Integrated methods for reconstructing the decoration and production process of the *frigidarium* wall-paintings, at the Sarno Baths, Pompeii

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Abstract

This paper explores the potentiality of investigating Roman wall decorations by integrating the visual examination of the technical aspects of wall paintings and plasterworks, to the application of virtual reconstruction. It also aims at reconstructing the process of making wall decorations and at identifying the group of artisans that made them, as an occasional group of workers or a properly organized workshop.

The *frigidarium* (i.e. the room with a cold-water pool) in the Sarno Baths was selected as case study to apply this approach. The presence of several missing parts in the decorations allowed the observation of the full stratigraphic sequence of paintings and plasterworks. The visual analysis and the identification of the tool-marks provided the necessary elements to reconstruct the sequence of operations performed by artisans during the process of making the decoration and highlighted the presence of features denoting different people participating in the decoration project. The accurate survey of the paintings preserved portions and archival records allowed the reconstruction of the geometry of the decorative scheme, thus completing the missing parts both on the walls and the vaults. The fully reconstructed decorations were subsequently elaborated in a sequence of intermediate stages, corresponding to the main phases of the productive process. A sample of the surviving wall-paintings was chosen to test the application of virtual conservation, digitally cleaning the surface from salt deposits and integrating small abrasions in the paint layers. Lastly, the potentiality of virtual reconstruction was stretched further, as it was used to reconstruct a set of plaster-workers' tools, on the basis of tool marks.

The investigation identified the decorations of the *frigidarium* as a high-quality product, reflecting technical skills mastered by a well-organized workshop, operating in Pompeii during the last decades of its life.

Highlights

- The naked-eye observation of decorations identified a high-quality and complex work.
- The process of making paintings and plasterworks was reconstructed.

- The decorations of the *frigidarium* can be considered the product of the activity of a proper workshop.
- The virtual reconstruction allows the understanding of the link between decoration and architecture.
- The representation of the productive process and tools is an effective means of communication.

Key words:

Pompeii, wall decoration, process of making, digital reconstruction in archaeology, tool marks

1. Introduction

The wall decorations of the *frigidarium* in the Sarno Baths allowed us to study a sample of high- quality Fourth Style paintings. This room is the only one in the entire complex to have preserved most of its original wall and vault decorations. Despite the diffuse presence of missing parts, the study of the preserved decoration, coupled with archival records and graphic and photographic documentation, provided enough elements for a stylistic analysis of these rooms. It was therefore possible to advance some hypothesis about the chronology of the decoration works in the whole building.

Conversely, the wall decorations in the *frigidarium*, despite being in very poor condition are still partially visible in situ and can be partly reconstructed using archival records [1-3]. Therefore, it was possible to understand the original decorative program, defining the criteria used for selecting the depicted repertoire and to advance hypothesis on the working skills of the decorators.

2. Research aims

The research on the *frigidarium* in the Sarno Baths was structured in order to allow for considerations and reflections on the social and economic issues related to its decoration. These included, in the first place, the understanding of the work organisation and the quality standards followed by the group of artisans who materially made the decoration, and whether they should be considered a proper workshop [4] or “just a decorators’ team” [5]. At the same time, the research aimed at recovering the former aesthetic appearance of the decoration, a detail necessary to understand the relationship between decoration and architectural space.

The accomplishment of these results was a real challenge, as a consequence of the poor preservation state of the decoration, which is highly fragmentary and, in large part, unreadable. Conversely, the many missing parts facilitated the visual analysis of painting technique, allowing us to appreciate the details of the whole process of making, from the bare wall, to the more superficial layers of the polychromy. The substantial barrier of the limited available evidence led us to experiment with digital reconstruction, stretching it to its full potential: from the large-scale of room reconstruction, to the small-scale of tool marks.

3. Materials and methods

The investigation focused on the *frigidarium*, selected as meaningful case study, for investigating the technical, social and economic aspects of wall decoration in a Pompeian building, during the last years of life of the town. The decoration is preserved only in smalls sections and some of the fragments now in place were actually lifted and re-applied on the walls during the conservation works occurred after the discovery of the complex, as documented and recorded in the archive literature [1-3].

The aspects of making the wall decorations were firstly investigated by careful naked-eye observation, under different lighting conditions (frontal and raking light), paying special attention to all the details useful for reconstructing a stratigraphic sequence of painted layers and plasterworks. Differences and similarities both in the serial decorative patterns and in the figural details were recorded, to identify the technical characteristics of the different artisans who joined the decoration project. Tool-marks were photographed and measured, to provide an accurate digital reconstruction of the tools used by the artisans.

The portions of decorated plasters preserved in their original position were the only ones considered as reliable, for taking the measures for the digital reconstruction of the decoration. The position of these portions is not affected by the invasive conservation works, which re-mounted the fragments of decorations inside thick metallic frames. The indirect survey of the painted surfaces was the starting point for the reconstructions, which were created following several stages: three- dimensional photogrammetric survey of the room; photoplan of each wall; digital survey of the surfaces in their current state; integration of the missing parts and reconstruction of the alignment of frames and painted partitions; coloured reconstruction only of the portions of which there was definite proof; and lastly, coloured integration of missing fresco portions, created using the elements preserved on other walls as a reference or thanks to archival records.

