from a manuscript book that was dedicated to Philip II of Spain (1527-1598) by his chronicler and art adviser Felipe de Guevara (Brussels ca. 1500-Madrid, 1563) [2]. In this paragraph, the author expresses his preference for the new style of narrative azulejos that had become fashionable in Italy, comparing them with the traditional Hispano-Moresque tiles in Spain that he describes in no uncertain terms as "vulgar". But above all, the remarks clearly reveal the new aesthetic conception, distinctly erudite and influenced by Renaissance painting, which the Spanish cultural elite demanded of the ceramic claddings for the classicist architecture of their profane spaces.[1]

While it is possible that in the 16th century another space in the Iberian Peninsula may have been decorated with azulejos in this style, the central room in the Pleasure House at the *Quinta da Bacalhôa* [3] is, to date, the only known example that literally embodies the aesthetic preference expressed by Felipe de Guevara in the above paragraph. The vast majority of the azulejo works created in the following decades were destined for religious spaces and most of them did not belong to the category of profane or religious narrative painting that would be revived in Portugal at the beginning of the 18th century, but were either simple hagiographic panels or, more commonly, grotesques and numerous versions of patterned tiles. Besides, if Philip II did enjoy any panels of this type painted for his palaces by Juan Flores during the years in which he worked for the king (1562-1567), they subsequently disappeared. Neither do we know of anything similar among the few works which this same artist made before he settled in Talavera; all the extant works from that period are patterned tiles and azulejos depicting heraldic or religious themes [4]. All of which confirms the enormous importance of the majolica azulejos at the *Quinta da Bacalhôa*, especially the ones adorning the central room in the pavilion by the lake. Gazing at the azulejos in the Pleasure House today, it is easy to imagine, bearing in mind their content and significance, that the lines Felipe de Guevara wrote circa 1560 could just as well have been penned around the same time by Brás [Afonso] de Albuquerque before he commissioned the decoration for his country estate at Vila Fresca de Azeitão around 1565.

The arrival of the imported tiles at Bacalhôa must have coincided with the arrival of their author, presumably Juan Flores [4], accompanied by his personal tools and a certain number of plain biscuits, ready to fulfil his client's assignment aided by a few collaborators. This second phase of the works must therefore have been undertaken in the presence and with the participation of the painter chosen by Albuquerque to oversee the operation, designing and painting the most important elements himself and instructing his collaborators on how to execute the decoration. We do not know whether Flores painted any azulejos during his presumed first stay in Lisbon circa 1555 [5, pp. 102-103] because to date no evidence has come to light about such work. Besides, we have no

1 Before he lived in Madrid, where he died, Guevara spent many years in Flanders where his father, Diego de Guevara (ca. 1450-1520), had been the Spanish crown's ambassador since the days of Emperor Charles I of Spain and V of Germany (1500-1558).

idea of the length of that supposed stay, and we must not forget that Juan Flores was also a master easel painter, a trade he practised in Spain and possibly Portugal as well. Consequently, we do not know whether during that presumed first stay he had occasion to apply on Portuguese clay the tile painting procedures he had learned in Antwerp. However, the results of the analyses performed suggest that while the author of the finest azulejos at Bacalhôa had acquired that previous experience, he may have had lingering doubts about the compatibility between his procedures and the clay commonly used in Lisbon [6]. That may explain why on this occasion he not only brought some painted tiles with him but a considerable number of biscuits probably made with the clay he was accustomed to using in his workshop, destined for the most critical works that awaited him at Bacalhôa. It is logical to think that this would have enabled him to avoid risks when firing in Lisbon the more delicate figurative panels that he had been commissioned to make during his initial works at the Pleasure House, for which he had to deploy the full extent of his expressive skills and invest an enormous amount of time. It is equally understandable that the painter began his work in that particular building because it demanded the direct intervention of the most skilful artist of the team, and because of his deferred work for Philip II [4] may well have been thinking that he could not extend his stay in Portugal indefinitely.

However, it would appear that he was not the only painter who worked on the azulejos in this space. If we analyse the pictorial style and the skilfulness of the painting, it becomes apparent that there were at least two authors. The most highly qualified artist, possibly Flores, painted the two narrative panels and may have participated in the painting of the patterned azulejos that surround the scenes and line most of the walls in this room. A second painter appears to have authored the panel depicting the River Tagus.

The work process must have been planned very carefully because the central room was the most important space in the Pleasure House. In addition to its location at the axis of symmetry, it fulfilled a special function as the space where the palace residents and their guests were able to access the lake, whether to bathe, fish for carp or take a boat out on the water. We do not know if this space was also used as a changing room for the bathers.[2]

We can deduce the importance of this room from the aesthetic emphasis of the decoration, notably the iconography of the three pictorial panels included in the mural ornamentation which allude to water, wine-induced excesses and the exaltation of the virtue of chastity. The first panel, which presides over the room, features the River Tagus allegory. The second panel, situated on the left wall above a door, represents the scene of the *Abduction of Hippodamia* by an inebriated centaur, and on the opposite wall, above the other door, we see the third panel, which depicts *Susanna and the Elders*. The remaining wall surfaces are lined with patterned tiles and a high skirting board of the same material runs around the entire perimeter of the room. We do not know what motifs decorated the stucco ceiling, now lost, or what the original paving looked like, although it was probably considerably more delicate than what we see today. The only extant elements today, therefore, are large parts of the wall decoration, executed with azulejos featuring repetitive motifs probably intended to resemble rich fabrics, and three majolica panels with their frames, which look like paintings on wood panel, hanging on the three available walls.

2 The two wooden doors that prevented access to this space from the two adjacent galleries have been lost. Only the hinge holes in the thresholds remain today. The doorway that opens onto the lake never had a door, although we do not know if it had a curtain.

2. ICONOGRAPHIC AND STYLISTIC NOTES

2.1. The River Tagus allegory

Adorning the rear wall is the allegorical figure of the River Tagus, a logical choice because the waters of its minor tributary, the São Simão stream, feed the lake in front of the pavilion, and in turn those waters are used to irrigate the plants in the kitchen garden and the orchard.[3] The Tagus allegory is therefore a symbolic tribute to the element to which the estate owes its fertility, cool temperatures and the pleasures of bathing (Figure 1).



Figure 1. The remains of the River Tagus allegory (image © Associação de Colecções | The Berardo Collection)

This is not the only fluvial allegory painted on azulejos at Bacalhôa. In fact, the estate boasts a veritable collection comprising another six such panels. One represents the River Tagus, like this one, and is today on display in the *Museu do Palácio da Bacalhôa*, although we are not sure where it was located originally [3, p. 27]. That second allegory of the Tagus has reached us in a fragmentary state, like the one in the Pleasure House, but its stylistic characteristics are very different from the panel that interests us here. By contrast, the other five river allegories are all in good condition and in all likelihood they have always adorned the palace loggia that faces west and opens onto the Boxwood Garden.

Fluvial allegories became very common in the Renaissance after the colossal sculptural group of the River Nile, carved out of white marble, was discovered by chance in 1515 at the Campo Marzio in Rome. By all accounts, it adorned the *Serapeum Campense* dedicated to the Egyptian deities Serapis and Isis. Today, this sculptural group is thought to be a Roman copy of a Greek work of the Hellenistic school of Alexandria. Some scholars

3 It is important to note that the flow rate of this tributary must have gradually diminished because there is no trace of the river bed today, although the area it occupies is rich in underground waters from the north face of the Sierra de Arrábida.

believe the marble version may have been inspired by another work in black basalt, which Pliny the Elder described as being in the Forum of Peace. Nowadays on display in the Vatican Museums, for centuries the famous marble version graced the Vatican's Belvedere Courtyard, which is known to have been frequented by the artists of the Renaissance who visited the Eternal City to complete their training. In fact, a great painter from Antwerp, Maarten van Hemskerk (1498-1574), is the author of a drawing, now preserved at the British Museum, in which he depicted for the first time, circa 1532-33, the exact place in the Belvedere Courtyard where the famous Hellenistic allegory of the Nile and another of the Tiber were situated, face to face, near the Laocoön Group (inv. 1949.0713.639). The drawing must have returned with the painter to the Netherlands after his stay in Rome, dated between 1532 and 1537. Circumstances such as this led to the spread of the iconographic model throughout Europe, where it was adopted by many cities built on the banks of a river. Lisbon was one such city and the River Tagus, the source of its commercial prosperity, could not be an exception in this popular phenomenon. Rome did the same with the Tiber, Seville with the former Betis, now Guadalquivir, and even Madrid had its allegory of the modest River Manzanares, a tributary of the Jarama which in turn flows into the River Tagus.

As well as the emblematic river of Lisbon, the Tagus subsequently played a very special symbolic role during the days when the kingdom of Portugal was united to that of Castile by virtue of the physical fact of being a shared watercourse and a direct trade route between the two courts. In 1619, Philip II of Portugal and III of Spain visited the great Portuguese city and the details of the event were recorded in a book by João Baptista Lavanha (1555-1624), the famous mathematician and cosmographer of Genoese roots who served both crowns [7]. Published in 1622, the book's frontispiece features an allegorical image of the River TAGVS engraved by the Flemish artist Joan Schorquens, who was born in Antwerp in the late 16th century (Figure 2) [8].



Figure 2. Top of the frontispiece of the book by João Baptista Lavanha (1622) (image: Biblioteca Nacional de Portugal PURL 28507, through Wikimedia Commons).

Although we have not found a specific illustration that may have served as the model for the Tagus allegory in the Pleasure House, we have identified a similar one from the Flemish art circle of Juan Flores (Figure 3). It is a river allegory engraved by Abraham de Bruyn (1539-1587), an artist who worked in Antwerp for the printing house of Cristophe Plantin, where the best editions promoted by Philip II were printed. We know that the members of the Floris family maintained close ties with Plantin and they undoubtedly used numerous illustrations produced at his printing house.



Figure 3. River allegory by Abraham de Bruyn (1540-1587) (image: National Gallery of Art, Washington, A. Nr. 1950.2.5).

Unfortunately, only 46 of the 91 original azulejos in the allegorical panel of the River Tagus in the Pleasure House have survived and it is therefore difficult to gain an idea of the exact original appearance of the central scene, but it probably featured the conventional allegorical figure of the river set within a landscape of cattails with a large ceramic or metal vase from which the water poured. By contrast, it would be very easy to reconstruct the cartouche that frames the scene because its composition coincides literally with one of the two patterns adopted in the five river allegories in the palace loggia that opens onto the Boxwood Garden, which were analysed on another occasion [9]. Specifically, the model followed here is the same as the one that frames the EVPHRATES and DOVRO rivers. This is not the only coincidence we find between this panel and those in the Gallery of the River Gods, as the loggia is called today: the size of the azulejos, the dimensions of the panel itself (7 x 13 azulejos), the composition of the biscuit and the type of glaze are all almost identical. Unlike most of the other tiles in this room, even the pictorial style of the panel suggests that its author may have participated in the aforementioned set of panels in the loggia. In fact, all the panels may have been made at the same time and at the same workshop. If so, that would mean that this first panel was the only one of the three in this room that was not painted by Juan Flores but by one of his collaborators. We do not know what may have motivated this decision, but it clearly demonstrates that even in this special place the work was undertaken by several painters.

2.2. *The Abduction of Hippodamia*

The panel depicting the abduction of Hippodamia is in a similarly poor condition because of the 112 original azulejos barely 58 have survived, some of them intact but many others only as fragments. Azulejos that depict faces are known to be greatly coveted by looters of this type of work, and the multitudinous nature of this scene probably held a particular appeal for predators. The original panel would have included numerous complete faces but only three remain today, all broken due to failed attempts to remove them.

Despite the fact that many pieces are missing, we can perceive from the extant ones that the author of this panel was a highly skilled artist, on a par with the author of the *Susanna and the Elders* panel. They may even have been the same person. Unlike the river allegories, these scenes are not framed by elaborate *ferronnerie* cartouches, frequently found around wall paintings, but instead have a simple border of glyphs in the manner that became popular in paintings on wood panel during the classicist Renaissance period.

The episode we know as the *Abduction of Hippodamia* or the *Battle of the Lapiths and Centaurs* is a well-known tale from classical mythology which Ovid described in Book XII of his Metamorphoses. Hippodamia was the daughter of the king of Argos and famed for her beauty. When she married Pirithous, king of the Lapiths, the monarch invited all the inhabitants in his kingdom to the wedding banquet, including the centaurs. Unaccustomed to drinking wine, these mythical creatures, part man and part horse, became inebriated during the feast. Under the effects of the alcohol, Eurytus, the chief, abducted the beautiful Hippodamia and his fellow centaurs seized the other women and even some of the young men. This led to a fierce battle in which the Lapiths finally managed to rescue the victims and punish their savage guests for their debauchery. In the struggle, Pirithous was aided by his friend Theseus. Ovid's text describes one of the moments of the battle as follows: "For savage Eurytus, wildest of the wild centaurs, now inflamed with sudden envy, drunkenness and lust, upset the tables and made havoc there so dreadful that the banquet suddenly was changed from love to uproar. Seized

by the hair, the bride was violently dragged away. When Eurytus caught up *Hippodame* each one of all the centaurs took at will the maid or matron that he longed for most. The palace, seeming like a captured town, resounded with the affrighted shrieks of the women."

The azulejo panel does not describe the moment of the battle but the episode that triggered it, in which Eurytus attempts to abduct Hippodamia by prising her from the grasp of her husband Pirithous, who tries to prevent it while simultaneously looking over his shoulder to call for assistance from his friend Theseus, who responds immediately by unsheathing his sword (Figure 4). Luckily, parts of these three figures escaped the brutal destruction of the panel, especially Theseus who is missing his head and a foot.



Figure 4. *The Abduction of Hippodamia* (image © Associação de Colecções | The Berardo Collection).

However, unlike the River Tagus allegory, in this case we do know of an engraving that may have inspired the panel: a print made in Rome in 1542 by Enea Vico (1523-1567)- Figure 5. Santos Simões referred to this possibility advised by Mrs. Scoville, then owner of the estate, who had found a copy from this series in the collections of the National Gallery in Washington [10, p. 105- note 27].

There is no objective reason to doubt that the painter of the Bacalhôa panel, most probably executed ca. 1565, followed the print by Vico, however it should be borne in mind that this print was neither the only one to reproduce this iconographic model nor the first to do so, as can be deduced from certain depictions prior to its date. For example, a maiolica plate attributed to the so-called "Painter of the Apollo basin" depicts the same scene with the arms of the Vitelli family (Figure 6a).[4] The painter dated his work on the back

4 The plate was auctioned at Sotheby's on 19 January 2016 (lot 166) and was attributed by John Mallet. See Mallet, "Il Pittore del Bacile di Apollo", in Gian Carlo Bojani (ed.), *La Maiolica Italiana del Cinquecento, Il Lustro Eugubino e l'Istoriato del Ducato di Urbino*, Florence, 2002, pp. 89-90.

of the piece, indicating on a *tabula ansata* the year 1[5]33, when Vico (who only began his activity following his arrival in Rome in 1540) was ten years old.



Figure 5. *The Abduction of Hippodamia*, Enea Vico, Rome, 1542 (image: www.lacma.com M.88.91.235).

A ceramic work of higher quality is a plate in the Victoria and Albert Museum, in London, depicting a similar scene, reasonably attributed to Nicola da Urbino (1480-1537/38). Despite being a similar scene to the present one, the work was purchased in auction as *The Rape of Helen* and was originally presented as such (Figure 6b).[5] It is dated by experts to ca. 1533 and, in any case, if it was by Nicola da Urbino it would have to predate his death in 1537/38[6] and that of Frederick II Gonzaga whose heraldic arms appear on the plate and died in 1540. Other ceramic works reproduced the same subject at less certain dates but with very similar iconography. An anonymous plate is in the *Palazzo Madama* in Turin; another, in the collections of the *Kunstgewerbemuseum* in Berlin, is attributed to Orazio Fontana (1510-1571); and a large bowl is in the Metropolitan Museum in New York.

5 On the back of the plate the artist wrote: "Chrone paris Rapi elena al tenpio", although it is clear that this is a personal contribution by the artist, as it does not appear in any of the known prints.

6 Date given in Gordon Campbell's "The Oxford Dictionary of the Renaissance", Oxford University Press, 2003.



Figure 6. Maiolica plates with similar depictions of the abduction of Hippodamia. Left side (6a): dated "1[5]33" and atributed to the "Painter of the Apollo basin"; Right side (6b): 1535-1538, attributed to Nicola da Urbino (image © Victoria & Albert Museum C-2246. 1910).

From the date of those two maiolica plates it can be inferred that there were probably other prints prior to Vico's that reproduced the same composition of this subject, although none of the several we have found so far is dated before 1542. What is certain is that Vico's print and others of similar appearance - of which we have identified up to eight - were extremely successful and hence the existence of numerous works that reflect compositions very similar to the prints. There are known versions in wall paintings, such as one by an anonymous Italian artist (ca. 1580) that decorates the *Palazzo Besta* in Teglio (Lombardy); a panel by an anonymous Dutch artist from the second half of the 16th century (Inv. 436) in the *Staatliche Kunsthalle* of Karlsruhe (Inv. 436); an oil on canvas, also anonymous, in the *Musée Magnin* in Dijon; and an oil on panel in the Vienna trade (Dorotheum, 14 April 2005).[7]

Although it is very possible that the painter of the Bacalhôa panel used Vico's print of 1542 as a source, even though there must have been earlier prints of possibly higher quality of the same composition, it is not so clear that all these works reproduced one by Rosso Fiorentino. The attribution is due to Giorgio Vasari,[8] but there are several arguments that point in another direction. In principle, some of the engravings that reproduce it, in particular the Lebas print (1803), indicate that the composition is by Raphael. Despite this, in "Le Peintre Graveur" Adam Bartsch takes up Vasari's attribution, thus encouraging other later authors to maintain it. However, if we look at the style of all the prints and the works that they inspire, none of them points to Rosso's very personal style, and yet all of them reflect the style of Raphael or of his most close disciples. Other authors have suggested Salviati and also Perino del Vaga. The latter is suggested in the painting's file in the *Musée Magnin*. Indeed, the style followed in these paintings, ceramics and prints

7 This painting was subsequently auctioned at Christie's in London on 9 June 2010 (lot 212).

8 "Enea Vico da Parma, il quale […] intagliò in rame il ratto d'Elena del Rosso" (Enea Vico from Parma who engraved in copper the abduction of Helen, by Rosso) Vite, volume 7, Sienna 1792, p. 157.

is close to the work of Raphael's pupils in Rome, and not so much to the Mannerists of Fontainebleau. Incidentally, it should also be noted that all the versions of this work, whatever their medium, differ markedly from the only interpretation of this subject documented as a work by Rosso: his fresco decorating the Gallery of Francis I of France at Fontainebleau, painted c. 1533-1539.

The signature on the Vico illustration (Figure 5) appears in a small cartouche at the foot of the composition: "ENEA/VICCO/FACIEBA/T/1542". On the right, we see the abbreviated signature "TOM. BARL. EXC", which must refer to the printer Tommaso Barlacchi.[9] We do not know whether the author of the Bacalhôa panel used a similar cartouche to insert his signature and the date, now lost, but it seems unlikely because the proportions of the rectangle on the illustration do not coincide with those of the azulejo panel, which is more horizontal. The painter of this panel did not change the arrangement of the figures but simply cut off the bottom of the composition in the illustration, eliminating part of the ground. With the same intention, he increased the distance between Pirithous and Theseus, extending the size of the banquet table by exactly one tile length and adding a plate at its left side, next to the lying jug that appears in the print, an object that must have been a personal contribution by the panel's author as it does not appear in any of the known engravings. But the fact that, by removing a column of tiles, the panel and print may be superimposed (Figure 7) suggests that the stencil he used to paint the scene must have been taken literally from the illustration, on which he would have created a grid to transfer the composition to the panel, making the scale slightly larger than the original.

There is some debate about the identification of the episode depicted on the illustration because Vasari, who was familiar with it, interpreted it as the Abduction of Helen, and some modern authors who do not recognise the centaur in the scene have accepted this hypothesis. However, it is plain to see that the figure that abducts Hippodamia is a centaur with long ears, a vine wreath on his head in reference to wine and his inebriation, and the body of a horse. We cannot see the front legs because they are concealed by his body and the clothes of the abducted woman, and also because he is depicted in the prancing position, resting only on his back hooves.[10]

The choice of this episode, inspired by a classical text that enjoyed great popularity during the Renaissance, is probably related to the banquets that the Albuquerque-Noronha couple offered to guests at their Azeitão retreat. The Hippodamia episode, represented in this precise location, may be interpreted as a type of veiled warning to guests about the risks of immoderate drinking and the uncontrolled erotic appetites that could ensue if the diners did not exercise caution during the feast. It is well-known that "moderation", the virtue which the Greek paideia called "sophrosyne", was one of the guiding principles in the education of virtuous citizens in classical Greece. The term, and the concept it describes, is equivalent to the Latin "temperantia" (temperance), which

9 We are grateful to Dr. Juan Antonio Gómez for his assistance with the aspects surrounding the issues prompted by the Vico illustration and its subsequent influence.

10 The known scenes of the *Abduction of Helen* do not include centaurs and the action usually unfolds by the sea, suggesting the voyage between Sparta and Troy, or at least boats or their sails are visible behind the figures. We will not deal on this occasion with the different titles that could be given to this scene, which probably served the artists with minor modifications - or without them - to apply to the various abductions of women narrated in classical myths. The two most frequent titles applied to this scene are the abductions of either Hippodamia or Helen, although there were also other more forced ones.

incidentally is mentioned along with the other cardinal virtues in the azulejo cartouche above a door in the room adjacent to the place where this panel is located.

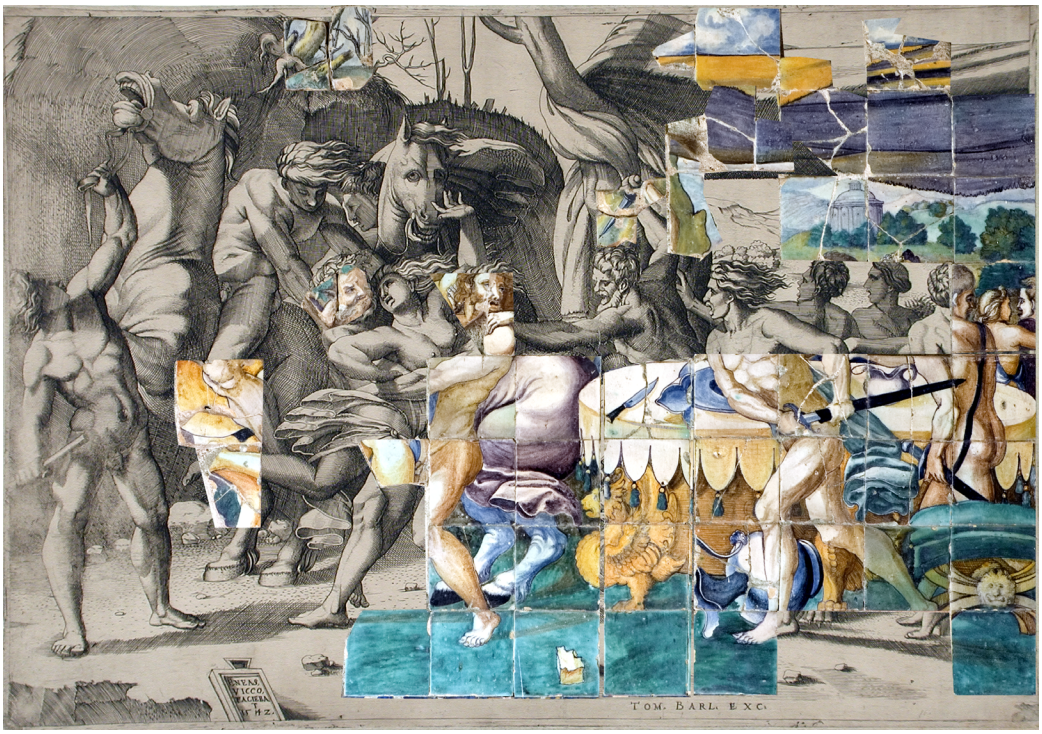


Figure 7. Superposition of the remainder of the panel, minus the column of tiles that make up the extra length, over the print (image © Associação de Colecções | The Berardo Collection).

2.3. *Susanna and the Elders*

Several factors have contributed to make this panel (Figure 8) the most famous image at Bacalhôa, not least its sheer beauty and the relatively good condition in which it has reached us. The fact that it is still largely intact is astonishing because the central motif – an almost completely naked figure being sexually harassed – could have severely challenged modesty and conventional morality. Indeed, it is remarkable that it has never been censored in any of the waves of puritanism that have swept across Catholic Europe since 1565 to the present day.

The panel was painted by an artist with excellent academic training who attempted to reproduce with a ceramic procedure the same degree of reality that painting achieved in the 16th century in Italy and Flanders. Contemplating this "istorya insigne", as the humanist Felipe de Guevara would have described it, we can imagine the paintings that must have graced the interior walls of Brás [Afonso] de Albuquerque's country estate.

The story of Susanna is one of the episodes in the Book of Daniel (Ch. 13) that was incorporated into the Bible at a very early date, perhaps in its Greek and Latin versions in the first century BCE. Its propaedeutic message is related to the heroic defence of female

chastity. Susanna was the wife of Joakim, who lived in exile in Babylon and, according to some scholars, was a wealthy Jew. Two elders conspire to lie in wait for Susanna and rape her, and an occasion arises when the beautiful young woman is applying oils before bathing at the fountain in her husband's lush garden. The panel depicts the moment when Susanna is accosted by the lustful elders. When she rejects them, they plot their revenge by accusing her of having committed adultery with a young man they have seen lurking nearby. Defenceless before the false accusation, Susanna cries in despair, silently begging for divine protection. After a hasty and controversial trial that condemns her to death, she is led to the place where she will be stoned. However, the prophet Daniel unexpectedly halts the group before they reach their destination and accuses the judges of having reached their verdict without full knowledge of the facts. He proposes interrogating the two elders separately, and when this course of action is pursued the accusers offer contradictory versions of the event, making their lie plain to all the observers. Daniel was still a young apprentice in the art of counsel – or the legal sciences, as we call it today – at the court of Nebuchadnezzar. The teaching behind the story presents the young Daniel as a defender of justice and Susanna as a virtuous woman and the victim of vengeful slander who is saved at the last minute by the divine justice exercised through the intervention of the prophet Daniel.

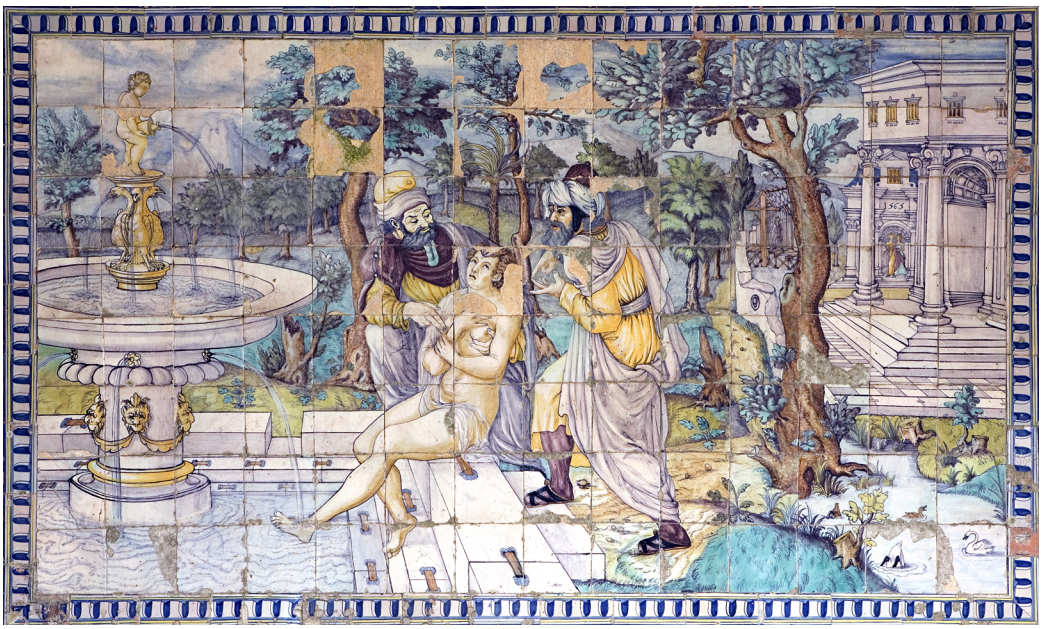


Figure 8. Panel of *Susanna and the Elders* (image © Associação de Colecções | The Berardo Collection)

As in the case of the *Abduction of Hippodamia*, the painter of these azulejos may have drawn inspiration from an illustration but unfortunately we have not found the source. The theme must have been very well known at the time because it was interpreted in countless ways by Italian and Flemish painters and sculptors. Abraham de Bruyn (ca. 1539-1587), the aforementioned engraver from Antwerp, made a series of different scenes from the story of Susanna, some of them signed and dated in 1570, so Flores must have drawn inspiration for this work from an earlier source. The great Flemish painter

Maarten van Heemskerck (1498-1574) made a series of drawings on this same theme which were engraved by Cornelis Cort in 1566, which also rules him out as a possible source of inspiration [11].

Irrespective of the graphic source that may have inspired the composition of this ceramic panel, two aspects draw our attention: the quality of its pictorial execution and its distinctly Flemish air. The first aspect is observed in the firm drawing made with fine black lines by a confident hand. The palette is broad and nuanced, including as many as seven different hues: deep black, purple-black, grey, chestnut ochre, golden ochre and two shades of green. Some of the traits of the work betray the author's Flemish training, such as the depiction of the animals scattered around the landscape, the creative freedom with which he interprets the Doric order and his minute attention to the details. The white marble and gilt bronze fountain where Susanna prepares to bathe acquires a special prominence. At its apex, a boy pours water from a jug, while the four eagles that form the pedestal of its base expel water through their open beaks, filling the fountain's upper basin. Beneath it, water spouts from four bronze jets to fill the lower tank in which Susanna has already introduced a foot when she is accosted by the elders. Another interesting detail is the close attention which the painter paid to the system that was used to join the blocks of marble in fountains to prevent the loss of water: holes were made in the blocks and gilded bronze cramps with their ends turned down were inserted in the orifices which were then filled with molten lead.

Equally remarkable is the detailed depiction of the two garden pavilions on the right-hand side of the scene. The larger of the two is a *distyle-in-antis* portico with Composite order columns and pilasters raised on a stylobate accessed by three steps and covered by an entablature in which the triglyphs appear to be suspended as simple ornaments of the frieze. The rear of the portico leads to a passageway covered by a coffered barrel vault. Above the semicircular arch of the doorway we see a small spherical aeolipile or fire-blower, a motif that was frequently used in classicist architecture and appears in Renaissance architecture treatises.

The pavilion in the background is an *aedicula* with pilasters on a facade that culminates in a mansard with a pediment that stands out against a dark grey slate roof like the one that originally covered the rooms of the Pleasure House. The plain frieze is inscribed with the date 1565, denoting the painter's desire to indicate the year when this panel was made and, in all likelihood, the other azulejos in the room in which it is located. Two ladies emerge from the pavilion door, about to commence their stroll but oblivious to the elders harassing the chaste Susanna. Near the two women, a young man crosses a stream via a wooden bridge with a little fish-scale slate roof, possibly alluding to the passer-by who served as the excuse for the elders to make their accusation of adultery.

In terms of symbolism, the panel contains curious details which at first sight seem insignificant but may well hold hidden meanings. It is important to remember that the act which the lascivious elders interrupt is the bath, something which today we understand as a simple hygiene practice or an instinctive act that we share with many other living species. These species are possibly referenced by the group of ducks and swans swimming and plunging their heads into the waters of the little lake that occupies the bottom right-hand corner of the scene. However, in the 16th century, Christianity – and nearly every other religion since antiquity – viewed bathing as an important ritual act to purify the mortal body inclined by its human nature to commit sin. Our attention is drawn to the unusual, although perhaps intentional, location of the palm tree; a common

vegetal element in depictions of this theme, on this occasion it appears just behind Susanna, as if sprouting from her back. Compared with the other trees, the palm adopts a much smaller, almost symbolic scale, suggesting that it serves a metaphorical purpose here. After all, this was the plant that provided the Holy Family with sustenance on their flight to Egypt, and for Christians it has always represented the tree that bears fruit in the desert where the divine word is revealed to the prophets. It is also mentioned in the *Litaniae Lauretanae*, which compare Mary's purity with natural elements: "quasi palma exaltata sum", the phrase which in Christian theology recalls her victory over original sin. The palm tree in this scene is therefore probably a symbol of Susanna's carnal purity. Behind the oaks, palm and other trees we see the hedge that delimits the garden, perhaps recalling another of the metaphorical praises which the Song of Songs dedicates to Mary's purity and virginity by comparing her with a "hortus conclusus", an enclosed garden where the trees of a miniature paradise grow and bear fruit.

The symbolic dimension of the biblical story of Susanna is deeply rooted and begins with her name. Susanna is derived from the Hebrew word for the Madonna lily, which since antiquity has signified purity. The figure of Susanna is the biblical and mortal version of pagan deities like Demeter, Ceres and Pomona, all goddesses of the fertility of the land and marriage. According to legend, Pomona was constantly harassed by and had to defend herself from woodland fauns, the same fauns that populate the landscaped area in front of the rooms in the Pleasure House at this estate. In the biblical story, Susanna was not a goddess but a well-to-do mortal married to a wealthy man. Susanna's presence in the Pleasure House is evidently explained by the relationship with María de Noronha, wife of Brás [Afonso] de Albuquerque: like her biblical counterpart, she would have bathed in the lake that irrigates her husband's splendid garden and may have been secretly observed by anyone peering over the high wall that shelters the lake, possibly as an element of visual protection.

There is one final symbol which we can perhaps discover in a detail of the vegetation in this delightful garden at *Vila Fresca*. Flemish and subsequently Dutch painters were frequently experts in landscapes and vases, benefitting from the enormous advances in botany that were achieved in the Netherlands from the 15th century onwards. In the foreground of this particular scene of *Susanna and the Elders* we see three leafy holm oaks depicted in their usual greyish-green colour with thick, gnarled trunks in a much darker tone. Another two trunks of the same species – a withered one on the right and another sprouting afresh on the left – flank the protagonists. Holm oaks, emblematic trees of the Iberian Peninsula, are designated in Latin, like oaks, cork oaks and gall oaks, with the generic term "Arbor quercus", and it is perhaps no coincidence this is precisely the name from which *Alburquerque* in Spanish and *Albuquerque* in Portuguese are derived, the surname of the person who commissioned all of these azulejos.

2.4. The patterned azulejos in the central room

The pictorial panels described above perform the same role in this garden room as the oil paintings on wood panel in the interior rooms of the palace. Similarly, the ornamental repeated motifs that line the walls on which these panels hang (Figure 9) imitate the ornamental fabrics or embossed, gilded and polychrome-painted leathers that covered the walls of the interior spaces in the 16th century.



Figure 9. Patterned azulejos in the central room of the Pleasure House (image © Associação de Colecções | The Berardo Collection).

In this case, the motif chosen to decorate the patterned tiles in the room is what is generically termed "de lazo y follaxe" (loop and foliage) in the documents commissioning patterned tiles from Juan Flores in the 16th century. It is an apt name for this product because it mentions the two essential elements. The "loop" is formed by white bands that generate two interlocking patterns: one with quatrefoil medallions that resemble ironwork and, set within them, wheels with eight spokes that simulate the sails of a windmill. Four of the sails sit in front of the quatrefoil and four behind it. Extensions emerge from the quatrefoils forming the secondary motif, which is smaller and has four stylised vegetal finials that form the "foliage". The vegetal element is completed with multi-petal flowers that appear in the centre of the main motif on the blank reserve, highlighted against a golden yellow ground. At their centre, the secondary motifs also have white flowers, somewhat simpler, set against a black ground. The white bands of the loops stand out against a deep blue ground. The brighter of the two shades of green used in the narrative panels serves here to fill in the background of four of the eight sails. The ornamental effect of this motif is truly remarkable and its execution demonstrates great command of the technique, although on some of the azulejos the painter forgot to trace the ochre outline around the shadows cast by the bands on the yellow grounds, or perhaps this omission evidences the intervention of a less skilled assistant.

