Project Report

Conservation of the Architectural Surfaces in the Tablinum of the House of the Bicentenary, Herculaneum

Phase I: Examination, Investigations, and Condition Assessment

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The Getty Conservation Institute (GCI) works internationally to advance conservation practice in the visual arts—broadly interpreted to include objects, collections, architecture, and sites. The Institute serves the conservation community through scientific research, education and training, model field projects, and the dissemination of the results of both its own work and the work of others in the field. In all its endeavors, the GCI focuses on the creation and delivery of knowledge that will benefit the professionals and organizations responsible for the conservation of the world's cultural heritage.

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Cover: Figurative scene from the east wall of the tablinum of the House of the Bicentenary, showing Venus and Mars posing amorously with cupids in a pastoral setting. Courtesy of 1992 Archivio Foglia, Soprintendenza Pompei.

Contents

Introduction

Project Background

The conservation of the architectural surfaces in the tablinum (reception room) of the House of the Bicentenary (Casa del Bicentenario) at the ancient Roman site of Herculaneum is a collaborative project of the Getty Conservation Institute (GCI), the Herculaneum Conservation Project (HCP), and the Parco Archeologico di Ercolano (PA-ERCO).[1] The field project, begun in 2011, aims to address conservation issues critical to the preservation of the architectural surfaces of the archaeological site of Herculaneum and in the region through a combination of scientific investigations, documentation, and preventive and remedial conservation treatments.[2]

During the initial period of study (2008–11), the GCI and HCP carried out scientific investigations on flaking paint of figurative scenes on wall paintings at the site, using the tablinum as a case study. From 2011 on, the project shifted focus and became a field project to study and conserve the architectural surfaces in the tablinum and to implement a full conservation program, including the design of passive measures and remedial treatments to mitigate ongoing deterioration of the decorated architectural surfaces. The tablinum was selected given the significance, aesthetic refinement, and severe deterioration of its wall paintings, as well as the significance of the mosaic pavement. The present research focuses on developing methodologies to conserve the decorative surfaces, with an emphasis on flaking and powdering paint in figurative scenes, a typical condition of wall paintings at the site and in the greater Vesuvian archaeological region.

Scope of the Report

The primary objectives of Phase I of the Herculaneum project are to identify original and added materials, understand physical and environmental conditions, provide relevant information for the conservation of the site, and create a body of knowledge to inform future conservation practice. Phase II will include treatment testing, stabilization, cleaning, filling of cracks and losses, minimal reintegration and presentation, climate improvement strategies, and establishment of long-term monitoring and maintenance protocols for the wall paintings. Phase III will focus on treatment and presentation of the mosaic pavement.

This volume compiles reports on the research and activities undertaken during Phase I and includes the following components:

- “Description of Architectural Surfaces in the Tablinum of the House of the Bicentenary” defines the stylistic and iconographic elements of the tablinum. This report also describes original technique based on visual examination and preliminary analysis.

- “Reconstruction and Remounting Materials and Techniques of the Wall Paintings in the Tablinum of the House of the Bicentenary” details the methods used in the excavation and reconstruction of the tablinum by archaeologist Amedeo Maiuri in 1938 to preserve the tablinum in situ. The report uses historical documentation and visual evidence as the foundation for the research.
- “Previous Interventions (1939–2011) to the Tablinum of the House of the Bicentenary” describes interventions to the tablinum from 1939 to 2011 (the beginning of the current field project) based on historical documentation, oral histories, visual evidence, and scientific study.
- “Environmental Assessment of the Tablinum of the House of the Bicentenary” summarizes the methodology and results of the environmental monitoring and implementation of pilot climate improvement strategies from 2011 to 2015.
- “Scientific Report on the Wall Paintings in the Tablinum of the House of the Bicentenary” summarizes the results of scientific research undertaken from 2008 to 2016 to identify original and restoration materials (support, plaster, paint, binding media, and surface coatings) and other deterioration agents present (surface accumulations, salts, and microbiological growth) on the wall paintings.
- “Conditions of the Wall Paintings in the Tablinum of the House of the Bicentenary” describes the various conditions of the wall paintings in the tablinum, including their distribution and severity.
- An illustrated glossary defines terms used to describe original technique, previous interventions, and conditions.

The results of Phase II and Phase III will be published separately following the completion of each phase.

Site Context

The archaeological site of Herculaneum is located in the modern city of Ercolano, at the western base of Mount Vesuvius along the coast of the Mediterranean Sea in the Campania region of southern Italy, approximately 15 km from Naples. Part of a serial UNESCO World Heritage property that includes Pompeii and Torre Annunziata, the ancient Roman town of Herculaneum is thought to have attained its present form in the third to second century BCE. It was a thriving community until the catastrophic eruption of Mount Vesuvius in 79 CE buried the entire site in pyroclastic material, at once causing massive destruction and preserving it as a city frozen in time until its rediscovery almost two millennia later.

Formal excavations at the archaeological site of Herculaneum, in which tunnels were dug through the volcanic tuff, were first carried out in the eighteenth century by order of King Charles of Naples. From 1927 to 1961, under the direction of archaeologist Amedeo Maiuri, a significant portion of the city was uncovered as an open-air excavation (Pace 2000; Camardo and Notomista, forthcoming). In contrast to the eighteenth-century excavations, Maiuri’s approach was archaeologically sensitive and followed a modern and scientific philosophy prioritizing in situ preservation of archaeological material in its physical context (Maiuri 1958). His team’s excavations revealed a trove of Roman architecture, art, and artifacts that provide an account of Roman daily life with a tangibility rarely encountered to this day (Camardo 2007). Buildings and architectural elements, including wall paintings and mosaics, were reconstructed based on the archaeological information from Maiuri's excavations, and objects were preserved in situ in vitrines where possible, creating a site museum of Roman life. Limited excavations were further undertaken after Maiuri's extensive campaign (Deiss 1974). Today, a majority of the ancient city of Herculaneum remains buried under the modern city, with only about one-third of the site exposed (Camardo and Court 2013).

Description of the House of the Bicentenary

The House of the Bicentenary was built between 10 BCE and 5 CE; however, the wall painting scheme dates to a later period, approximately 50–62 CE (Piqué, MacDonald-Korth, and Rainer 2015; Maiuri 1958).[3] A stately house, it retains its upper story, a central atrium, two alae, the tablinum, and the triclinium, along the central axis. The house is located in Insula V, at the north end of the nearly square excavation.[4] The main entrance opens onto the Decumanus Maximus (a Roman main street), and the peristyle garden is at the southern end. The house is flanked on either side by the House of Apollo the Lyre Player (Casa del Apollo Citarredo) and the House of the Beautiful Courtyard (Casa del Bel Cortile).

The House of the Bicentenary shows no visual evidence of eighteenth-century excavation.[5] Discovered by Maiuri's team in 1938, it earned its name because it was excavated two hundred years after the discovery of Herculaneum. Maiuri and his team preserved the wall paintings, mosaic pavement, and architectural elements of the house in situ, including a unique example of a lattice folding wood screen door with a richly carved and inlaid lintel. Work included reconstruction of missing architecture, remounting of detached and fallen fragments of painted plaster, restoration of the decorative scheme, and application of a wax coating (Maiuri n.d.).