For a better accuracy, naked-eye observation was also used for the digital survey, to verify in situ the small details, under different lighting conditions. Moreover, a virtual cleaning of the portion of the decoration depicting a Nilotic landscape, on the western side of the bath, was made experimentally (Fig. 1a), to offer a realistic representation of what the paintings should look like after a conservation intervention [6-8]. The choice to work on this part of the decoration was due to the preservation state of the depicted scenes, still clearly visible, especially in lower portion, despite the presence of a thick and diffuse salt deposit.

A clearer painting was obtained after ideally removing the salt deposits, filling fractures and applying mimetic integrations on the missing parts (Fig. 1b). Moreover, this image was further enriched with some elements, invisible to the naked eye, but identified thanks to multi-spectral analyses and the measurement of cuprorivaite (Egyptian blue) concentrations [9]. Finally, the missing parts were filled with the *sottotono* technique (i.e. using a lower tone of colour) (Fig. 1c).

4. Results

4.1 Painting technique and plasterworks: making the decoration

The visual observation of the decorations yielded a picture of technical complexity and great attention to detail. The decoration was made starting from the vaults and proceeding to the lower part of the walls, in order to prevent any damages to the completed portions. The mortar was applied by *pontate*, i.e. large rectangular portions, laid following the structure of the scaffoldings used by the artisans during the decoration works. The general scheme of the decoration was traced on the walls by incising thin lines, used both for outlining the panels and for sketching the silhouette of the larger figural elements. The smaller figures instead, were directly painted on wet mortar, without any preparatory drawings. The openwork borders framing the figural panels and dividing the plain fields were similarly free-hand painted, without using any silhouettes. This aspect is quite visible if we compare the different details in the execution of the

same pattern, repeated across the room. A technical variability can be observed also by comparing the figural panels, where we can notice different ways of painting and different levels of expertise (Fig. 2a-b).

The visual observations suggested that most of the decoration was painted on the walls following a principle of colour layering. In particular, the monochrome fields of the socles and the panels were painted starting from a first *a fresco* layer (i.e. applying a suspension pigment in water, to the wet mortar), reprised by applying layers of different colours by *mezzo fresco* (i.e. applying a suspension pigment in water, to the mortar, which is still wet, but at a more advanced stage of the carbonatation reaction) and by *a secco* technique (Fig .2c). The thickness of the layers painted *a secco* (i.e. mixing the pigments with a binder and applying the colour on dry mortar) masked the incised lines, minimizing their perception and giving a uniform appearance to the decoration.

As observed for paintings, plasterworks were made using incisions as guidelines, visible, in this case, both for outlining the panels and for sketching the guidelines of the figures (Fig. 2d).

Plasterworks were modelled following two different practices. Figures were free-hand modelled and finished painting small details (Fig. 2e). The borders were made using a two-step moulding process, by sliding a flat mould on the wet plaster and decorating it by pressing small stamps, carved with different patterns and made in wood, as attested by grain marks left on the surface (Fig. 3).

4.2 Decorative scheme: geometric analysis and reconstruction

It was generally possible to create reliable reconstructions of the geometrical scheme of the paintings of the southern wall and of the vault of room 7a, of the eastern and northern walls of room 7 and of lower parts of the vault of room 7 (Fig. 4). According to the reconstruction of the north wall, the figural parts were recreated following Niccolini's drawings. The graphic reconstruction of the decorative details of the stucco borders required particular care, being essentially overlooked by Niccolini [3].

The eastern wall of the same room posed a different problem, for the lack of a graphic documentation, with only a few traces left of the aediculae, painted on a red background in the middle section and no sign of the decoration on the lower part. In this case, the interpanels separating the aediculae were reconstructed following the ones visible on the northern wall, while a residue of black-painted plaster near the floor suggested us the existence of a socle, in direct connection with the socle of the ante-chamber (room 5), decorated by alternating bucrania and small shrubs, on black background (Fig. 5).

The reconstruction of the geometrical scheme of the vaults of rooms 7 and 7a, linked to the walls by an elaborate stucco border, was more difficult. The slight planimetric irregularity of the floor plan in both rooms is reflected in the vault decoration, whose sides are made symmetrical by elongated, triangular borders on red background, framing the rectangular space decorated by the stucco low relief.

This solution is necessary to easily divide the vaults according to a geometric orthogonal design. Both ceilings have a complex decoration in extremely low-relief stucco, accompanied by borders framing several squares of varying shapes and dimensions, decorated by stucco low reliefs, on monochrome background (Fig. 7; 9).Thanks to the preserved portions of decoration (about 15% in the vault of room 7 and about 25% in the vault of room 7a vault), it was possible to observe that the decorative scheme of the vault of room 7 was conceived as a continuation of the wall-paintings of the room, with two blue-background bands, above the underlying interpanels. In the vault's lower section, between the two blue bands, there is a concave square, flanked by large rectangular panels. Although the central decoration of the vault was not preserved, the survey led us to think that the vault was divided into 15 rectangular sections framed by stucco borders and, in some cases, finished with small green-background medallions placed on the points of intersection.