2.5. The skirting

Lastly, the cladding in this room is completed by a skirting (Figure 10) which in our opinion contains several unusual stylistic characteristics. The first is the format, which differs from the skirting in the other two rooms in the Pleasure House where it is resolved with rectangular pieces placed horizontally and the special dimensions of ca. 26 x 13 cm. In the case of this central room, the azulejos are square and have the common dimensions of ca. 13 x 13 cm. Besides, the skirting here is formed by two azulejos placed one on top of the other, with the result that it is considerably higher than the skirting in the end rooms. A third and even more remarkable difference is that this skirting, unlike the ones we see in the end rooms, is made of simple patterned azulejos when the importance of this space would have suggested figurative tiles of the finest quality. Besides, the background is mainly white, which is highly unusual in the patterned tiles designed by Flores.



Figure 10. Skirting in the central room of the Pleasure House (image © Associação de Colecções | The Berardo Collection).

These differences would have made this skirting much cheaper to execute than the skirting boards in the secondary rooms, which seems contradictory. Lastly, most striking of all is the inferior quality of the design, execution and colours. We can infer this at a glance by comparing the azulejos in the skirting with the patterned ones above them. In this case, the drawing is far less assured, the blues are not as deep, the greens greatly evaporated during the firing have contaminated the immediately adjacent white background, and we can even discern unexpected confusions of colour between the yellow and ochre elements.

Although we have no clear explanation for this apparent anomaly, it certainly raises questions. If this central room is the most important one in the Pleasure House, as its position at the axis of symmetry, architectural function and decoration would appear to confirm, why does the skirting reveal an inferior artistic quality than the skirting boards in the end rooms, which were presumably less important? If this room was where

bathers changed, could the lower part of the wall have been semi-concealed by a bench for their clothes? Inevitably, another unknown quantity springs to mind, if only as a reflection: which room was the intended destination of the skirting tiles with children's scenes that were discovered in the subsoil outside their original context [3, Figure 37] and are currently held in the *Museu do Palácio da Bacalhôa*?

3. ANALYTICAL CHARACTERIZATION BY SEM-EDS

3.1. Samples

The panels, patterned tiles and skirting tiles were sampled from *in situ*, to which were added samples of the Tagus river god panel, patterned wall tiles and skirting band taken from fragments conserved at the reserves of the *Museu do Palácio da Bacalhôa*. Figure 11 illustrates some sampling spots and the codes attributed through which the samples will be referenced. Sampling was done with a scalpel, in areas already damaged.

Table 1 includes data on each sample studied. The first column (Identification) includes the name of the panel or other similar exclusive labelling, by which the object will be identified. The second column (Sample References) includes the technical reference of the items prepared for observations and analyses. The last column indicates how many measurements were averaged in the semi-quantification of the chemical composition of each.

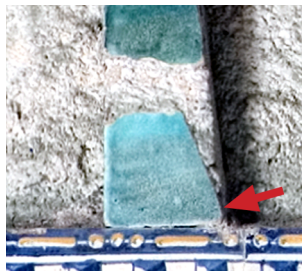
Table 1. Name of items with short-name underlined, sample references, and number of analytical results averaged

Identification	Sample References	Total no. of results
***Susanna* and the Elders**	Bac001/01; /-02; -/03; -/04	5 (glaze); 3 (biscuit)
Abduction of Hippodamia	Bac024/01; -/02	3 (glaze); 2 (biscuit)
Tagus river god	Bac006; Bac017/01; -/03; Bac083/01	9 (glaze); 9 (biscuit)
Wall patterned tiles	Bac003/01; -/02; -/03; Bac040/01; -02; Bac078; Bac142	9 (glaze); 6 (biscuit)
Skirting band tiles	Bac075/02; -/03; Bac114; Bac136; Bac161	4 (glaze); 5 (biscuit)
Susanna frame tiles	Bac096/01; -/02	4 (glaze); 4(biscuit)
Hippodamia frame tiles	Bac074	1 (glaze); 1 (biscuit)
Tagus frame tiles	Bac064	2 (glaze); 1 (biscuit)

Susanna and the Elders **(Bac001/01)**



Abduction of Hippodamia **(Bac024/01)**



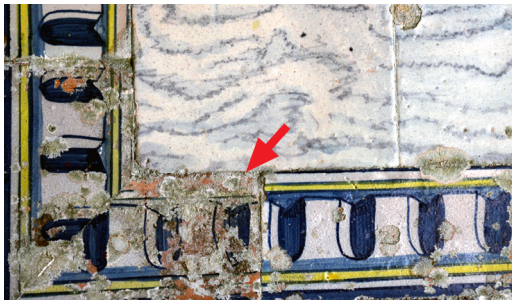
Tagus river god (Bac017/01)



Wall patterned tiles under the Tagus frame (Bac003/01)



Susanna frame tile (Bac096)



Tagus frame tile (Bac064)



Figure 11. Examples of sampling spots on previously damaged areas of the panels and patterned tiles addressed by this paper (images © Associação de Colecções | The Berardo Collection).

3.2. Methods and instrumental means

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

SEM observations and EDS analyses were made at LNEC using a TESCAN MIRA 3 field-emission microscope combined with a BRUKER XFlash 6|30 EDS system. The samples

were uncoated and the observations were made in backscattered electrons mode (BSE), with a chamber pressure of typically 10 Pa, at an accelerating voltage of 20kV with the sample sections at a distance of 14 ± 1 mm from the detector. SEM images were typically acquired at magnifications of 350 x and 700 x for the glaze and 1,000 x or over for inclusions in the biscuit.

The selection of areas for EDS quantification avoided large inclusions in the glaze or biscuit representing more than ca. 5% of the full selected area. From our previous experience, the adequate minimum measurement areas are 200 x 200 μm for glazes and 500 x 500 μm for biscuits. In general, multiple measurements were made and in such case the results are averages and smaller non-overlapping areas may be used to the same effect. Whenever possible, the analyses were performed on white glazes to avoid interference from elements diffused from the blue, green or violet pigments which, when present, were neglected. The yellow pigments remain at the surface and therefore do not entail the same problem. Still, in the case of zinc-bearing yellow pigments, the analyses must be performed at a safe distance from the colour.

Minor elements, usually representing less than 1% of the compositions, such as magnesium (Mg) and iron (Fe) in the glazes, or titanium (Ti) in the biscuits were not included in the tables of results.

The quantification of tin (Sn) in the glazes may be problematic because the aggregation of crystals often results in a large variance. That problem was dealt with by using larger areas whenever aggregation was visually detected in the SEM images or, when that was not possible, averaging the results of multiple analyses on different areas.

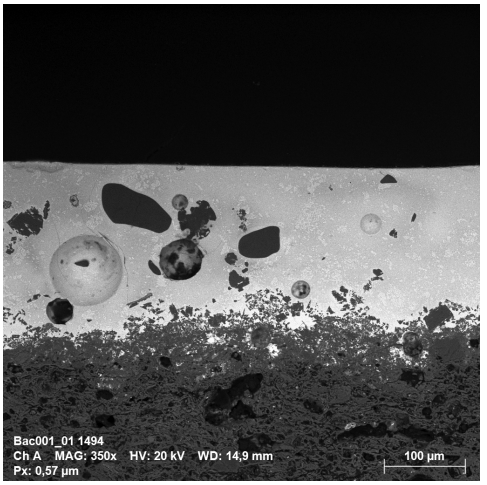
The amount of oxygen (O) was calculated through the remaining elements stoichiometry of their most commonly considered oxides (Na_2O, MgO, Al_2O_3, SiO_2, K_2O, CaO, Fe_2O_3, SnO_2, PbO) and the result was normalised to 100 %.

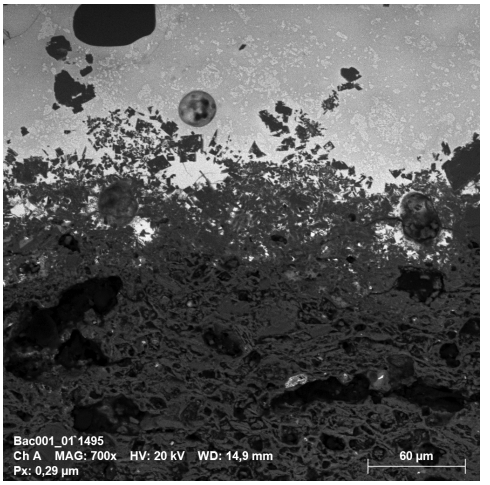
3.3. Results

3.3.1. Morphology of the glazes

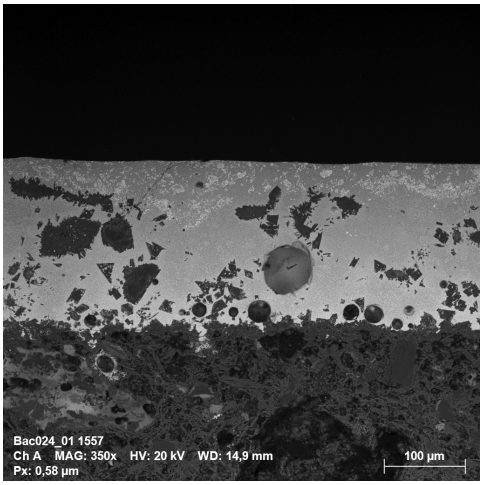
Figure 12 depicts, at the same magnifications for comparison purposes, sectional SEM images of the samples showing the main micro-morphological characteristics generally associated with the glazes and their interfaces. The light grey area on top is the glaze, while the dark grey area corresponds to the biscuit. Because of its colour, the inclusions in the glaze are conspicuous: gas bubbles retained in the glass, grains of sand (larger compact dark inclusions, usually with rounded edges) and bits of feldspars, often in disaggregation. The white spots in the midst of the glaze are crystals of the opacifier (tin oxide) while a continuity of similar white spots near the surface of Bac 024/01 and Bac017/01 corresponds to the lead-rich yellow pigments. It will be noticed that *coperta* (a layer of sprinkled transparent glaze) may have been applied over the yellow colour in those two cases but its presence is doubtful because what is seen may result from the yellow pigment being painted already dispersed in glaze without tin. On the other side, optical images of samples from the wall patterned tiles, skirting tiles and frame tiles, in which the yellow pigment was applied in a denser layer, show that in the tiles sampled representing these cases coperta was clearly absent.

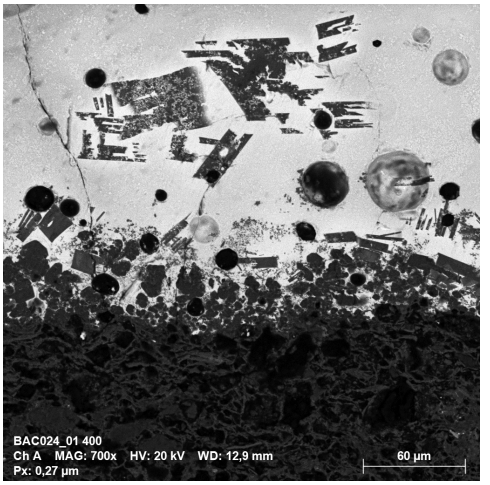
Bac001/01 (*Susanna and the Elders*)



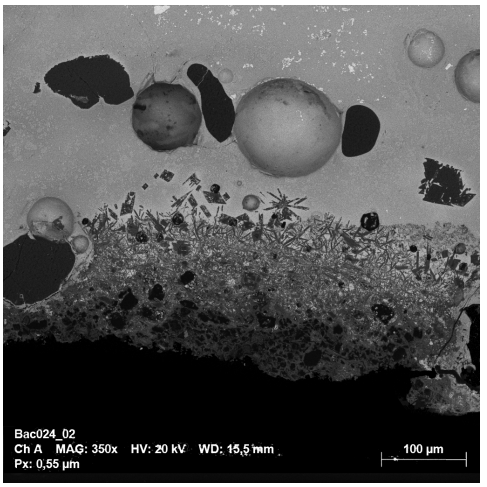


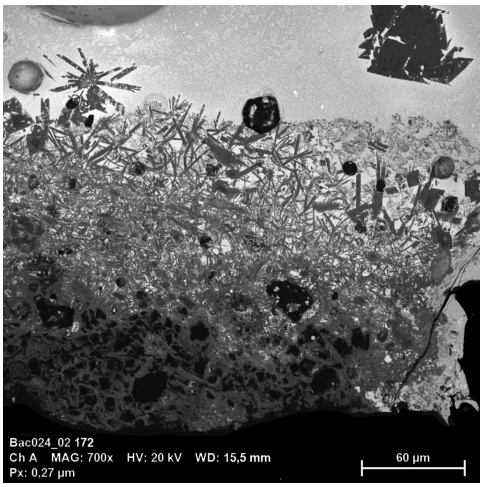
Bac024/01 (*Abduction of Hippodamia*)



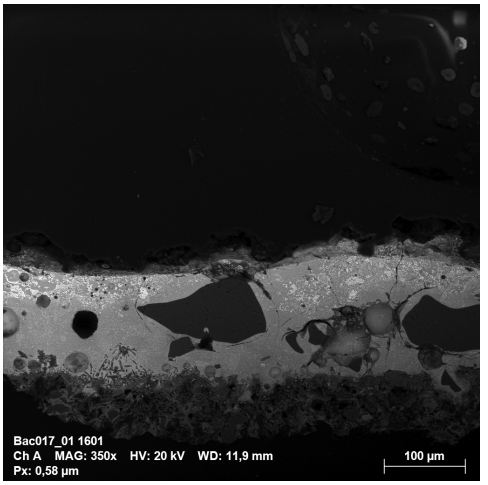


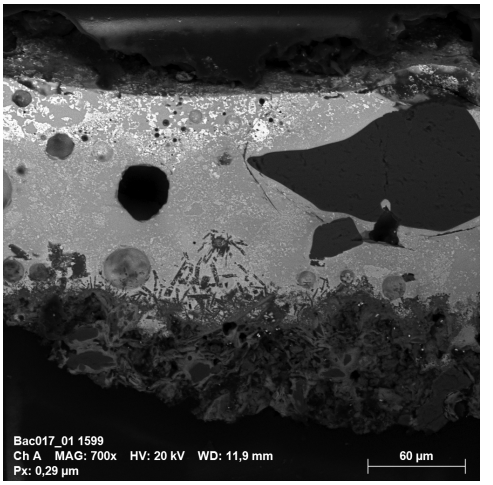
Bac024/02 (*Abduction of Hippodamia*)



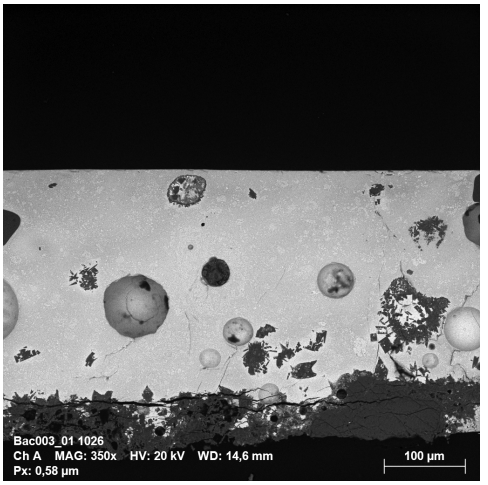


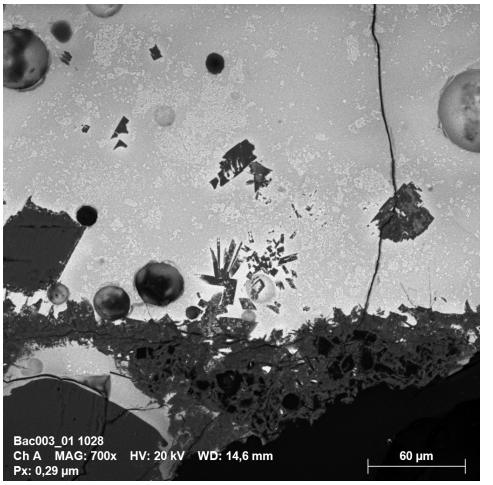
Bac017/01 (Tagus river god)



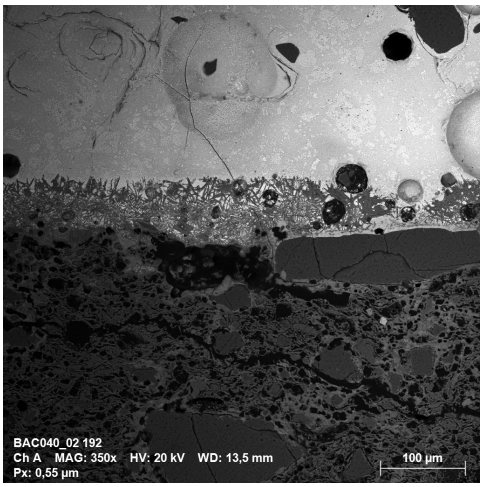


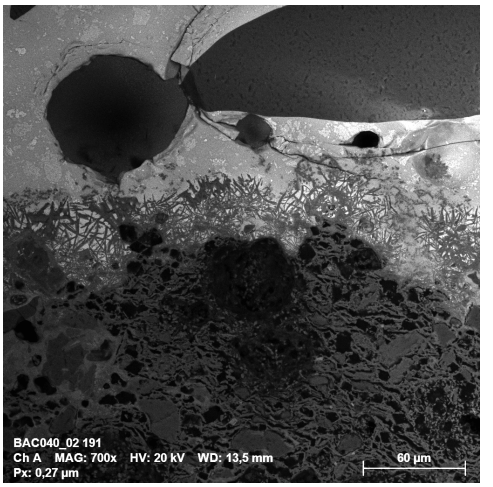
Bac003/01 (Wall pattern)



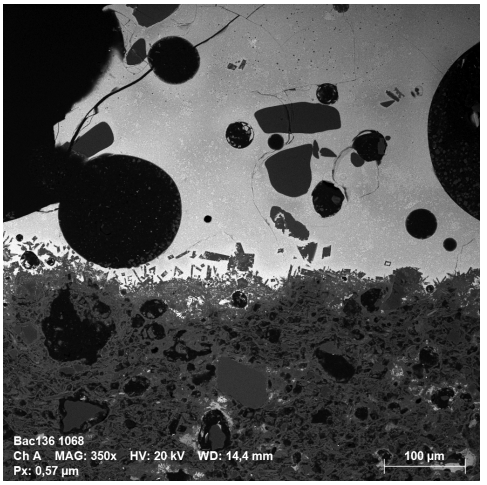


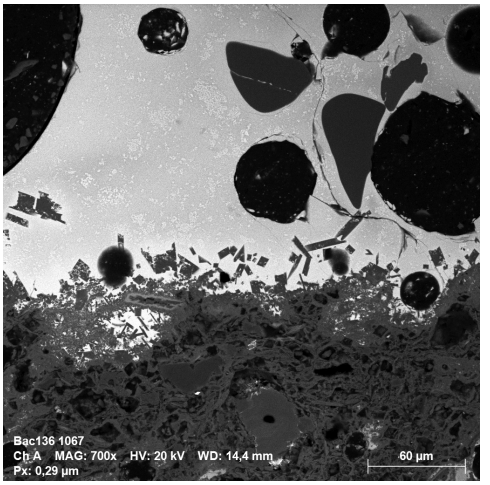
Bac040/02 (Wall pattern)



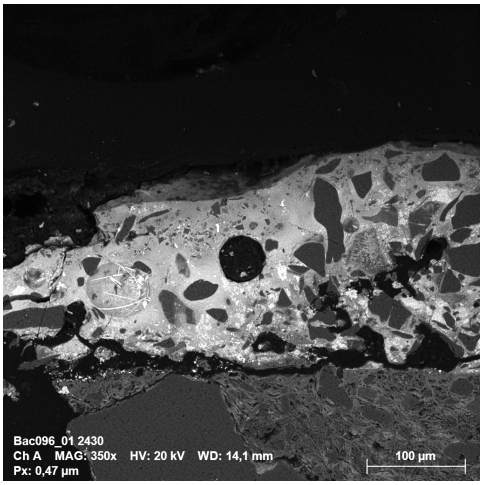


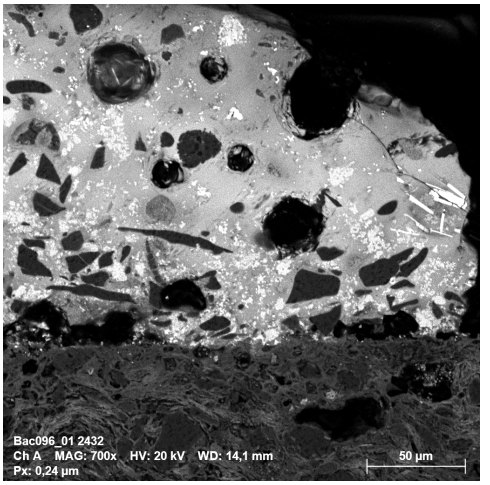
Bac136 (Skirting pattern)



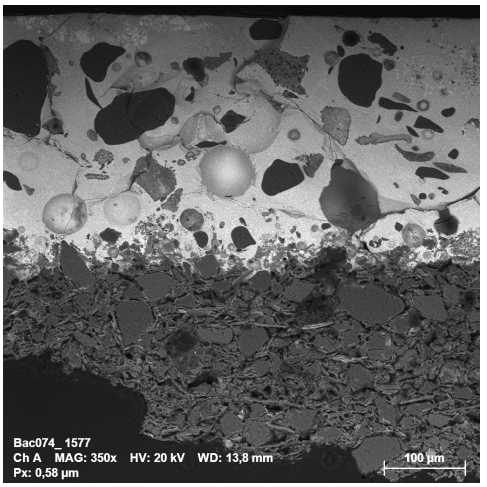


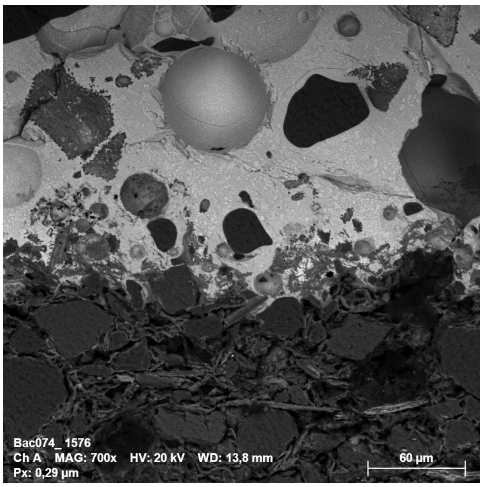
Bac096 (Frame tile of *Susanna and the Elders*)





Bac074 (Frame tile of *The Abduction of Hippodamia*)





Bac064 (Frame tile of Tagus river god)

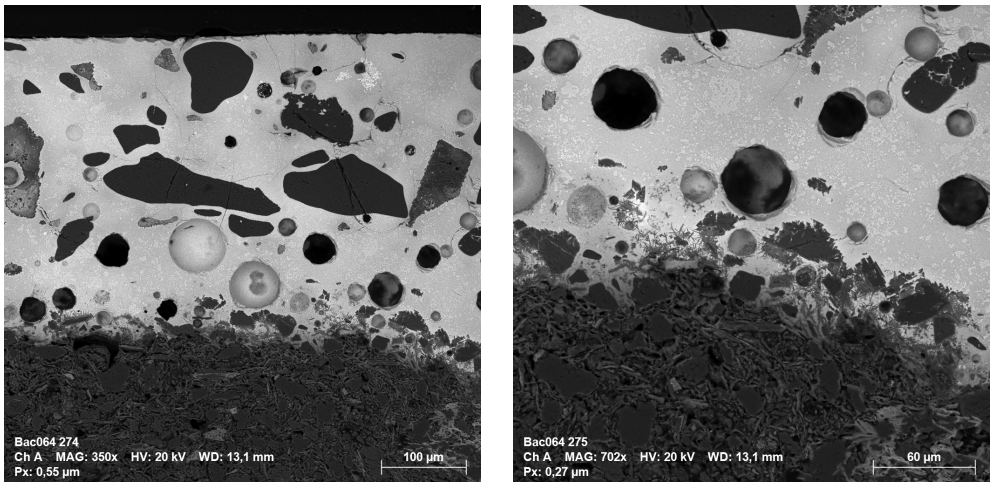


Figure 12. SEM-BSE images showing the main micro-morphological characteristics of azulejos of the central room of the Pleasure House of Bacalhôa. Left side: glaze section at 350 x; Right side: detail of the biscuit-glaze interfaces at 700 x (images LNEC).

3.3.2. Composition of the glazes

Table 2 includes the semi-quantitative results of analyses of the glazes by EDS in weight %. The distinctive silica to lead ratios (Si/Pb), that determine the minimum temperature at which the glazes may be properly fired, have been evaluated and are included in the table.

Table 2. Semi-quantitative composition of the glazes of the tiles studied, determined by EDS (values in wt. % with oxygen obtained by stoichiometry and sum of all elements normalised to 100%) with Si/Pb ratios included

Sample		O	Na	Al	Si	K	Sn	Pb	Si/Pb
Susanna and the Elders	average	**30.50**	**1.19**	**2.26**	**19.41**	**3.14**	**10.18**	**33.32**	**0.58**
	st. deviation	--	0.16	0.36	2.00	0.32	1.82	4.02	
Abduction of Hippodamia	average	**29.58**	**1.42**	**3.14**	**17.95**	**2.46**	**9.54**	**35.91**	**0.50**
	st. deviation	--	0.10	0.27	0.91	0.35	0.93	2.84	
Tagus river god	average	**29.23**	**1.21**	**2.10**	**18.27**	**2.70**	**10.28**	**36.21**	**0.50**
	st. deviation	--	0.53	0.24	1.61	0.74	3.16	4.02	
Wall patterned tiles	average	**30.74**	**1.64**	**2.41**	**19.16**	**2.76**	**11.86**	**31.43**	**0.61**
	st. deviation	--	0.50	0.74	1.62	0.66	2.57	5.88	
Skirting band tiles	average	**30.69**	**0.89**	**2.30**	**19.89**	**3.79**	**8.48**	**33.96**	**0.59**
	st. deviation	--	0.24	0.21	1.28	0.37	1.27	3.31	
Susanna frame tile	average	**43.15**	**2.61**	**4.14**	**31.01**	**5.53**	**5.48**	**8.08**	**3.84**
	st. deviation	--	0.80	0.25	1.97	0.65	5.36	1.82	
Hippodamia frame tile	-	**28.65**	**1.09**	**2.19**	**17.38**	**1.07**	**12.89**	**36.72**	**0.47**
Tagus frame tile	average	**30.95**	**1.46**	**2.67**	**19.06**	**1.11**	**13.92**	**30.84**	**0.62**
	st. deviation	--	0.01	0.11	0.23	0.02	3.21	3.54	

3.3.3. Composition of the biscuits

Table 3 includes the semi-quantitative results of analyses of the biscuits by EDS in weight %. Lead occurs in most cases, deriving from percolation into the biscuit when the raw glaze is applied. Its content was determined but not considered because it is not part of the natural composition of the biscuit and depends on the proximity to the interface. The presence of lead renders the quantification of sulphur doubtful because of a superposition of spectrographic peaks and therefore it too was not considered, as well as elements of contents often below 1% such as phosphorus, chlorine and titanium. The calcium to silicon ratios (Ca/Si), that may be used to characterize a clay and are related with its aptitude for tin-glazing, have been evaluated and are included in the table.

Table 3. Semi-quantitative composition of the biscuits of the tiles studied, determined by EDS (values in wt. % with oxygen obtained by stoichiometry and sum of all elements normalised to 100%), with Ca/Si ratios included

Sample		O	Na	Mg	Al	Si	K	Ca	Fe	Ca/Si
Susanna and the Elders	average	**43.89**	**1.83**	**4.71**	**8.02**	**22.37**	**1.23**	**13.88**	**4.07**	**0.62**
	st. deviation	--	0.67	0.10	0.49	0.57	0.34	0.60	0.50	
Abduction of Hippodamia	average	**43.26**	**1.09**	**4.73**	**9.40**	**20.28**	**1.64**	**15.16**	**4.45**	**0.75**
	st. deviation	--	0.04	1.93	0.53	0.38	0.03	2.19	0,23	
Tagus river god	average	**43.99**	**1.14**	**4.75**	**8.89**	**22.18**	**2.30**	**12.60**	**4.15**	**0.57**
	st. deviation	--	0.39	1.40	0.75	1.61	0.43	1.89	0.43	
Wall patterned tiles	average	**43.69**	**1.03**	**4.24**	**9.13**	**21.38**	**1.37**	**14.97**	**4.21**	**0.70**
	st. deviation	--	0.30	0.81	1.53	1.79	0.36	1.24	0.44	
Skirting band tiles	average	**42.42**	**1.07**	**3.95**	**7.78**	**20.08**	**1.70**	**19.09**	**3.91**	**0.95**
	st. deviation	--	0.58	0.67	0.95	1.85	0.85	6.57	0.92	
Susanna frame tile	average	**46.40**	**1.31**	**2.02**	**9.28**	**27.72**	**3.30**	**6.09**	**3.89**	**0.22**
	st. deviation	--	0.09	0.13	0.51	1.14	0.33	0.73	0.35	
Hippodamia frame tile	-	**46.83**	**1.33**	**1.13**	**7.86**	**29.66**	**2.78**	**6.64**	**3.79**	**0.22**
Tagus frame tile	-	**46.34**	**1.01**	**0.95**	**7.97**	**28.67**	**2.75**	**8.29**	**4.02**	**0.29**

4. DISCUSSION OF THE INSTRUMENTAL RESULTS

The samples, except for the frame of *Susanna and the Elders* (Bac096), present interfaces with easily noticeable crystalline outgrowths, often remarkably wide and it is interesting to note that in the same sort of tile (samples Bac003 and Bac040 of the patterned tiles) or indeed in the same panel (samples Bac024/01 and Bac024/02 of *The Abduction of Hippodamia*) there is a considerable variation in the development and morphology of the interfaces, possibly caused by uneven heating or cooling conditions inside the kiln where the glazes were fired.

Figure 13 compares the morphologies in Figure 12 with samples of known provenance from the productions of the workshops of Lisbon in the 16th century that we designated by "the circle of João de Góis" [12; 13]. The morphology of most glazes, and particularly the development of the interfaces, are compatible with the productions of that technical circle. It may be verified that, on the other side, they are not compatible with the contemporary majolica productions attributed to Juan Flores in Spain [4], nor with the Bacalhôa panels and tiles that were determined to have likely been imported [14].

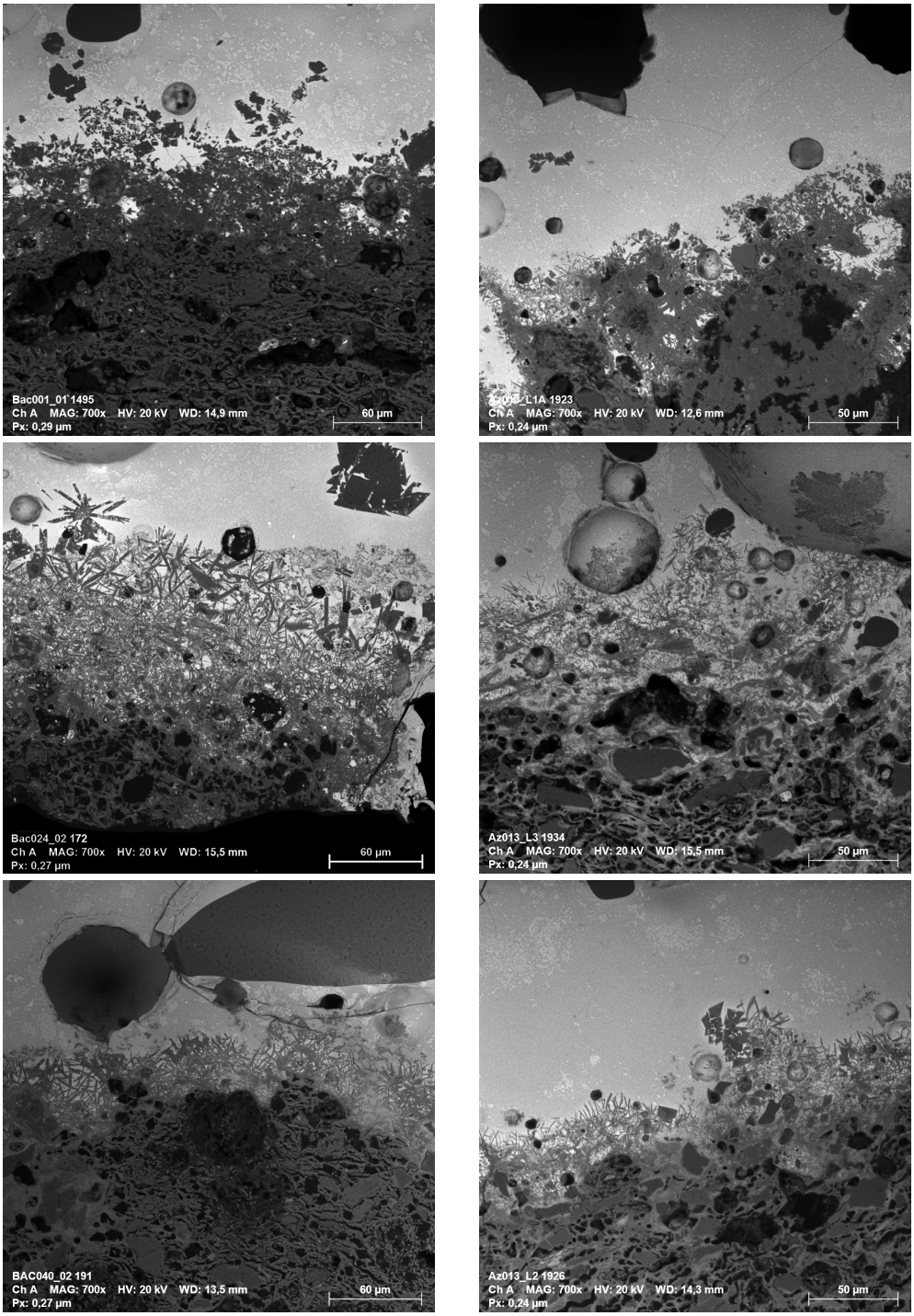


Figure 13. Comparison at the same magnification of glaze sections of tiles from the central room of the Pleasure House of Bacalhôa (left side) with similar morphologies in tiles with the monogram of João de Góis at *Igreja da Graça* (right side). From top to bottom: Bac001/01 (Susanna) vs. Az013/L1; Bac024/02 (Hippodamia) vs. Az013/L3; Bac040/02 (patterned wall tile) vs. Az013/L2 (images: LNEC).

Considering the Si/Pb ratios in Table 2, it will be seen that all ratios are within a small region from 0.47 to 0.62, except sample Bac096 from one of the frame tiles of the panel of Susanna, for which Si/Pb= 3.84. That ratio is derived from the low content in lead which might also result from a lixiviation suggested by the decayed condition of the tile. However, the composition of the tile also differs from all the others by the high contents in sodium and potassium, which are not compatible with a lixiviation process, and low content in tin. All these are incongruous with the contemporary productions of the workshops of Lisbon known to us [12] but consistent with a recipe possibly aimed at being cheaper at the cost of being fired at a higher temperature and probably for a longer time.

Table 4 compares the results in Table 2 with the average glaze composition of tiles of the circle of João de Góis [12, p.40], and the imported panel with the Albuquerque coat-of-arms, also in the Pleasure House [14]. The frame tile of the *Susanna and the Elders* panel is clearly different from all the other tiles sampled from the room and from the glazes of the circle of João de Góis by its higher contents in K and lower in Sn and Pb (the most expensive raw materials) resulting in a high Si/Pb ratio. The Albuquerque coat-of-arms also differs on the same counts, although the differences are not as remarkable. Both are enhanced against coloured backgrounds in Table 4.