The tablinum contains some of the most celebrated wall paintings at Herculaneum. It is located at the south end of the atrium along the main axis of the house, and a large opening in the south wall leads to the peristyle garden. The walls are decorated with red, yellow, and black monochrome backgrounds embellished by delicate architectural, floral, or figurative elements, including centrally located figurative scenes of superb quality in either a rectangular or a round format, imitating portable painting. The floor of the tablinum is a mosaic pavement with a rectangular central motif in colored *opus sectile* enclosed with a black-and-white braided border. This type of interior decoration is characteristic of the Roman Fourth Style and can be found at other archaeological sites in the Vesuvian region, including Pompeii, Oplontis, and Stabiae (Piqué, MacDonald-Korth, and Rainer 2015).

In the years following the 1938 excavation and reconstruction, though there is little written documentation, visual evidence shows that a number of intermittent treatments and maintenance interventions were carried out. The present conditions of the tablinum are the result of a complex history of the room, from occupation in ancient Roman times, to the eruption of Mount Vesuvius and subsequent burial, to the excavation, reconstruction, and restoration in 1938, followed by environmental exposure, maintenance practices, and eventual deferred maintenance over the next decades and continuing to the present. The House of the Bicentenary, including the tablinum, has been closed to the public since the 1990s due to structural problems, water infiltration, and other issues.

Conclusion

This project aims to ensure the long-term stability of the tablinum wall paintings and mosaic pavement through passive measures and remedial treatments to prevent further deterioration of these exquisite and irreplaceable architectural surfaces. Through scientific analysis, technical investigation, innovative treatment solutions, and a holistic approach to the conservation of the ensemble of architectural surfaces, this room will serve as an example of a methodological approach for the conservation of similar wall paintings and decorated architectural surfaces at Herculaneum and other ancient Roman archaeological sites in the region.

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Finally, the authors are indebted to Timothy P. Whalen, the director of the GCI, Jeanne Marie Teutonico, associate director of Programs at the GCI, Susan Macdonald, head of the Buildings and Sites department, and Tom Learner, head of the Science department for their ongoing support.

This volume would not have been possible without the dedication and tireless work of all of our colleagues.

Notes

1 The Parco Archaelogico di Ercolano (PA-ERCO) was known previously as the Soprintendenza Pompei (SP), the Soprintendenza Speciale per i Beni Archeologici di Pompei, Ercolano e Stabia (SSPES), the Soprintendenza Archeologica di Napoli e Pompei (SANP), and the Soprintendenza Archeologica Pompei (SAP) at various times since the beginning of the project.

2 From 2008 to 2011, the GCI carried out scientific investigations at the site to address a number of conservation issues, including characterization of ancient glass, carbonized wood, and injection grouting of plaster and wall paintings, as well as the study of flaking paint on figurative scenes of the wall paintings in the House of the Bicentenary.

3 The structure and paintings were possibly damaged by the earthquake of 62 CE, which is known to have affected Pompeii and Herculaneum (Wallace-Hadrill 2012). Modifications to the house can be seen where openings have been sealed, and shops with apartments at the front of the house appear to have previously opened onto the atrium (Guidobaldi and Esposito 2013).

4 For the purposes of this report, north is based on the direction of Mount Vesuvius, thus the walls of the tablinum are labeled east, south, and west.

5 The house itself does not show any evidence of early excavation during the Bourbon period; however, it is possible that Bourbon tunnels extended into the adjacent peristyle garden.

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CHAPTER 1

Description of Architectural Surfaces in the Tablinum of the House of the Bicentenary

Leslie Rainer and Francesca Piqué

Excavation Context

The archaeological site of Herculaneum is located at the base of Mount Vesuvius and was buried by the eruption of 79 CE, along with other known Roman sites in the region, including Pompeii, Stabiae, Oplontis, and Boscoreale. The first excavations at Herculaneum were carried out underground through tunnels (*cunicoli borbonici*) in the eighteenth century. From 1828 to 1875, limited open-air excavations were carried out. Later, from 1927 to 1961, under the direction of Amedeo Maiuri, extensive open-air excavation was undertaken (fig. 1.1).[1] All phases of excavation revealed a wealth of artifacts, objects of everyday life, and a body of exceptional Roman wall paintings, stuccoes, and mosaics, many in a good state of conservation, as testified by excavation photographs (fig. 1.2).

FIGURE 1.1.
Map of the archaeological site of Herculaneum, showing the extent of the excavated urban area under the direction of Amedeo Maiuri.
(Maiuri 1958, Tav V)

FIGURE 1.2.
View of the Decumanus Maximus during excavation in 1961. The House of the Bicentenary is on the left. (Historical Archives of the Soprintendenza Pompei, Maiuri, B165)

Description of the House of the Bicentenary[2]

The House of the Bicentenary (Casa del Bicentenario),[3] constructed between 10 BCE and 5 CE (Maiuri 1958, 223) and excavated by Amedeo Maiuri in 1938–39, is a noble house of grand proportions located on the northern end of the excavated site on the Decumanus Maximus, Insula V, no. 15, described in site files variously as UF47 or BCN-V-15, 16 (figs. 1.3–1.5).[4] It retains upper stories, an open atrium (fig. 1.6) with a black-and-white mosaic pavement, wall paintings, an exquisitely decorated tablinum, and a peristyle garden. Maiuri describes the structure of the house and its decoration in detail in his volume

FIGURE 1.3.
Exterior of the House of the Bicentenary (1938–39), as seen from the Decumanus Maximus at the time of excavation. (Historical Archives of the Soprintendenza Pompei, Maiuri, C2789)

FIGURE 1.4.
Exterior of the House of the Bicentenary (2012).
(Photo: Scott Warren)

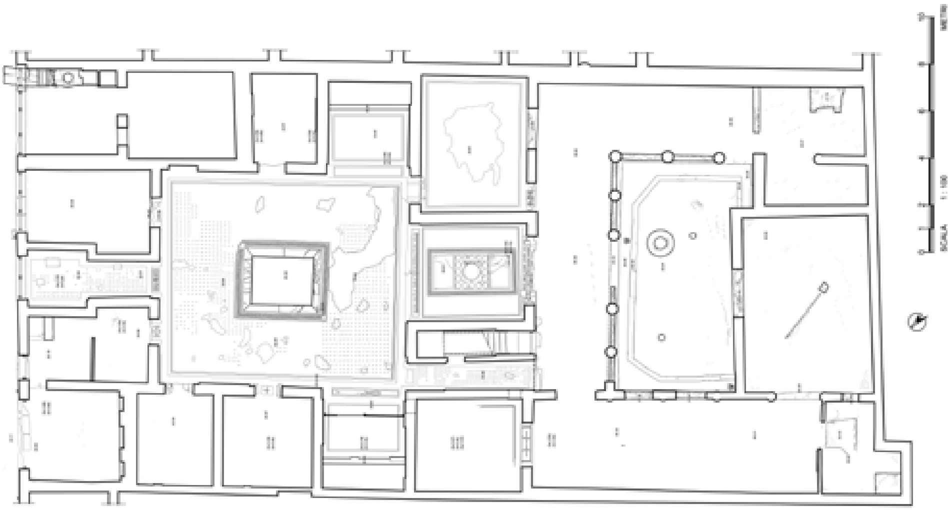

FIGURE 1.5.
Floor plan of the House of the Bicentenary. (Maiuri 1958, 222)