Conversely, the ceiling of room 7a can be reconstructed almost entirely, despite the considerable asymmetries deriving from the irregular geometry of walls of the room. This irregularity had surely an impact on the decoration scheme, literally cut by the southern wall, in the S/W corner. In this case, the areas with preserved mortar belong to the lower quarters of the vault's northern part and by mirroring them, a plausible reconstruction of the decoration of the lower portions of the ceiling was obtained. Contrary to room 7, the vault of room 7a has a geometrical scheme completely independent from the walls. Its main feature is an intricate weave of stucco borders, with four round medallions laid in an almost angular position, suggesting, thanks to comparable occurrences, the existence of a larger medallion, at the centre of the vault (Fig. 9).

4.3. Decorative program and the painters' workshop

On the basis of the technical analyses and reconstructions, a historical-artistic and stylistic- iconographic reflection was carried out to understand the semantic content of the decorative program observed inside the *frigidarium*. Apart from the usual elements alluding to water, fitting perfectly with the thermal context, some particularly significant themes were detected, i.e. a frieze depicting a Nilotic landscape and a panel representing the myth of Hylas, the youth kidnapped by the nymphs. Both scenes show the effort to include the apotropaia necessary to protect the public from the attack of the demons haunting the Baths [10].

The complex decorative program, coupled with the quality of its execution, confirms the high profile of the artisans working in the *frigidarium*. Therefore, a stylistic comparison with high- quality painted decorations attributable to the Fourth Style of Pompeii was carried out, focusing on the decorative syntax, ornamental motifs and the subjects depicted. The analysis of the frequent *motivi firma* (decorative patterns invariably repeated in the same way) points to the use of denotes cartoons or reference models that may be attributed to the repertoire of a specific workshop. Many similarities with the paintings of two particularly notable contexts of the Pompeian repertoire were identified: the Temple of Isis and the House of the Vettii, which had been decorated by the same painters' workshop [11-12].

5. Discussion

Thanks to the detailed technical observations, a more in-depth reconstruction, aiming at representing the process of making the decoration, was possible for the northern wall. The digital reconstruction represents the sequence of operations, summarized in eight reconstructive drawings, starting from laying the mortar and ending with the finishing of the painted surfaces (Fig. 6). The digital reconstruction re-creates objectively the appearance of the moulds used for decorating the stucco borders. The choice of wood was convenient, as wet wood does not stick to wet mortar (Fig. 3).

The presence of incised silhouettes in painted figural panels can be considered as evidence of the use of cartoons, a practice already observed in Pompeian paintings [13]. The evidence of this tool is absent in the plasterworks, seeming to suggest that plaster-workers were working following different practices. The integration between the painted and the plastered surfaces, well documented by the combination of the two techniques in the same portions of the walls and by the use of painted details to complete the plasterwork decorations, points to a close integration between the artisans specialized in the two techniques. The few portions of preserved plasterwork do not allow to distinguish between different artisans, while paintings reveal different quality levels in their execution. The portions with a better execution are concentrated on the north wall or in its proximity. This wall, being the background of the

cold-water pool, was surely the most important part of the room. It is therefore possible to recognise a particularly skilled hand, maybe that of the leader of the group of painters.

6. Conclusions

The digital reconstruction was useful to recreate successfully the overall decoration of the room, recognising the main lines of the project, behind the general decoration scheme. The technical complexity that emerged during the observation of the technical aspects of paintings and plasterworks was confirmed by the analysis of the loose fragments of painted mortars collected from the bottom of the pool, facing the north wall [14]. This characteristic is also coupled with the complex decoration scheme, adapted to the complex volumes of the room, and with the general good level of homogeneity in the quality of the decoration execution. These features led us to consider the decoration as the result of the work of a proper workshop, where the actions of different artisans were coordinated by one or more people leading the project. More in detail, according to the high quality of the execution, the complexity of the decorative program and the stylistic similarities identified, there is a strong evidence suggesting that the decoration of the *frigidarium* can be attributed to the Vettii workshop, surely the leading workshop during the last years of Pompeii [15].

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Author Contributions

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§ 2: CB

§ 3: PB, CB

§ 4.1: CB

§ 4.2: PB

§ 4.3: CS

§ 5: PB, CB

§ 6: PB, CB, MS, CS

Fig. 1; 3-10: PB

Fig 2: CB

Captions:

Fig. 1. Digital conservation of the Nilotic frieze, on the western wall of the pool: a) current situation; b) digital conservation, based on naked eye observations; c) digital conservation, with *sottotono* integrations and the addition of elements visible thanks to the multi-spectra analysis and the Egyptian blue maps.

Fig. 2. a-e Technical details of paintings and plasterworks in the *frigidarium*: different quality levels comparing two figural panels and openwork borders (a-b); the sequence of superimposed layers of painting on the northern wall (c); incised lines outlining the figure of the flying Eros (d); incised lined, for sketching a figure of low-relief stucco Cariatis (e).

Fig. 3. Digital reconstruction of a mould used by plaster-workers.

Fig. 4. Room 7, sector N, view from S. Survey and reconstruction of the wall decorations. Fig. 5. Room 7, survey and reconstruction of the painting of the eastern wall.

Fig. 6. Digital reconstruction of the process of making the decorations, northern wall, room 7.