Table 4. Comparison of the average glaze semi-quantitative compositions by EDS of the panels in the central room of the Bacalhôa Pleasure House with the characteristic average composition of the circle of João de Góis and the Albuquerque coat-of-arms panel

Sample	O	Na	Al	Si	K	Sn	Pb	Si/Pb
Susanna and the Elders	30.50	1.19	2.26	19.41	3.14	10.18	33.32	0.58
Abduction of Hippodamia	29.58	1.42	3.14	17.95	2.46	9.54	35.91	0.50
Tagus river god	29.23	1.21	2.10	18.27	2.70	10.28	36.21	0.50
Wall patterned tiles	30.74	1.64	2.41	19.16	2.76	11.86	31.43	0.61
Skirting band tiles	30.69	0.89	2.30	19.89	3.79	8.48	33.96	0.59
Susanna frame tile	43.15	2.61	4.14	31.01	**5.53**	**5.48**	**8.08**	**3.84**
Hippodamia frame tile	28.65	1.09	2.19	17.38	1.07	12.89	36.72	0.47
Tagus frame tile	30.95	1.46	2.67	19.06	1.11	13.92	30.84	0.62
Circle of João de Góis	29,10	1.10	2.80	17.80	1.40	N.D.	47.80	0.40
Albuquerque coat-of-arms	36.76	2.87	3.21	25.12	**5.64**	**5.66**	**20.74**	**1.21**

Note: For technical reasons the contents in Sn could not be determined accurately when the research on the circle of João de Góis was first made [12], and for that reason the element has been omitted (N.D.), resulting in an increase of up to 10% in the other contents, but leaving the Si/Pb ratio unchanged

The most relevant elements to define a workshop provenance should be those that are integrated by the potter according to a personal recipe: silicon (Si), the main element in a glass, integrated as sand; lead, the main fusing agent, integrated as an oxide; sodium and potassium, alkaline fusing agents integrated, respectively, as sea salt and ashes of potassium-rich organic materials; and tin, integrated also as an oxide. To offer a simplified visualization of the contents in Table 4, Figure 14 depicts a scatter chart in which the horizontal axis (X axis) represents the (Na+K)/Pb ratio and the vertical axis (Y

axis) represents the Si/Pb ratio. The normalization to the content in lead makes the other contents relative to it, rendering irrelevant the fact that for one of the cases the content in tin is unknown because it is not considered in the ratios.

The graphic representation in Figure 14 clearly separates the Susanna frame tile and the Albuquerque coat-of-arms from the rest. The panels, wall linings, and the two remaining frame tiles may be clustered together with the circle of João de Góis, as seen from the chart. This cluster can be further detailed by sorting the samples according to the ratio of the alkaline fusing agents to lead (Table 5), suggesting a difference in this respect between a group formed by the João de Góis circle and the frame tiles of the Hippodamia and Tagus panels vis-à-vis the remaining samples clustered together in the plot of Figure 14.

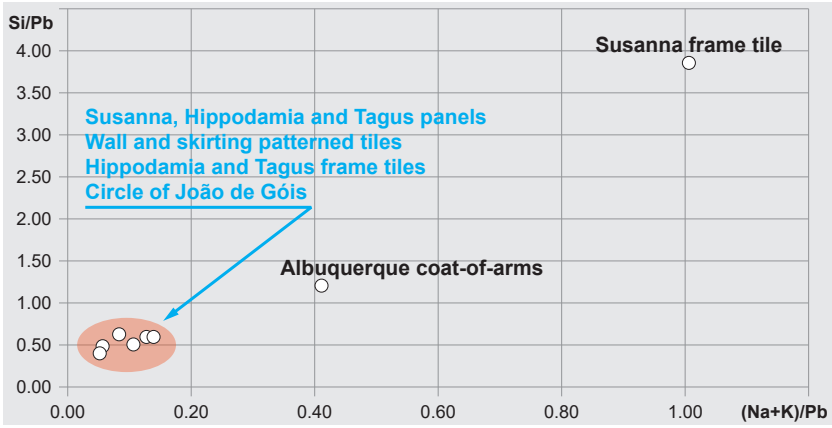


Figure 14. Graphic representation of the contents in the alkalines fusing agents (Na+K) and of silicon (Si), both normalised to the content in lead (Pb) in a X-Y scatter chart.

Table 5. Panels and tiles clustered in the plot of Figure 14 sorted by the ratio of fusing agents

Panel / tile	Circle João de Góis	Hippodamia frame	Tagus frame	Tagus panel	Hippodamia panel	Susanna panel	Skirting tiles	Wall tiles
(Na+K) / Pb	0.05	0.06	0.08	0.11	0.11	0.13	0.14	0.14

Table 6 compares the results in Table 3 with the average biscuit composition of tiles of the circle of João de Góis [12, p.41], and the imported panel with the Albuquerque coat-of-arms [14]. There are two clearly different groups, one of which with low magnesium (Mg) and calcium (Ca) contents, resulting in Ca/Si ratios of 0.30 or lower, and higher potassium (K) (highlighted against a green background). These features correspond to what might be expected from Miocene clays of the region of Lisbon used by potters since ancient times.[11] The other group corresponds to biscuits of a clay with characteristics unknown from the region of Lisbon at this time suggesting they were likely imported [6; 14].

11 A study made by us on the calcium-poor Miocene clay layers of the region of Lisbon has shown that the composition of some sublayers matches the composition of the biscuits used by the João de Góis circle, leading us to believe that for most of the 16th century the Lisbon azulejo workshops likely used the same red clays long used by potters (to be published).

Table 6. Comparison of the average biscuit semi-quantitative compositions by EDS of the panels, frames and patterned linings in the central room of the Pleasure House with the characteristic average composition of the circle of João de Góis and the Albuquerque coat-of-arms panel

Sample	O	Na	Mg	Al	Si	K	Ca	Fe	Ca/Si
Susanna and the Elders	43.89	1.83	4.71	8.02	22.37	1.23	13.88	4.07	0.62
Abduction of Hippodamia	43.26	1.09	4.73	9.4	20.28	1.64	15.16	4.45	0.75
Tagus river god	43.99	1.14	4.75	8.89	22.18	2.30	12.6	4.15	0.57
Wall patterned tiles	43.69	1.03	4.24	9.13	21.38	1.37	14.97	4.21	0.70
Skirting band tiles	42.42	1.07	3.95	7.78	20.08	1.70	19.09	3.91	0.95
Susanna frame tile	46.40	1.31	2.02	9.28	27.72	3.30	6.09	3.89	0.22
Hippodamia frame tile	46.83	1.33	1.13	7.86	29.66	2.78	6.64	3.79	0.22
Tagus frame tile	46.34	1.01	0.95	7.97	28.67	2.75	8.29	4.02	0.29
Circle of João de Góis	45.70	1.20	**1.50**	8.60	26.80	**3.10**	**8.90**	4.20	**0.30**
Albuquerque coat-of-arms	43.69	0.86	4.44	7.69	22.23	1.22	15.91	3.95	0.72

The chart in Figure 15 offers a two-dimensional representation of two of the most determining elements in Table 6, the contents in Mg and Ca, normalized to the content in silicon. The graphic representation is again very clear, separating the items in two groups and clustering all frame tiles with the circle of João de Góis, while the panels, wall patterned tiles and skirting band, cluster with the Albuquerque coat-of-arms panel.

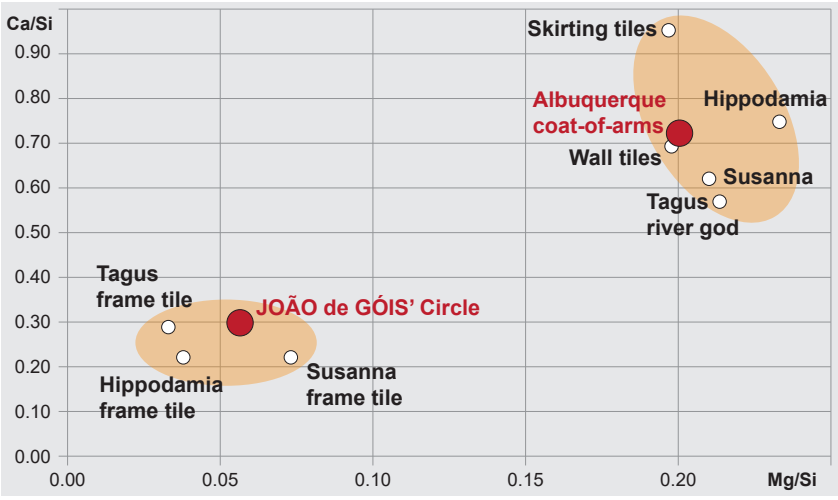


Figure 15. Graphic representation of the contents in calcium (Ca) vs the content in magnesium (Mg), normalised to the content in silicon (Si).

5. CONCLUSION

The samples collected from all the panels, frame tiles, wall lining and skirting band of the central room of the Pleasure House of Bacalhôa do not, in general, differ substantially in terms of morphology. The only exception is a single tile of the frame of *Susanna and the Elders* that does not show, at the scale studied, any crystalline interfacial outgrowths.

In stylistic terms, the panels *Susanna and the Elders* and *The Abduction of Hippodamia* are the work of a highly skilled painter and may be tentatively attributed to Juan Flores. The Tagus river god is too incomplete for a definitive conclusion, but may be from a different hand. Likewise, the patterned tiles lining the wall show a high artistic acumen of the designer and are homogeneously painted with a considerable technical quality. On the other side, the skirting band represents an inferior effort on both counts.

Excepting the single tile sampled from the frame of *Susanna and the Elders*, the morphological and compositional compatibility of the remaining glazes with the glazes used shortly after this time at *Igreja da Graça* [15], as well as later, by João de Góis and his technical circle [12; 13], and the differences on both counts from contemporary panels by Juan Flores extant in Spain or presumably imported from there [4; 14], suggest that all the tiles lining the Central Room of the Pleasure House were glazed, painted and fired in Portugal. The absence of a clearly perceivable *coperta* over the yellow, also vouches against a production in Spain because most panels and tiles that were presumably imported from there, clearly depict a tansparent *coperta* layer sprinkled over the yellow pigment [14].

As pertains to the ceramics, the composition of the biscuits of the panels, of the patterned tiles, and of the skirting band, are compatible with the composition of the imported panels, as exemplified by the Albuquerque coat-of-arms. This result suggests that the biscuits were imported unglazed, presumably from Talavera where Juan Flores had his workshop at the time [4]. The biscuits of the frame tiles, however, use a different clay, compatible with the clays used by the circle of João de Góis around this time and into the 1580s. This is likely clay from the region of Lisbon, probably from a calcium-poor Miocene layer that fires to a varying shade of dark orange to red in oxidation atmospheres [13, Figures 4 and 12].

The case of the Susanna frame tile is very interesting. Its design is simpler than the design of the Hippodamia and the Tagus frame tiles, which are identical (both types are depicted in Figure 11). Since the results point to the use of local clay also in the Susanna frame tile with an odd glaze composition, then it too must have been manufactured in Lisbon. This case could easily be dismissed on the basis that it corresponds to a single tile and it may represent an anomalous result, except for the fact that in our research we found several similar cases, all corresponding to presumably unimportant frame tiles in which the lower content in expensive lead – often with Si/Pb ratios of 2.5 or higher – is compensated by higher contents in the cheaper fusing agents: sodium and potassium. The same tiles also have low contents in the other expensive raw material: tin (typically less than 6%), and their biscuits are often in the early stages of vitrification, meaning that they were fired to a higher temperature and maybe for a longer time than normal for the lead-rich glazes. This suggests that these tiles were made by a potter other than Flores (because such high Si/Pb ratios are unknown from his productions in Spain [4]), either as a test, or, more likely, to satisfy a commission for frame tiles. He may have fired the tiles in a smaller kiln in which higher temperatures could be attained. It is maybe fortunate that his recipe was not used in more important work, because if the temperature was insufficient, then the

adhesion between the glaze and the biscuit would likely be impaired, eventually leading to a separation exactly as seen in the image of Bac096 at 350x in Figure 12, in which the glaze is seen to be clearly detached from the biscuit.

Although the Flemish potters João and Filipe de Góis must have been connected with the production of at least part of the majolica tiles of Bacalhôa, as demonstrated by the more than likely commission by Brás [Afonso] de Albuquerque of the panels for *Igreja da Graça*, one of which signed with the monogram of João de Góis [15], the nature of such connection remains uncertain. Did they supply the glazes? Did they take care of part of the painting? The morphology of the glaze/biscuit interfaces is very similar to the interfaces found in productions connected with the Góis brothers [13] and it is likely that these tiles were fired in the same kiln in Lisbon, near the Boavista beach [16] and in that case they were probably glazed and painted somewhere nearby. But the glazes of the panels and patterned tiles in the central room of the Pleasure House, albeit very similar to those used by João de Góis, with which they may be clustered (Figure 14) are still somewhat different in the contents in alkaline fusing agents, which are characteristically low in the productions of João de Góis (Table 5). On the other side, the same table shows that the contents in potassium of the frame tiles of the Hippodamia and the Tagus panels are compatible with the productions of João de Góis, and these same tiles also have characteristically high contents in tin, suggesting that in them we may have a production of lesser responsibility that was fully entrusted to his workshop.

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The 16th century azulejo panels of the *Loggia of the River Gods* in the *Palácio da Bacalhôa*

João Manuel Mimoso, Alfonso Pleguezuelo, Maria Augusta Antunes, Sílvia Pereira, Álvaro Silva

ABSTRACT

The west façade of the first floor of the *Palácio da Bacalhôa* in Azeitão, Portugal, opens onto a loggia, today called *Loggia of the River Gods* because its walls are decorated with a continuous azulejo wainscot panel, interrupted only by the doors, formed by a pattern of polychrome arabesque motifs and five figurative panels depicting *potamoi*. The figures, with the shape of a man with a vase out of which the river waters pour, are allegories of the Euphrates, Danube, Douro, Mondego and Nile rivers set within cartouches of Flemish inspiration. Illustrations and photographs from before the restoration of the palace in the late 1930s prove that what we see today is indeed what was there at the time.

Several art historians studied the panels but a consensus was never reached as to their provenance because no objective proof could be offered.

This paper includes an iconographic and stylistic study of the five river god allegories, connecting them with a sixth incomplete panel featuring an allegory of the River Tagus in the central room of the Pleasure House by the lake. It also presents an analytical study of the tiles, concluding that they were likely glazed and painted in Portugal using imported ceramic biscuits.

RESUMO

A fachada oeste do piso nobre do Palácio da Bacalhôa abre numa *loggia* hoje chamada Varanda dos Deuses-Rio, porque as suas paredes são decoradas com um silhar contínuo, interrompido apenas pelas portas, constituído por azulejos com um padrão de arabescos policromos envolvendo cinco painéis figurando alegorias aos rios Eufrates, Danúbio, Douro, Mondego e Nilo. Cada rio é figurado por um *potamos* com forma humana, num enquadramento aquático limitado por uma cartela de ferronnerie inspirada em desenhos flamengos. Ilustrações e fotografias anteriores ao restauro do palácio, iniciado na segunda metade da década de 1930, provam que o que vemos hoje é de facto a decoração que existia nessa época.

Vários historiadores estudaram os painéis mas nunca foi possível obter um consenso sobre a sua origem, por falta de prova objectiva.

Este trabalho inclui um estudo iconográfico e estilístico das cinco alegorias, ligando-as a um sexto painel incompleto, com uma alegoria ao rio Tejo, existente na sala central da Casa de Prazer junto ao lago. Apresenta também um estudo analítico dos azulejos, concluindo por uma provável produção em Portugal utilizando chacotas cerâmicas de origem estrangeira.

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KEYWORDS: Renaissance majolica; Azulejos; Palace of Bacalhôa; João de Góis; Jan Floris; Juan Flores

Acknowledgements

We are thankful to Mr. Joe Berardo and to Mr. Renato Berardo, who authorised the sampling of the unique azulejo heritage of *Palácio e Quinta da Bacalhôa*; and to *Associação de Colecções | The Berardo Collection* and *Bacalhôa Vinhos de Portugal* for their support to this project.

Instrumental research conducted at *Laboratório Nacional de Engenharia Civil* (LNEC) within the scope of the national infrastructure E-RIHS.pt funded by FCT, the Portuguese Foundation for Science and Technology. LNEC Research Project 0202/1101/19014.

How to cite

MIMOSO, J.M. et al. – *The 16th century azulejo panels of the Loggia of the River Gods in the Palácio da Bacalhôa* in Studies in Heritage Glazed Ceramics, No. 4, LNEC, Lisbon, Portugal, 2022, pp. 35-56.

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1. ICONOGRAPHIC NOTES

In Greek mythology the river gods (*potamoi*) were the sons of Oceanus and Tethys and each major river had its own divinity. The allegorical representation of rivers as reclining *potamoi* with a vase from which water was pouring became iconic in the Renaissance. One of the earliest depictions was in a lost drawing by Raphael (1483-1520) depicting the Judgement of Paris of which Marcantonio Raimondi (1480-1534) made a print ca. 1515 (Figure 1a). In Flemish depictions, the prototypical river god is represented with a headdress of aquatic plants, a vase from where the stream flows and a paddle in his hand, set against a background of cattails, as shown in a print by Adriaen Collaert, II (Antwerp 1560-1618) - Figure 1b.



Figure 1. a. - River gods by Marcantonio Raimondi, after Raphael (ca. 1515); b. - Neptune as a river god in a depiction by Adriaen Collaert II (after 1580) (images: Metmuseum, Rogers Fund 1919, Acc. Nr. 19.74.1 and Harris Brisbane Dick Fund 1928, A. Nr. 28.44.130).

In the Bacalhôa estate there are seven panels representing river gods, of which five (Euphrates, Danube, Douro, Mondego and Nile, Figures 3 to 7) decorate a loggia in the *piano nobile* [1] and will be the subject of this paper. A sixth representation, an allegory of the Tagus, belonging obviously to the same set and today largely incomplete (Figure 8), decorates a wall in the Pleasure House by the lake [2], while the seventh (again an allegory of the Tagus) is unrelated to the others and was tentatively restored from a number of tiles and fragments recovered within the estate [1, p. 27]. Its original placement is unknown and today it is preserved at the *Museu do Palácio da Bacalhoa*. It will be addressed in a dedicated paper yet to be published.

Of the seven fluvial allegories those of the River Tagus are, symbolically, the most eminent of the group because they refer to the most important river in Portugal and the one visible from the estate to which the town of Lisbon is adjoined. It is also an important source of the agricultural wealth of its wide valley and, above all, it harboured the country's commercial and military fleets. But apart from the two panels dedicated to the Tagus elsewhere on the estate, the allegories in the open loggia above the palace garden represent a surprising mix of rivers, some important to Portugal (the Douro and

the Mondego), some of international relevance (the Danube, the Euphrates and the Nile), and if the presence of the first two seems straightforward, the selection of the later needs further understanding. In the *Commentarios*, Brás [Afonso] de Albuquerque's biographical masterwork about his father, we learn that after the submission of Khor Fakkan in the Gulf of Oman, an old man was taken to Albuquerque and told him that "…having read the life of Alexander [the Great], who had conquered that land, he thought that the Macedonians were not better at arms than the Portuguese. Afonso de Albuquerque was astonished to hear that the Muslim had read the life of Alexander, **because he himself was a reader and very interested in the subject**. The Muslim took a Persian book from his breast, bound in carmine velvet in the local manner, and presented it, and it was the best gift anyone could offer him, and he considered it a good omen for the determination he had to conquer Ormuz" [3].[1] The parallel between Alexander and Albuquerque was later strengthened by his extraordinary success in establishing a Portuguese domain in Asia, which earned him the same epithet as Alexander: *The Great*. It is thus to be expected that Brás, proud of his famous father, would want to heighten the parallel by portraying the rivers related to the conquests of Alexander: the Danube, the Euphrates, the Tigris, the Nile and the Indus. Seen from this angle, the presence of allegories of the Danube, the Euphrates and the Nile is not surprising; it is the diverse presences of the Douro and the Mondego that is odd… Maybe Brás [Afonso] de Albuquerque changed his mind midway… One possible clue is the fact that the cattail leaves near the inscription "MONDEGUO" had to be shortened to make room for the long name of the river, although their original size is still visible (Figure 2). This could suggest that the original sketch was intended for a river with a shorter name. Another possibility is that the three Portuguese rivers (Tagus, Mondego and Douro) were originally intended to decorate three of the rooms of the Pleasure House, while the loggia would accommodate only the rivers connected to the empire of Alexander - maybe only the present three symbolising Alexander's campaigns in Europe, Asia and Africa, or maybe five, of which two were finally never made.



Figure 2. "MOMDEGUO" inscribed over leaf sketches left unpainted to accommodate the long name of the river (the picture was enhanced for greater clarity).

1 "…porque lendo elle a vida de Alexandre, que aquella terra conquistára, não achára que a sua gente tivesse nenhuma ventage á Portuguesa. Afonso Dalboquerque espantado do Mouro dizer que lêra a vida de Alexandre, perguntou-lhe onde a lêra, porque elle tambem era lido e muito affeiçoado a suas cousas. O Mouro tirou hum livro do ceio escrito em Parse, enquadernado em veludo carmesim ao seu modo, e deu-lho, que Afonso Dalboquerque mais estimou que quantas cousas lhe podéra dar, e ouve-o por bom pronostico pera a determinação, que levava pera conquistar Ormuz…"

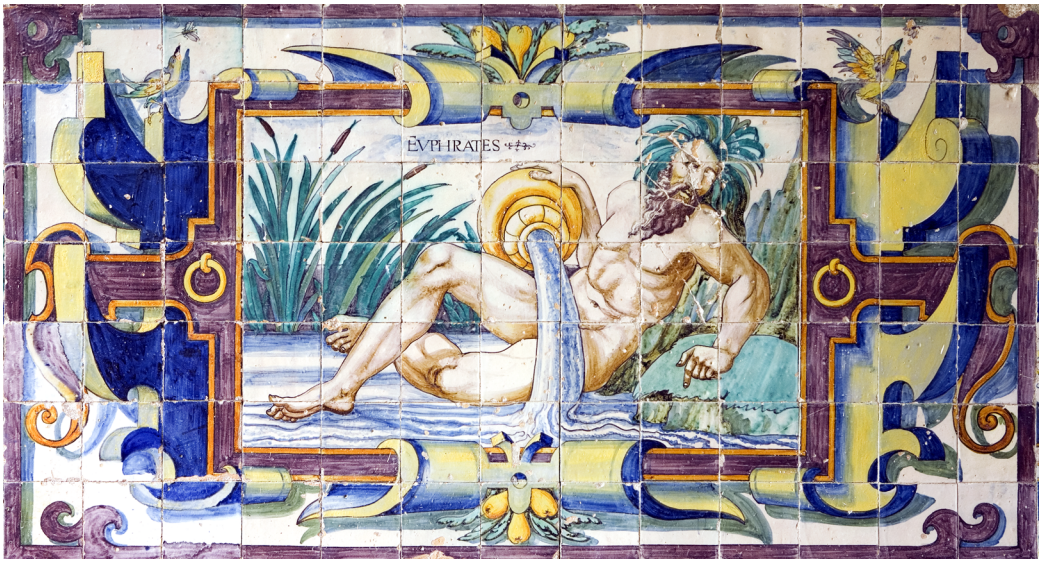


Figure 3. The river god allegory of the Euphrates (all images of the panels © Associação de Colecções | The Berardo Collection).



Figure 4. The river god allegory of the Danube.

The cycle of related river god panels at Bacalhôa was studied by João Miguel dos Santos Simões in 1969, who attributed the panels to *a Lisbon workshop with the collaboration or influence of Flemish majolica potters* [4].[2] He also remarked on a dual authorship because of the varying quality of the paintings, presuming the work of a master and his apprentice. As for the originality of the sketches, he was of the opinion that they had been copied

2 "alguma oficina de Lisboa onde não era estranho o trabalho ou a influência directa de malegueiros flamengos."

from foreign prints. However, our own search in databases did not yield a single print on which any of the figures in the panels might have been based, suggesting that the sketches for the paintings may have been expressely made for the purpose and did not copy previously existing prints.

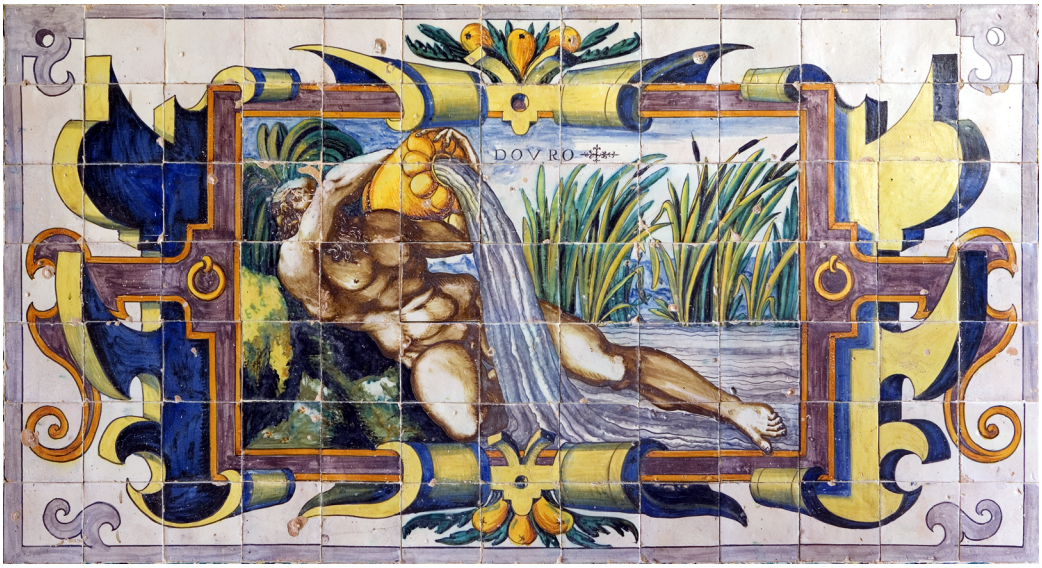


Figure 5. The river god allegory of the Douro (a tile that is misplaced in the panel was digitally recomposed in this illustration).

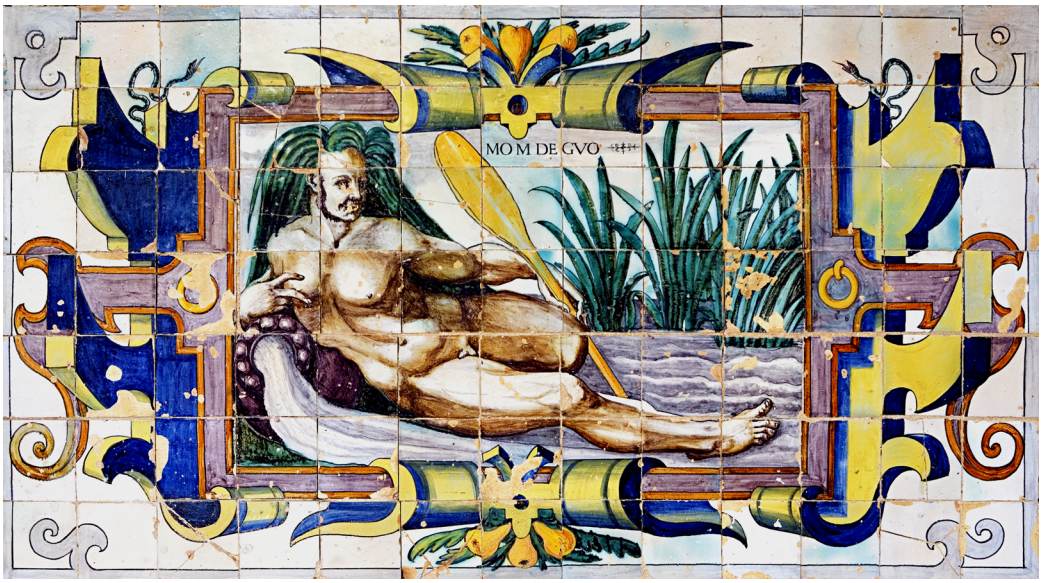


Figure 6. The river god allegory of the Mondego (note how the painting changes from the shoulders down).[3]

3 The reason for this change has not been determined but the continuity of the painting of elements such as the cattails vouch for a single chronology for the whole panel.



Figure 7. The river god allegory of the Nile.



Figure 8. The most complete part of the Tagus river god at the Bacalhôa Pleasure House.

On considering the images of the panels, two striking details may have been noted: the orthographic mistakes in the names of rivers: "TANUBIO" for "DANUBIO" and "WILO" for "NILO" (the Portuguese names of the Danube and the Nile) in Figures 4 and 7. The first may be easily explained by the fact that there was not yet a set orthography of the Portuguese language [4] and the sounds indicated by the letters *D* and *T* are similar (the only difference being that one is voiced and the other is voiceless). Therefore, the name

4 The first published ortography (that we know of) was *Orthographia da lingoa portuguesa* by Duarte Nunes de Leão (Évora ca. 1530- Lisbon 1608) published in 1576.

of the river might conceivably be written with either an initial D or a T. However, the designation "WILO" cannot be explained thus, not least because the letter "W" was not part of the Portuguese or Spanish alphabets of the time.

Figure 9 compares the 16th century handwriting of the Dutch "N; n" and "W; w" [5] with the Portuguese and Spanish upper and lowercase "N", sourced from coeval documents [6] and a more elaborate Portuguese capital "N" [7]. It may be seen that, although for the writer no confusion was possible because the letter "W" was not used in Portuguese, a calligraphic capital "N" could easily be taken for a "W" by, for example, a Flemish person not sufficiently fluent in the local language who might think that "Wilo" was the name of some other river (in Dutch, the name of the Nile would be written "Nijl" or "Nÿl"). And the fact that Brás [Afonso] de Albuquerque did not demand an immediate correction of the mistake gives us, today, important information as well as the notion of a possibly gentle nature: that a painter, neither Portuguese nor Spanish, but presumably Flemish, recently arrived in the Iberian Peninsula and therefore unaware of the local alphabet, was involved in the work.[5] That man, skilled at painting Latin text, may have also been one of the painters of the river god panels, but we cannot be sure of that.

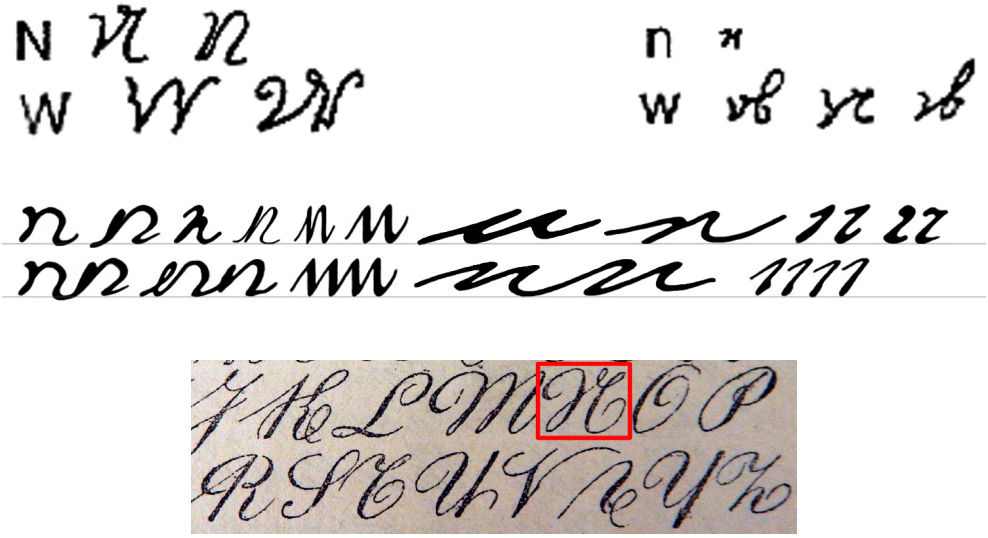


Figure 9. Top to bottom: Dutch "N; n" and "W; w" sourced from 16th century documents; Portuguese or Spanish upper and lowercase "N" sourced from 16th century documents; a more elaborate calligraphic "N" from a 19th century Portuguese manual on palaeography.

5 Both Juan Flores and João de Góis were Flemish and were probably involved in the production of the panels for Bacalhôa, but at the time (ca. 1565) both had lived in the Peninsula for six years or more [8; 9] and it would be expectable that neither of them would make such a mistake.

2. STYLISTIC STUDY OF THE PANELS

The stylistic analysis of these allegories yields interesting data both in the design of the cartouches and in the more nuanced pictorial language used in the allegorical figures. This duality, between cartouches and scenes, already raises a first question related to their authors. Moreover, they were not always the same. In this respect, it should be remembered that in Flemish painting and later in 17th century Dutch painting, the collaboration of more than one painter on a single work was common, given the degree of specialisation achieved by the artists of those schools. It is therefore not uncommon to find paintings signed by two painters who were respectively responsible for the main scenes depicted in them and for the borders of flowers, fruit and animals that formed the pictorial frame. Another frequent case was the collaboration of a painter specialising in figures with another expert in landscape painting. It is possible that this fact, which has been confirmed on numerous occasions in the history of art, is useful for a better understanding of what follows in the analysis of the details of the fluvial allegories of the *Quinta e Palácio da Bacalhôa*. The possibility that this set of allegories was executed by several artists should therefore come as no surprise. The idea of the artist as the sole author of a work is a recent historical phenomenon that was born in the 19th century with the romantic myth of the work of art understood as the intimate and exclusive expression of the soul of an artist. Until that time, the work of art was the result of the greater or lesser creativity and talent of an artist, who was usually the master and head of a workshop, and of the material collaboration of the apprentices, journeymen or masters without their own workshop who, under his orders, carried out different tasks in the process of executing the works.

The panels represent allegories of each river set in a Flemish-style *ferronnerie* cartouche contrasted to appear three-dimensional. The illusion of volume derives from an implied light source on the left side of each panel with highlights painted in light yellow, while dark areas are painted in a deep cobalt blue.

The cartouches of the five rivers are of two basic types that follow a very similar scheme, giving the impression of being designed by the same artist, perhaps Juan Flores (Antwerp ca.1520, Talavera 1567), a painter of whom we only know of one *ferronnerie* cartouche in vertical format, in the old refectory of the convent of *Santo Domingo* in Plasencia (Cáceres), a work that was attributed to him years ago for stylistic reasons, although we have no documentary or analytical support that has yet confirmed this [10]. However, although the compositions at Bacalhôa are horizontal and simpler, the cartouches follow the same outlines as the one at *Santo Domingo* and are very similar to other cartouches designed by his brothers Cornelis Floris (1514-1575) and Jacob Floris (1524-1581). But it is not only the ironwork cartouches that reveal the Flemish training of the author of the designs for these allegories, but also other apparently minor iconographic details such as the way in which flowers, fruit and various animals are integrated into the frames, or the way in which the fingers and toes of the figures are arranged.

The two main types of cartouches are represented by: Figures 10a, 10b (*Type 1* used in the Euphrates and Douro panels in the loggia, and also in the Tagus panel in the Pleasure House); and Figures 10c, 10d (*Type 2*, used in the Danube, Mondego and Nile panels). It is quite possible that the author made full-scale sketches on paper for both patterns, one of which he may have used himself for the River Euphrates, the highest-quality panel of them all. We suppose that his collaborators would have used the same stencil for the

Douro and the Tagus and this could be the reason for the small differences that can be seen in these two cartouches with respect to the first one, when analysed in some detail. The first difference between the three is that the Douro (Figure 10b) lacks the small spiral curl on the right scroll that show the Euphrates and the Tagus (indicated by an arrow in Figure 10a), a difference that can be interpreted as an oversight on the part of the painter who executed the cartouche for that river. Identical differences can be detected in the interpretation of Type 2.

Figure 10c (from the Nile panel) depicts the *ferronnerie* of the second type as we presume it was supposed to look in all three panels. However, in the other two panels of this same type, the middle arm of the ironwork is split in two (indicated by an arrow in Figure 10d). The painter was seemingly baffled by this feature because he did not draw the edges needed to complete the separations and painted half of the area in yellow and the other half in blue, against the rule of using those colours to represent light and shadow.



Figure 10. Right side of the cartouches illustrating the various types. From left to right: Euphrates (10a); Douro (10b); Nile (10c); Danube (10d).