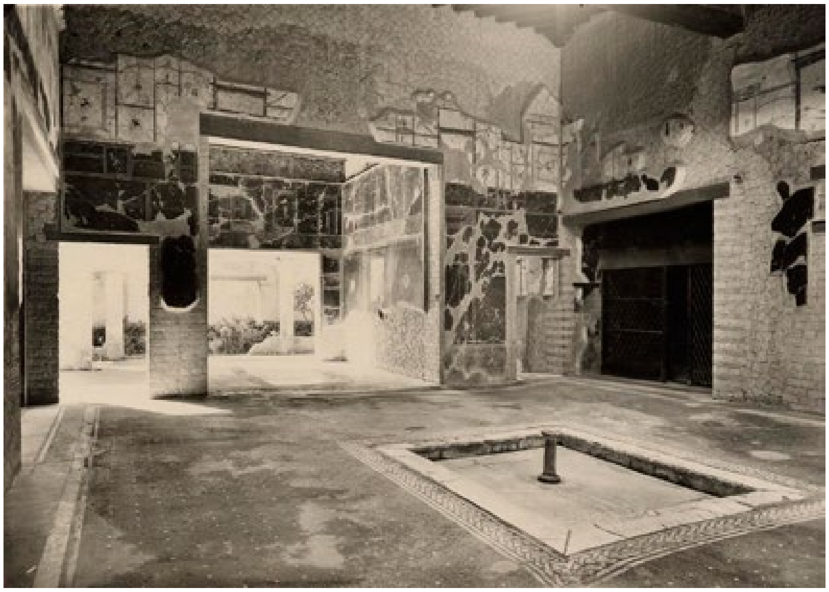

FIGURE 1.6.
View of the tablinum of the House of the Bicentenary (1938–39) from the atrium at the time of excavation.
(Maiuri 1958, 226)

FIGURE 1.7.
View of the tablinum from the atrium (1992). (Historical Archives of the Soprintendenza Pompei, Foglia, 14973b)

Ercolano: I nuovi scavi,[5] concluding that "it is one of the most beautiful in elegance and symmetry at Herculaneum."[6] Of particular note is the tablinum (ambiente or room 10), a formal reception room and a typical feature of Roman architecture, decorated with a sophisticated scheme consisting of finely executed wall paintings and a highly refined mosaic pavement (fig. 1.7). The house is also known for a set of wax tablets found in a chest in an upper-story room describing a legal trial known as the trial of Iusta.[7] A cruciform element was also found in an apartment at the rear of the house and at one time was thought to be early evidence of Christian practice at Herculaneum.[8]

Description of the Tablinum

The tablinum measures approximately 5 m long on the east wall, 5.55 m long on the west wall, 4.2 m wide, and 5.2 m high. The room is composed of three main walls oriented approximately east, south, and west, with orientation based on Mount Vesuvius as north. The tablinum opens to the north onto the atrium, and to the south onto the peristyle garden of the house. The floor is decorated with a highly sophisticated mosaic pavement in *opus sectile* and *opus tessellatum*. Wall paintings would have covered east, south, and west walls of the room (figs. 1.8–1.10), though they are now fragmentary due to damage from the eruption in 79 CE and from subsequent excavation and reconstruction. On all three walls, the plaster extends to approximately 80 cm from the current ceiling (the presumed height of the original wall), and along the top of the wall paintings, the plaster curves slightly inward, and traces of stucco attachments can be seen along the top of the east and west walls.[9] A band of exposed tuff approximately 80 cm high extends along the top of all three walls.

On the east wall, paintings extend the full height of the presumed original wall. The south wall has paintings above the opening to the peristyle garden and on two side panels flanking the opening down to approximately 80 cm above ground level. The west wall has paintings that extend to approximately 100–145 cm above ground level. The base of the south and west walls is exposed tuff, constructed using modern tuff blocks in *opus incertum* on the west wall and in *opus vittatum* on the south wall.

FIGURE 1.8.
East wall of the tablinum of the House of the Bicentenary (2011).
(Photo: Massimo Brizzi)

FIGURE 1.9.
South wall of the tablinum, 2011.
(Photo: Massimo Brizzi)

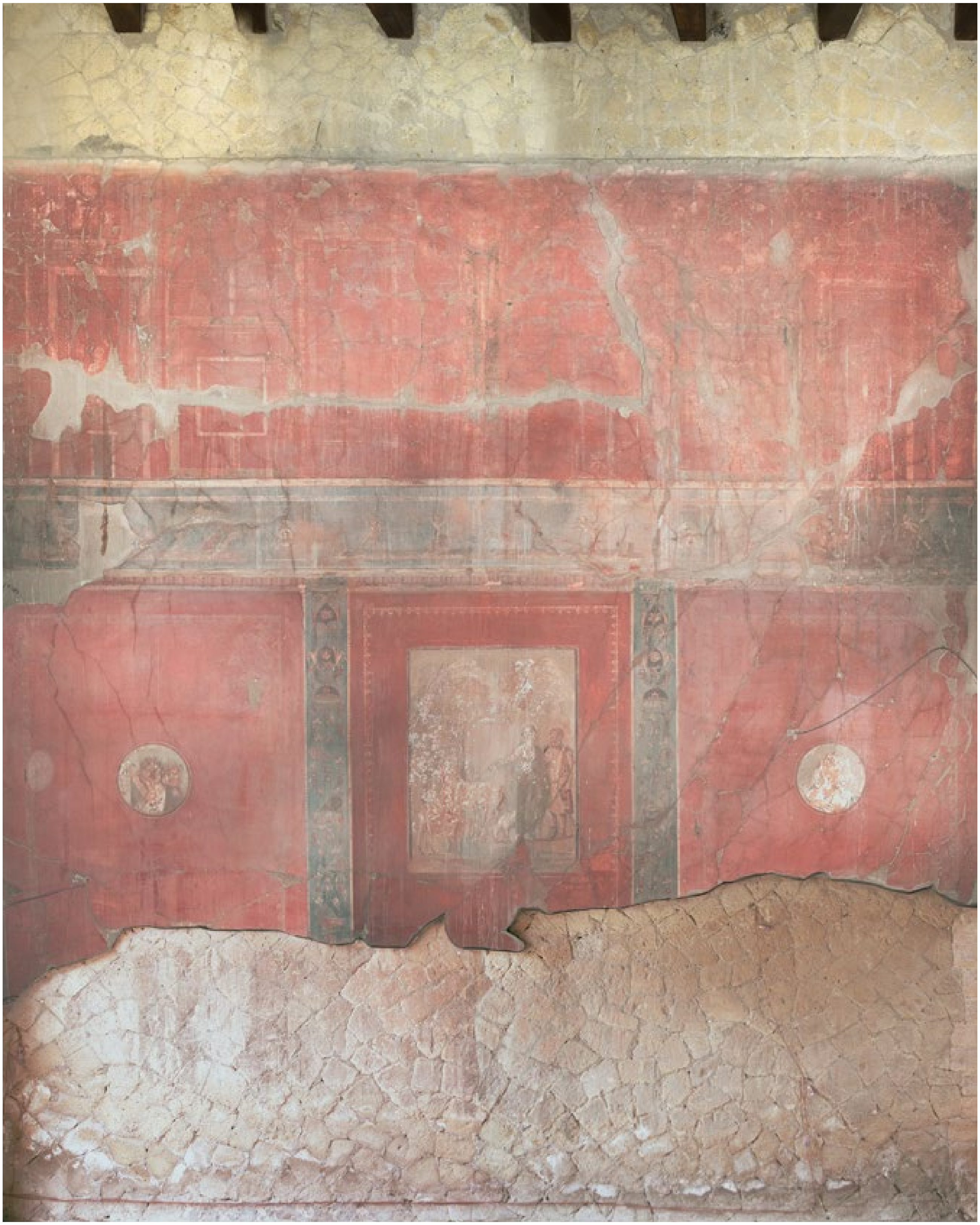

FIGURE 1.10.
West wall of the tablinum, 2011.
(Photo: Massimo Brizzi)