Fig. 7. Room 7, vault, survey and reconstruction of the geometric scheme. Fig. 8. Room 7, northern wall, reconstruction of the wall decorations.

Fig. 9. Room 7a, vault, survey and reconstruction of the geometric decoration.

Fig. 10. Room 7, northern and southern walls, survey and reconstruction of the geometric scheme. Left: (a) S wall, survey; (b) reconstruction. Right: survey of N wall: missing parts in dark grey; thick salt deposits in light grey.

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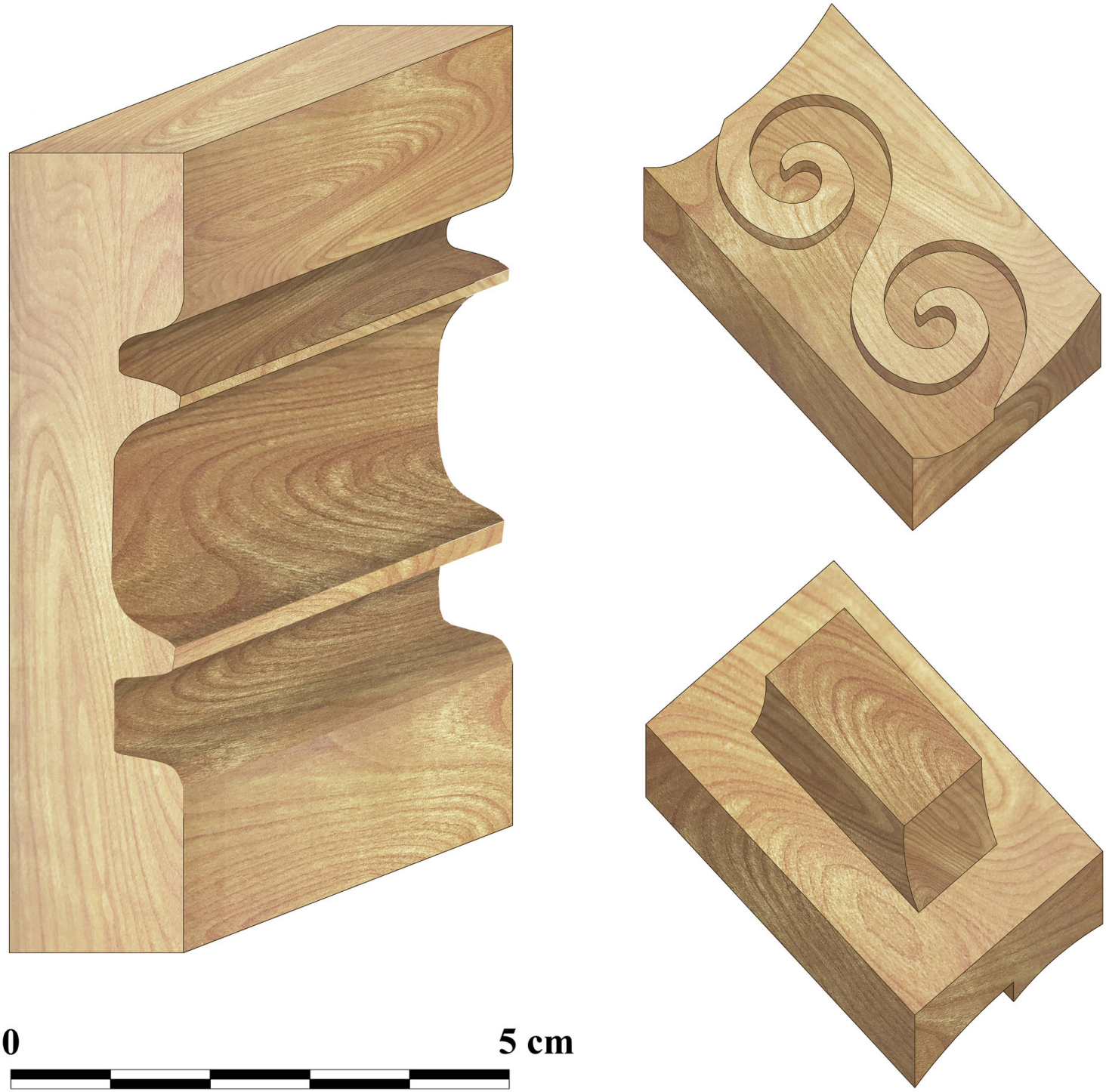
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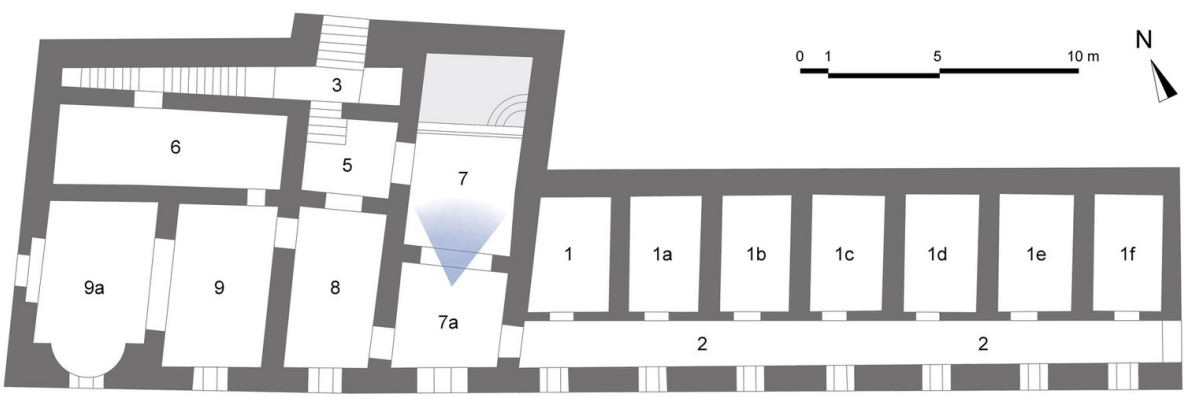
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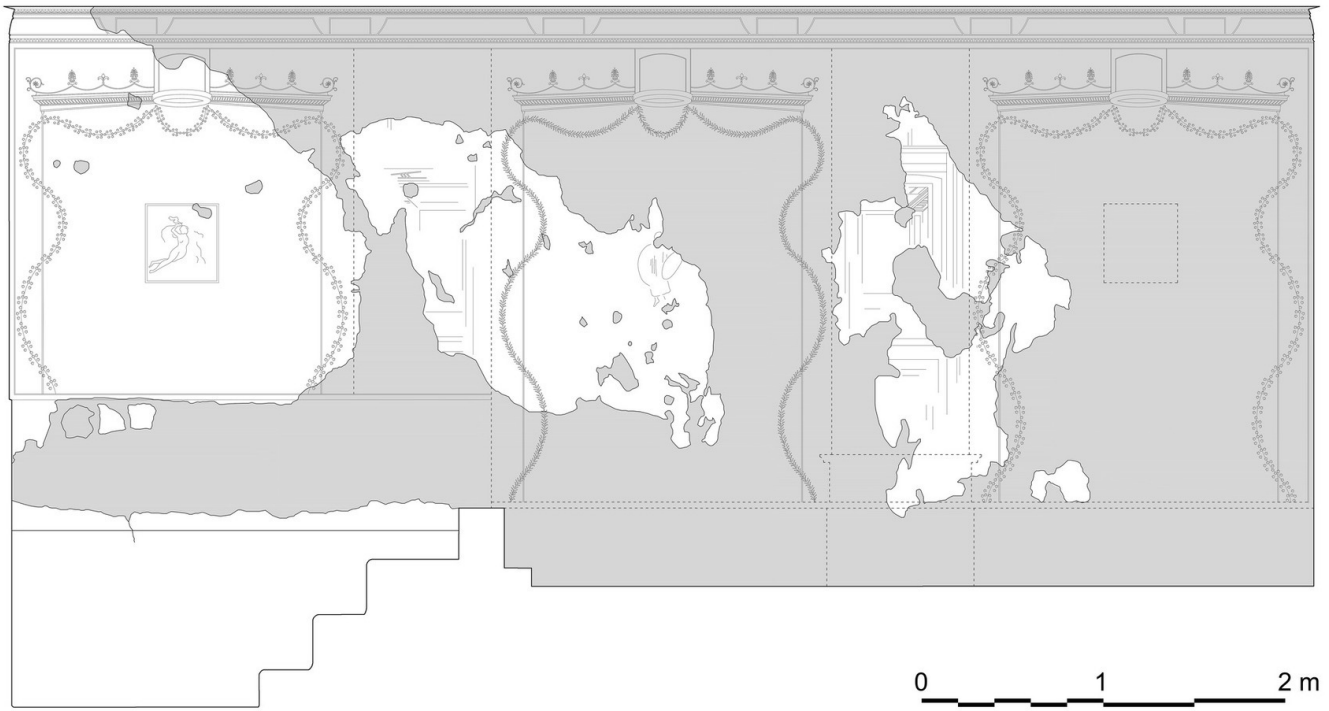
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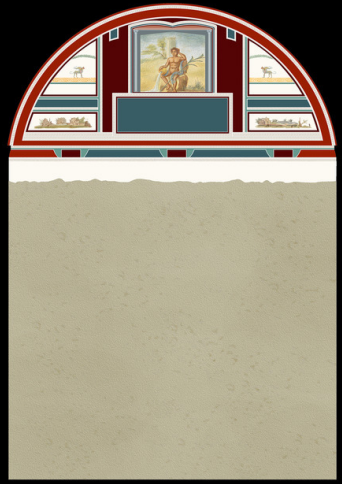