However, although the cartouches of Types 1 or 2 are almost identical in both groups, the interpretations made with the brush and, above all, the use of colours show several very noticeable differences. The painter of the Euphrates cast shadows on the white background of all the elements that make up the cartouche, including the meticulously painted birds (Figures 3, 10a), while these shadows are absent in all the other allegories. Secondly, he applied the same colour to the outer border of the composition and to the inner frame of the cartouche and, in both cases, he used a manganese purple that is quite saturated with pigment (Figure 3). In contrast, in all the other cases, the inner frame is executed in the same shade of purple, but a very soft grey is used for all the outer borders (Figures 4 to 8). These two differences, in addition to the pictorial quality, establish a barrier between the Euphrates allegory and all the others, but we can still detect other differences of nuance between the latter.

The colour used to represent the anatomy of the human figures is, of course, the most obvious difference between the panels in this set. The only figure that uses a more natural colour, and distributes the light and shade more smoothly and with a better

understanding of the male musculature, is the figure of the Euphrates river god. If we compare the way of painting this river with the figures of the panels *Susanna and the Elders* and *The Abduction of Hippodamia* in the central room of the Pleasure House [2], we will find sufficient reason to tentatively attribute the three panels to the same person, possibly Juan Flores himself. On the other hand, in the other rivers, one or two colours are used: mixtures of iron oxide and manganese purple, in different proportions and in all cases with excessive chromatic saturation, which gives the anatomy of the figures a hardness far removed from the softness we see in the Euphrates. For example, in the Danube and the Nile, a very dark brown pigment is used almost exclusively, which we cannot justify as ethnic differences between the peoples who inhabit their basins since the Danube combines this skin colour with a blond beard. On the other hand, in the Douro and in the lower part of the Mondego, dark brown is combined with lighter ochre, thus achieving a less harsh effect, but equally far removed from the soft tone observed in the skin tones of the Euphrates. Finally, the skin colour of the Tagus river god (Figure 8) is similar to the softer variant used in the upper part of the Mondego. Even in the case of the latter river, there are contradictions within the panel itself, both in the cartouche and in the figure, which suggests that it was painted by two different artists. In the figure there are two different colours in the skin tones and in the cartouche, the cut-outs in the central part show contradictory shading and misinterpreted perspectives of a possibly correct original design. In conclusion, we have been able to identify four different chromatic ways of representing human skin in the panels, which seems to support the idea that the pictorial execution of this set was the work of a team of several painters, one of whom stands out clearly for the academic correctness and finesse of his style.

The way in which the beards of the figures are depicted, both in terms of colour and formal definition, is also very revealing. In the Euphrates river god, the beard is dark but the undulations of the locks are depicted with great softness, applying light and shade with the brush as the only instrument. In contrast, in the case of the Douro, the undulations of the beard, which has very dark hair, are achieved using the *sgraffito* technique, that is, by scratching the applied pigment with an implement, perhaps the end of the brush itself, thus revealing lines of the underlying white glaze. Regardless of the use of this process, which has only been identified in the Douro, the chromatic aspect of the beards offers a certain variety since the Danube, as mentioned above, shows a blond beard with a Nordic appearance, while in the beard of the Nile river god brown and blond parts are mixed, helping to define volumes and waves in the locks.

The varying ways of representing water are also very evident because in three of the panels this element is blue (Euphrates, Danube and Nile) while in another two it is depicted in grey (Douro and Mondego) and, finally, in the sixth case (the Tagus in Figure 8) grey tinged with green was used. Considering the panels in which blue was used for the flowing water, it is clear that the painters resorted to different ways of representing the waves, from which we can deduce that although only three colours were used, the painters seem to have used four or five manners to stylise the water, which confirms the impression we obtained when we analysed the representation of human skin and also of the beards.

Finally, there are two details in these river allegories that establish links with other panels at Bacalhôa (Figure 11), namely: the two ducks swimming in the waters of the River Nile, similar in composition -although clumsily executed - to two that appear in the pond in the panel of *Susanna and the Elders*; and the birds perched on the Euphrates cartouche, which

are very similar to those that decorate one of the faun panels probably manufactured abroad [11]. These coincidences seem to form a common thread linking the designs (not always the execution) of these river allegories with other panels, leading us to suppose, along with the other stylistic arguments noted, that it was a single artist who supplied the designs for the river gods as well as for the other panels mentioned, possibly Juan Flores [8], but it was a group of painters who executed his project.

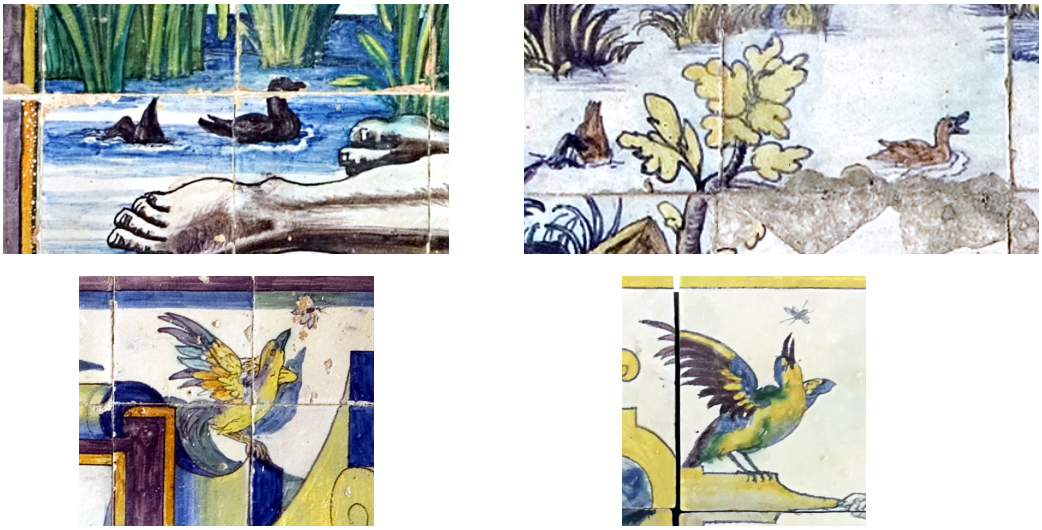


Figure 11. Top: the ducks in the Nile panel vs. the ducks in the *Susanna and the Elders* panel; Bottom: the bird in the Euphrates panel vs. the bird in one of the faun panels (the tip of the wing was restored).

3. INSTRUMENTAL CHARACTERISATION BY SEM-EDS

3.1. Samples

All river god panels were sampled and Figure 12 illustrates some sampling spots and the codes attributed, through which the samples will be referenced. Sampling was done with a scalpel in areas already damaged.

Table 1 includes data on each sample studied. The first column (Identification / details) repeats the identifications in Figure 12 and includes additional data on the sample. The second column (Sample Ref.) includes the technical reference of the items prepared for observations and analyses. The last column indicates how many measurements were averaged in the semi-quantification of the chemical composition of each sample.

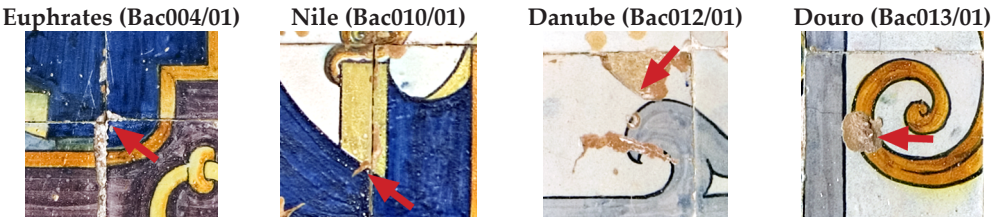


Figure 12. Examples of sampling spots on previously damaged areas of the river god panels addressed by this paper.

Table 1. Short name of panels, sample references and number of analytical results averaged.

Identification / details	Sample Ref.	Total no. of results
Euphrates, blue glaze area	Bac004/01	3 (glaze); 1 (biscuit)
Euphrates, orange glaze area, biscuit small	Bac004/02	1 (glaze); 1 (biscuit)
Nile, blue glaze area	Bac010/01	1 (glaze); 1 (biscuit)
Nile, white glaze area	Bac010/02	1 (glaze); 1 (biscuit)
Nile, yellow glaze area	Bac010/03	2 (glaze); 2 (biscuit)
Mondego, orange glaze only	Bac011/01	2 (glaze)
Mondego, white glaze area, biscuit very small	Bac011/02	3 (glaze); 1 (biscuit)
Mondego, biscuit only	Bac011/03	1 (biscuit)
Danube, white glaze area	Bac012/01	1 (glaze); 1 (biscuit)
Douro, biscuit only	Bac013/01	2 (biscuit)
Douro, white glaze only	Bac013/02	1 (glaze)
Douro, orange glaze area, biscuit small	Bac013/03	2 (glaze); 2 (biscuit)

3.2. Methods and instrumental means

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

SEM observations and EDS analyses were made at LNEC using a TESCAN MIRA 3-field emission microscope combined with a BRUKER XFlash 6|30 EDS system. The samples were uncoated and the observations were made in backscattered electrons mode (BSE), with a chamber pressure of typically 10 Pa, at an accelerating voltage of 20 kV with the sample sections at a distance of 14 ± 1 mm from the detector. SEM images of the glazes were typically acquired at magnifications of 350x and 700x.

The selection of areas for EDS quantification avoided large inclusions in the glaze or biscuit representing more than ca. 5% of the full selected area. From our previous experience, the adequate minimum measurement areas are 200 x 200 μm for glazes and 500 x 500 μm for biscuits. Smaller non-overlapping areas may be used to the same effect.

In general, multiple measurements were made and in such cases the results are averages. Whenever possible, the analyses were performed on white glazes to avoid interference from elements diffused from the blue, green or violet pigments which, when present, were neglected. The yellow pigments remain at the surface and therefore do not present the same problem. Still, in the case of zinc-bearing yellow pigments, the analyses must be performed at a safe distance from the colour.

Elements usually representing less than 1% of the compositions, such as magnesium (Mg) and iron (Fe) in the glazes, or titanium (Ti) in the biscuits, were not included in the tables of results.

The quantification of tin (Sn) in the glazes may be problematic because the aggregation of crystals often results in a large variance. That problem was dealt with by using larger areas whenever aggregation was visually detected in the SEM images or, when that was not possible, averaging the results of multiple analyses on different areas.

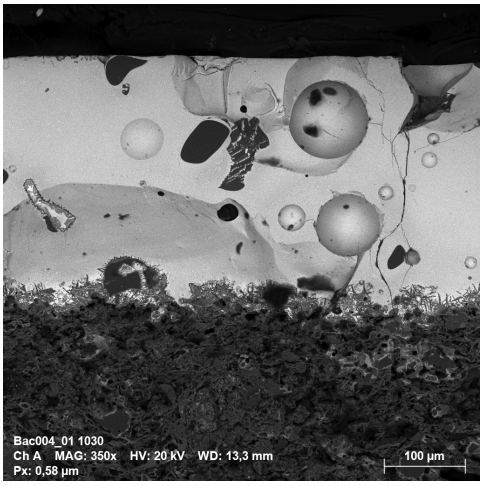
The amount of oxygen (O) was calculated through the remaining elements stoichiometry of their most commonly considered oxides (Na_2O, MgO, Al_2O_3, SiO_2, K_2O, CaO, Fe_2O_3, SnO_2, PbO) and the result was normalised to 100%.

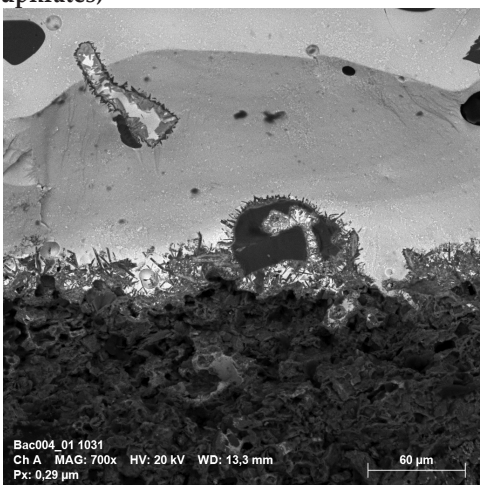
3.3. Results

3.3.1. Morphology of the glazes

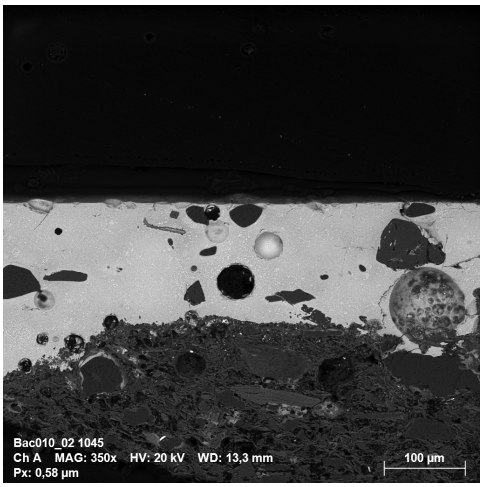
Figure 13 depicts, at the same magnifications for comparison purposes, sectional SEM images of samples from all panels showing the main micro-morphological characteristics generally associated with the glazes and their interfaces. The light grey area on top is the glaze, while the dark grey area corresponds to the biscuit. Because of its colour, the inclusions in the glaze are conspicuous: gas bubbles retained in the glass, grains of sand (larger compact dark inclusions, usually with rounded edges) and bits of feldspars, often in disaggregation. The white spots in the midst of the glaze are crystals of the opacifier (tin oxide) while a continuity of similar white spots near the surface of Bac 011/01 and Bac013/03 corresponds to the lead-rich yellow pigments. It will be noticed that *coperta* (a layer of transparent glaze) is not plainly visible over the yellow colour at the spots sampled of the panels Mondego and Douro and maybe was not used at least in those two panels. Its use on any of the other panels needs confirmation through a sampling of their yellow areas.

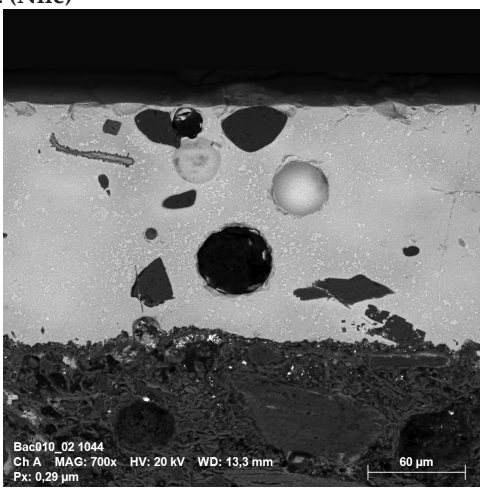
Bac004/01 (Euphrates)



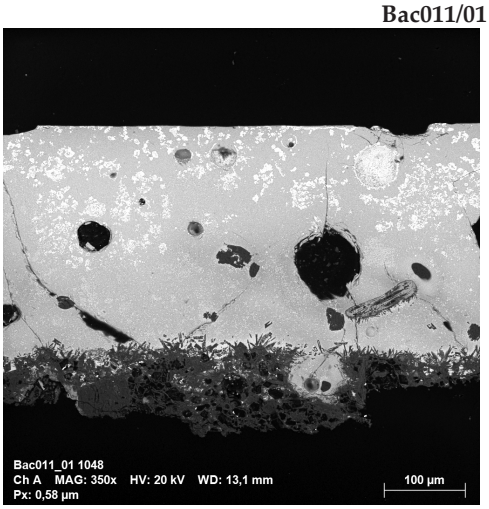


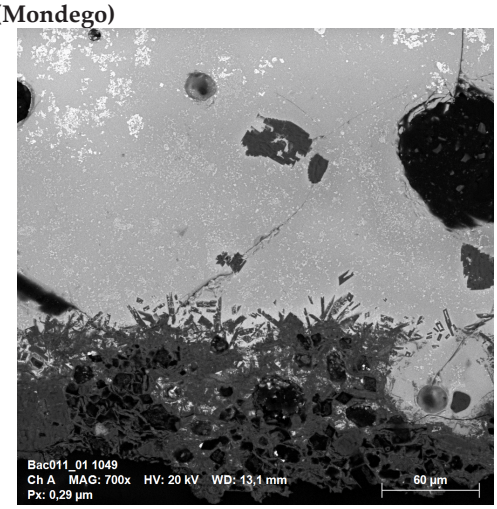
Bac010/02 (Nile)





Bac011/01 (Mondego)





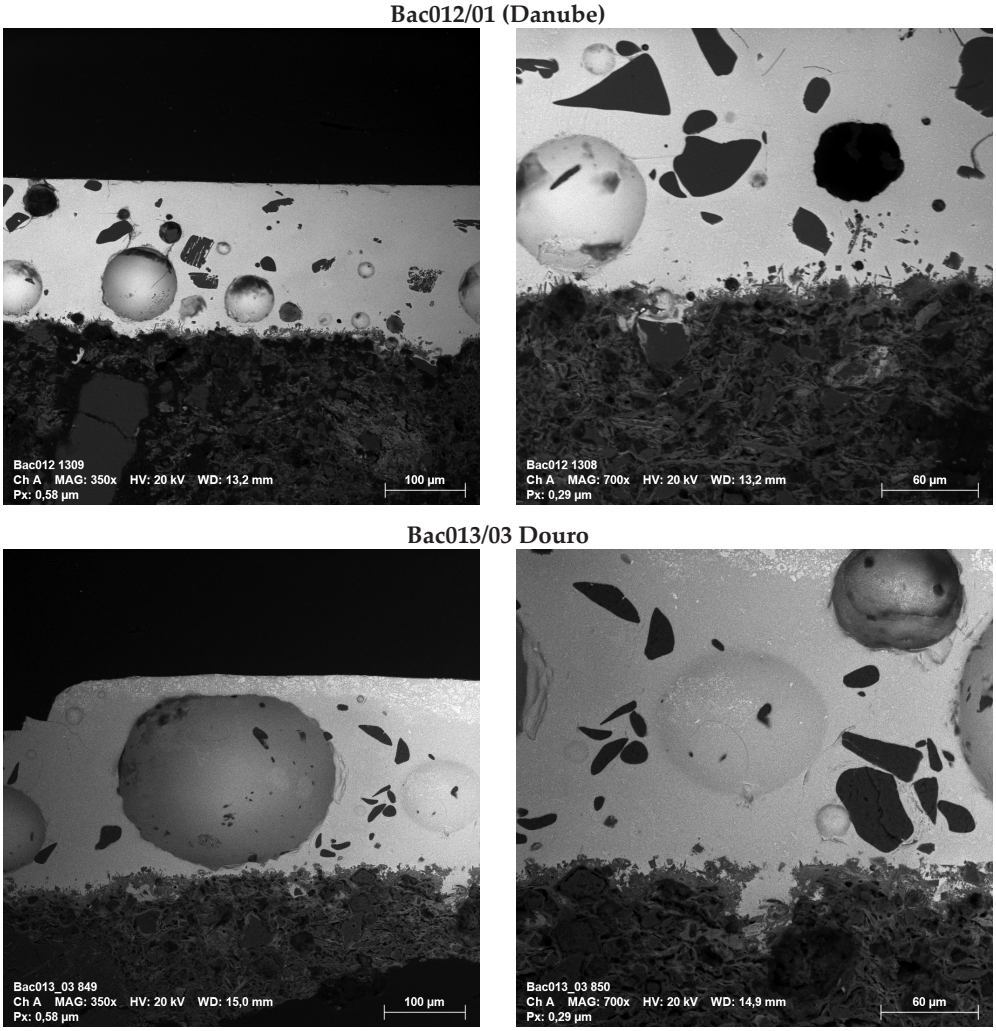


Figure 13. SEM-BSE images depicting the main micro-morphological characteristics of azulejos of the river god panels in the *loggia* of the Palace of Bacalhôa. Left: glaze section at 350 x; right: detail of the biscuit-glaze interfaces at 700 x (images: LNEC).

3.3.2. Composition of the glazes

Table 2 includes the semi-quantitative results of analyses of the glazes by EDS in weight %. The silicon to lead ratios (Si/Pb) have been determined and are also included in the table. This ratio is a technological trait set by the glaze recipe and gives important information about the firing conditions in the kiln because the lower the ratio, the lower the temperature at which the glaze could be properly fired.

Table 2. Semi-quantitative composition of the glazes of the tiles studied, determined by EDS (values in wt. % with oxygen obtained by stoichiometry and sum of all elements normalised to 100%) with Si/Pb ratios included.

Samples		O	Na	Al	Si	K	Sn	Pb	Si/Pb
Bac004 Euphrates	average	27.03	0.63	1.62	17.15	2.04	7.53	44.01	**0.39**
Bac010 Nile	average	27.67	0.60	1.58	17.36	2.38	9.83	40.58	**0.43**
Bac011 Mondego	average	29.26	1.00	2.34	18.31	2.33	9.78	36.97	**0.50**
Bac012 Danube	-	25.71	0.45	1.56	15.81	1.89	8.12	46.46	**0.34**
Bac013 Douro	average	28.96	0.59	2.19	18.82	1.62	6.94	40.87	**0.46**
All five river god panels in the loggia	average	28.10	**0.71**	**1.92**	**17.76**	**2.12**	**8.66**	**40.72**	**0.44**
	st.deviation	-	0.39	0.42	1.69	0.68	1.65	5.02	0.06
	cv	-	0.55	0.22	0.10	0.32	0.19	0.12	0.13

Note: *st.deviation* indicates the standard deviation of all results; *cv* indicates the coefficient of variation (cv= st.deviation / average)

3.3.3. Composition of the biscuits

Table 3 includes the semi-quantitative results of analyses of the biscuits by EDS in weight %. Lead occurs in most cases deriving from percolation into the biscuit when the raw glaze is applied. Its content was determined but not considered because it is not part of the natural composition of the biscuit and depends on the proximity to the interface. The presence of lead renders the quantification of sulphur doubtful because of a superposition of spectrographic peaks and therefore it too was not considered, as well as elements of contents often below 1% such as phosphorus (P), chlorine (Cl) and titanium (Ti). The distinctive calcium to silicon ratios (Ca/Si) have been determined and are included in the table.

Table 3. Semi-quantitative composition of the biscuits of the tiles studied, determined by EDS (values in wt. % with oxygen obtained by stoichiometry and sum of all elements normalised to 100%) with Ca/Si ratios included.

Samples		O	Na	Mg	Al	Si	K	Ca	Fe	Ca/Si
Bac004 Euphrates	average	42.58	0.84	4.65	7.64	20.52	2.89	16.85	4.03	0.82
Bac010 Nile	average	43.98	0.71	4.15	8.77	22.40	2.21	13.45	4.33	0.60
Bac011 Mondego	average	42.85	0.77	5.57	8.26	19.98	1.73	16.72	4.13	0.84
Bac012 Danube	-	43.57	1.12	4.52	8.96	21.49	2.55	13.73	4.07	0.64
Bac013 Douro	average	43.74	1.03	5.05	8.06	22.13	2.22	13.62	4.15	0.62
All five river god panels in the loggia	average	43.49	**0.87**	**4.75**	**8.31**	**21.59**	**2.27**	**14.55**	**4.18**	0.67
	st.deviation	-	0.25	0.77	0.82	1.38	0.50	2.69	0.38	0.17
	cv	-	0.29	0.16	0.10	0.06	0.22	0.18	0.09	0.25

Note: *st.deviation* indicates the standard deviation of all results; *cv* indicates the coefficient of variation (cv= st.deviation / average)

4. DISCUSSION OF THE INSTRUMENTAL RESULTS

Figure 14 compares images of the glaze-biscuit interfaces of samples from the Euphrates (Bac004), Mondego (Bac011) and Douro (Bac013) panels in which the crystalline outgrowths are more developed and better defined, with images of samples from the actual tiles in the *Igreja da Graça* that bear the monogram of João de Góis (Az013/L1, Az013/L2 and Az013/L3), made in Lisbon and presumably dating from the second half of the 1560s [12].

The comparison shows that in both cases the interfaces are well-developed but the interface is somewhat thicker in the samples from the *Igreja da Graça*. On the other hand, the panels that our previous research concluded have probably been imported from Spain, such as the Albuquerque coat-of-arms in the fourth room of the Pleasure House, have very different interfaces with a small or, at the same magnification, even absent interfacial crystalline outgrowth [11].

Table 4 compares the glaze composition of all panels in the Loggia of the River Gods with the Tagus river god panel in the Pleasure House [2], the composition determined for the circle of João de Góis from the second half of the 1560s to 1584 [13, p.40] and, finally, the panel with the Albuquerque coat-of-arms also in the Pleasure House [11].

Table 4. Comparison of the average glaze semi-quantitative compositions by EDS of the panels in the Loggia of the River Gods with other panels on the estate and the productions of the workshops of Lisbon (circle of João de Góis) from the second half of the 1560s to 1584

Sample	O	Na	Al	Si	K	Sn	Pb	Si/Pb
All five river god panels	28.10	**0.71**	**1.92**	**17.76**	**2.12**	**8.66**	**40.72**	**0.42**
Tagus river god	29.23	**1.21**	**2.10**	**18.27**	**2.70**	**10.28**	**36.21**	**0.50**
Circle of João de Góis	-	**1.10**	**2.80**	**17.80**	**1.40**	**N.D.**	**47.80**	**0.40**
Albuquerque coat-of-arms	36.76	**2.87**	**3.21**	**25.12**	**5.64**	**5.66**	**20.74**	**1.21**

Note: At the time when the composition of the productions of the circle of João de Góis was researched, the contents in tin (Sn) were determined but, for technical reasons, were not considered sufficiently accurate. As a consequence, all other contents may be overvalued by up to 10% which, however, does not alter the silicon to lead ratio (Si/Pb) or the conclusions.

The results in Table 4 show that the characteristic traits of the glaze formulations associated with the productions of the circle of João de Góis: low contents in sodium (Na) and potassium (K); and high contents in lead (Pb) with a Si/Pb ratio of around 0.4 are also present in the six river god panels (including the Tagus allegory in the Pleasure House). In comparison, the composition of the Albuquerque coat-of-arms panel also in the Pleasure House of Bacalhôa, which we studied previously and concluded to have been imported from Spain [11], is strikingly different on all those counts (indicated in red in Table 4).

Table 5 compares likewise the average biscuit composition of all panels in the Loggia of the River Gods again with the Tagus river god panel in the Pleasure House, the panel with the Albuquerque coat-of-arms, and, finally, the composition determined for the circle of João de Góis [13, p.41].

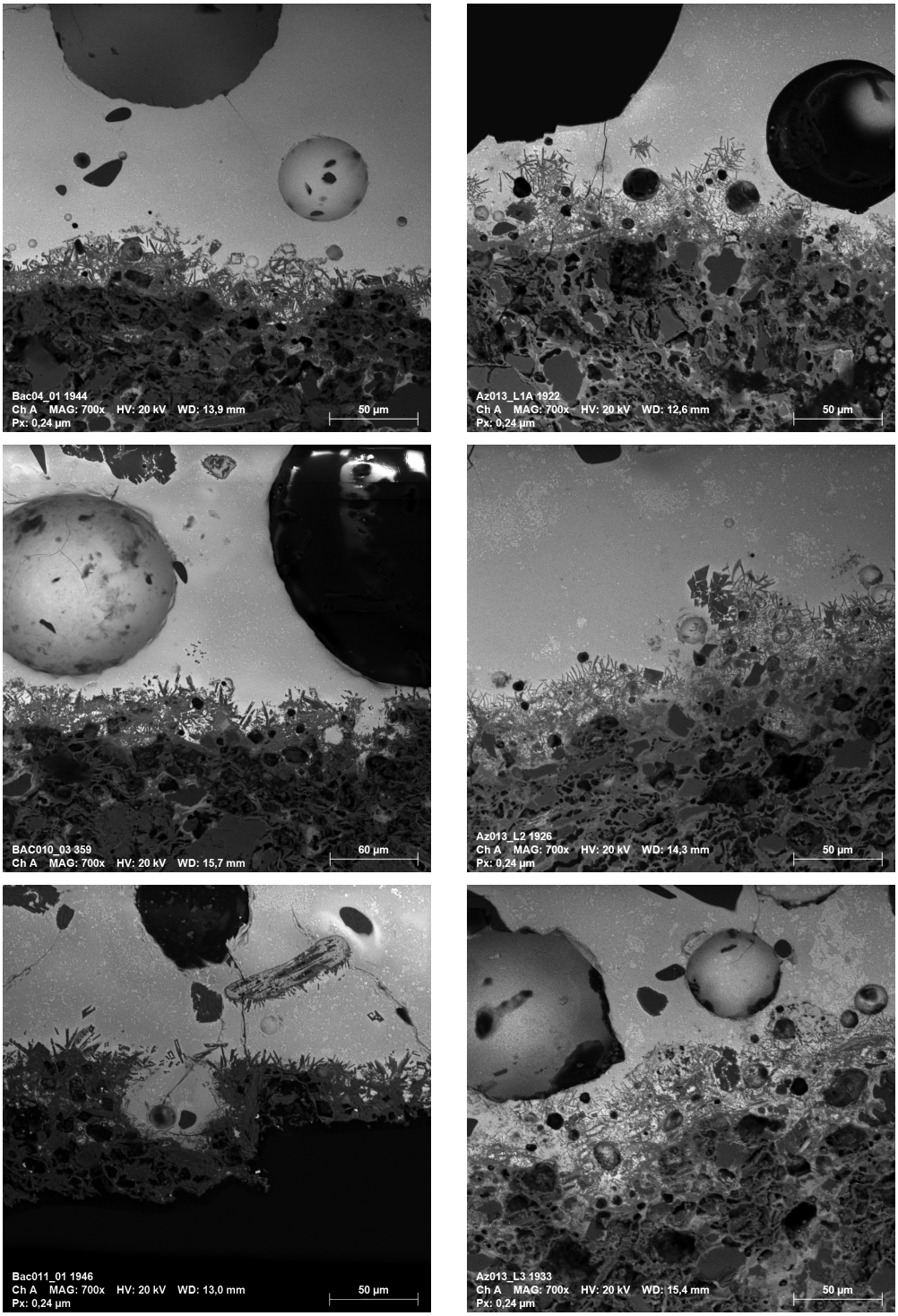


Figure 14. Comparison at 700x of the interfaces of samples from the river god panels with the tiles signed by João de Góis at the *Igreja da Graça*. From top to bottom, left side: Bac004/01; Bac010/03; and Bac011/01; right side: Az013/L1; Az013/L2; and Az013/L3 (images: LNEC).

Table 5. Comparison of the average biscuit semi-quantitative compositions by EDS of the panels in the Loggia of the River Gods with other panels on the estate and the productions of the workshops of Lisbon (circle of João de Góis) from the second half of the 1560s to 1584.

Sample	O	Na	Mg	Al	Si	K	Ca	Fe	Ca/Si
All five river god panels	43.49	**0.87**	**4.75**	**8.31**	**21.59**	**2.27**	**14.55**	**4.18**	**0.67**
Tagus river god	43.99	**1.14**	**4.75**	**8.89**	**22.18**	**2.30**	**12.60**	**4.15**	**0.57**
Albuquerque coat-of-arms	43.61	**0.74**	**4.59**	**7.67**	**21.98**	**1.04**	**16.30**	**4.07**	**0.74**
Circle of João de Góis	-	**1.20**	**1.50**	**8.60**	**26.80**	**3.10**	**8.90**	**4.20**	**0.30**

The results in Table 5 are clear as regards the difference between the average compositions that characterise the local clays used in the productions of João de Góis: low contents in magnesium (Mg), and calcium (Ca), resulting in a comparatively low Ca/Si ratio (indicated in red), and those of the river god panels. On the other hand, the semi-quantitative composition of the biscuits of the Tagus river god panel is very similar to the average composition of the other five panels in the loggia. The composition of the biscuit of the Albuquerque coat-of-arms is also similar to the six river god panels, from which it differs mostly by a lower content in potassium. We published a Principal Component Analysis (PCA) of these results, together with those of other panels, in another article [14] showing that when compared with other panels of different compositions, the five river god panels of the loggia, the Tagus river god, and the Albuquerque coat-of-arms are sufficiently similar to be clustered together.

5. CONCLUSION

The instrumental study showed that the five panels analysed do not differ one from the other in any remarkable manner, both in terms of morphology and of glaze and biscuit compositions. Therefore, they may be presumed to have been manufactured by the same workshop at around the same time.

However, the artistry as well as the painter's knowledge in terms of the correct depiction of light and shadow sets apart the allegory of the Euphrates as clearly superior to the rest, showing that it was painted by a different artist, maybe Juan Flores to whom the most remarkable panels on the Bacalhôa estate have been attributed [2; 8]. The set of panels depicts differences in the rendition of the same basic themes, again suggesting the participation of several other painters.

The tentative attribution of one of the panels to Flores and the presumption of a common chronology date all panels to around 1565 [2].

The compatibility of the glazes with the compositions later used by João de Góis, together with the compatibility of the biscuits with the biscuits of panels that were very likely imported from Spain, suggests that the five river god allegories addressed by this paper were manufactured in Portugal, probably using locally-made glazes applied over biscuits that were imported [11; 14].

The similar development of the crystalline interfacial outgrowths in the panels presently studied when compared to the tiles bearing the monogram of João de Góis at the *Igreja da Graça* (Figure 14) suggests that, besides the similar glaze composition, the river god

panels may have been fired in the same kiln used by João and Filipe de Góis [9, pp. 17-20], following a similar firing schedule.

The technical attributes listed above may suggest the manufacture of the river god panels by the workshop of João de Góis or that of his brother Filipe [9]. However, even if the manufacture at the Góis' premises and the firing at the kiln they used is indeed a very likely possibility, it cannot be assured that they were produced under any of them- one of the visiting Flemish master potters, presumably Juan Flores himself, may have directed the production. In fact, ***if*** Juan Flores did indeed paint one of these panels, then they should date from before the earliest known panels signed by João de Góis [12] and there is evidence (to be published) suggesting that before the contact with Flores the technology of João de Góis was not particularly advanced. And yet the technical quality of the river god panels testifies to a refined technology.

Confining the present argument to the glaze recipe, which was seen to be practically undistinguishable from that later used by the circle of João de Góis, one wonders whether Flores did indeed use an already well-established formulation of the Góis workshop, as may seem likely, or whether he experimentally developed the recipe himself for the purpose of using a local low-firing kiln. And, expanding now the argument, there is a clear possibility (already raised in another context [13, pp.41-44]) that Jan Floris de Vriendt, alias *Juan Flores*, was a main source source of the sophisticated knowledge later applied by João de Góis with results such as the superb altarpiece of *Nossa Senhora da Vida* [15].

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The 16th century majolica azulejos of *Palácio e Quinta da Bacalhôa*: the *Rape of Europa* and related panels

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ABSTRACT

A water chest in the Boxwood Garden of the Palace of Bacalhôa, near Lisbon, is decorated with two 16th century panels of majolica azulejos, the upper one with a depiction of the abduction of Europa by Zeus, based on a print, and the lower one with three colourful mascarons. The edges of the chest are lined with green on white *alizares* (dihedral tiles) decorated with an arrow and egg pattern.

At the *Museu Berardo Estremoz* is displayed another panel with a single mascaron, originally part of a wainscot panel from a demolished house in Lisbon, in which the design and colours are practically identical to the panel cladding the lower part of the water chest in Bacalhôa.

Given the lesser artistic quality of these panels when compared with the tile decorations found e.g. in the central room of the Pleasure House of the estate, they never attracted much attention from art historians. Yet, it is precisely the fact that they are so clearly different that makes them interesting research subjects towards the establishment of the history of the early production of azulejos in Portugal.

This paper includes a brief iconographic scrutiny of the panels and an instrumental study of the tiles, towards an insight on their provenance.

RESUMO

Um tanque de água no Jardim de Buxo do Palácio da Bacalhôa, perto de Lisboa, é decorado com dois painéis de azulejos de majólica do século XVI, o superior com uma representação do rapto de Europa por Zeus, baseado numa estampa, e o inferior com três mascarões pintados com cores vivas. As arestas do tanque são revestidas com cantoneiras decoradas a verde com um padrão de óvulos e setas.