General Description of the Wall Paintings

According to Maiuri, the Roman wall painting scheme of the tablinum is among the best examples of the Fourth Style (ca. 50–62 CE) remaining at the site.[10] The paintings incorporate figurative scenes and architectural elements over monochrome background colors (see appendix 1.1). The walls of the room are divided into three distinct decorative levels, or registers: upper, lower, and base (fig. 1.11). In the lower register, the background color on the east and west walls is predominantly red; the panel on the east wall framing the central rectangular scene exhibits areas of yellow. The background of the lower register of the south wall, framing the opening to the garden, is black, with a green band along the border. The majority of the upper wall is red; however, there are also areas of yellow on the upper east wall.[11] The areas framing the central rectangular scenes on the east and west walls as well as the upper registers likely had yellow backgrounds, which were converted to red by the heat of the eruption. In the *Diario di scavo* (17 January 1939), Maiuri describes the background colors as follows: "the central background is red on the sides and yellow in the center" (*il campo centrale è di lati rosso e al centro di giallo*); further on, he writes that the upper register "is yellow transformed to red with designs in perspective and other" (*è di giallo cambiato in rosso con disegni di prospettive e altro*). Extant only as fragments on the east wall, the base of the walls was once embellished with horizontal bands of monochrome color accentuated with floral motifs; the painted surface directly above the floor has a black monochrome background with yellow and red bands of color.

On both the east and west walls, the lower register is divided into three panels by decorative vertical bands exhibiting floral and grotesque designs.[12] In the center of the walls are

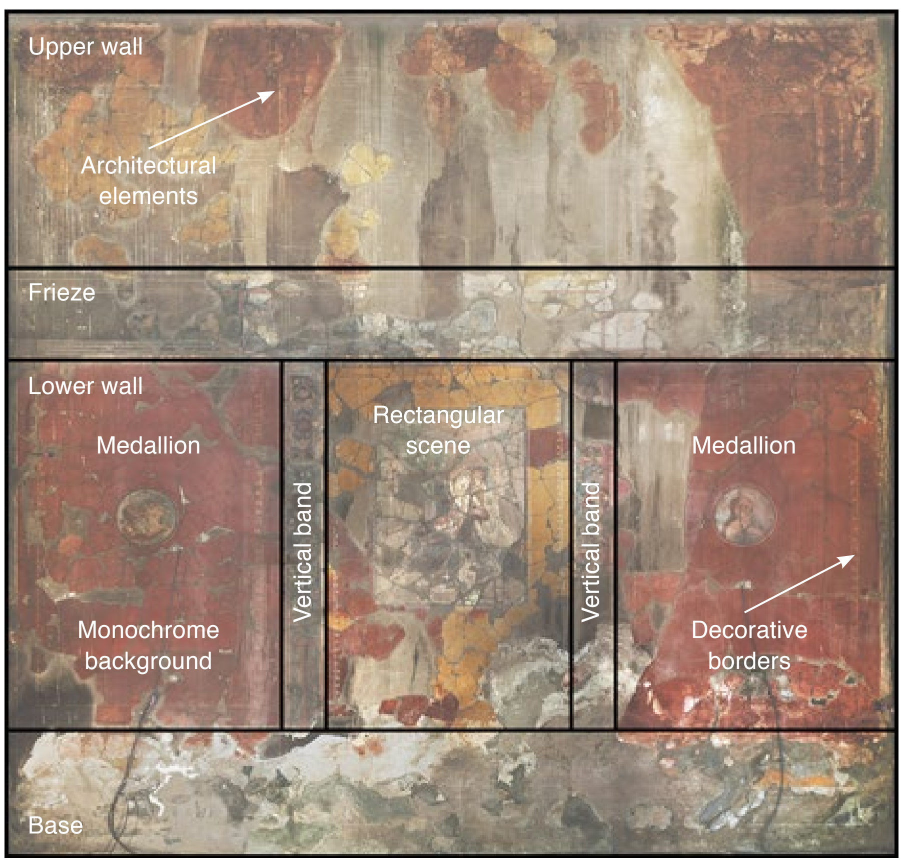

FIGURE 1.11.
Image of wall painting on the east wall, indicating the three decorative registers: upper, lower, and base, and the decorative elements.
(Photo: Massimo Brizzi)

FIGURE 1.12.
Upper border of the east wall, showing a slight curvature and lip of plaster with traces of stucco attachments, where a cornice would have been applied.

large rectangular paintings with mythological scenes: on the east, Mars and Venus, and on the west, Pasiphaë and Daedalus. Flanking the vertical bands to the north and south are round medallions with paintings of bacchantes, maenads, and Silenus figures. A frieze with a black background, depicting scenes of cupids hunting and fishing and Amazons fighting on horseback, extends along all three walls and marks the division between the upper and lower registers. Within the frieze, theatrical masks and Gorgon heads punctuate these animated scenes.[13] The upper register of all three walls is painted with architectural perspectives, sculptural figures on pedestals, female figures holding garlands, and animals and fantastical creatures (see fig. 1.11).

The plaster along the upper edge of the wall paintings ends with a curvature and has traces of stucco attachments, indicating the presence of a cornice (fig. 1.12). The ceiling is no longer extant but was likely decorated with polychrome stuccoes, as is commonly seen in other houses at Herculaneum and in the Vesuvian region.

Given the complex physical history of the wall paintings due to the eruption of Vesuvius and the subsequent burial, excavation, remounting, restoration, and reconstruction, the wall paintings are now a composition of original and restoration plasters. The paintings on the east and south walls appear to be largely remounted with reconstruction of missing elements, while the majority of the west wall appears to have remained in place, with portions at the top and bottom made up of recomposed fragments. The paintings extend down to the floor only on the east wall.

Division of the Wall Paintings

Names and abbreviations have been assigned to the different sections of the walls, which correspond to specific locations and features of the decorative scheme. These abbreviations are used in the nomenclature of the information associated with that area (i.e., image names, description of area, sample locations, etc.) (see appendix 1.2).

Iconographic Description of the Wall Paintings

This section provides a description of the figurative and decorative elements of the wall paintings[14] and is crucial to understanding the cultural and artistic value of the painting and ensuring that original traces of paint, now deteriorated, are recognized and preserved. As presented today, the wall paintings are largely reconstructed and fragmentary, with extensive damage. A drawing by Maiuri from the time of excavation in 1938 provides the best reference for the complete decorative scheme of the wall paintings (fig. 1.13).