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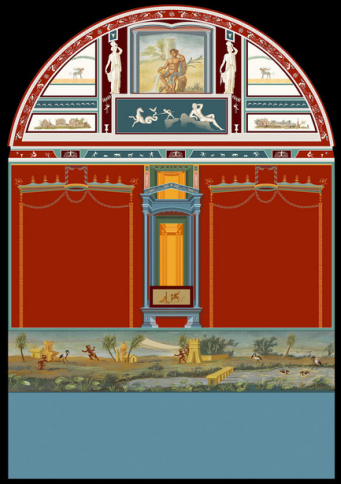

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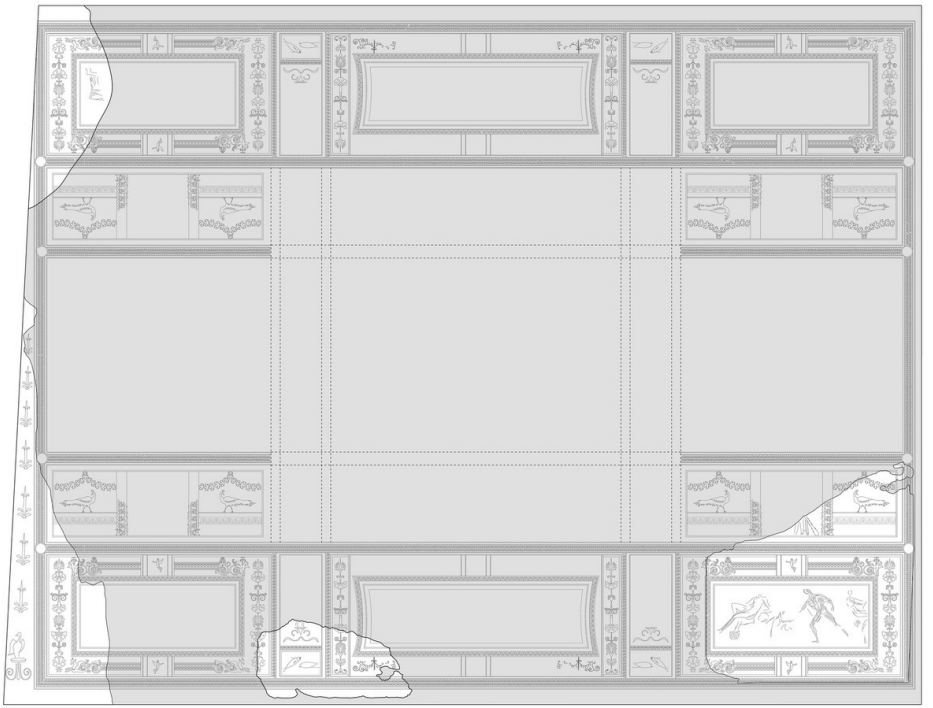

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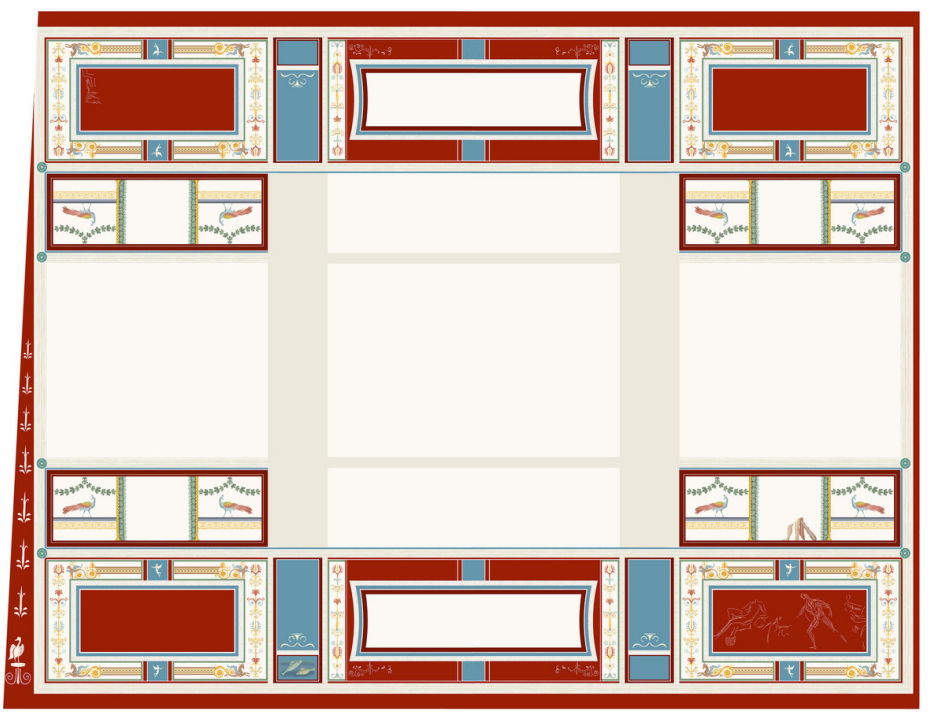