No Museu Berardo Estremoz está exposto outro painel com um único mascarão, originalmente parte de um silhar de uma casa em Lisboa, cujo desenho e pintura são praticamente idênticos ao painel que reveste a parte inferior do tanque de água na Bacalhôa.

Dada a menor qualidade artística deste conjunto quando comparado com os painéis figurativos aplicados noutros locais da propriedade, nunca justificou um estudo detalhado por parte dos investigadores. No entanto, é precisamente o facto de serem tão claramente diferentes que os torna interessante tema de investigação para o estabelecimento da história da produção inicial de azulejos em Portugal.

Este trabalho inclui um breve estudo iconográfico dos painéis e os resultados de uma investigação analítica com vista a determinar a sua proveniência.

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KEYWORDS: Renaissance majolica; azulejos; Palace of Bacalhôa; João de Góis

Acknowledgements

We are thankful to Mr. Joe Berardo and to Mr. Renato Berardo, who authorised the sampling of the unique azulejo heritage of *Palácio e Quinta da Bacalhôa*; and to *Associação de Colecções | The Berardo Collection* and *Bacalhôa Vinhos de Portugal* for their support to this project.

Instrumental research conducted at *Laboratório Nacional de Engenharia Civil* (LNEC) within the scope of the national infrastructure E-RIHS.pt funded by FCT, the Portuguese Foundation for Science and Technology. LNEC Research Project 0202/1101/19014.

How to cite

MIMOSO, J.M. et al. – *The 16th century majolica azulejos of Palácio e Quinta da Bacalhôa: the Rape of Europa and related panels* in Studies in Heritage Glazed Ceramics, No. 4, LNEC, Lisbon, Portugal, 2022, pp. 57-80.

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1. INTRODUCTION

A water chest in the Boxwood Garden of the Palace of Bacalhôa, near Lisbon, is decorated with two 16th century panels of majolica azulejos, the upper one with a depiction of the abduction of Europa by Zeus, whose aquatic setting matches the location, and the lower one with three colourful mascarons (Figure 1). The edges of the chest are lined with green on white *alizares* (dihedral tiles) decorated with an arrow and egg pattern that were seemingly manufactured specifically for this application. There are also complementary decorative tiles (seen in Figure 1) that have biscuits of a different colour and are probably left-overs from earlier applications elsewhere in the estate. They will not be covered by this paper.

At the *Museu Berardo Estremoz* is displayed another panel with a single mascaron (Figure 2), part of a wainscot panel retrieved from a house in Lisbon before its demolition, which, except for its smaller length, is practically identical to the panel cladding the lower part of the water chest in Bacalhôa. All these panels and the green *alizares* have in common biscuits fired to a conspicuous terracotta colour.



Figure 1. The panels lining the water chest in the Boxwood Garden of Bacalhôa: *The Rape of Europa* and the three mascarons. The green-on-white arrow and egg *alizares* clad the edges of the water chest (image © Associação de Colecções | The Berardo Collection).

Given the lesser artistic quality and glamour of these panels, particularly when compared with the main panels found at the Palace and its Pleasure House [1], they never attracted much attention from art historians. Yet, it is precisely the fact that they are so clearly different that makes them interesting research subjects towards the establishment of the history of the early production of azulejos in Portugal.

This paper includes an iconographic and stylistic scrutiny of the panels and an analytical study of the tiles, towards an insight on their date and provenance.



Figure 2. The panel with a single mascaron displayed at the *Museu Berardo Estremoz* (image © Associação de Colecções | The Berardo Collection, Inv. 101-395).

2. ICONOGRAPHIC AND STYLISTIC STUDY OF THE PANELS

We do not know what this area of the Palace of Bacalhôa, now known as the Boxwood Garden, may have looked like in the successive phases of its long history. All we know about its vegetation is that it had orange trees, probably along the walls, and also that there was a time when it was planted with carnations, as is written in a description dated from 1631. Three of its walls are original while a fourth, the one on the west side, was removed in the past. The three benches that served and still serve today as resting places for visitors must also be original. Likewise, its central fountain, with a reservoir of Arrábida breccia and a central stem of white marble and elegant design, gives the impression of dating from the mid-16th century [1]. We know nothing about the original layout of its paths, which may have been peripheral, together with four paths that crossed the garden and joined in the centre, forming the classic four flower beds. Regardless of its primitive architectural layout, we also do not know if there were mural paintings in this garden or if there were other sculptures during the Renaissance, but those we see today have been placed there in recent times. The only iconic element that is certainly original from the 16th century is the water chest lined with tiles that we see today.

The reservoir itself may be coeval with the renovation of the Palace, completed in 1554, because one of its sides is still lined with Hispano-Moresque tiles,[1] likely the last vestige of its former more utilitarian self. Only later was it transformed into the decorative water chest we see today.

1 Their pattern is the same that was used to clad the sides of some of the benches in the garden [1, Fig. 17].

It is somewhat surprising how little artistic value has been attributed to this element in the past, and one of the reasons may be that the art historians who mentioned the tile panels did not consider the original function of the element on which they were applied. Joaquim Rasteiro in his 1895 monography about the estate refers to it as a seating bench, presumably because he did not examine it from nearby. Reynaldo dos Santos only refers to it in 1957 as "the mediocre Rape of Europa" [2, p. 59] without alluding to the function of the element it covers. Nor does Santos Simões seem to have taken much interest in this ensemble, which he interprets as a flowerbed [3, p. 106]. But noting the pipes visible at the bottom of the tank allows us to state, without doubt, that it is clearly a reservoir in which the water needed to irrigate the flowerbeds was stored. We believe that it is important to know this function because it may justify the choice of the motifs that decorate it.

It is worth remembering that in the 16th century, these reservoirs were called "water chests". It is perhaps no coincidence, therefore, that their size and even their decoration simulate motifs that closely resemble that multi-functional container furniture that abounded in 16th-century European houses and palaces (Figure 3). Many of them were made of fine wood, decorated on their outer surfaces with ornamental motives carved in gilded and polychrome reliefs and with fine mythological paintings on the smooth surfaces of their interiors so as not to diminish their capacity to contain. This is probably the reason why this 'water chest' has three mascarons centred in oval cartouches formed by fittings of a clearly Flemish inspiration on its outer face and a mythological painting on the inner face of its lid as did the most precious chests of the time (Figures 15, 16). For the same reason, the surface on which *The Rape of Europa* is applied is not vertical or tilted backwards, as is usual for the backs of benches, but forwards, simulating that the lid is a tilting element which, in this case, is depicted as if it were already closing. It may have been precisely this practical function that led to the choice of the theme that decorates the lid of the ark: a mythological episode that takes place in a maritime setting.



Figure 3. A North Italian (?) renaissance chest dated 1500-1600 (image © Victoria & Albert Museum, London, Acc. Nr. 7224-1860).

The Greek myth of Europa states that she was a Phoenician princess from Tyr whose beauty attracted Zeus himself. One day, when she was picking flowers near the shore with other maidens, Zeus took the shape of a bull and mingled with the herd of Europa's father. In time, she noticed the beauty of the bull and sat on its back, whereupon Zeus took to the sea and ran away with her to Crete. The Latin poet Ovid (43 BCE - c. 18) made of the legend one of the episodes of his masterwork *Metamorphoses*, a poem in fifteen books dealing with transformations in Greek and Roman mythology, in this case Jupiter (the Latin equivalent to Zeus) into a bull. The episode closes the second book of *Metamorphoses* and in its poetic rendition Ovid states that as she saw the land receding, Europa's right hand clasped one of the bull's horns, and her other hand gripped its back while her tunic fluttered in the wind. The fact that the name of the Tyrian princess would, in time, originate the name of the whole continent of Europe (while Zeus' avatar as a bull is at the origin of the constellation and western zodiac sign *Taurus)* suffices to make this an important legend.

Apart from the fact that this water-related myth was suitable for decorating a utilitarian garden element, its choice may also have had deeper motivations, related to history and, above all, to the interest of European humanist culture in alluding to myths of classical antiquity on which to base and legitimise the new forms of power of the then *Modern Age*. Europa, princess of the Phoenician kingdom of Tyr, became, through her unplanned betrothal to Zeus, the mother of the first three kings of Crete, a culture that is at the origin of Greece itself. The myth therefore alludes to Phoenicia, Crete and Greece, i.e. the first three known thalassocracies of the Mediterranean. It was easy to relate them to Portugal, a kingdom that by the mid-16th century had already formed the maritime trading empire that was the origin of its most brilliant historical period. In short, the myth made it easy to recognise Portugal as a New Greece. If Phoenicia, Crete and Greece were the masters of the Mediterranean of Old, Portugal and Spain were now the masters of the Atlantic, the Indian and the Pacific. No one more appropriate than Brás [Afonso] de Albuquerque, son of one of the protagonists of this colossal modern epic and then owner of the Bacalhôa estate, to leave in the garden of his palace a reminder of this idea that was surely very present in the minds of this humanist generation.

One of the earliest illustrated printed editions of the *Metamorphoses*, abridged and translated to French, was published in Lyon in 1557 and in it the episodes were illustrated by Bernard Salomon (Lyon c.1506- c.1561).[2] On the lower left side of Figure 4 is reproduced the original 1557 illustration from a woodcut by Salomon for this particular episode, flipped horizontally as if seen in a mirror. This edition, later also published in Dutch, was very successful, originating copies and forgeries from other editors. Of interest to us is a Latin edition published in Frankfurt in 1563 with very sharp ilustrations by Virgil Solis (Nuremberg 1514-1562).[3] For the episode of "Jupiter into a bull", Solis used the original Salomon illustration, now inverted left to right, slightly altered and improved with more detail (reproduced at the lower right side of Figure 4).

2 For a review of the 1557 French edition of the *Metamorphoses* and its illustrations, as well as of previous editions, see *ICONOS* (Sapienza Università di Roma, site in Italian at: www.iconos.it – last visited September 30, 2021).

3 The 1563 edition was subsequently published in Latin and German. Information obtained from *The Ovid Collection*, University of Virginia (https://ovid.lib.virginia.edu/index.html – last visited September 30, 2021).

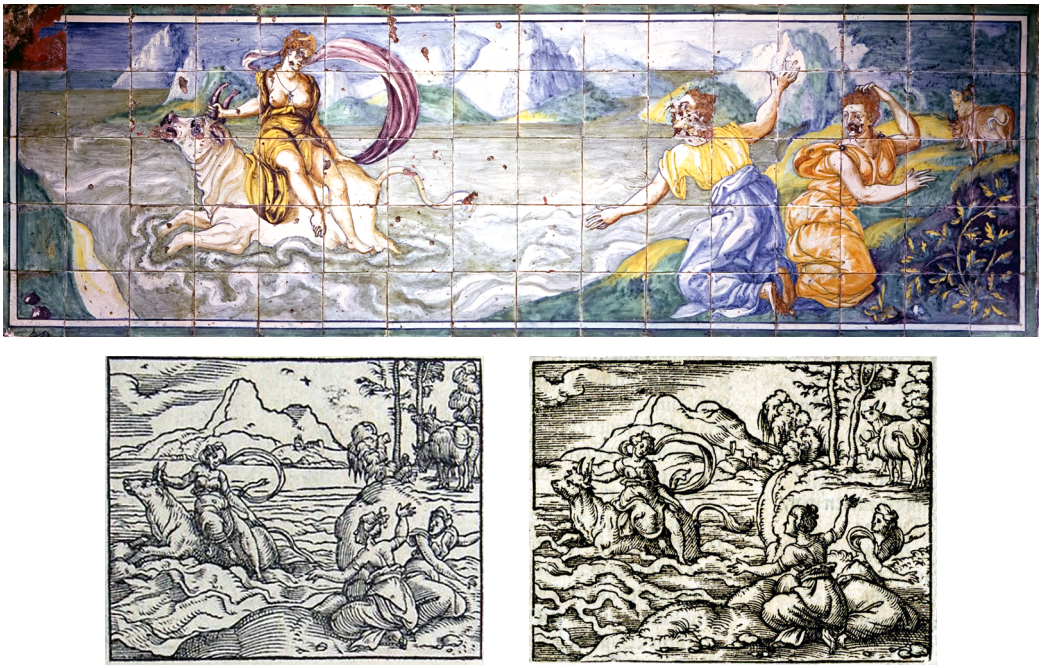


Figure 4. Top: *The Rape of Europa* before its recent conservation intervention. Lower left side: illustration in the 1557 abridged French edition of Ovid's *Metamorphoses* published in Lyon (image: UVa Library- illustration flipped horizontally to allow for an easier comparison); lower right side: illustration in the 1563 Latin edition published in Frankfurt (image © The Trustees of the British Museum).

Addressing the sources of the figurative representations in Bacalhôa, Ana Paula Correia [4] pointed to the use of the 1563 representation based on the similarity of the flying scarf and the position of the bull's tail, with which we agree, adding the rendition of the waves around the bull, graphically different in both prints. However, there is a detail that suggests that the illustration to Ovid's *Metamorphoses* was not the only source: the colours of Europa's garments. Figure 5 illustrates three Italian maiolica plates and although the colours of the maids' clothing vary, the colours of Europa's garments are similar to the panel: a *peplos* in hues of yellow / orange and a purple wimple. In Greek literature, Moschus' *Europé* states that the bull was of a light brown colour and Europa's *peplos* was purple, as befitted her royal condition,[4] and indeed in ancient representations Europa is usually vested in blue or purple. Ovid's poem states that the bull is white but offers no clue as to the colours of Europa's tunic. Therefore, in the panel in Bacalhôa the colours must have been copied from a painting, or else the print used was one illustrating a text other than Ovid's, from which the colours could be determined. An early such text is Jean-Antoine de Baïf's *Le Ravissement d'Europe* (published in Paris in 1552) of which the relevant parts read as follows: about Europa hurrying to join a group of girls who were going to pick flowers "…you tie your hair with a knot, and **for dress you put a silk garment stripped with gold** that waves shimmering"; about the colour of the bull,

4 For a translation to French of the Greek poem written by Moschus of Syracuse ca. 150 BCE, see MUSAGORA- Langues et Cultures de L'Antiquité in https://www.reseau-canope.fr/cndpfileadmin/musagora/mondes-antiques-mondes-modernes/le-mythe-deurope-dans-la-litterature/litterature-grecque-ancienne/moschos-de-syracuse/ Nov 2021.

which is the only detail in Ovid's poem "…its gleaming hair was so white, more than the whitest of flowers"; about what happens immediately after the bull takes to the sea: "…Weeping she calls on her companions who follow her from the margin, and her bare arms towards them she tends, but her help in vain she awaits. Europa, seating on the bull, with one hand holds a horn, with the other, fearing the waves of the sea, **she holds up her purple drapery**. On her back, against her wimple, the wind blows as on a sail".[5] In the depictions, the colours of Europa's garments match this description, with yellow, ochre or orange used for the golden *peplos*, and purple for the wimple, and it is interesting to note that this is the first mention we know of a wimple- in the older pictorial depictions Europa was usually holding the folds of her tunic, or else a mantle of a different colour.



Figure 5. Mid-16th century Italian maiolica plates depicting *The Rape of Europa* having in common the colour of the bull and of Europa's *peplos* and wimple. Left side: LWL *Museum für Kunst und Kultur* Inv. Nr. O-188 LM; right side: Wikimedia Commons,[6] attribution to Sailko (bottom image from a plate at the *Museo Civico di Palazzo Mosca*, Pesaro).

The greatest problem the painter faced in adapting the composition of the print to his own work was the different proportions of the tile panel. Its lower height and greater horizontal extension constrained him to make several changes which he nonetheless

5 (…) "tu troussas en un neu simplement Tes crins espars, et pour abillement **Sur toy tu mis une cotte de soye Rayée d'or**, qui luysamment ondoye Parmi l'éclat d'un serien satin"; (…) "Son poil luisant eust bien de sa blancheur Eteint le teint de la plus blanche fleur"; (…) "Elle, pleurant, crioit à ses compagnes, Qui la suyvoient à travers les campagnes: Et ses bras nus devers elles tendoit; Mais leur secours en vain elle attendoit… Europe, estant dessus le bœuf assise, D'une des mains une corne tient prise, D'une craignant les flots de la marine, **Elle troussoit sa vesture pourprine**. **Dessus son dos dans un guimple de toyle Le vent s'entonne ainsi qu'en une voyle**…"- the simplified translation is ours, the full text is available at: https://www.reseau-canope.fr/cndpfileadmin/musagora/mondes-antiques-mondes-modernes/le-mythe-deurope-dans-la-litterature/litterature-francaise/leurope-de-moschos-par-jean-antoine-de-baif/ (consulted in November 2021).

6 https://commons.wikimedia.org/wiki/Category:Rape_of_Europa . The images depict the full plates and were cropped to depict only the part relevant to the present argument.

managed to resolve with some skill. Firstly, he lengthened the landscape on the far left and right sides and increased the distance between the three main groups of figures: fleeing bull with Europa, gesticulating maidens, and finally the cattle of the herd. Secondly, he reduced the area of the background landscape and the sky in the panel, which forced him to place the herd at the level of the maidens and not above them as in the print. As a result, the maiden who in the print has her left arm stretched forward, in the tile panel has to give way to the animals and therefore her arm is now bent, touching her head in anguish. Other changes and additions were gratuitous contributions by the artist. For example, the small town in the background, perhaps Tyr, has disappeared from the panel. The trees in the print were converted into a formless mass of vegetation concealing their trunks and, finally, the lower corner at this end of the scene was filled by the painter with a thicket in which the leaves are painted in halves, green and yellow, a stereotypical formula that was frequently used in Italian ceramics and passed on to Flanders and the Iberian Peninsula.

The colouring used here is particularly vivid in the figures and somewhat more sombre in the landscape. The ochre and blue tunics of Europa and the maidens are particularly well resolved with a pictorial modelling of folds and well-studied shadows, especially in the case of the protagonist. It may be noticed from Figure 4 that Europa is more unveiled than in the print: her breast and right leg are now fully exposed, and her bare neck has a pendant with a cross made with six pearls. And this raises again the possibility that the source may have been, not the print directly, but rather a maiolica plate or an easel painting made after the print and depicting her similarly unrobbed (as in one of the plates in Figure 5). Else this adaptation was done by the painter, likely at the client's request. In all cases, the finesse and sensuality with which Europa is depicted accentuates the profane character of this scene and reminds us of the tendency towards eroticism typical of Northern Mannerism, also evident in this scene in details such as the sophistication of the hairstyle or the capricious and forced position of the feet toes of the protagonist.

The landscape, on the other hand, is somewhat less detailed. The closest shots are painted in green and yellow, while the mountains in the background are rendered in faded blue, simulating the distance with the usual procedure established by atmospheric perspective. Maybe what create the stormy atmosphere that accentuates the drama of the episode are the absence of appeasing white clouds and, above all, the green colour of the water used by the painter to represent a rough sea that would have been cheerful and luminous if he had used blue. In the choice of this colour for the water, we perceive a certain parallel, perhaps accidental, with the representation of the river in the allegory of the Tagus in the Central Room of the Pleasure House.

The theme of the panel and the image of Europa are somewhat related to the depiction of female nudity in other panels in the House of Pleasure: *The Abduction of Hippodamia*, in which the female figure, now lost, was also unrobed, and *Susanna and the Elders* [1]. In all of them, the mythic context justifies the nudity, while the female figure personifies innocence. Together with the *Secret Garden* of fauns, the panels typify the profane part of the estate [1].

The direct or indirect inspiration of the Europa panel in a print by Bernard Salomon is of some interest for the history of the pictorial sources for tile panels in the Iberian context. A similar fact was confirmed in 1961 by Alice W. Frothingham [5] in one of the sets attributed with certainty to Cristóbal de Augusta, a tile painter with northern family antecedents, such as Juan Flores [6] and João de Gois [7]. The set is preserved in the

church of the *Convento de Madre de Dios* in Seville and is made of three panels decorating an altar with *The Four Horsemen of the Apocalypse* on the front, and on the sides *Babylon the Harlot* and *The Angel with de Key*. The composition of the three scenes is inspired by three woodcuts by Bernard Salomon illustrating the edition of Jean de Tournes' *Figures du Nouveau Testament*, published in Lyon in 1554. This coincidence proves that the Lyon editions illustrated by Salomon were widespread in the Iberian Peninsula, and that at least Cristóbal de Augusta used them in his panels painted in Seville sometime between 1569 and 1588, the latest known date of his productions.

The lower panel of the water chest has the same dimensions of *The Rape of Europa*, and seemingly the repeating design of mascarons was sketched so as to adapt its module to those set dimensions. The design of three heads in medallions may trace its ancestry to fronts of chests such as the ones illustrated in Figures 3 and 15. Mascarons were very often used in connection with other grotesque designs during the Renaissance (Figure 6). Observing the panel in Figure 1, there was obviously the intention to use many of the decorative elements also used to compose the design illustrated in Figure 6: female mascarons with a peculiar headdress, medallions set in *ferronerie*, festoons, foliage… Yet, in the panel the varied elements do not build up a balanced whole: *ferronerie* is seen both inside and outside the medallions, sometimes curled but with edges missing and without forming continuity. The design must have been adapted from one or more sources without the sense of proportion and of perspective needed for a good result. But in the end, the colourful paint - with the mascarons depicted against a dark yellow and orange shield - imparts a gaiety that distracts from the graphic failures.

A panel presently in the *Museu Berardo Estremoz* (in South Portugal) depicts one more module of the design, with a single mascaron (Figure 2). It is part of a longer wainscot panel removed from a house before its demolition [3] and a comparison with Figure 1 confirms that the design and colours show only minimal differences between the two panels. It is interesting to note that the module is the same, suggesting that the wainscot must have been made after the panel for Bacalhôa, likely by the same workshop and transposed from the exact same stencil.



Figure 6. A pattern of *grotteschi* published ca. 1580 with *ferronerie* cartouches and two mascarons - one male, one female, by Theodor de Bry (Liège 1528 – Frankfurt 1598) (image: Metropolitan Museum of Art - The Elisha Whittelsey Collection).

3. ANALYTICAL CHARACTERIZATION BY SEM-EDS

3.1. Samples

Figure 7 illustrates some sampling spots and the codes attributed through which the samples were referenced. Sampling was done with a scalpel in areas already damaged. The images show that whenever the biscuit is clearly visible, its colour is of a hue of terracotta, at times quite dark. Actually, it was verified that the biscuits of all original tiles in the panels, as well as the *alizares*, are of this colour range.

Table 1 includes data on each item studied. The first column (*Identification*) includes the name of the panel or other similar exclusive labelling, by which the object will be identified. The second column (*Sample references*) includes the technical references of the items prepared for observations and analyses. The last column indicates how many measurements were averaged in the semi-quantification of the chemical composition of the glazes and biscuits of each item.

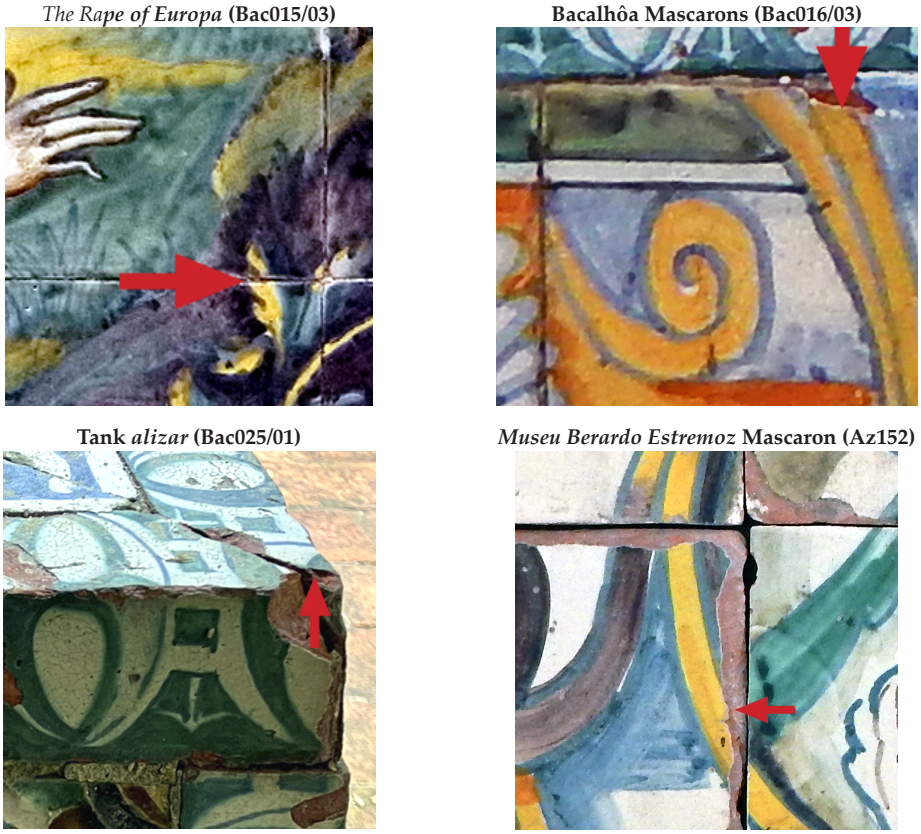


Figure 7. Examples of sampling spots on previously damaged areas of panels and tiles.

Table 1. Identification of items, sample references, and number of analytical results averaged

Identification	Sample References	Total nr. of results
***The Rape of Europa* panel**	Bac015/02; -/03	6 (glaze); 2 (biscuit)
Bacalhôa Mascarons panel	Bac016/02; -/03	2 (glaze); 2 (biscuit)
Bacalhôa tank *alizares*	Bac025/01; -/02; -/03	5 (glaze); 4 (biscuit)
Museum Mascaron panel	Az152	1 (glaze); 1 (biscuit)

3.2. Methods and instrumental means

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

SEM observations and EDS analyses were made at LNEC using a TESCAN MIRA 3 field emission microscope combined with a BRUKER XFlash 6|30 EDS system. The samples were uncoated and the observations were made in backscattered electrons mode (BSE), with a chamber pressure of typically 10 Pa, at an accelerating voltage of 20 kV with the sample sections at a distance of 14 ± 1 mm from the detector. SEM images were typically acquired at magnifications of 350 x and 700 x for the glaze and 1,000 x or over for inclusions in the biscuit.

The selection of areas for EDS quantification avoided large inclusions in the glaze or biscuit representing more than ca. 5% of the full selected area. From our previous experience, the adequate minimum measurement areas are 200 x 200 μm for glazes and 500 x 500 μm for biscuits. In general, multiple measurements were made and in such case the results are averages and smaller non-overlapping areas may be used to the same effect. Whenever possible, the analyses were performed on white glazes to avoid interference from elements diffused from the blue, green or violet pigments which, when present, were neglected. The yellow pigments remain at the surface and therefore do not entail the same problem. Still, in the case of zinc-bearing yellow pigments, the analyses must be performed at a safe distance from the colour.

Minor elements, usually representing less than 1% of the compositions, such as magnesium (Mg) and iron (Fe) in the glazes, or titanium (Ti) in the biscuits were not included in the tables of results.

The quantification of tin (Sn) in the glazes may be problematic because the aggregation of crystals often results in a large variance. That problem was dealt with by using larger areas whenever aggregation was visually detected in the SEM images or, when that was not possible, averaging the results of multiple analyses on different areas.

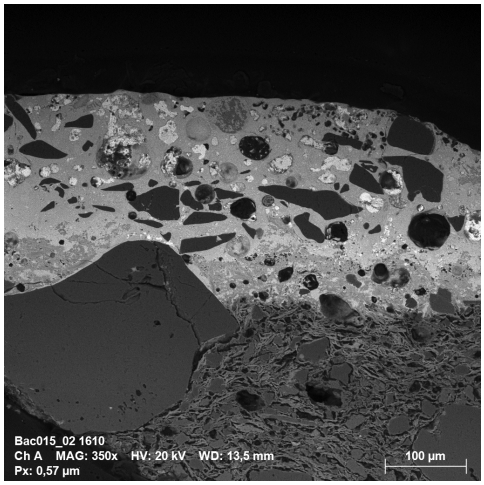
The amount of oxygen (O) was calculated through the remaining elements stoichiometry of their most commonly considered oxides (Na_2O, MgO, Al_2O_3, SiO_2, K_2O, CaO, Fe_2O_3, SnO_2, PbO) and the result was normalized to 100 %.

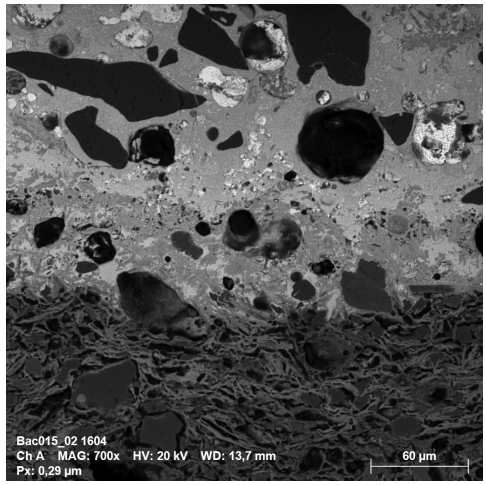
3.3. Results

3.3.1. Morphology of the glazes

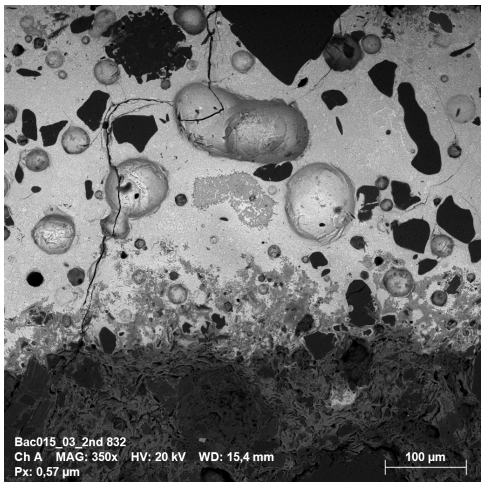
Figure 8 depicts, at the same magnifications for comparison purposes, sectional SEM images of samples from all panels showing the main micro-morphological characteristics generally associated with the glazes and their interfaces. The light grey area on top is the glaze, while the dark grey area corresponds to the biscuit. Because of its colour, the inclusions in the glaze are conspicuous: gas bubbles retained in the glass, grains of sand (larger compact dark inclusions, usually with rounded edges) and bits of feldspars, often in disaggregation. The white spots in the midst of the glaze are crystals of the opacifier (tin oxide) while a continuity of similar white spots near the surface of Az152 corresponds to the lead-rich yellow pigments. It will be noticed that *coperta* (a layer of transparent glaze) was not applied over the yellow colour.

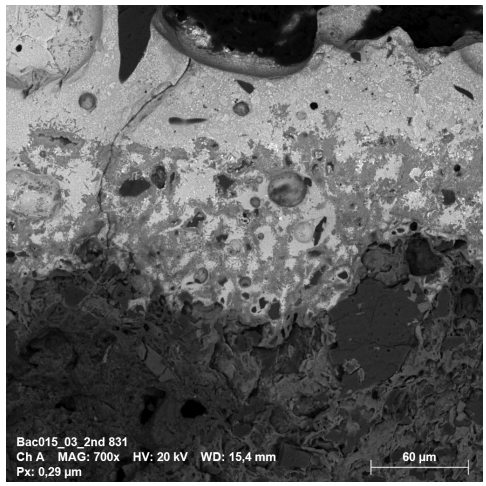
Bac015/02 (*The Rape of Europa* panel)



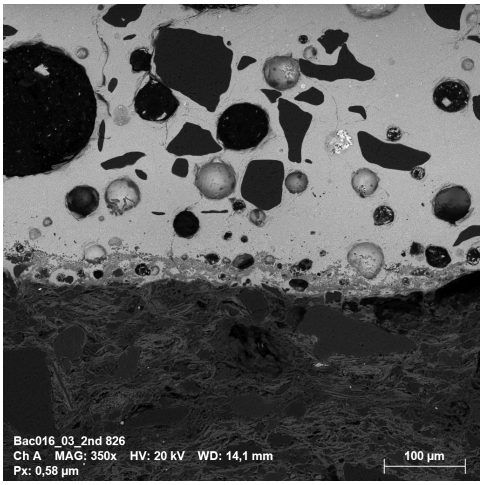


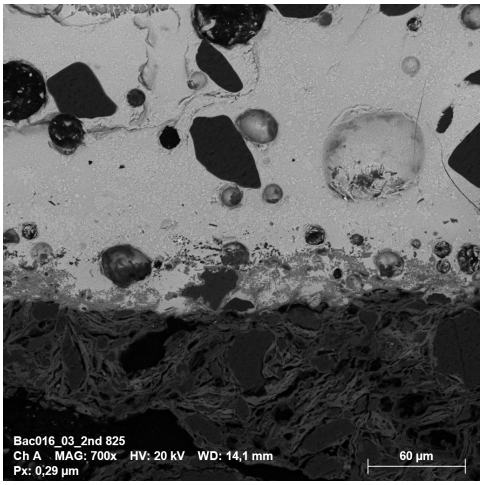
Bac015/03 (*The Rape of Europa* panel)



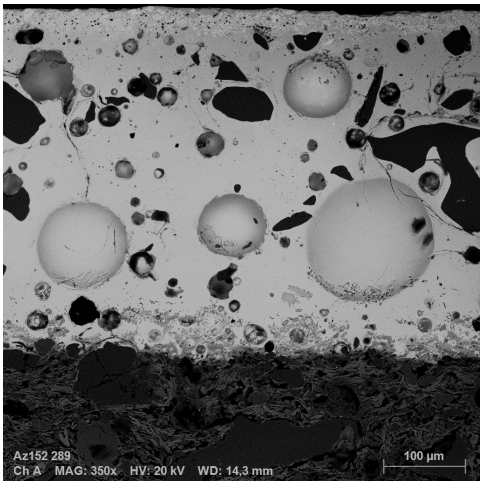


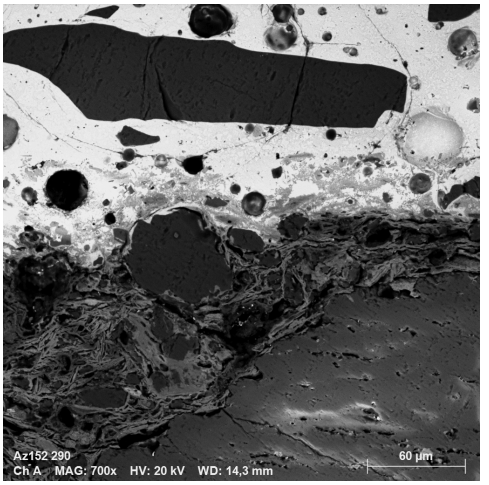
Bac016/03 (Bacalhôa Mascarons panel)



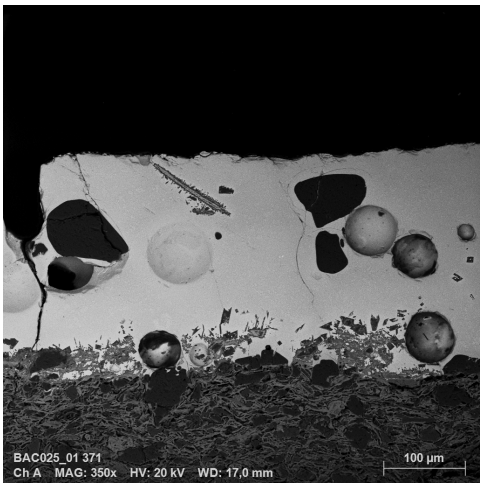


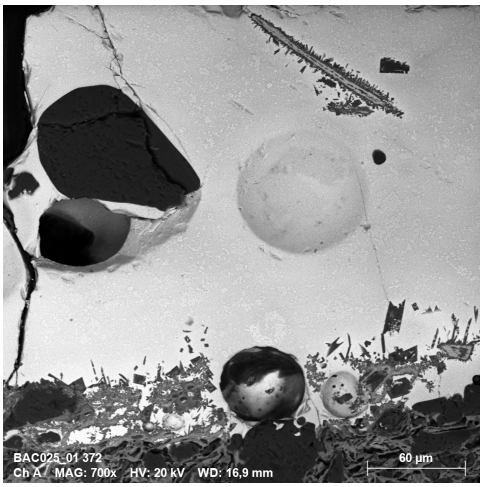
Az152 (Museum Mascaron panel)





Bac025/01 *Alizar*





Bac025/02 *Alizar*

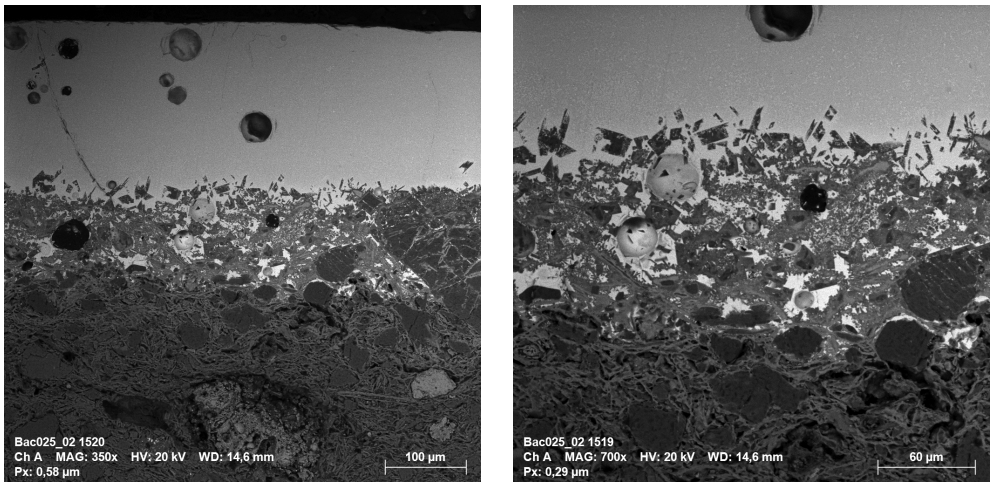


Figure 8. SEM-BSE images showing the main micro-morphological characteristics of the tiles from *The Rape of Europa*, Mascarons panels and the tank *alizares*. Left side: glaze section at 350 x; Right side: detail of the biscuit-glaze interfaces at 700 x (images: LNEC).