Figurative Scenes: Central Rectangular Panels

The rectangular panel in the center of the east wall depicts Venus and Mars in an amorous pose in a rocky setting (fig. 1.14). Venus, her right arm raised to frame her face and touch Mars' hair, wears a wreath in her hair; her body is partially covered with a dark purple cloth. Mars is depicted as a young man surrounded by cupids playing with objects symbolic of his weaponry.[15] One cupid holds Mars' lance, while two others play at his feet.

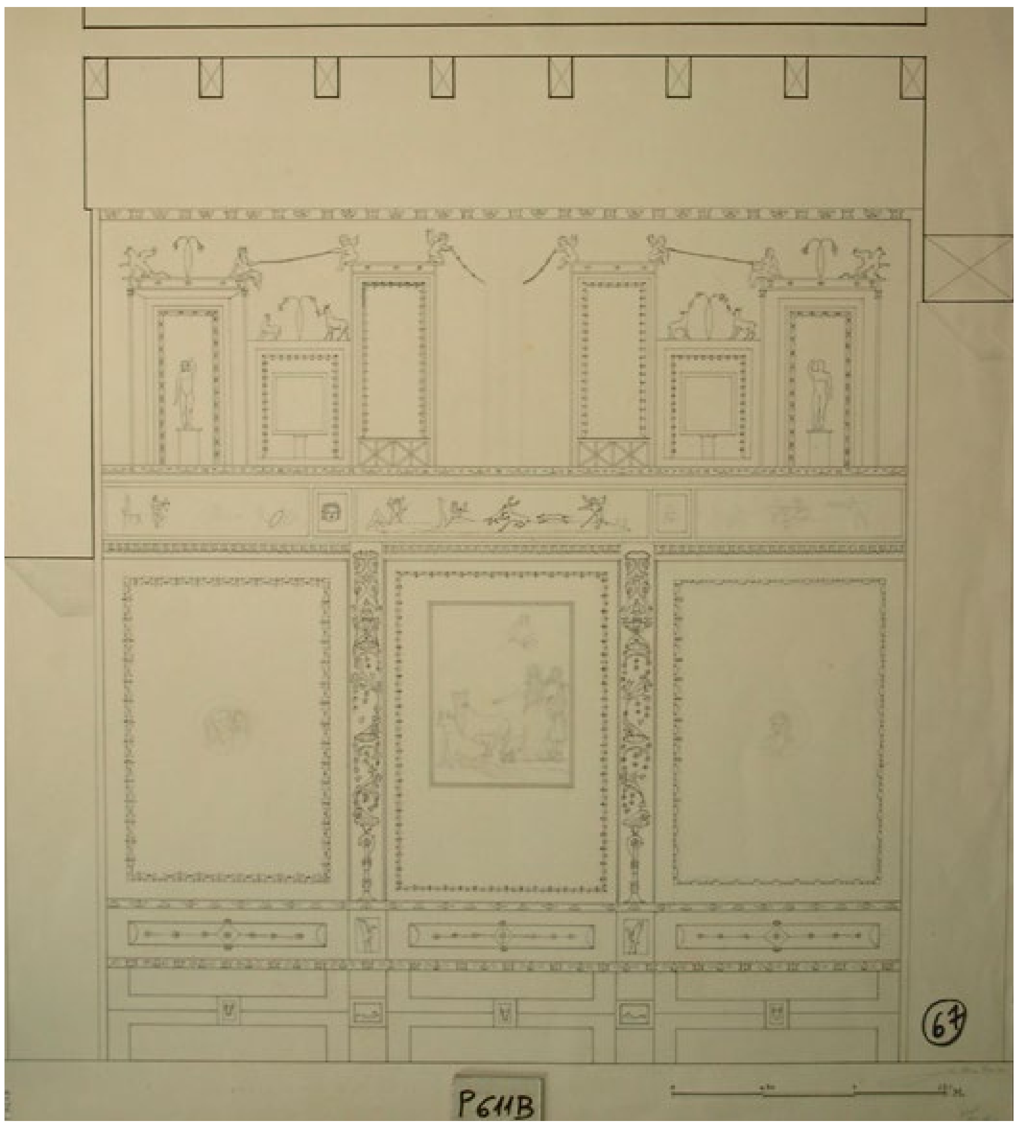

FIGURE 1.13.
Decorative schematic by Maiuri, showing a reconstruction of the full design of the tablinum walls from evidence gleaned during excavation and restoration (1938).
(Historical Archives of the Soprintendenza Pompei, Maiuri, P611b)

FIGURE 1.14.
Panel in the center of the east wall, showing Venus and Mars posing amorously in a pastoral setting. (Historical Archives of the Soprintendenza Pompei, Maiuri, A2653)

FIGURE 1.15.
Figurative scene in the center of the west wall, showing Pasiphaë and Daedalus with a herd of cows against a rocky landscape. Pasiphaë points to the bull with whom she is in love. (Historical Archives of the Soprintendenza Pompei, Maiuri, C2779)

On the west wall, the rectangular scene depicts Daedalus and Pasiphaë facing a small herd of cows in a pastoral setting with craggy rocks in the background (fig. 1.15). Pasiphaë, wearing an elegant, light-blue dress, indicates to Daedalus the bull that is the object of her desire. Daedalus, with matted beard and hair and dressed in a rough tunic, listens while holding his right hand to his face and a tool in his left hand. The bull turns toward Pasiphaë, staring at her with almost human eyes. Next to the bull, two calves drink and a ram grazes on a tuft of grass. In the upper right of the painting, a male figure observes the scene from a perch above the rocky background.[16]

Figurative Scenes: Medallion Paintings

On the east wall, the medallion paintings on the north and south ends of the tablinum, respectively, represent an old bearded Silenus, a companion to Dionysus, behind a young and beautiful maenad with flowers in her hair (fig. 1.16), and a bust of a bacchante (fig. 1.17).

The medallion paintings on the west wall represent, on the north, a bust of a young bacchante wearing a wreath, her right hand lifted to her décolleté (fig. 1.18); on the south, a bust of a bacchante held by a young satyr (fig. 1.19).

FIGURE1.16.
Medallion painting on the east wall, north end of the tablinum (toward atrium), depicting an old bearded Silenus and a young maenad. (Historical Archives of the Soprintendenza Pompei, Maiuri, D1440b)

FIGURE 1.17.
Medallion painting on the east wall, south end of the tablinum (toward peristyle garden), depicting a bacchante figure. (Historical Archives of the Soprintendenza Pompei, Maiuri, 2588)

FIGURE 1.18.
Medallion painting on the west wall, north end of the tablinum (toward atrium), depicting a bacchante figure wearing a wreath. (Historical Archives of the Soprintendenza Pompei, Maiuri, C2780)

FIGURE 1.19.
Medallion painting on the west wall, south end of the tablinum (toward peristyle garden), depicting a bacchante figure with a young satyr. (Historical Archives of the Soprintendenza Pompei, Maiuri, C2781)

Vertical Bands

Two vertical bands, both with black backgrounds, divide the lower register of the east and west walls. The bands are richly painted, showing candelabra and spiraling foliage from which vines branch off, ending in flowers and griffins. The branches have an S shape and are transformed at the top into complex arabesques with shells, swans, masks, and stylized dolphins (fig. 1.20).