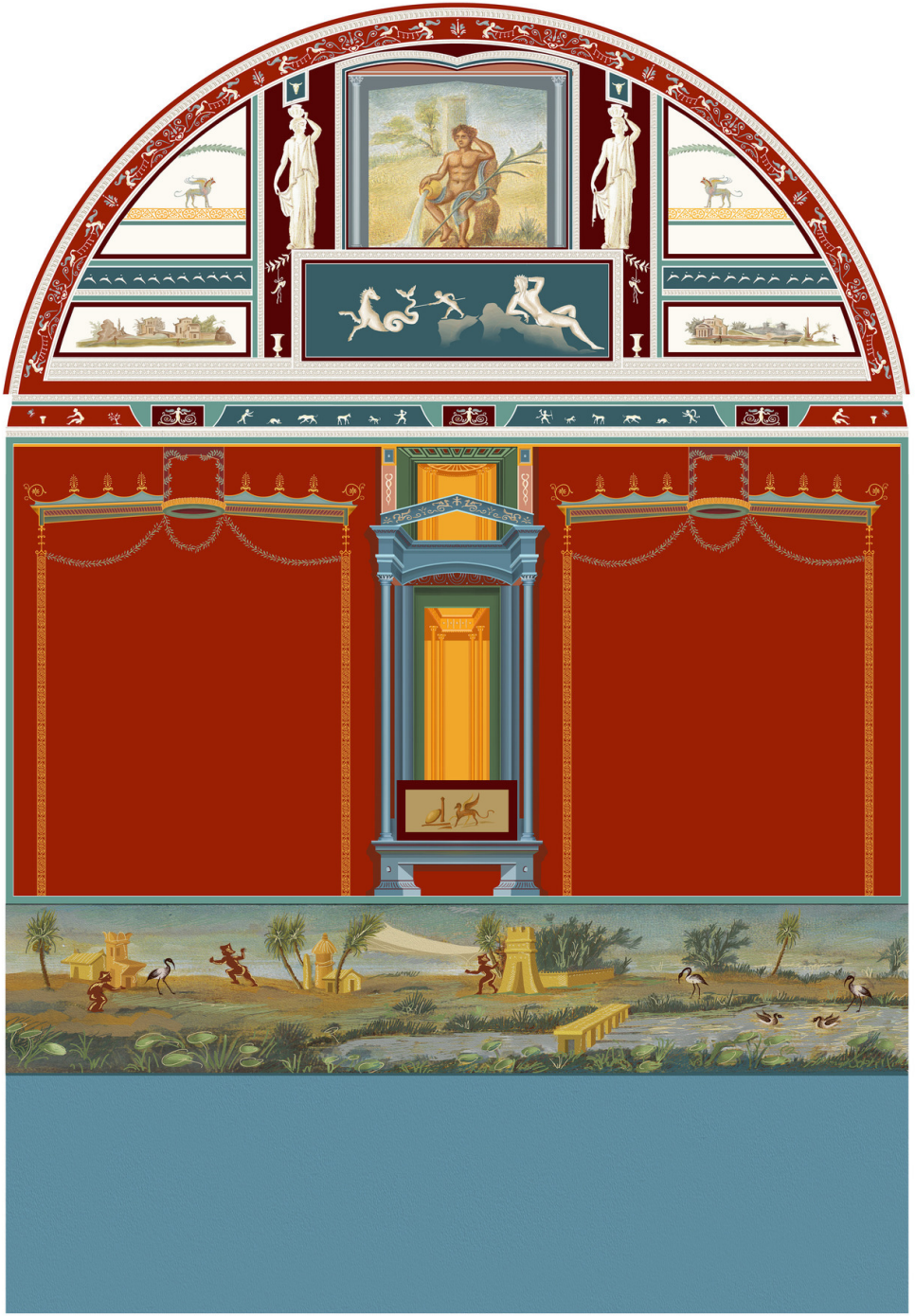
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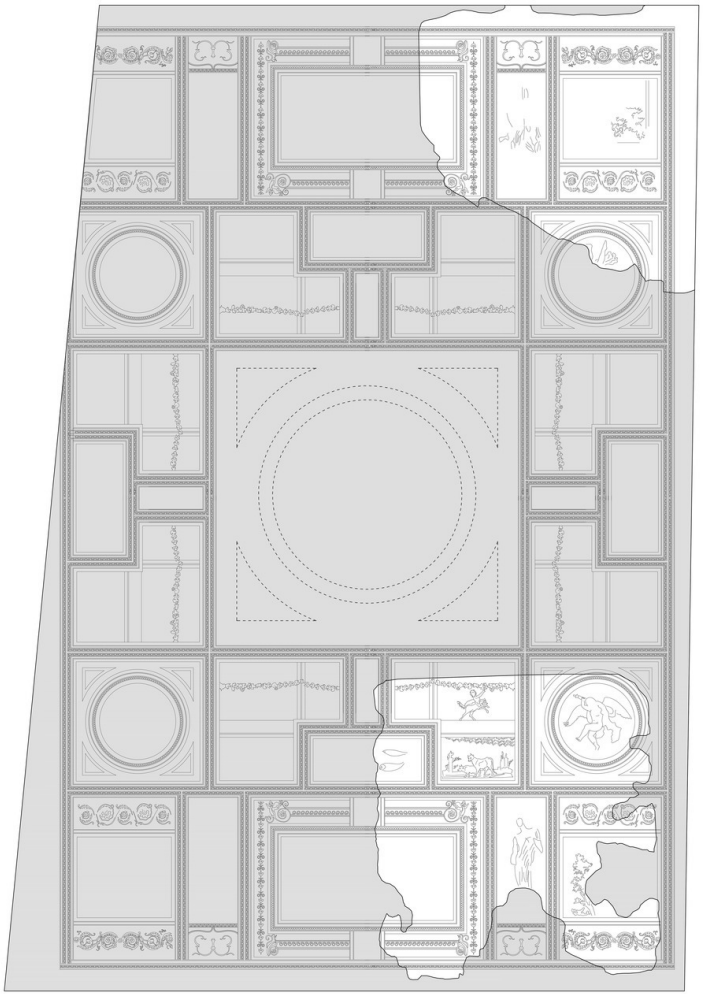