3.3.2. Composition of the glazes

Table 2 includes the semi-quantitative results of analyses of the glazes by EDS in weight %. The silicon to lead ratios (Si/Pb) have been determined and are also included in the table. This ratio is a technological trait set by the glaze recipe and gives important information about the firing conditions in the kiln because the lower the ratio, the lower the temperature at which the glaze could be properly fired.

Table 2. Semi-quantitative composition of the glazes of the tiles studied, determined by EDS (values in wt. % with oxygen obtained by stoichiometry and sum of all elements normalized to 100%) with Si/Pb ratios included

Sample		O	Na	Al	Si	K	Sn	Pb	Si/Pb
The Rape of Europa	**average**	27.03	**0.25**	**3.09**	**14.65**	**1.01**	**16.26**	**37.71**	**0.39**
	st. deviation	-	0.04	0.40	1.42	0.13	2.81	6.10	
	cv	-	0.16	0.13	0.10	0.13	0.17	0.16	
Bacalhôa Mascarons	**average**	25.50	**0.16**	**2.60**	**14.16**	**0.67**	**12.84**	**44.07**	**0.32**
	st. deviation	-	0.07	0.39	0.26	0.08	0.19	0.99	
	cv	-	0.42	0.15	0.02	0.11	0.01	0.02	
Museum Mascaron	-	24.59	**0.15**	**2.21**	**13.42**	**0.66**	**13.49**	**45.48**	**0.30**
Edge *alizares*	**average**	27.75	**0.57**	**2.75**	**16.45**	**1.53**	**11.02**	**39.93**	**0.41**
	st. deviation	-	0.40	0.93	3.59	0.24	1.19	10.13	
	cv	-	0.71	0.34	0.22	0.16	0.11	0.25	

Note: *st. deviation* indicates the standard deviation of all values averaged in the result; *cv* indicates the coefficient of variation (cv= st. deviation / average)

3.3.3. Composition of the biscuits

Table 3 includes the semi-quantitative results of analyses of the biscuits by EDS in weight %. Lead occurs in most cases deriving from percolation into the biscuit when the raw glaze is applied. Its content was determined but not considered because it is not part of the natural composition of the biscuit and depends on the proximity to the interface. The presence of lead renders the quantification of sulphur doubtful because of a superposition of spectrographic peaks and therefore it too was not considered, as well as elements of contents often below 1% such as phosphorus, chlorine and titanium. The distinctive calcium to silicon ratios (Ca/Si), related with the appetence for tin-glazing and the colour of the biscuit when fired in an oxidation atmosphere, was determined and is included in the table.

Table 3. Semi-quantitative composition of the biscuits of the tiles studied, determined by EDS (values in wt. % with oxygen obtained by stoichiometry and sum of all elements normalized to 100%) with Ca/Si ratios included

Sample		O	Na	Mg	Al	Si	K	Ca	Fe	Ca/Si
The Rape of Europa	**average**	46.56	**1.17**	**1.29**	**10.52**	**27.54**	**3.79**	**4.26**	**4.87**	**0.15**
	st. deviation	-	0.23	0.60	0.09	1.43	1.05	2.28	0.00	
	cv	-	0.19	0.47	0.01	0.05	0.28	0.54	0.00	
Bacalhôa Mascarons	**average**	46.39	**0.97**	**1.22**	**9.81**	**27.41**	**2.65**	**6.86**	**4.69**	**0.25**
	st. deviation	-	0.09	0.11	0.14	0.14	0.35	0.11	0.43	
	cv	-	0.09	0.09	0.01	0.01	0.13	0.02	0.09	
Museum Mascaron	-	47.00	**1.22**	**1.77**	**10.57**	**27.92**	**2.67**	**4.80**	**4.05**	**0.17**
Edge *alizares*	**average**	47.39	**0.91**	**1.66**	**10.64**	**28.77**	**3.38**	**2.36**	**4.90**	**0.08**
	st. deviation	-	0.27	0.50	0.45	1.02	0.34	1.22	0.66	
	cv	-	0.30	0.30	0.04	0.04	0.10	0.52	0.14	

4. DISCUSSION OF THE INSTRUMENTAL RESULTS

The biscuits of all tiles are the colour of terracotta, particularly intense in the case of the *alizares*. This colour results from firing calcium-poor clays in an oxidation atmosphere, but such clays are generally considered unsuited for majolica, where a relatively high content in calcium results in cream biscuits to which glazes connect easily, also needing less of the expensive tin oxide for proper opacification. And yet, for several years, maybe for an extended period of more than two decades, terracotta was precisely the colour of many of the biscuits of the circle of João de Góis, such as the panel *Nossa Senhora da Vida* (Figure 10) and the lining of *Capela de São Roque dated* "1584" [8]. Concerning *São Roque*, José Queirós remarked in 1913 about the unsuitability of low-calcium clays: "The tiles […] are of red clay. The red clay, when not from Vale do Pereiro,[7] more or less drives the tin-glaze out" [9].[8] Another disadvantage is that those biscuits need a glaze with a high

7 *Vale do Pereiro* is an area in Lisbon, now urbanized, from where, at the time of the author's writing, were extracted clays from a Miocene layer called "Argila dos Prazeres" which, probably, was not the exact clay used in the panels addressed by Queirós.

8 "Os azulejos […] são de barro vermelho. O barro vermelho, quando não tem as qualidades do do Valle do Pereiro, atira mais ou menos com o esmalte fóra".

content in expensive tin, otherwise the dark biscuit colour will come through and taint the whiteness of the glaze. Figure 9 depicts the range of hues, comparing optical images of samples from the panels presently studied with samples of panels by the workshop of João de Góis and, possibly, associates sharing the same technology.

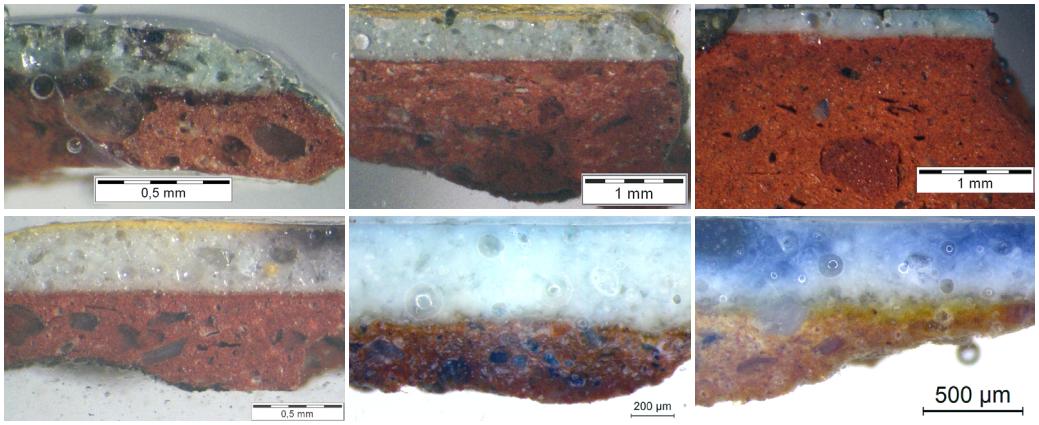


Figure 9. From left to right, upper row: Bac015/02 (*The Rape of Europa*); Bac016/03 (Bacalhôa Mascarons); Bac025/01 (*Alizar*); lower row: Az152 (Museum Mascaron); Az032/01 (*Nossa Senhora da Vida*); Az068/05b (*Capela de São Roque*,[9] Lisbon).

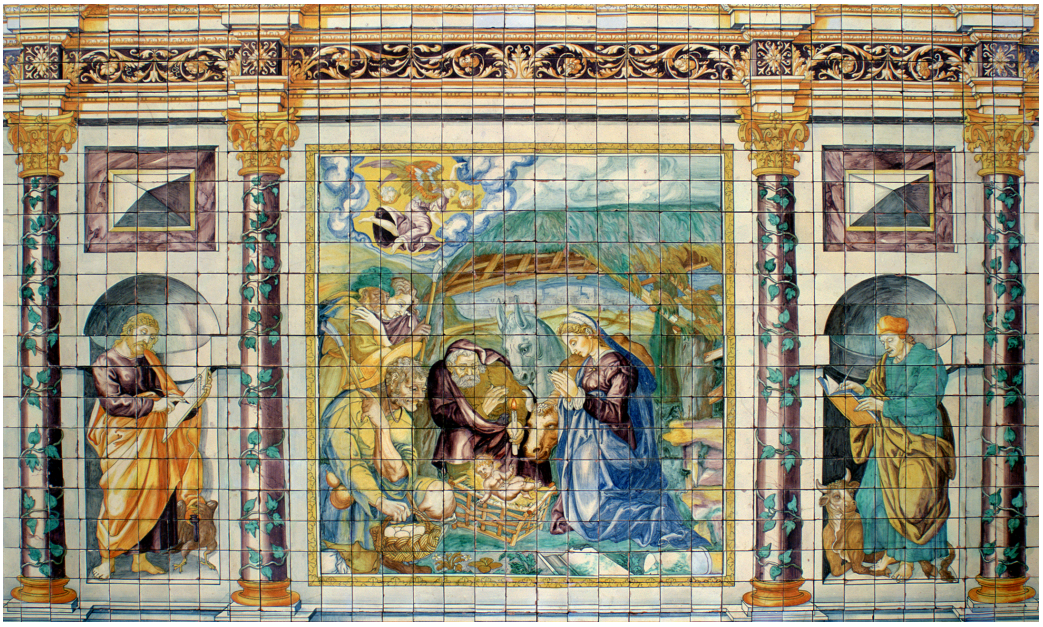


Figure 10. The lower part of the panel *Nossa Senhora da Vida* (image © Museu Nacional do Azulejo, Lisbon).

9 In this case, some samples are of a cream colour, not because of a recurring high content in calcium, but because the kiln atmosphere must have been better controlled by 1584, when the panel was manufactured.

The fact that these calcium-poor clays, used in Lisbon in the 1560s until at least the 1580s, are difficult and expensive to tin-glaze and therefore rarely used elsewhere for majolica, points immediately to a local production when such biscuits are found in 16th century tiles. The earliest known tiles by the workshop of João de Góis are those in the signed panel of *Igreja da Graça*, very likely connected to the burial of Afonso de Albuquerque there in 1566 [10] but they depict several shades of biscuit colours from cream to terracotta, likely derived from the use, at this time, of clay from a thin Miocene sublayer richer in calcium albeit with very variable composition [to be published]. The earliest known panel to depict in general the same range of biscuit colours seen in *The Rape of Europa* and the Mascarons panels is *Nossa Senhora da Vida*, once at *Igreja de Santo André* in Lisbon and presently in *Museu Nacional do Azulejo* (Figure 10). This is attributed to the workshop of João de Góis based on an incomplete signature and presumed to date from the second half of the 1570s to 1581 [11]. Figure 11 compares the interfaces of several glaze sections of this panel with those of tiles of the panels presently studied, showing that they have a comparable development and morphology.

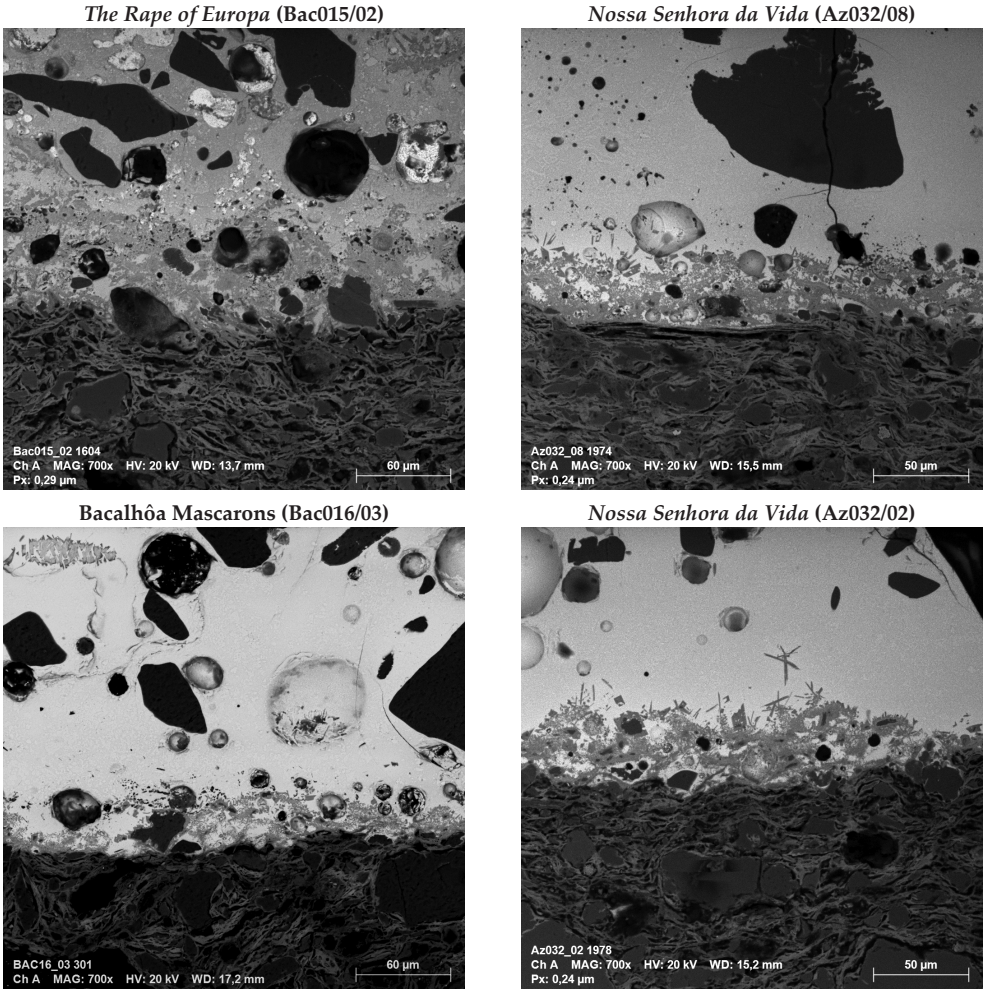


Figure 11. Comparison of the interfaces of samples from *The Rape of Europa* and Mascarons (left side) with *Nossa Senhora da Vida* (right side) (images: LNEC).

Table 4 compares the average glaze compositions of all panels with the tiles in *Igreja da Graça* signed by João de Góis, the panel *Nossa Senhora da Vida* and, for good measure, the five river god panels of the west loggia of the Palace of Bacalhôa [12].

Table 4. Comparison of the average glaze semi-quantitative compositions by EDS of the panels and tiles studied with samples from the panel in *Igreja da Graça* signed by João de Góis, the panel *Nossa Senhora da Vida* and the five river god panels of the west loggia of the Palace of Bacalhôa

Sample	O	Na	Al	Si	K	Sn	Pb	Si/Pb
The Rape of Europa	27.03	**0.25**	**3.09**	**14.65**	**1.01**	**16.26**	**37.71**	**0.39**
Bacalhôa Mascarons	25.50	**0.16**	**2.60**	**14.16**	**0.67**	**12.84**	**44.07**	**0.32**
Museum Mascaron	24.59	**0.15**	**2.21**	**13.42**	**0.66**	**13.49**	**45.48**	**0.30**
Edge *alizares*	27.75	**0.57**	**2.75**	**16.45**	**1.53**	**11.02**	**39.93**	**0.41**
João de Góis *Igreja da Graça*	29.83	**0.83**	**3.27**	**18.35**	**2.11**	**9.22**	**36.39**	**0.50**
Nossa Senhora da Vida	24.84	**0.81**	**2.34**	**13.83**	**0.79**	**11.09**	**46.30**	**0.30**
Loggia river gods	28.10	**0.71**	**1.92**	**17.76**	**2.12**	**8.66**	**40.72**	**0.44**

The results in Table 4 show that the characteristic traits of the glaze formulations associated to the productions of the workshop of João de Góis: relatively low contents in sodium (Na) and potassium (K); and high contents in tin (Sn) and lead (Pb) with a Si/Pb ratio of around 0.4±0.1 [13, p.40] are present in all panels. To assess graphically the relative standing as pertains to the percent contents in the relevant elements, towards a possible finer discrimination, Figure 12 depicts the ratios Si/Pb, (Na+K)/Pb and Sn/Pb in a ternary plot. The normalization to the content in lead was made so that the other contents might be comparable with the very important silica to lead ratio.

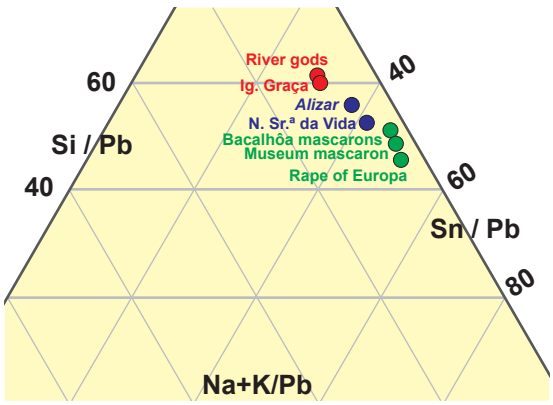


Figure 12. Ternary plot of ratios related to relevant elemental contents in the glazes.

Figure 12 confirms graphically the proximity of all compositions as pertains the elements considered. It may, however, be noted that *The Rape of Europa* and the Mascarons panels are closer to *Nossa Senhora da Vida* than to the panels of *Igreja da Graça* and the river gods.

Table 5 compares the average biscuit compositions of all panels with the tiles in *Igreja da Graça* signed by João de Góis, the panel *Nossa Senhora da Vida* and, again, the five river god panels of the west loggia of the Palace of Bacalhôa.

Table 5. Comparison of the average biscuit semi-quantitative compositions by EDS of the panels and tiles studied with samples from the panel in *Igreja da Graça* signed by João de Góis, the panel *Nossa Senhora da Vida* and the five river god panels in the loggia of the Palace of Bacalhôa

Sample	O	Na	Mg	Al	Si	K	Ca	Fe	Ca/Si
The Rape of Europa	46.56	1.17	1.29	10.52	27.54	3.79	4.26	4.87	0.15
Bacalhôa Mascarons	46.39	0.97	1.22	9.81	27.41	2.65	6.86	4.69	0.25
Museum Mascaron	47.00	1.22	1.77	10.57	27.92	2.67	4.80	4.05	0.17
Edge *alizares*	47.39	0.91	1.66	10.64	28.77	3.38	2.36	4.90	0.08
João de Góis, *Igreja Graça*	44.44	0.90	1.33	8.37	24.85	3.30	13.02	3.79	0.52
Nossa Senhora da Vida	45.37	1.35	1.70	10.24	25.27	3.52	7.44	5.11	0.29
Loggia river gods	43.49	0.87	4.75	8.31	21.59	2.27	14.55	4.18	0.67

Of the characteristics of the clay used in Lisbon at the time: relatively low content in magnesium (Mg), relatively high content in potassium (K) and very low content in calcium, with Ca/Si ratios around 0.3 but, in some instances, lower [8; 13], all are present in *The Rape of Europa*, both Mascarons panels and *Nossa Senhora da Vida*. The edge *alizares* also comply with these characteristics but have an unusually low Ca/Si ratio (highlighted in Table 5 against a blue background). The signed panel at *Igreja da Graça* differs only in the unusually high content in calcium (yellow cells in Table 5), while the clay used in the biscuits of the river god panels differs on all counts (purple cells in Table 5), but particularly in the relatively high content in magnesium, highlighted in red on Table 5.

Based on the most remarkable distinguishing characteristics, the contents in magnesium and calcium, Figure 13 plots the ratio Mg/Si against the ratio Ca/Si of the biscuits of all panels and the *alizares*. The loggia river god panels and the signed panel of *Igreja da Graça* are clearly separated, but all the other panels and the *alizares* may be clustered together. Again in this case the panel *Nossa Senhora da Vida* is seen to be particularly close to *The Rape of Europa* and the Mascarons panels.

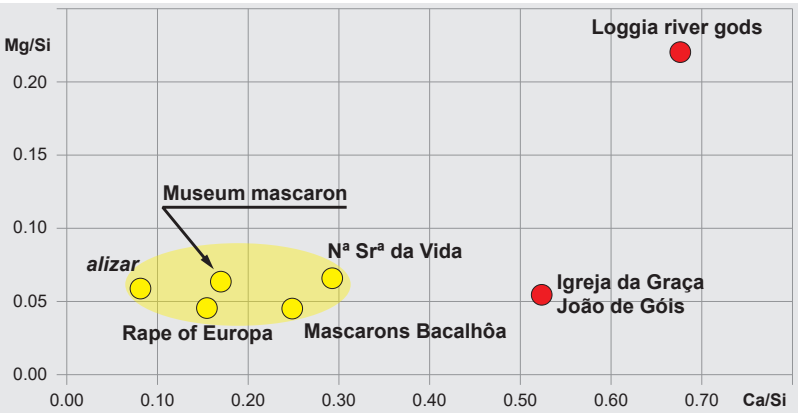


Figure 13. Scatter plot of ratios related to relevant elemental contents in the biscuits.

The analytical similarity with the panel *Nossa Senhora da Vida* suggested a comparison of the paintings, resulting in a few hints of affinity, but nothing conclusive. For instance, considering the colours of the garments, nothing may be inferred from colours obtained

from a single pigment, such as the manganese purple used in Europa's wimple, but the tunic of Europa is painted in two colours (saffron yellow and brown) that can only be obtained by mixing pigments, and similar colours are used in *Nossa Senhora da Vida* for the same purpose. There is also a small plant, sketched with a distinctive morphology, occurring in both panels (Figure 14).



Figure 14. The use of similar colours for the golden garments of Europa (left side) and St. Luke from the panel *Nossa Senhora da Vida* (centre). Right side: depiction of an unclassified similar plant in *The Rape of Europa* (top) and *Nossa Senhora da Vida.*

5. CONCLUSIVE NOTES

The panel *The Rape of Europa* was (directly or indirectly) sketched after an illustration in a book first published in 1563 in Frankfurt, therefore its chronology must be more recent, probably by several years. The technical characteristics of the panels studied correlate with the characteristics of panels attributed to the workshop of João de Góis, or his close associates [8; 13] of which the technical similarity with the panel *Nossa Senhora da Vida*, dated from the second half of the 1570s up to 1581 [11] is particularly remarkable. But, although *The Rape of Europa* is not actually as mediocre as a superficial assessment may lead to believe, its artistry is certainly inferior to *Nossa Senhora da Vida*.

The main lining of Bacalhôa with majolica tiles dates from around 1565 and the death of Brás [Afonso] de Albuquerque in 1581 sets a limit to the purchase of tiles [1]. When trying to ascribe the panel within that period, considering that Albuquerque was born in 1500, one is tempted to presume that he would more likely make new purchases earlier in the period, then at a time when he was already over 70 and with diminishing life prospects. That piece of logical reasoning may, however, be unsuited in this case because Albuquerque was seemingly undeterred by his age and, even though he was wealthy enough to live in idle retirement, he occupied a number of important and demanding positions in public service until 1574, when he sought excuse as president of the Lisbon Senate justifying his request with the excessive work for his age… Still, in

1578 he represented Lisbon in the *Cortes*[10] for which he had been elected and he was a defeated candidate for the same office in the 1579 election, when he was 78 or 79 years old [14]. Brás [Afonso] de Albuquerque's wife Maria de Noronha died during the 1570s and maybe that was the reason why he sought excuse from his post in Lisbon because notwithstanding his age, he wooed a lady of noble birth, Catharina de Menezes, who was 40 or more years his junior, and with whom he re-married. Therefore, age does not seem an obstacle in this case, and the water chest may plausibly have been commissioned during the 1570s, even in the late years of the period.

There is a detail that remains unexplained: what may have prompted such a unique design for a water tank? In Renaissance Italy the family of a bride used to offer a special chest called *cassone* with a dowry (Figure 15). A rich *cassone* might be decorated inside with a painted scene symbolically related to marriage (Figure 16). A conceivable hypothesis is that the chest may be related with the re-marriage of Albuquerque. If it was made on that occasion, then the scene depicted may also be freely interpreted as Brás [Afonso] eloping with his young bride over the Tagus to Bacalhôa. Did he order the chest himself? Or was it offered as a dowry by the bride's family because of his fondness for majolica tiles?[11] We cannot know unless some documental evidence is one day found, but although the exact date of his second marriage is as yet unknown, a connection would place the panels well into the 1570s and that date would indeed fit with the technical proximity to the panel *Nossa Senhora da Vida*.



Figure 15. An Italian renaissance *cassone*, typically a marriage chest given at the time of the wedding by the family of the bride (image: Wikimedia Commons, picture taken at *Palazzo Vecchio*, Florence, Italy, by JoJan).

10 A national legislative assembly usually convened by the king or to recognize a new king.

11 Just such an instance occurred in 1602 when the Duke of Frías, Juan Fernández de Velasco y Tovar, father of Ana de Velasco y Téllez-Girón, acquired figurative wainscot panels to the Loayza workshop in Talavera [3, p.88], presumably as part of the dowry for his daughter's marriage in 1603 to the Duke of Bragança D. Teodósio II. The panels still grace two of the rooms of the ducal palace in Vila Viçosa.



Figure 16. A panel for (presumably) the inner lid of a *cassone*, with a scene from the moral tale of Penelope and Ulysses (Italy, ca. 1475, image © Victoria & Albert Museum, London, acc. Nr. 5792-1860).

The *alizares* are interesting on their own, because the clay is not exactly the same, and in terms of aptitude for tin-glazing, for which a relatively high content in calcium was always considered desirable [15], their clay should be considerably worse than the clay used for the panels. And maybe for that reason the *alizares* have, today, large lacunae and restored areas because of the detachment of glaze. There are several Miocene clay layers in the region of Lisbon, one of which has for long been used by red-clay potters because it crops in the castle hill. We explored that layer and researched the composition of its ca. 21 m thickness.[12] Most of its sublayers are calcium-poor, corresponding to the biscuit of the *alizares*, while the sublayers corresponding to clays similar to those used in the panels are narrower and the sublayers producing clay with higher calcium contents, as found at *Igreja da Graça*, are thin and with a very variable composition. If to the quality of the clays was attached a price tag, the *alizares* were manufactured with a cheaper clay, either because they were considered work of a lesser responsibility or, as seems more likely, because the manufacture of the shaped dihedral biscuits was sourced out to a different potter's workshop where that particular sort of clay was used. Still, the glazing, painting and almost surely the firing was done at the same workshop that manufactured the panels, because the glaze composition and the morphology of the glaze-biscuit interfaces are very similar to those of the panels.

If future research contributes results towards the narrowing of the date estimate for *The Rape of Europa* and the Mascarons, it may prove of great interest towards the definition of the evolution over time of the productions of the workshop of João de Góis. If a date in the second half of the 1570s may be confirmed, then *The Rape of Europa* and the Mascarons were likely the last majolica tiles applied in the estate during the life of Brás [Afonso] de Albuquerque while, on the other side, the dihedral *alizares*, which became common in Portugal during the 17th century, are certainly among the earliest produced in Portugal.

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12 This is the *Forno do Tijolo* clay and the results will be published when the research is concluded.

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The tile floor of the *Palácio da Bacalhôa* oratory

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ABSTRACT

The only surviving tiled floor at *Palácio da Bacalhôa* graces a former oratory and is interesting not only for its singularity in Portugal, but also because, unlike others, the tile elements that compose it may be tentatively dated with a reasonable accuracy.

Seven small samples were collected from the floor, of which five from the central area: two from the white rhombi elements and three from elements with different shades of blue. Analytical research revealed that some tiles could not be connected with a Portuguese origin, but four of the seven sampled were manufactured in Lisbon, likely by the workshop of João de Góis.

The dating of the floor itself is somewhat compromised by the use of tiles from several provenances and chronologies in its assembling, corresponding also to a variability of hues composing areas where a single shade of blue was expected to be used.

RESUMO

O único pavimento em azulejo que chegou aos nossos dias no Palácio da Bacalhôa adorna um antigo oratório e é interessante não só pela sua singularidade em Portugal, mas também porque, ao contrário de outros casos, os elementos que o constituem podem ser tentativamente datados com razoável exactidão.

Foram colhidas sete pequenas amostras do pavimento, das quais cinco da área central: duas dos losangos brancos e três de elementos com diferentes tons de azul. A investigação analítica revelou que alguns azulejos não terão origem portuguesa, mas quatro dos sete amostrados foram fabricados em Lisboa, provavelmente pela oficina de João de Góis.

A datação do pavimento propriamente dito é algo comprometida pela integração de azulejos com proveniências e cronologias diversas, donde derivam variações de tons de azul que fogem à simetria do desenho.

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KEYWORDS: Renaissance glazed floors; azulejos; Palace of Bacalhôa; João de Góis

Acknowledgements

We are thankful to Mr. Joe Berardo and to Mr. Renato Berardo, who authorized the sampling of the unique azulejo heritage of *Palácio e Quinta da Bacalhôa*; and to *Associação de Colecções | The Berardo Collection* and *Bacalhôa Vinhos de Portugal* for support to this project.

Instrumental research developed at *Laboratório Nacional de Engenharia Civil* (LNEC) within the scope of the national infrastructure E-RIHS.pt funded by FCT, the Portuguese Foundation for Science and Technology. LNEC Research Project 0202/1101/19014.

How to cite

MIMOSO, J.M. et al. – *The tile floor of the Palácio da Bacalhôa oratory* in Studies in Heritage Glazed Ceramics, No. 4, LNEC, Lisbon, Portugal, 2022, pp. 81-108.

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1. INTRODUCTION

The tiled floor of one of the oratories of the *Palácio da Bacalhôa* [1, p. 36] is striking for its geometric composition, balance of colours and evenly application. Its singularity in Portugal makes it particularly interesting.

Figures 1 to 3 depict the floor as it was, seemingly until the late 20th century. At an unknown date, before the estate was acquired by the present proprietors, the altar was removed and a stone bathtub was installed, covering part of the floor to near the white central star. However, it is presumed that the tiles that were not affected by the installation are still in place under the tub.



Figure 1. The oratory at the first floor of the palace of Bacalhôa in the late 20th century (?), still with the altar in place (image © Associação de Colecções | The Berardo Collection).



Figure 2. A view of the floor as it originally was, seen from the door, showing the narrow strip of rectangular tiles around the step to the altar (image © Associação de Colecções | The Berardo Collection).



Figure 3. A view of the original floor from the top of the altarpiece (image © Associação de Colecções | The Berardo Collection).

This article makes a historical and stylistic introduction to the floor and reports the results of an analytical research aimed at determining its age and provenance of the tiles used.

2. PRELIMINARY STUDY OF THE FLOOR

2.1. On the use of the space

Given its location at the end of what may be considered to be the main sleeping room of the palace [1], the space whose floor we researched must have been what is usually called an oratory for private use, where the couple who owned the palace would say their daily prayers. In its private character it differs to some extent from what may be supposed to be the house oratory on the ground floor, located next to the exit to the garden, which was accessible to members of the family coming from any of the rooms on the upper floor, maybe even to possible guests or visitors.

In the oldest photographs we can see that the space was still used as an oratory in the mid-20th century, although the altarpiece, the altar table (at least its visible covering) and also the wooden platform in front of both pieces of furniture were not the original ones, but possibly those renovated at the end of the 18th or beginning of the 19th century. The chestnut-coloured paint that covered these elements may even have been applied much later than this and may have concealed a former decoration. However, the 20th century photos (as in Figures 1 and 2) show that the wooden platform occupies the same surface area as the original one, as it is perfectly visible that the floor slabs that surround it are the same ones that would have surrounded the original platform. The old photos do not show whether the wooden cladding we can see is simply a cover on a previous element that was to be hidden, perhaps because of its poor state of conservation, or whether it replaces entirely the older platform. It is also possible that, at the same time as the new altarpiece and altar were installed, repairs were made to the floor, although it is difficult without systematically resourcing to analytical means, to identify and date the pieces that may have been replaced on that occasion.

2.2. Stylistic notes

We do not know whether the original tile floor covered the entire circle, which is quite possible, although not everything would have been at the same level, since in front of the altar it was customary to place the table on a platform somewhat higher than the rest of the floor. In this case, given the small size of the oratory, it would probably have only a single step. We can imagine what this place would be like if we compare it with the image in Figure 4 of the chapel in the *Casa de Pilatos* in Seville [2]. The usual practice in these cases was to give a rectangular plan to this platform and to cover its floor with a somewhat different design to the rest of the oratory, often richer in geometry or colour as it was the area closest to the sacred image of the altarpiece or, where appropriate (certainly not in this case), to the Holy Sacrament.

If we begin the commentary on this interesting floor by its current appearance, the first problem we face is the number of chromatic nuances offered by the large number of pieces that compose it. The confusion is increased because it is also very evident that the original was indeed meant to be composed, as was usual, of various colours and various

hues of the same colour that were highlighted by contrast. However, the shades of blue present in this floor deviate from a rigorous geometric setting of repeating shapes and colours suggesting that the floor may have suffered alterations and restorations in the course of the centuries.



Figure 4. *Capilla de la Flagelación* (*Casa da Pilatos*, Seville- Spain) (images: Wikimedia Commons[1] by Jl FilpoC (left side) and Superchilum (right side).

The paving forms an almost complete circle made up of a central star design and eight radial sectors that correspond to two types of geometric patterns repeated four times each. One of the types (diamond sectors) is mostly formed of rhombi; the second is strikingly marked by a blue star (star sectors) - Figure 3. The major diagonals of the largest rhombi, such as those making up the eight-pointed white star, measure 22.5 cm, therefore the tile pieces were cut from 16 x 16 cm (or larger) square tiles.

Diamond sectors

These sectors seem to have been made up of rhombi in two different shades of blue, the dark ones alternating with the light ones. The dark ones show a rather cobalt-saturated glaze; the lighter ones have less cobalt pigment balanced with white (tin) pigment producing a tone somewhat close to grey. A few rhombi (in larger number in the sector that leads from the door to the altar) are of a sky-blue, again obtained from a balance between the blue and the white pigments.