Frieze

A frieze extends across the east, south, and west walls above the opening on the south wall. The frieze has a black background and is divided into three rectangular panels on each wall separated by panels with theatrical masks and Gorgon heads. On the east and west walls are scenes of cupids hunting (fig. 1.21a), framed by rectangular theatrical mask

FIGURE 1.20.
Detail of one of two vertical bands dividing the lower register of the east and west walls, showing grotesque decoration painted on a black background.

motifs, and two side panels with paintings representing Amazons fighting Greeks. On the south wall, the paintings depict cupids fishing (fig. 1.21b), flanked by Amazons on horseback (fig. 1.21c), and the theatrical masks of the east and west walls (fig. 1.21d) are replaced by circular framed Gorgon heads (fig. 1.21e).

An egg-and-dart motif concludes the decoration along the bottom of the frieze. On the west wall, the egg-and-dart motif is interrupted by the top of the vertical bands, which extend up to the lower edge of the frieze band (figs. 1.22a and 1.22b).

FIGURE 1.21A.
Frieze separating the upper and lower sections of the east, south, and west walls, depicting cupids and Amazons with rectangular framed theatrical masks and gorgons in circular frames . An egg-and-dart motif extends along the bottom edge of the frieze. Detail from west wall.

FIGURE 1.21B.
Detail of south wall frieze, showing cupids fishing.

FIGURE 1.21C.
Detail of south wall frieze, depicting Amazons on horseback fighting the Greeks.

FIGURE 1.21D.
Theatrical masks in rectangular frames separate scenes on the east and west walls. Detail from west wall.

FIGURE 1.21E.
Gorgon heads in circular frames separate scenes on the south wall frieze.


FIGURE 1.22A (UPPER LEFT), DETAIL (UPPER RIGHT).
Vertical bands on the east wall terminate at the lower edge of the frieze. Detail on right shows the lower edge of the frieze continuing above the vertical band.


FIGURE 122B (LOWER LEFT), DETAIL (LOWER RIGHT).
Vertical bands on the west wall extend into the frieze, and the egg-and-dart motif is interrupted in this area. Detail on right shows the egg-and-dart motif stopping at the edge of the vertical band, and the top of the decoration of the vertical band extending up through this area.

Upper Wall

Above the frieze, the decoration of the upper register is painted over a monochrome background with a series of architectural perspectives and pavilions with balustrades, behind which are sculptures on high pedestals. Figures holding garlands are seated on the corners of the architectural elements (fig. 1.23). On the west wall, now barely discernible, two deer are depicted facing each other. In the center of the east and west walls are two large Delphic tripods.[17] As mentioned above, portions of the background on the upper east wall are yellow and the remainder is red. It is possible that the background color on all three upper walls was originally yellow and that, similar to the central panels, large areas were converted to red by the heat of the eruption.

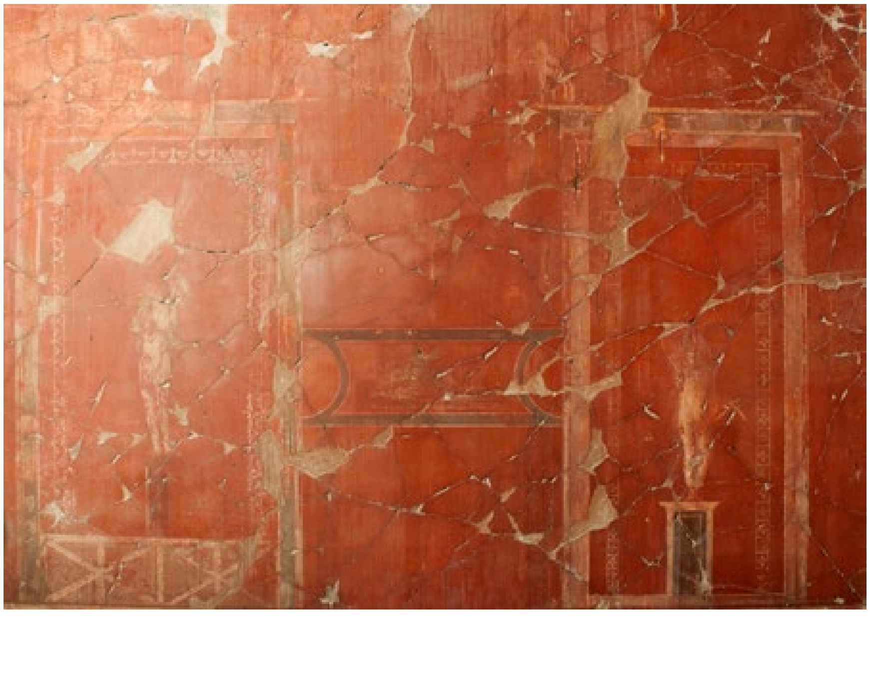

FIGURE 1.23.
Upper wall decoration above the frieze, depicting architectural perspectives, sculptural figures, female figures holding garlands, and animals and fantastical figures.

FIGURE 1.24.
The base of the wall remains intact only in the southeast corner of the east wall, where traces of a black background can be seen. Over this, geometric and floral decorations are applied, with a yellow-to-red band along the top separating the base of the wall from the lower section.

Base of Wall

The base of the walls, extant only on the east wall but fragmentary and largely deteriorated, appears to have a band of black with white lines along the very base of the wall, to imitate masonry and, as described by Maiuri, blue lozenges. Above the black base is a horizontal band decorated with floral motifs, and above this is a horizontal band of color, which is yellow at the south end of the room and red at the north, another indication of yellow converted to red (fig. 1.24).[18]

Original Materials and Technique of Execution

The technique of execution of the original Roman wall paintings in the tablinum involves a sophisticated structure of plaster and paint layering by location and decorative feature.[19] The wall paintings were executed over a complex stratigraphy of lime plaster layers, beginning with one or more lime and sand plasters, then building up the final layers with a combination of lime and crushed marble.[20]

Wall Construction

The walls of the tablinum were originally constructed of tuff[21] blocks in *opus reticulatum*[22] on the east and west walls and the upper south wall (fig. 1.25). During excavation and reconstruction, walls were either stabilized where possible or demolished and reconstructed. While there is no specific documentation recording which walls were reconstructed or retained, Maiuri made a clear effort to distinguish areas retaining their original wall support from reconstructed wall sections by using similar tuff blocks, but with a different technique of *opus incertum* in place of the original construction in *opus reticulatum*[23] (fig. 1.26). The masonry of the south wall pilasters differs and is in *opus vittatum* (*opus mixtum*)[24] (fig. 1.27).

FIGURE 1.25.
Original wall construction of tuff blocks in *opus reticulatum*, an original Roman construction technique in which blocks were placed in a diagonal linear pattern seen along the top of the walls.

FIGURE1.26.
Example of 1938 construction technique using *opus incertum*, in which blocks were placed following no regular pattern.

FIGURE 1.27.
View at the base of the south wall, showing the original wall construction in *opus vittatum*, alternating layers of tuff blocks and bricks.