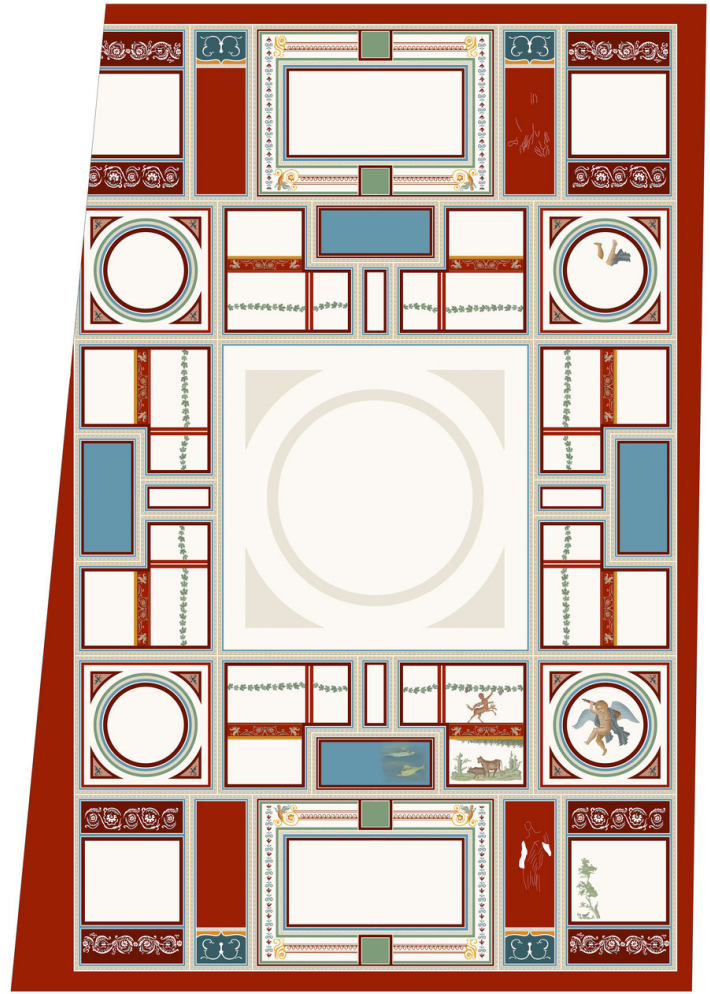

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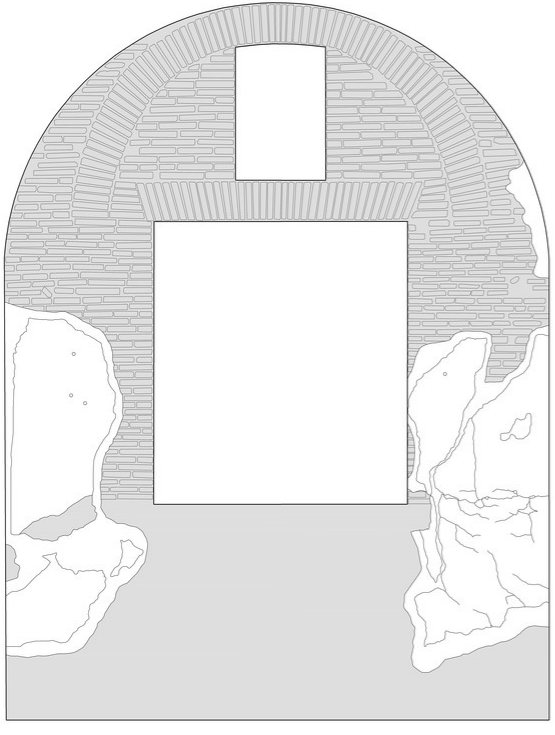

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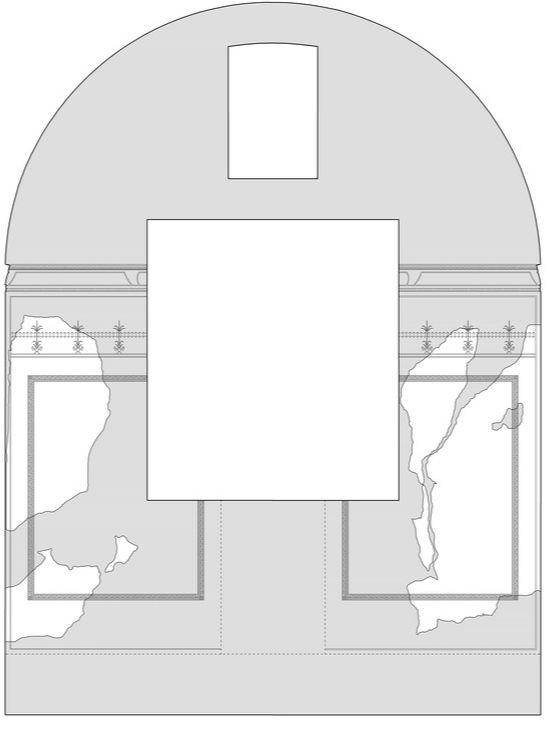

North wall