Star sectors

The surface area of these four sectors is larger than that occupied by the diamond sectors and their geometry is rather more complex because they do not form an extensible mesh like the previous ones, but a centrifugal composition that is not well resolved, originating

1 https://commons.wikimedia.org/wiki/Category:Capilla_de_la_Flagelación,_Casa_de_Pilatos

irregular polygons when approaching the boundaries of the composition.

The four stars are formed by eight dark-blue glazed rhombi and are surrounded by eight light blue square tiles. These squares are surrounded by eight rhombi of the dark-blue glaze mentioned above. The square, rhombi and irregular polygonal tiles that surround the previous lozenges, now of very varied shapes, would correspond to the light blue sort, although the colour distribution is not regular, either because the colours of the tiles used were not steady, or because some tiles have already been replaced in past restorations. Therefore, it is difficult to establish exactly what the original intention in the distribution of the shades of blue was.

The curved side of the sector is topped by a series of alternating square and diamond-shaped tiles, and then a strip that may have originally been entirely dark blue, as most of it has been preserved.

The rectangular shapes bounding the four sectors containing stars, as well as those running parallel to the walls of the circular plan, must have been intended to be of the light blue type, although what we see today is a mix of shades (Figure 5) that may partially derive from later alterations and restorations. Interestingly, the rectangular shapes are not pieces cut from tiles in the *alicatado* manner, rather, after applying the tiles, a straight continuing cut of limited depth was made through the tiles to define a second line parallel to the boundary, enhancing the geometry and sense of complexity of the floor, without actually imposing the work of cutting the tiles clean (Figure 5). It is not evident whether the cuts were made at the time the floor was applied, but they were probably filled with mortar to hide the varying colour of the biscuits as seen in Figure 7.

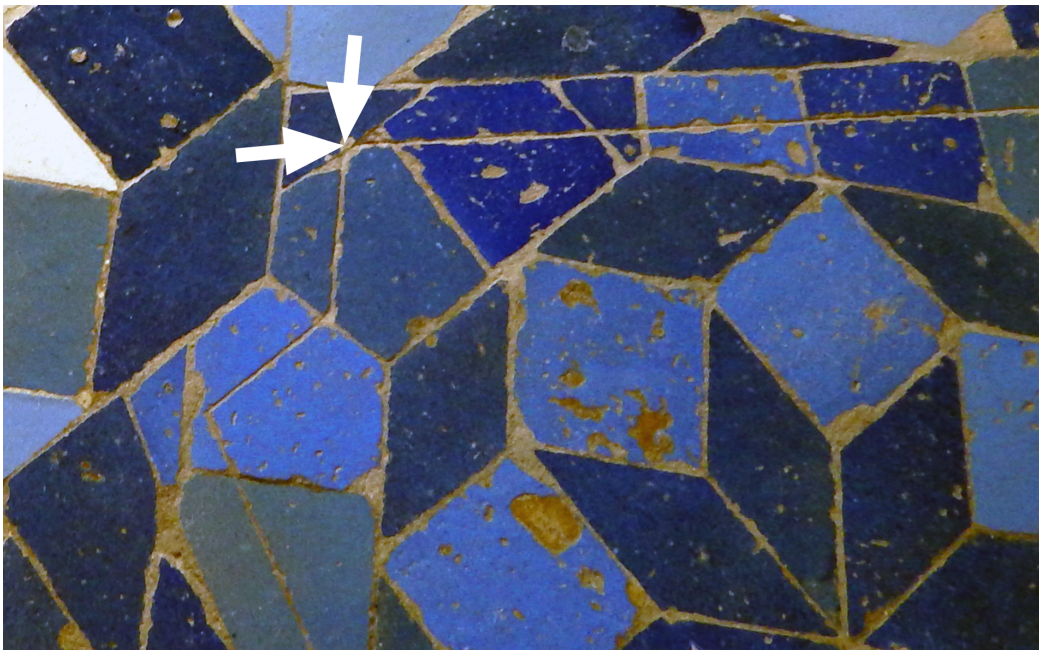


Figure 5. An enhanced view showing the variety of blue hues and the cuts through a continuity of tiles (two of them indicated by the white arrows), seemingly made with a small hatchet pick, giving the impression of more *alicatado* work than there really is in the floor (image © Associação de Colecções | The Berardo Collection).

The entire circle made up of the four diamond sectors and the four sectors of stars is surrounded by a band of tiles that must have been dark blue, set in a diamond pattern, and light-blue glazed triangles. There are five concentric perimetral strips between this band and the wall, one of which is made of dark-blue square tiles and the other four are made of light-blue squares or rectangles of two different widths. Here, too, several shades of blue are to be seen, set without a fixed rule as if remains of tiles of several hues had been used without a set rule, to cover this final continuance towards the wall.

Central star

In this mostly blue floor composition, the centre stands out chromatically, occupied by a star formed by eight white rhombi, possibly originally surrounded by eight dark blue tiles and eight light blue rhombi.

In this scheme, which we assume to be the primitive one, we can detect misplaced original pieces and others that seem to be later replacements. All that deviates from what we consider to be the four basic original colours, white, dark blue, light blue and sky-blue, could be interpreted as possibly later replacements after the original paving was installed.

In the colour white itself, two different hues seem to be distinguishable. One detail that is striking about one of the pieces is that it is contaminated with a drop of green glaze, evidence that it was fired in a kiln in which green-glazed ceramics were also fired.

In the blue tiles, the picture is even more complex than in the white tiles, as four or perhaps five different hues seem to be distinguishable, of which only three would maybe be expected to be the original ones. For example, some of the sky-blue elements have a chromatic purity and striking homogeneity that could point to a more recent manufacture than most of the rest. Even among the darker blues there seems to be a certain difference between those of the four stars and those used in the circle near the walls, although this difference is not evident in the photographs and would need to be verified *in situ*.

2.3. Precedents in Portugal

It is very likely that there were, and still remain, many other examples of Mudéjar floors in Portugal than has been published in the past. In fact, Portuguese painting offers numerous testimonies, although, admittedly, most of those we saw so far seem to be very early (e.g., in the *Mosteiro de Alcobaça* [3, plates I-V]) and very different from this case, mostly formed with Hispano-Moorish tiles. The two most important and best-known Mudéjar tiled floors in Portugal are at the *Palácio Nacional de Sintra*. Both are very different from each other and neither has been studied in detail, although their interest would recommend it. One of these covers the central space of the presbytery of the palace chapel [4, image p.28] and has been dated to the third quarter of the 15th century, given that, by constructional logic, it must have been installed before 1470, the year in which the altarpiece presiding over this space was commissioned. This dating is consistent with the style of the work. The glazes on this floor are quite worn from use, but, in general, the composition is well preserved and restored with pieces that were installed at a later date. In terms of its geometry and the colours of its glazes, it resembles some contemporary tiles made in Seville or by documented Sevillian potters who worked in other parts of Andalusia, Extremadura, Castille, Leon and Aragon. Some authors have also pointed to a possible Moroccan origin. Santos Simões mentioned a possible origin in Toledo [3,

pp.57-58], while Reynaldo dos Santos points to similarities with the floors of Andalusia [4, pp. 28-29].

The other tiled floor is that of the supposed bedroom of king Afonso VI (1643-1683) [3, plates VIII-VIIIA]. Although its application is much older than the chronology of that monarch, we have no arguments to date it, although the presence of tiles that seem to be decorated by the *cuerda seca* process could be dated to the second half of the 15th century. Reynaldo dos Santos atributes them to Fernán Martínez Guijarro [4, p. 29]. However, as the production of this Sevillian potter has not yet been analytically identified, but only by documentary means, it seems risky to venture such a hypothesis, or even a Sevillian origin, given that nothing similar to this floor has been found in western Andalusia, unlike the floor of the Sintra chapel.

A fragment of tiled paving has recently been found *in situ*, although in a very modified architectural context, on the site of the former convent of *Nossa Senhora da Graça*, in Tavira [5]. It is of the same type as the floor of the palace chapel in Sintra and can therefore be dated from the mid-14th to the 15th century. Although the above are only isolated examples, these facts prove that in Portugal there were floors in the Mudéjar tradition, although we do not actually know where they were made and who may have installed them.

However, the floor of the small oratory of the Palace of Bacalhôa should be much more recent and fits, in terms of style, into the late Mudéjar tradition which, in the case of Seville, persisted throughout the 16th century. But neither Santos Simões nor Reynaldo dos Santos seem to have been aware of its existence, maybe because of its secluded location n the Palace.

3. ANALYTICAL CHARACTERIZATION BY SEM-EDS

3.1. Samples

For technical reasons the number of samples was limited to seven. Since the centre of the floor is the place where more colours are to be found (two shades of white and three or four shades of blue) it was decided to concentrate the sampling there instead of dispersing it throughout the area. Also, the central area must have been the first to be laid and the condition of the tiles suggests that it is composed of mostly original elements, while other areas may have been restored or recomposed over the years. The two last samples were collected from the periphery at both sides of the room.

Figure 6 illustrates the sampling spots and the codes through which the samples were referenced. Sampling was done with a scalpel removing only very small scales, except in areas where the glaze had already been lost, allowing the collection of a slightly larger piece of biscuit. The tiles selected for sampling (representing two shades of white and three shades of blue) were already noticeably decayed which, besides making the sampling easier, ensured that the pieces selected could not have been applied in eventual 20th century restoration works.

Table 1 includes data on each sample and its analytical use.

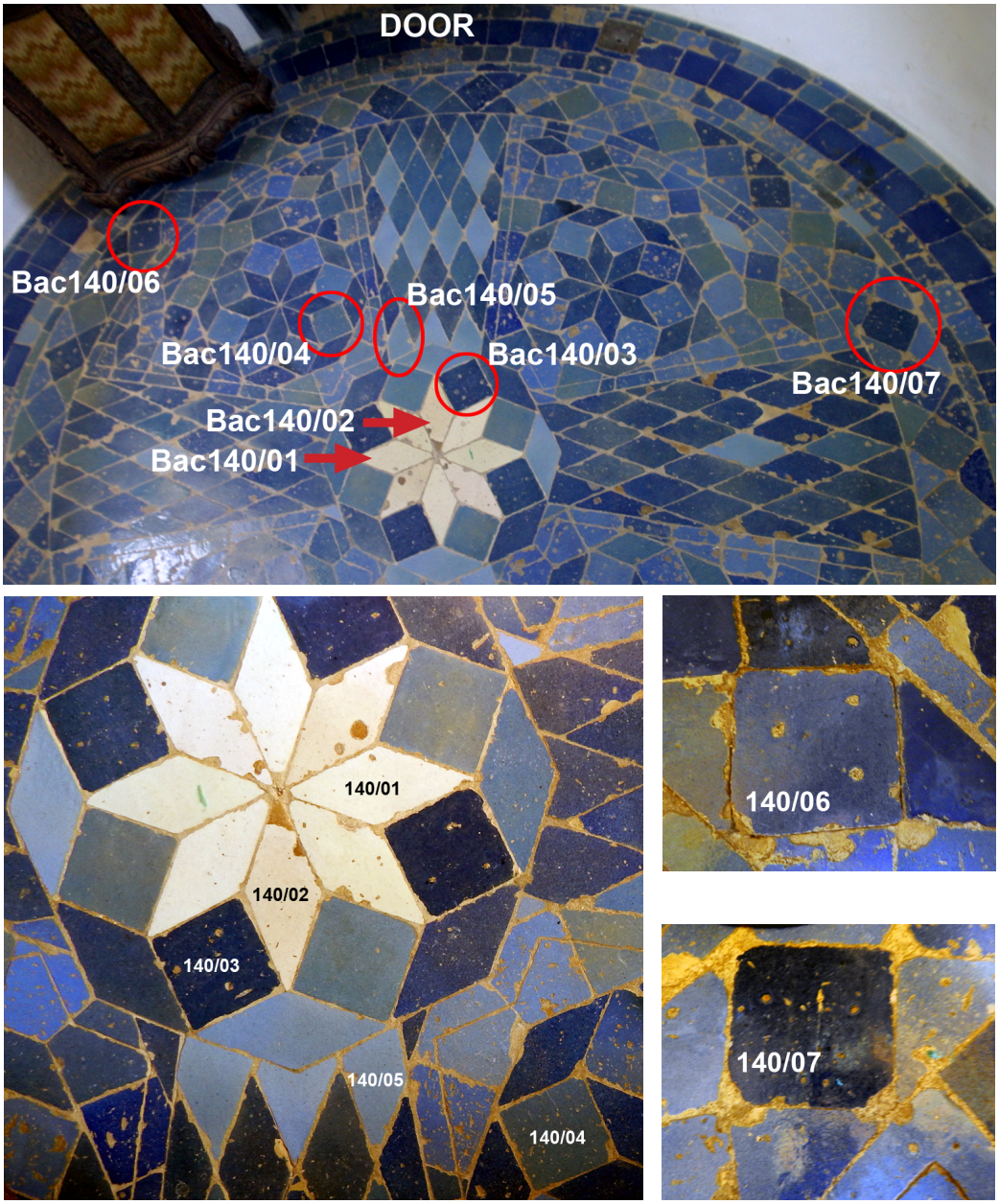


Figure 6. Sampled elements and reference codes.

Table 1. Identification of items and sample references

Identification	Sample Ref.	Number of analyses performed
White rhombus, with no stilt marks	**Bac140/01**	**glaze (1); biscuit (2)**
White rhombus, darker hue, with no stilt marks	**Bac140/02**	**glaze (2); biscuit (1)**
Deep blue square with stilt marks	**Bac140/03**	**glaze (2); biscuit (-)**
Medium blue square, with no stilt marks	**Bac140/04**	**glaze (2); biscuit (1)**
Light blue quadrilateral, with no stilt marks	**Bac140/05**	**glaze (2); biscuit (2)**
Dark blue square with stilt marks	**Bac140/06**	**glaze (3); biscuit (2)**
Dark blue square with smaller stilt marks	**Bac140/07**	**glaze (1); biscuit (1)**

3.2. Methods and instrumental means

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

The optical images of the sections were acquired with an Olympus DP20-5 digital camera coupled to an Olympus SZH stereomicroscope. SEM observations and EDS analyses were made at LNEC using a TESCAN MIRA 3 field emission microscope combined with a BRUKER XFlash 6|30 EDS system. The samples were uncoated and the observations were made in backscattered electrons mode (BSE), with a chamber pressure of typically 10 Pa, at an accelerating voltage of 20 kV with the sample sections at a distance of 14 ± 1 mm from the detector. SEM images were typically acquired at magnifications of 350 x and 700 x for the glaze and 1,000 x or over for inclusions in the biscuit.

The selection of areas for EDS quantification avoided large inclusions in the glaze or biscuit representing more than ca. 5% of the full selected area. From our previous experience, the adequate minimum measurement areas are 200 x 200 μm for glazes and 500 x 500 μm for biscuits. In general, multiple measurements were made and in such case the results are averages and smaller non-overlapping areas may be used to the same effect.

Minor elements, usually representing less than 1% of the compositions, such as magnesium (Mg) and iron (Fe) in the glazes, or titanium (Ti) in the biscuits were not included in the tables of results.

The quantification of tin (Sn) in the glazes may be problematic because the aggregation of crystals often results in a large variance. That problem was dealt with by using larger areas whenever aggregation was visually detected in the SEM images or, when that was not possible, averaging the results of multiple analyses on different areas.

The amount of oxygen (O) was calculated through the remaining elements stoichiometry of their most commonly considered oxides (Na_2O, MgO, Al_2O_3, SiO_2, K_2O, CaO, Fe_2O_3, SnO_2, PbO) and the result was normalized to 100 %.

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

3.3. Results

3.3.1. Optical microscopy of samples

Figure 7 depicts optical images of a selection of samples of which the terracotta colour of samples Bac140/04 and Bac140/05 is particularly remarkable. Samples Bac140/06 and Bac140/07 have a cream colour similar to those of the top row of Figure 7.

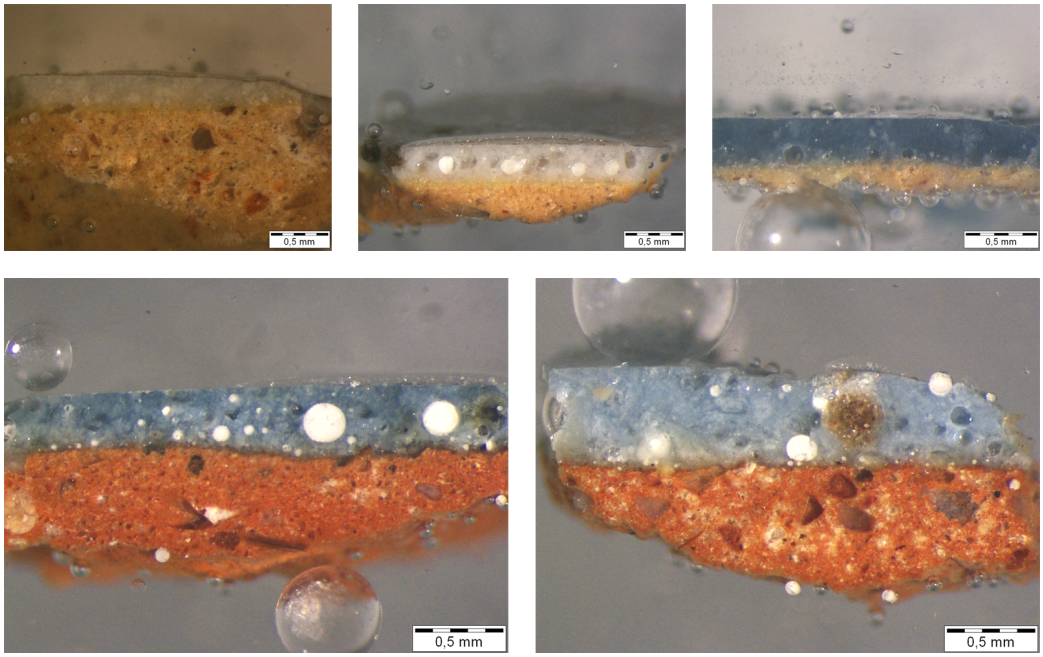
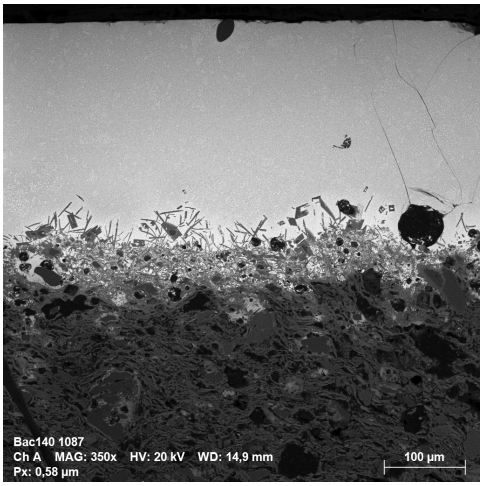
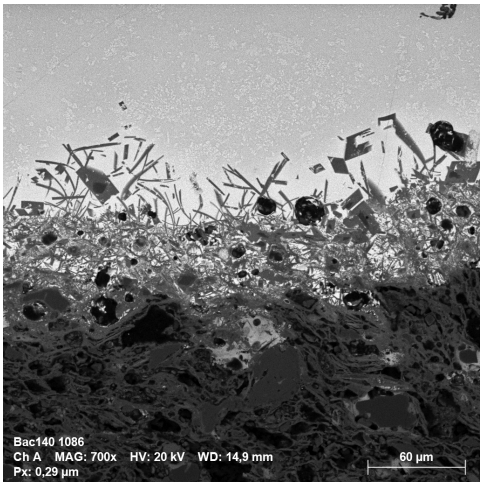


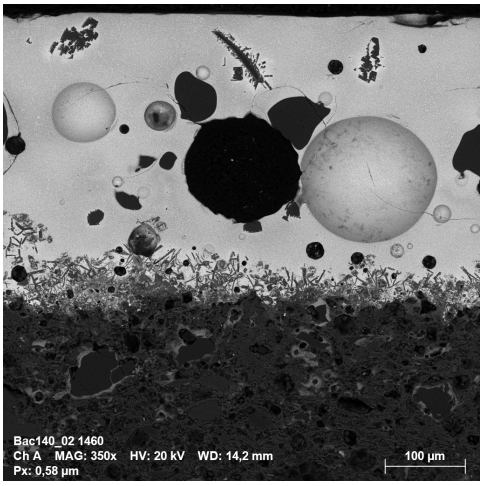
Figure 7. Top row, from left to right: Bac140/01; Bac140/02 and Bac140/03. Bottom row, from left to right: Bac140/04 and Bac 140/05 (images: LNEC).

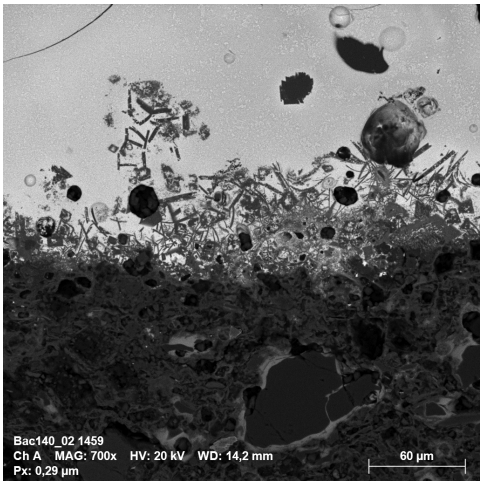
3.3.2. Morphology

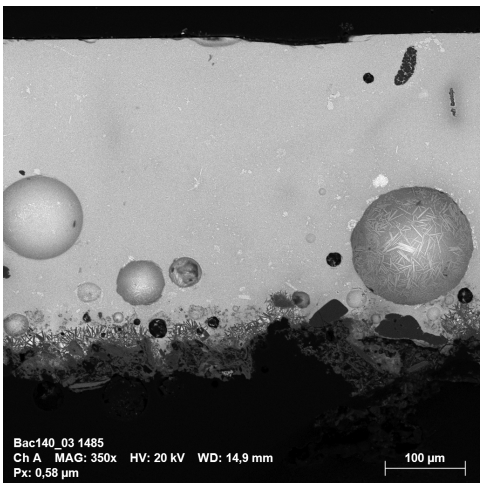
Figure 8 depicts, at the same magnifications for comparison purposes, sectional SEM images of the samples showing the main micro-morphological characteristics generally associated with the glazes and their interfaces. The light grey area on top is the glaze, while the dark grey area corresponds to the biscuit. Because of its colour, the inclusions in the glaze are conspicuous: gas bubbles retained in the glass, grains of sand (larger compact dark inclusions, usually with rounded edges) and bits of feldspars, often in disaggregation. The white specks in the midst of the glaze are aggregations of crystals of the white pigment (tin oxide).

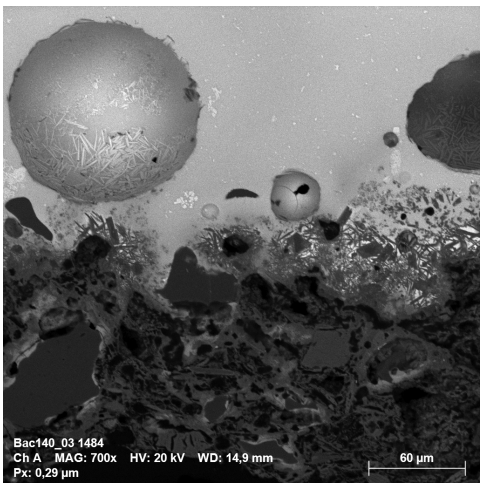

Bac140 1087
Ch A MAG: 350x HV: 20 kV WD: 14,9 mm
Px: 0,58 µm
100 µm


Bac140 1086
Ch A MAG: 700x HV: 20 kV WD: 14,9 mm
Px: 0,29 µm
60 µm


Bac140_02 1460
Ch A MAG: 350x HV: 20 kV WD: 14,2 mm
Px: 0,58 µm
100 µm


Bac140_02 1459
Ch A MAG: 700x HV: 20 kV WD: 14,2 mm
Px: 0,29 µm
60 µm


Bac140_03 1485
Ch A MAG: 350x HV: 20 kV WD: 14,9 mm
Px: 0,58 µm
100 µm


Bac140_03 1484
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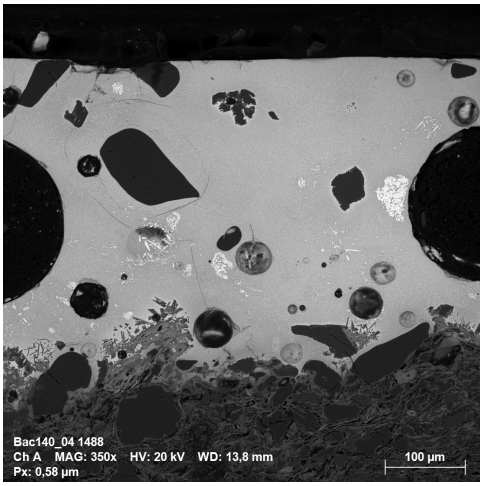
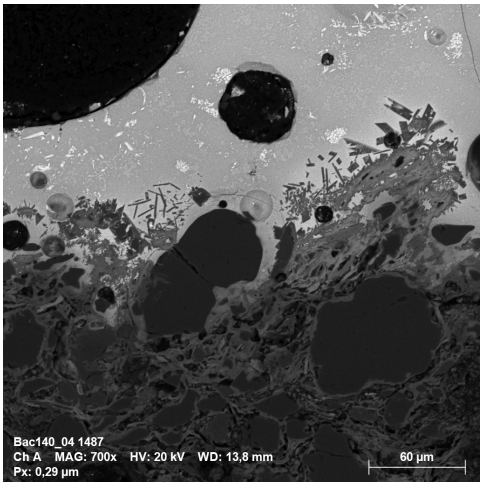
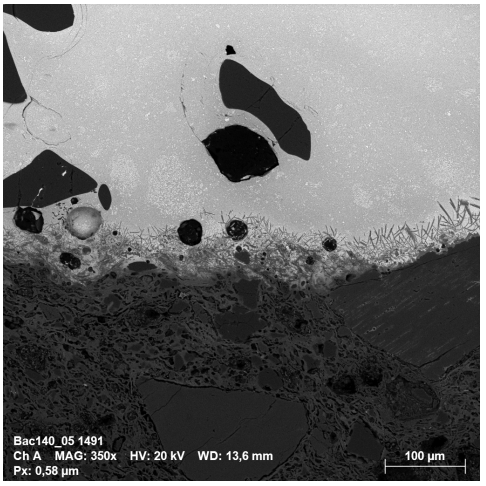
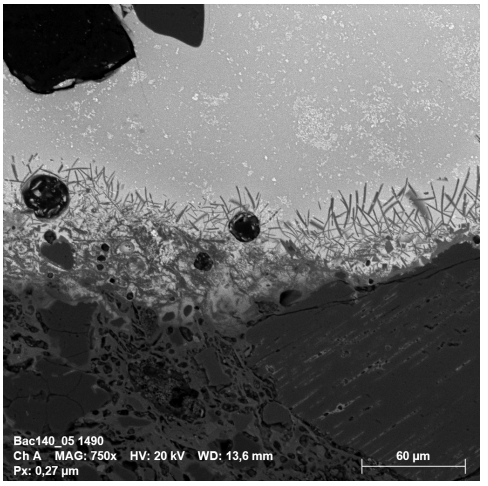
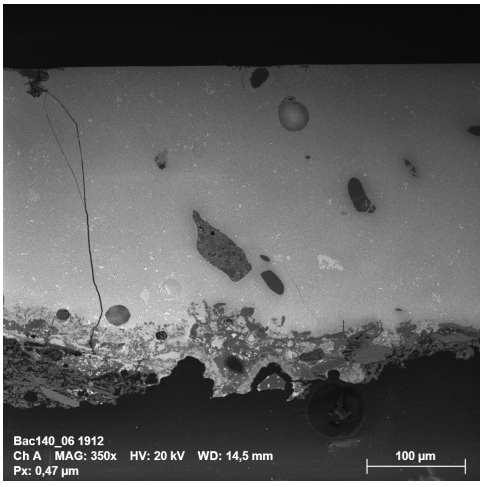
60 µm

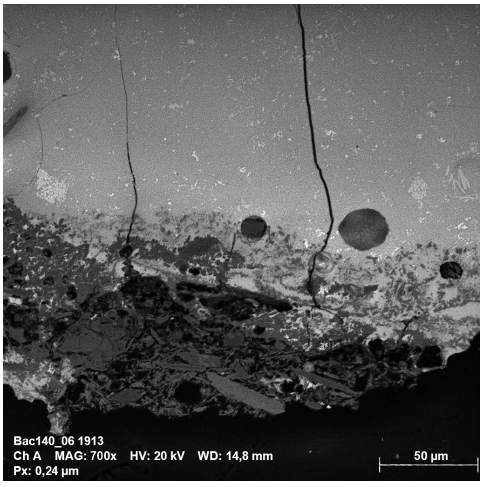

Bac140_04 1488
Ch A MAG: 350x HV: 20 kV WD: 13,8 mm
Px: 0,58 µm
100 µm


Bac140_04 1487
Ch A MAG: 700x HV: 20 kV WD: 13,8 mm
Px: 0,29 µm
60 µm


Bac140_05 1491
Ch A MAG: 350x HV: 20 kV WD: 13,6 mm
Px: 0,58 µm
100 µm


Bac140_05 1490
Ch A MAG: 750x HV: 20 kV WD: 13,6 mm
Px: 0,27 µm
60 µm


Bac140_06 1912
Ch A MAG: 350x HV: 20 kV WD: 14,5 mm
Px: 0,47 µm
100 µm


Bac140_06 1913
Ch A MAG: 700x HV: 20 kV WD: 14,8 mm
Px: 0,24 µm
50 µm

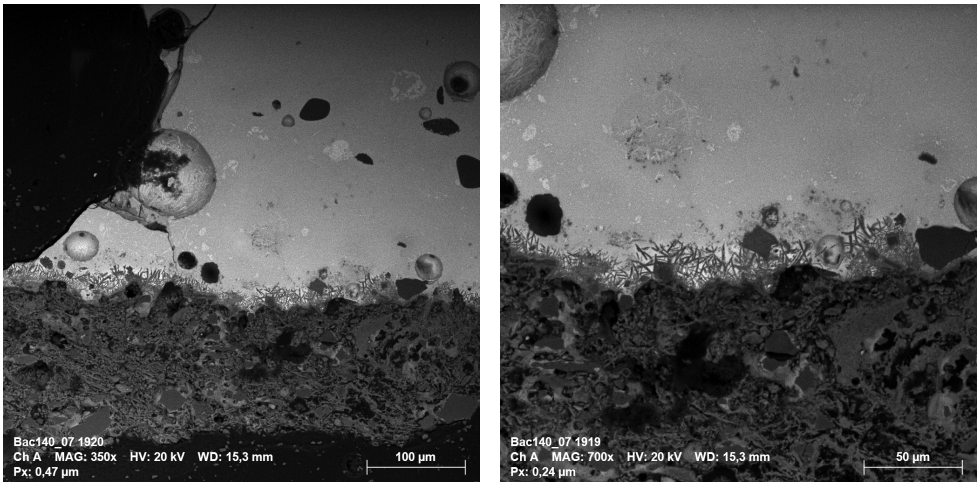
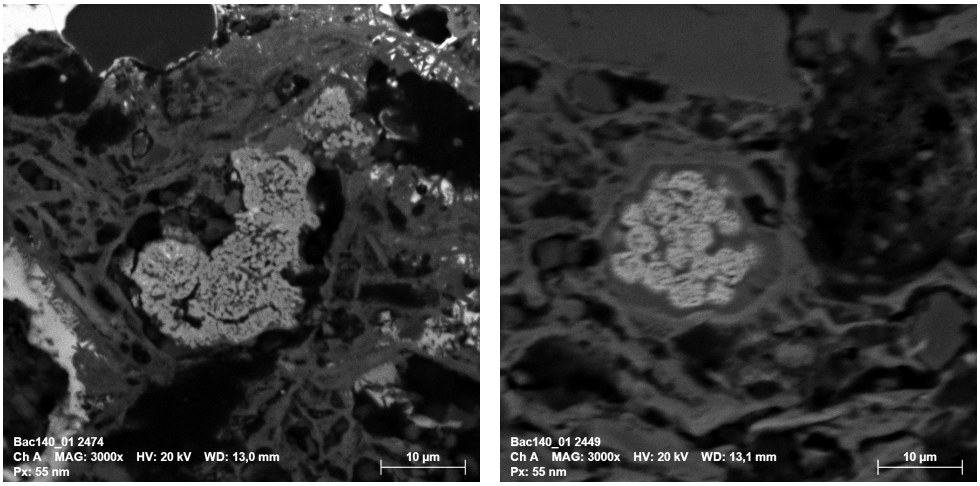


Figure 8. SEM-BSE images showing the main micro-morphological characteristics of, from top to bottom, Bac140/01, Bac140/02, Bac140/03, Bac140/04, Bac140/05, Bac140/06 and Bac140/07. Left side: glaze section at 350 x; Right side: detail of the biscuit-glaze interface at 700 x (images: LNEC).

Figures 9 and 10 depict images of morphological aspects or inclusions noted in the biscuits: framboidal crystallizations of pyrite [6] and rhombohedral dolomite crystals [7], not totally consumed over firing.



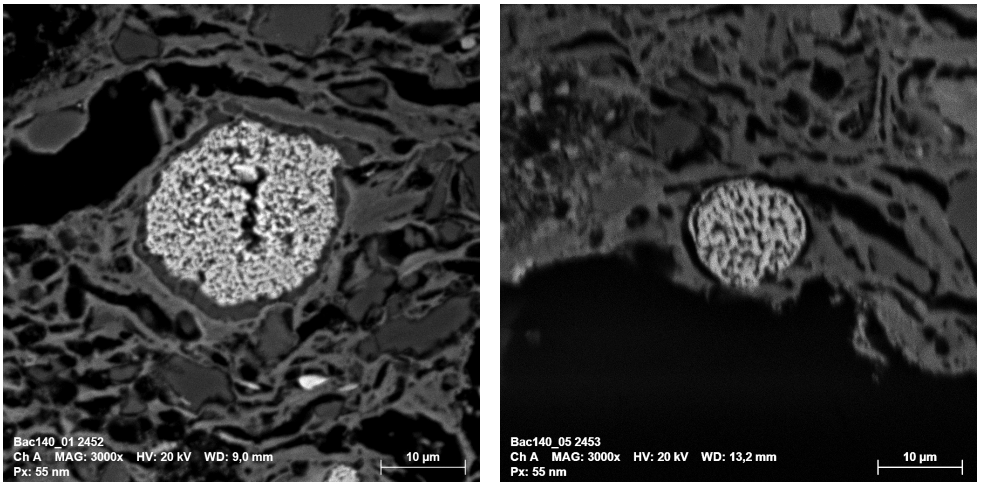


Figure 9. Top row: pyrite framboids in the biscuit of Bac140/01; lower row: more framboidal crystallizations of pyrite in the biscuits of Bac140/01 (left side) and Bac140/05 (right side) (images: LNEC).

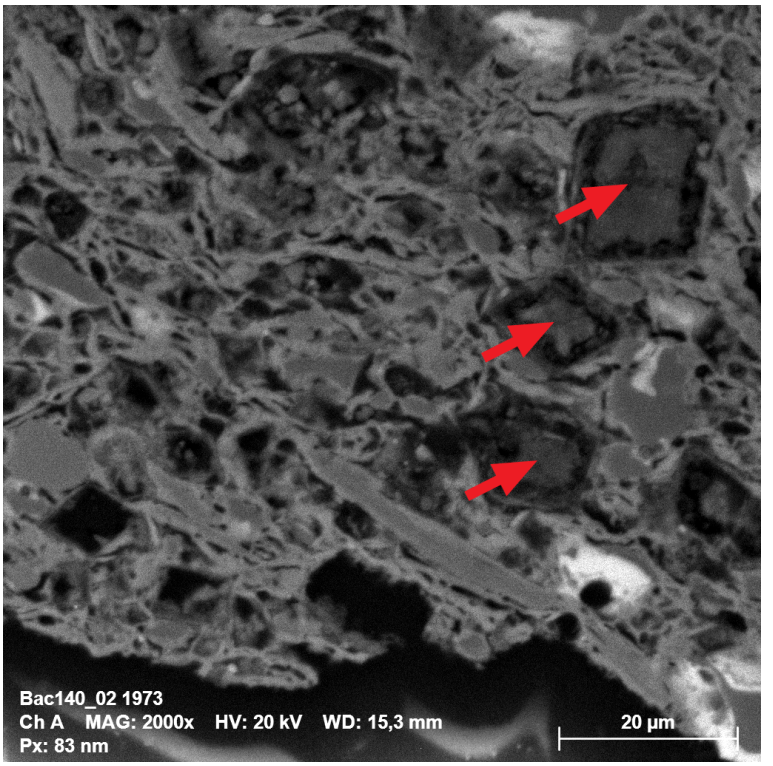


Figure 10. Rhombohedral dolomite crystals, not totally consumed over firing, in the biscuit of Bac140/02 (image: LNEC).