Plaster Layers

The stratigraphy described in the section below ("Plaster Stratigraphies") aims to provide a scheme of the sequential plaster layers making up the wall paintings. It is important to note that not all layers are original Roman plaster, and portions of the wall paintings decorating the tablinum were found as fragments and reconstructed during Maiuri's excavation and restoration work in 1938–39.[25] Therefore, both ancient Roman plasters and twentieth-century plasters are found in this complex system. Today, the wall paintings of the tablinum can be distinguished by areas with original paintings and decoration and by areas of modern reconstruction using neutral-toned plaster fills (fig. 1.28). The identification and differentiation of the plasters is based on visual examination and material characterization of the plasters.

Examination of the wall paintings in the tablinum of the House of the Bicentenary, combined with information from the excavation diaries and journals, reveals that for the most part, the paintings are not on their original support but were reconstructed and

FIGURE 1.28.
View of east wall of tablinum. The wall paintings in the tablinum are a complex system of original paintings and restoration plasters as reconstructed by Maiuri and his team to provide a complete design scheme. (Historical Archives of the Soprintendenza Pompei, Maiuri, C2782)

remounted on the walls during the restoration work conducted by Maiuri and his team at the time of excavation. The excavation journal (*Giornale dei lavori*) reports restorations performed in 1938 in the House of the Bicentenary, in which fragments collected in the house were taken to an atelier to be reassembled.[26] However, there is no specific mention of fragment collection in the tablinum, and mentions of the restoration and reconstruction of the wall paintings in the tablinum are sparse. (See Gittins et al. this volume).

Plastering Sequence

By examining the original areas of plaster, the following hypothetical sequence of application was reconstructed, which follows the typical technique of execution of Roman wall paintings (fig. 1.29).[27] The upper walls were probably plastered in one *pontata*, from the top of the wall, and extended down approximately 130 cm to the level of the frieze, where a join clearly

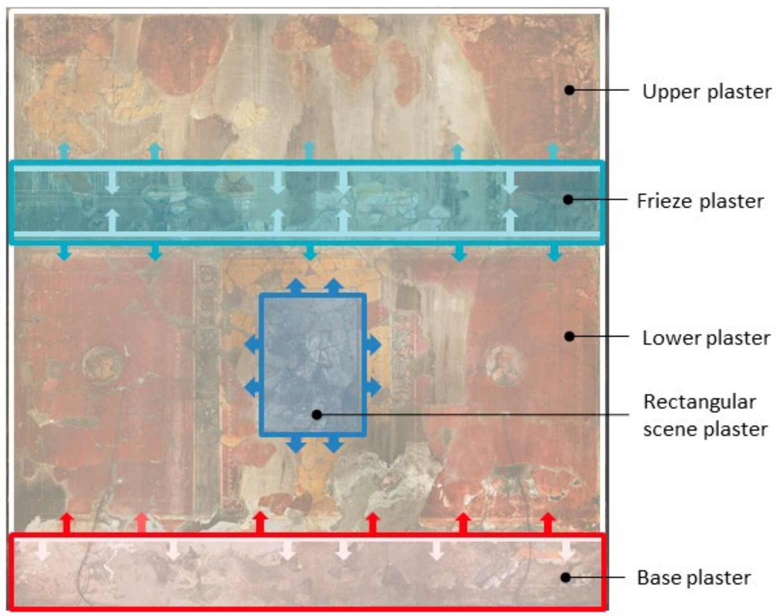

FIGURE 1.29.
Diagram showing the hypothetical plastering sequence of the walls based on visual examination. It appears the plaster was applied across the upper walls, then across the lower section, and finally along the base. The frieze was added to cover the plaster join between the upper and lower sections, and the plaster of the central rectangular scenes was applied into a recess left in the center of the wall once the plastering and painting of the full walls were completed.

can be seen. The lower register of the wall, approximately 185 cm high, was plastered down to approximately 70 cm from the floor. Another plaster join can be seen on the east wall between the lower section and the base of the wall, suggesting that the base of the wall was applied in a single *pontata* after the lower section. The frieze, approximately 50 cm high, appears to have been added over the join of the upper and lower sections with the application of an additional thin, fine-grained plaster layer. Likewise, the central rectangular scenes have an additional final plaster layer, suggesting that they were added after the rest of the wall decoration was completed. Each section of the wall shows a different plaster stratigraphy, as described below.[28]

Plaster Stratigraphies

It is believed that during excavation, limited areas of wall painting remained in situ on the original wall support, and plasters may retain the original stratigraphy at the base of the east wall, south corner, and areas of the west wall, as determined by visual assessment.[29] One or more coarse layers of plaster are thought to be present between the tuff wall and the lowest visible layer.[30] In all areas of the tablinum, the deepest discernible plaster is one or more gray layers composed of a lime binder containing aggregate with black volcanic sand and lumps of calcareous material. From areas at the base of the east wall, where lower plaster layers are exposed and measurements of wall painting thickness can be made, it is estimated that the extant lower layers are approximately 4–5 cm.[31] These lower plasters were likely applied in more than one layer, and in some cases possibly wet on wet.[32] In this description, emphasis is placed on the upper plaster stratigraphies, which are built up over these lower gray plaster layers on all parts of the walls except for the base, where paint is applied directly over the gray plaster layers (fig. 1.30).