3.3.3. Glaze compositions

Table 2 includes the semi-quantitative results of analyses of the glazes by EDS in weight %. The silicon to lead ratios (Si/Pb) have been determined and are also included in the table. This ratio is a technological trait set by the glaze recipe and gives important information about the firing conditions in the kiln because the lower the ratio, the lower the temperature at which the glaze could be properly fired.

Table 2. Semi-quantitative composition of the glazes determined by EDS (values in wt. % with oxygen obtained by stoichiometry and sum of all elements normalized to 100%)

	O	Na	Al	Si	K	Sn	Pb	Si/Pb
Bac140/01	28.03	0.45	2.76	16.48	1.82	7.20	43.25	0.38
Bac140/02	26.14	0.35	2.01	14.57	1.77	11.41	43.74	0.33
Bac140/03	30.66	1.32	1.61	19.99	2.01	3.15	41.26	0.48
Bac140/04	29.13	0.56	2.57	17.26	1.54	8.76	40.17	0.43
Bac140/05	29.71	0.26	2.77	17.77	1.69	8.12	39.68	0.45
Bac140/06	34.47	2.03	1.50	22.70	3.77	4.10	31.43	0.72
Bac140/07	30.66	1.41	1.48	19.92	2.02	2.31	42.21	0.47

3.3.4. Biscuit compositions

Table 3 includes the semi-quantitative results of analyses of the biscuits in weight %. The calcium to silicon (Ca/Si) ratios, related with the suitability of the clay to tin-glazing, have been determined and are included in the table.

Table 3. Semi-quantitative composition of the biscuits determined by EDS (values in wt. % with oxygen obtained by stoichiometry and sum of all elements normalized to 100%)

	O	Na	Mg	Al	Si	K	Ca	Fe	Ca/Si
Bac140/01	44.71	1.15	1.71	8.95	23.67	1.78	13.84	4.20	0.58
Bac140/02	42.28	0.61	3.62	6.93	19.78	2.17	20.38	4.22	1.03
Bac140/03	43.71	1.28	2.29	7.08	23.03	2.29	16.49	3.84	0.72
Bac140/04	47.23	1.09	0.83	8.72	28.91	3.12	6.39	3.70	0.22
Bac140/05	45.64	0.65	1.35	9.85	25.23	3.27	9.38	4.62	0.37
Bac140/06	43.29	1.55	2.00	6.32	22.58	1.32	19.23	3.70	0.85
Bac140/07	44.32	0.76	1.97	6.05	25.02	1.83	16.79	3.26	0.67

4. DISCUSSION OF THE INSTRUMENTAL RESULTS

4.1. The glazes

The morphological characteristics of the glazes are broadly compatible with the productions of the Lisbon workshop of João de Góis and his circle, namely as respects the profusion of crystals at the interface between the glaze and the biscuit [8, fig. 7], especially remarkable in samples Bac140/01, -/02 and -05. Therefore, in this case, the interfacial outgrowths do not allow an aggregation in separate clusters.

Glazes from the 16th century use three main fusing agents: sodium (Na), potassium (K) and lead (Pb) which must be balanced in the recipes. Portuguese azulejo panels may be separated from known Spanish and Flemish productions, as well as from later Portuguese productions, by their very low contents in sodium and potassium, two chemical elements that are incorporated by the potter as weighted raw materials, as well as by the low Si/Pb ratios [8; 9]. For a graphical assessment based on those two characteristics, Figure 11 plots the ratio (Na+K)/Pb against Si/Pb for all samples (the normalization to the content in lead enhances the comparability by making all other contents relative to it).

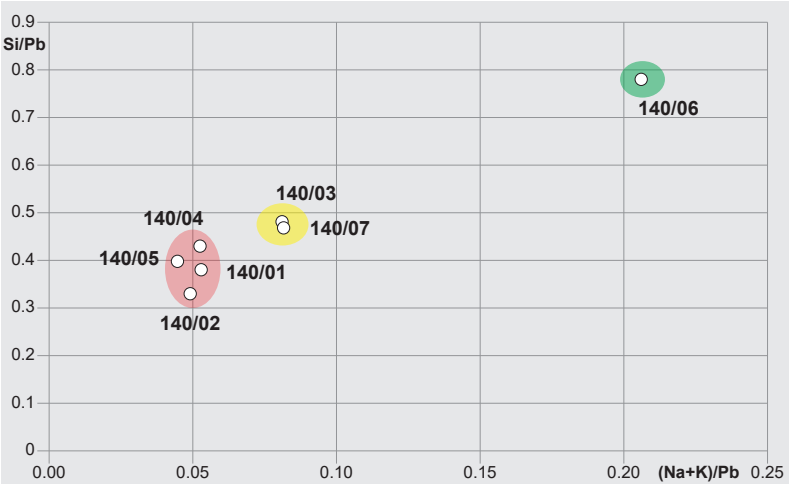


Figure 11. Comparison of the glaze compositions of all the Bac140 samples based on two characteristic content ratios.

Figure 11 clearly defines three clusters on the basis of the ratios compared: one is formed by samples Bac140/01; -/02; -/04 and -/05 (red cluster), while the remaining samples constitute two more clusters (yellow and green- this one with a single element).

Figure 12a compares the EDS spectra of Bac140/01 from the red cluster with one from the yellow cluster (Bac140/07) evidencing the very clear difference pertaining the low contents in sodium (Na) but also the higher contents in aluminium (Al) and tin (Sn) of the red cluster, extending to all of its four elements as may be verified from Table 2. In the yellow cluster, the contents in potassium are only slightly higher but in Bac140/06 (green cluster) the content is much higher.

The spectra may be compared with previously published reference spectra [8, p. 43] to confirm that the spectrum of Bac140/01, used to characterize the red cluster, conforms only with productions of the workshops of Lisbon, while those in the yellow cluster, with low contents in aluminium and tin and high Si/Pb ratios, are only similar, of the provenances studied, to mid-16th century Hispano-Moresque productions of the workshops of Seville. Figure 12b includes two such EDS spectra for comparison with the ones above them.

The composition of Bac140/06 is separated by its low content in lead compensated by higher contents in sodium and potassium. Following a graphical technique [10] Figure 13 offers a comparison of spectra of this sample with one from the yellow cluster, showing that the glaze formulations differ only markedly in the balance of fusing agents,

presumably aiming at a lower use of the expensive lead oxide by the workshop that manufactured the tile from which Bac140/06 was collected.

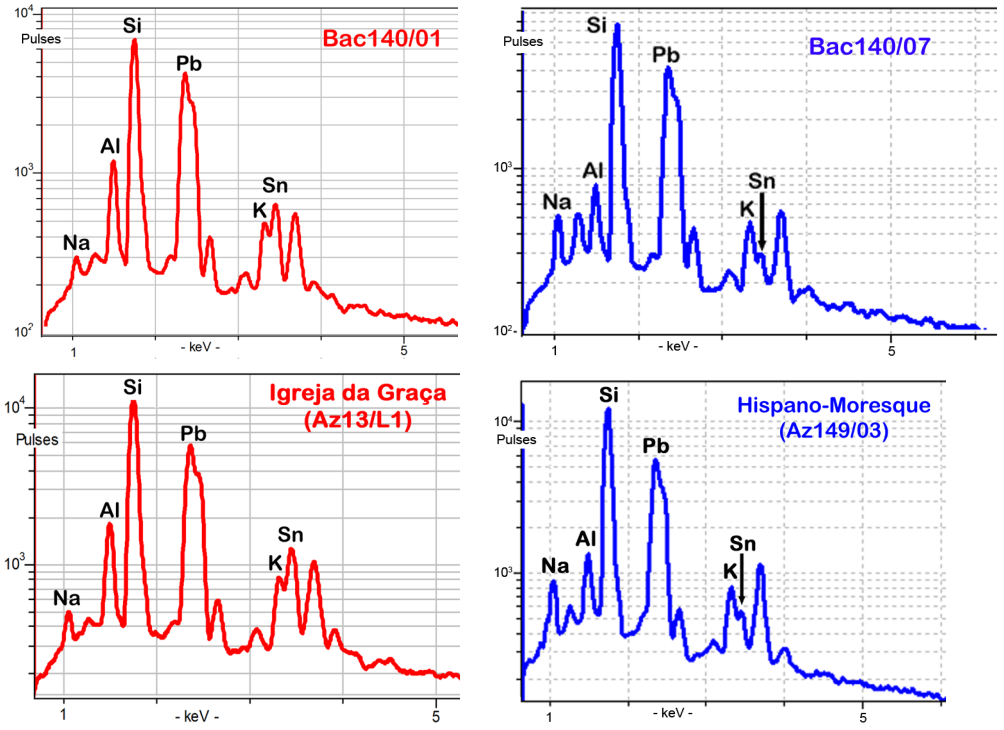


Figure 12. Top (12a) - Comparison of EDS glaze spectra of Bac140/01 (red cluster) and Bac140/07 (yellow cluster). Bottom (12b) - EDS glaze spectrum of one of the tiles bearing the monogram of João de Góis at *Igreja da Graça* and typical glaze spectrum of mid-16th century Hispano-Moresque Sevillian blue or green tiles.

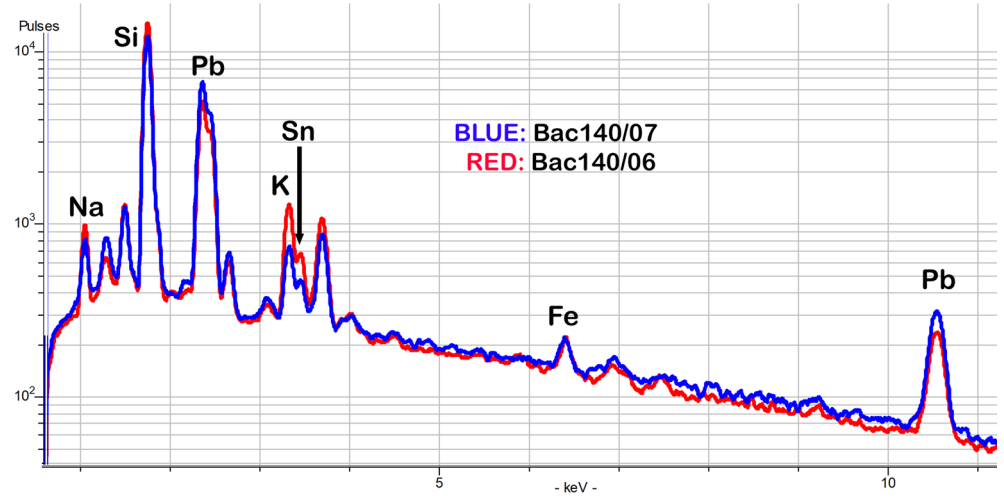


Figure 13. Superposition of the spectra of Bac140/07 from the yellow cluster and Bac140/06 from the green cluster for a graphical comparison of compositions.

The red cluster in Figure 11 includes two white tiles (samples Bac140/01 and -/02) and two blue tiles (samples Bac140/04 and -/05) and yet, from Table 2, the contents in tin (Sn) of the blue tiles are comparable to those of the white tiles. This is surprising, because a blue glaze needs much less tin than a white glaze, exactly as may be seen in the case of Bac140/03, and suggests that in both Bac140/04 and -/05, the blue pigment was added to a raw white glaze with a tin content compatible with majolica, while in Bac140/03 the tin content was low and finely balanced with the blue cobalt pigment as in Hispano-Moresque tiles manufactured in Seville. The images in Figure 7 are revealing: while in Bac140/04 and -/05 the glaze looks whitish, in Bac140/03 it looks blue and transparent, because its composition has little of the expensive tin, as befits a coloured glaze.

To support a better insight into the provenance of the tiles, a log-based principal component analysis (PCA) was performed comparing the elemental chemical composition of the glazes of the samples taken from the floor to those of other 16th century productions researched in the past, namely samples from the tiles in *Igreja da Graça* signed by João de Góis [8, figure 2; 11], the panel *Nossa Senhora da Vida* also by his workshop [8, figure 4], samples of Hispano-Moresque tiles ascribed to the workshops of Seville [8, figure 1], and the Albuquerque coat-of-arms in Bacalhôa which we concluded to be likely of foreign production [12] as well as the *Rape of Europa* panel, also in Bacalhôa, that we ascribed to a Portuguese workshop, likely that of João de Góis [13]. The semi-quantitative compositions obtained from [8] did not include the contents in tin (which, anyway, should not be used when comparing majolica with Hispano-Moresque tiles because these may have much less tin in their compositions) and therefore all elemental contents in the other cases were re-calculated for the PCA without considering the contents in tin.

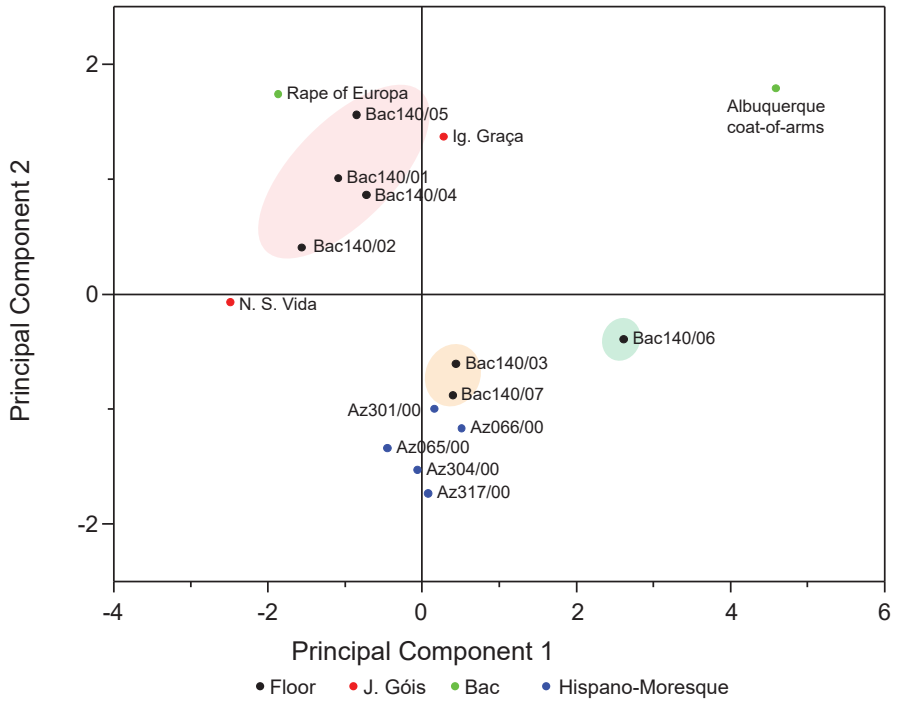


Figure 14. Score plot of the Principal Component Analysis of the glazes compared to those of known types.

The result of the PCA analysis of the glazes is presented in Figure 14 through a plot in the plane of the two first principal components (PC1 and PC2). PC1 explains 58 % of the variation and is controlled in the positive sense by the contents in sodium (Na), silicon (Si) and potassium (K), and in the opposite sense mostly by the contents in lead (Pb). PC2 explains 31 % of the variation and is controlled in the positive sense mostly by the contents in aluminium (Al), and in the opposite sense by the contents in sodium and lead, as seen in Figure 15, where the loadings plot is represented as a vector graph. Given the percentages of variation explained by each principal component, the planar projection of Figure 14 accommodates graphically ca. 90% of the compositional variation of the glazes of all test items included in the PCA analysis.

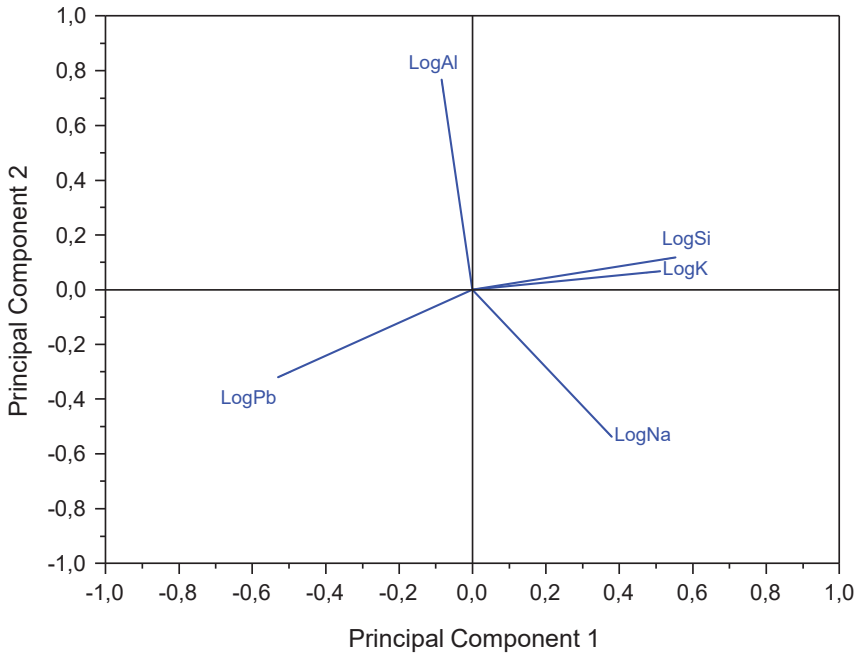


Figure 15. Loadings plot of the Principal Component Analysis of the glazes.

The score plot in Figure 14 is very clear and shows that: i) none of the glazes is similar to that of the Albuquerque coat-of-arms; ii) the glaze of two of the tiles with the stilt marks (Bac140/03 and Bac140/07 - yellow cluster) is only similar, in the group, to Hispano-Moresque glazes, while that of Bac140/06 (green cluster) is closer to them than to the others and mostly separated by its lower content in lead; iii) finally, the other four glazes can be clustered with the João de Góis panels in *Igreja da Graça* and the panel *Nossa Senhora da Vida*, as well as with the *Rape of Europa*, because in the projection of Figure 15 they fall within a small area (red cluster), exactly inside a triangle defined by the average compositions of those three panels which represent a chronologic period of 10 to 15 years.

The stilt marks on the tiles from which Bac140/03, -/06 and -/07 were collected suggest a Hispano-Moresque technology as used in Seville. As far as we know, to avoid such unsightly marks and increase the number of tiles that could be fired together, Flemish potters have always fired tiles upright, over two cylinders of rolled clay (Figure 16), occasionally causing the running of dense paint as is often seen in the patterned tiles and figurative panels of Bacalhôa.



Figure 16. A fragment of tile that was never applied and still has adhered one of the supporting cylinders for firing upright (image: *Museu do Palácio da Bacalhôa* c. Associação de Colecções | The Berardo Collection).

4.2. The biscuits

The interpretation of the composition of biscuits is very different from the interpretation of glaze compositions, because clays are natural products and not the result of a man-made recipe. Also, they are naturally variable, even if extracted from the same pit, because the layers result from tens of thousands, sometimes more than a million years of natural deposition and transformation, and the composition of a layer representing such a long period may vary considerably as the extraction attains deeper sublayers of clay.

The result of a comparative PCA analysis of the biscuits of all the samples studied with the same tiles and panels previously identified is presented in Figure 17 through a plot in the plane of the two first principal components (PC1 and PC2). PC1 explains 59 % of the variation and is controlled in the positive sense mostly by the contents in aluminium (Al), silicon (Si), potassium (K) and iron (Fe), and in the opposite sense mostly by the contents in magnesium (Mg) and calcium (Ca). PC2 explains 20 % of the variation and is controlled in the positive sense mostly by the content in magnesium and iron, and in the opposite sense by the contents in sodium (Na) and silicon (Si), as seen in Figure 18, where the loadings plot is represented as a vector graph. The planar projection of Figure 17 accommodates graphically ca. 79 % of the compositional variation of the biscuits of all test items included in the PCA analysis.

The score plot of the PCA in Figure 17 shows that: i) the biscuit of sample Bac140/02 is very similar to that of the Albuquerque coat-of-arms panel (green cluster); ii) samples Bac140/03, -/06 and -/07 fall together (blue cluster) in the midst of the Hispano-Moresque tiles; iii) Bac140/01, -/04 and -/05 are dispersed in the first and fourth quadrants where the panels attributed to the circle of João de Góis are set too- they could reasonably be clustered together because they stand alone thanks to their low contents in calcium and magnesium and relatively high in aluminium and potassium (red cluster represented in three separate groups).

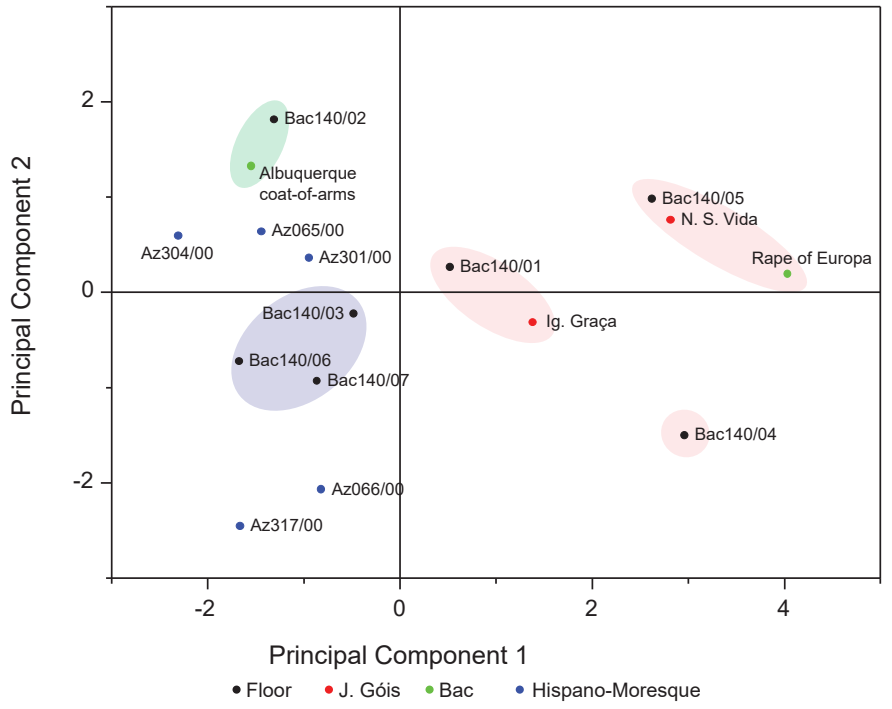


Figure 17. Score plot of the Principal Component Analysis of the biscuits compared to those of known types.

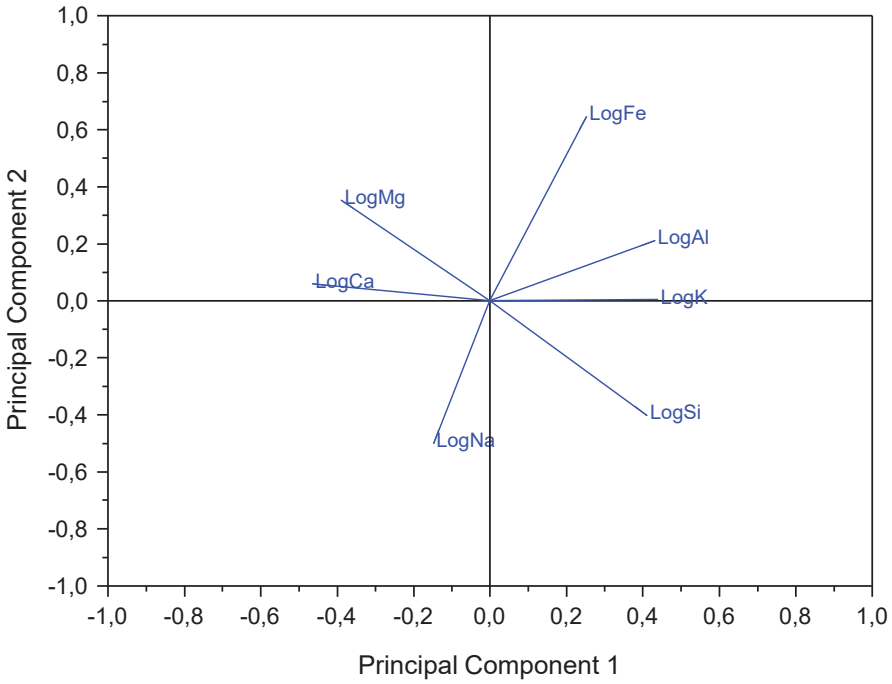


Figure 18. Loadings plot of the Principal Component Analysis of the biscuits.

The rhomboid-shaped hollows of euhedral dolomite crystals that characterize the biscuits of imported tiles, as well as the biscuits that were presumably imported unglazed [7; 12] are also present in the biscuit of Bac140/02 (Figure 10). Therefore, although the tile was very likely glazed in Lisbon as shows the PCA of the glazes in Figure 14, the biscuit belongs to the set that was likely imported (or else was made with imported clay) and because of that it clustered in the biscuit PCA of Figure 17 with the Albuquerque coat-of-arms panel.

As for the biscuits of Bac140/04 and -/05, they share the characteristics of the clay used by the circle of João de Góis [8]. Bac140/01 deviates from them, particularly in the high content in calcium, resulting in a cream-coloured biscuit, while the clays used in Bac140/04 and -/05 result in terracotta-coloured biscuits (Figure 7). We have already encountered biscuits similar to that of Bac140/01, with relatively high contents in calcium, in the production of João de Góis, precisely in the tiles that bear his monogram at *Igreja da Graça* [11], explaining their proximity in the PCA plot of Figure 17. A further point to note in the comparison is that the regular and aggregated framboidal crystallizations of pyrite, as found particularly in Bac140/01 (Figure 9), also occur in the biscuits of tiles by the workshop of João de Góis at *Igreja da Graça* (Figure 19) and elsewhere. Although such crystallizations are known in several clays, they are not a particularly common feature.

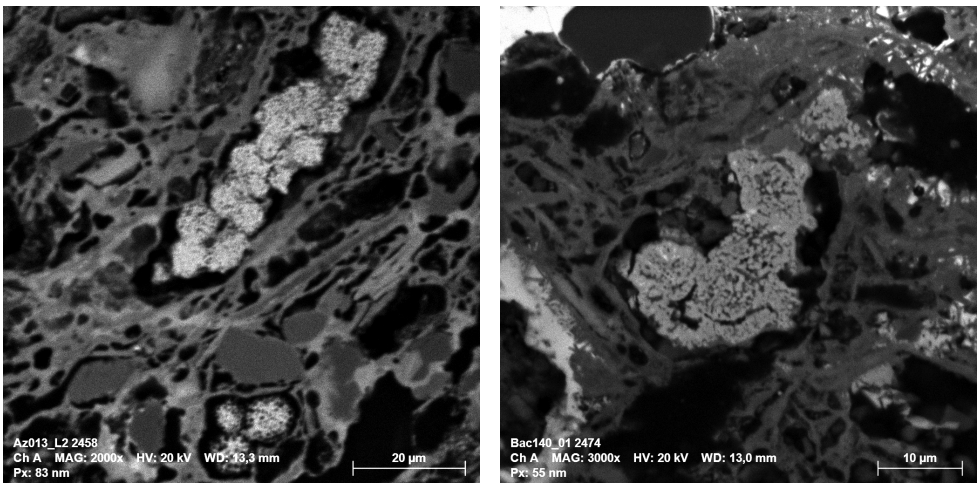


Figure 19. Framboidal pyrite in the tiles of *Igreja da Graça* signed by João de Góis (Az013/L1- left side) and the Bacalhôa oratory floor (Bac140/01 - right side) (images: LNEC).

5. CONCLUSIONS

The only tiled floor remaining at the *Palácio da Bacalhôa* graces a former oratory and is a masterpiece of which no existing peers are presently known to us. Seven tiles were sampled, five of them from the centre of the floor, where more colours and hues are present. Therefore, taking into consideration the variability seen in the floor itself, the conclusions are drawn from a relatively small number of pieces. Still, the results form a coherent image and we believe that, notwithstanding the eventual occurrence of individual elements that may have been renovated, as suggested by tiles of unusual shades of blue found here and there, the conclusions are generally applicable to the whole floor.

Tiles of at least two different geographic provenances were identified. The tiles marked "1" in Figure 20a, one of which corresponds to sample Bac140/03, have stilt marks, as have tiles 140/06 and 140/07 in Figure 8, and the composition of their glazes is unknown to us from Portugal at the time when the floor was presumably laid. The results suggest that they were probably manufactured in Seville, Spain. But while the biscuits of all three tiles are similar, two different glazes were identified in them, only one of which (that of Bac140/03 and 140/07) is fully compatible with the glazes of mid-16th century Hispano-Moresque tiles that we researched in the past. The other, even though still compatible with a 16th century chronology, may be from a different workshop or from the same workshop but at a later time, when the technology had evolved towards a reduction in the use of lead which was an expensive raw material.

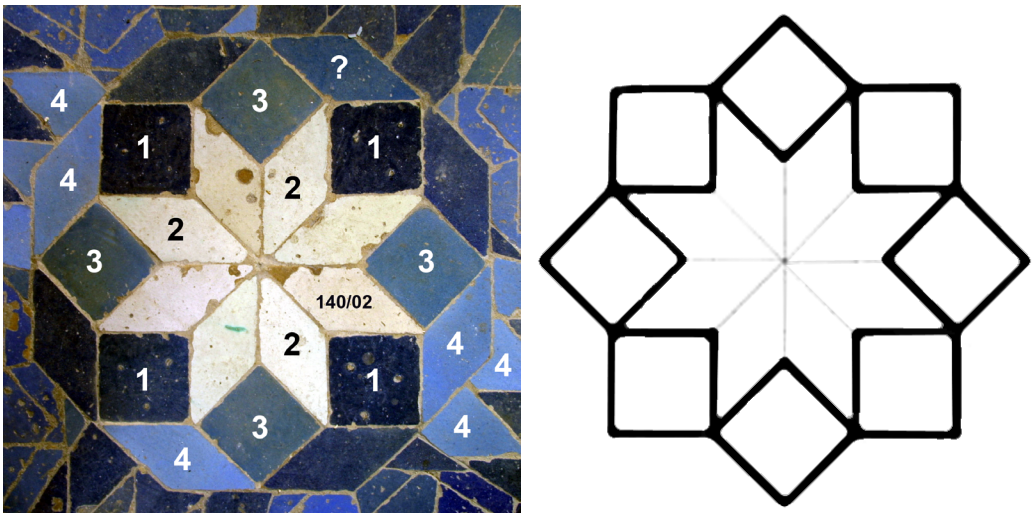


Figure 20. Left side (20a) - The chromatic elements of the central star of the oratory floor; Right side (20b) - The geometric design based on Islamic eight-pointed star patterns.

All the other tiles studied have glazes morphologically and compositionally compatible with the 16th century productions of the Lisbon workshop of João de Góis where azulejos were already being manufactured in 1561 [14]. One of these tiles (marked 140/02 in the image of Figure 20) was very likely glazed over a foreign biscuit, part of a large set imported around 1565 [7; 15]. However, results point to the use of Portuguese clay for the remaining biscuits (Bac140/01, -/04 and -/05). One of them is glazed in white and its biscuit is richer in calcium than the rest, a composition similar to tiles from the panels of *Igreja da Graça* signed by João de Góis [11] in which the same aggregations of framboidal pyrite were also found. The panels of *Igreja da Graça* may be dated through their inferable connection with the burial there of Afonso de Albuquerque in May 1566 [11]. The clays used in the tiles from which samples 140/04 and 140/05 were collected are similar to those used e.g. in the panel *Nossa Senhora da Vida*, which may be dated to the second half of the 1570s up to 1581 [16].

The different provenances and chronologies point to the widespread use of remainders-tiles that were manufactured by several workshops at different times, maybe for several different purposes, and kept in deposit in the palace for future use. When was the floor laid? The conclusion that a medley of tiles of several provenances and chronologies was

used, only allows stating 1565 as an *ex post* date. A likely date would set the floor in the 1570s because of the presumed chronologies of the tiles made in Lisbon and also because around 1565, when the lining of Bacalhôa with majolica tiles was proceeding at full pace and, presumably, on a "cost no object" basis [1; 15], the decision would very likely have been to purchase new tiles of homogeneous colours, instead of using remainders with such a variety of hues, often colliding with what might be expected from a symmetrical design, as in the case of the pieces marked "4" in Figure 20a with which one of the rhombi (marked "?") is at odds.

In the *Museu do Palácio da Bacalhôa* are kept various scratched and worn blue tiles indicating that more such floors once existed in the estate. In the oratory the floor tiles are not worn as should befit a span of around 450 years, however the private use of a space well inside the house adjacent to a bedchamber and the likely use of a carpet from the door to the altar, explain the absence of visible wear. On the other side, the tiles are obviously decayed, particularly those nearer to the walls from where harmful moisture passes on to the floor, and some of these have clearly been renovated sometime in the past. Also, the white tiles at the entrance are broken (Figure 2) suggesting that they may be older than the rest, maybe the only remainders of an earlier floor.

The design of the floor is unique but its star elements, based on the common Islamic eight-pointed star patterns (Figure 20b), follow the 16th century Mudéjar decorative style, with an unusual prevalence of rhombic shapes that makes it all the more interesting. Since many of the tiles are presumably of local manufacture, they must have been cut on site to set shapes and dimensions, rather than imported ready to assemble. Unfortunately, the author of the exquisite design and the master tiler or tilers who carried out the decorative scheme in the *alicatado* manner with such skill will remain unknown, unless documentary evidence is one day found.

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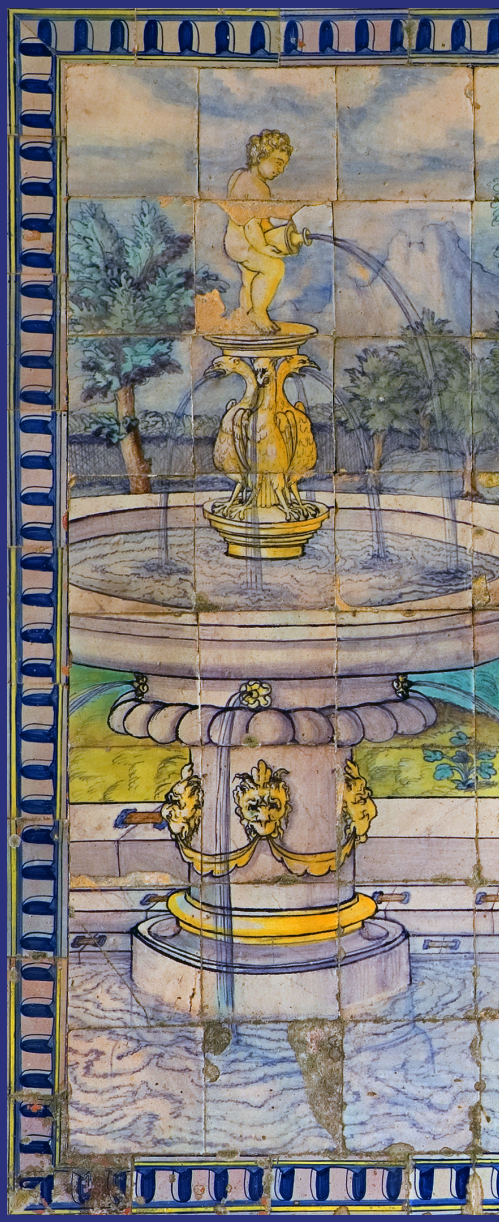

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ISBN 978-972-49-2316-1

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