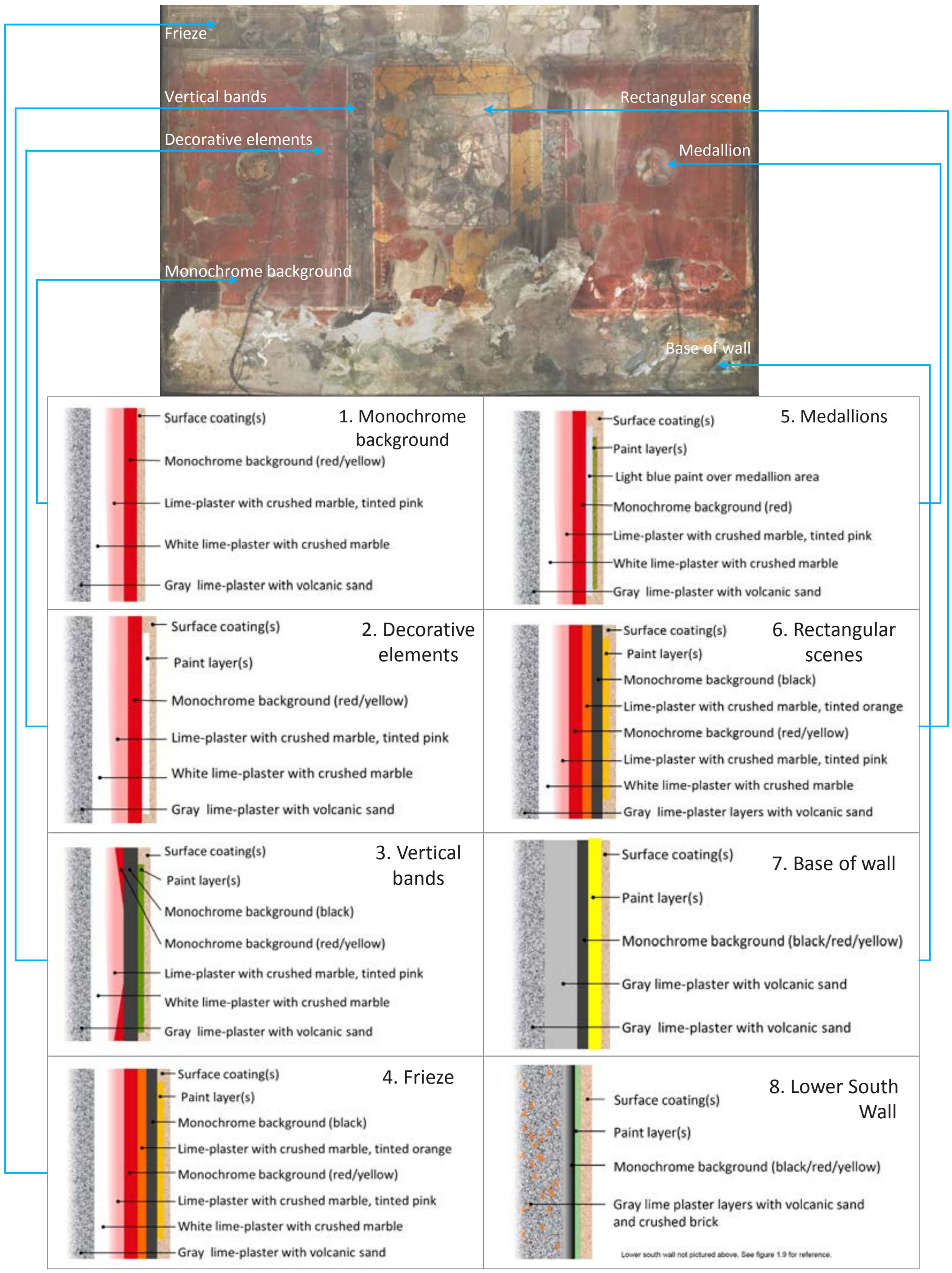

FIGURE 1.30.
Schematic of the plaster and paint stratigraphies by location and design element of the wall paintings.

Upper Walls: East and West

The upper east and west walls would have had one or more coarse gray plaster layers, followed by one or more upper plaster layers. The upper white plaster layers measure approximately 1 cm and were likely applied wet on wet. One or more fine white plaster layers consisting of a lime binder with coarsely ground crystalline calcite (identified as crushed marble) as the primary aggregate are found over the lower gray plaster layers. The monochrome background color was directly applied over this layer while the plaster was still fresh.

Upper Walls: South

Similar to the upper east and west walls, the lower plaster layers of the upper south wall would have had one or more coarse gray plaster layers, followed by one or more upper plaster layers composed of lime and crushed marble. The final layer of plaster on the upper south wall, measuring approximately 0.5 cm, however, is pink tinted with red ocher,[33] applied across the entire wall in this zone, similar to the lower east and west walls. Given the location of the tablinum on the central axis of the house and the opening of the atrium onto the tablinum, this area may have been a presentation zone (see fig. 1.7).

Lower Walls: East and West

The lower register of the east and west walls would likely have had one or more coarse gray plaster layers as the upper register and base of the wall. One or more fine white plasters consisting of a lime binder with coarsely ground crystalline calcite (identified as crushed marble) as the primary aggregate were applied over the lower gray plaster layers, likely wet on wet. The final layer of plaster was pink tinted with red ocher and applied across the entire wall in this zone, on both the east and west walls, prior to application of the paint layer. The pink-tinted plaster can be seen under yellow, red, and black monochrome areas on the lower register of the east and west walls. The upper fine plaster layer is similarly tinted on the upper south wall. These areas with pink-tinted plaster could be considered primary presentation zones.

Lower Wall: South

The lower register of the south wall, consisting of the two pilasters flanking the opening to the garden, has a different upper plaster stratigraphy from that of the east and west walls. In this area, the plaster is composed of a lime and sand plaster with crushed brick (*cocciopesto*) added, which provides a water-resistant plaster with a pozzolanic effect.[34] The paint is applied directly over this layer. There is no fine white plaster layer in this area.

Rectangular Scenes

These scenes are painted over an additional white layer of lime and crushed marble plaster (approximately 2.4 mm thick), inset into a recess left in the wall painting over the pink-tinted plaster. A buildup of fine white plaster can be seen around the edges of the scenes where it overlaps the monochrome background layer. On the east wall, in the area of a deep loss, a layer of pink-tinted plaster can be seen under the final plaster layer, which corresponds to the pink-tinted plaster found directly under the monochrome background in the adjoining central section.[35]

Frieze

The frieze has a complex stratigraphy, with different layering depending on location, as it covers the *pontata* join of the upper and central or lower walls (see upper and lower wall stratigraphies) and appears to have been applied after they were painted. Over the final plaster and paint layers of the upper and lower registers, one or more layers of a fine plaster with crushed marble were applied. The uppermost plaster layer is tinted[36] and the black monochrome background is applied over it.

FIGURE 1.31.
Visible stratigraphy at the base of the east wall, showing multiple layers of gray plaster. Along the base, color was applied directly over the gray plaster. In the other areas, one or more toned or white plaster layers were applied over the gray plaster as preparation for the wall paintings.

Base of Wall

The original plasters applied to the base of the wall survive only on the east wall. It can be seen from the superposition of layers that these were applied after the plasters on the lower register of the walls, though it cannot be determined whether they were applied at the same moment of construction as the upper plasters but last in sequence, or whether they were applied at a later time as a repair or refurbishment of the base of the wall. The plaster at the base of the wall appears to be made up of one or more coarse plaster layers followed by one or more fine plaster layers (fig. 1.31), all lime-based with dark volcanic aggregate and lumps of calcareous material. Paint is applied directly over the final gray plaster in this location.

Painting Materials and Techniques

The paintings were originally executed in a mixed technique over gray, white, or tinted plaster layers, with colors applied as monochrome blocks in the fresco technique, and decorative elements and figurative paintings applied likely in the *secco* technique using pigments mixed with a binder.[37] Although an exhaustive study of the different pigments used has not been carried out, the palette is composed of recognized pigments commonly used in Roman painting.[38] The presence of a number of pigments has been suggested on the basis of non-invasive investigation and material analysis, including lime (white), yellow and red ocher, cinnabar, green earth, Egyptian blue, and carbon black.[39] There has been some alteration of colors, as seen in the conversion from yellow to red ocher and in areas of cinnabar, which have changed from a brilliant red to a dark brown, as seen on one of the vertical bands on the east wall (fig. 1.32).

FIGURE 1.32.
Detail of a vertical band on the east wall, showing the range of colors used in the execution of the wall paintings, including white, yellow and red ocher, cinnabar, green earth, Egyptian blue, black, and other pigment mixtures, as well as the alteration of cinnabar to a dark brown.

FIGURE 1.33.
Brushstrokes of thinly applied color are visible at the top of the wall at the edge of the monochrome color areas of the wall paintings.

The technique of execution involved different plaster and paint sequences, depending both on the type of decoration and on location. The painting scheme can be loosely divided into three different groups: monochrome backgrounds, decorative elements, and figurative painting. Consistent with Roman wall painting technology, the monochrome background and the decorative elements and figurative scenes were likely executed by different artisans and painters as described by Tertullian.[40]

Monochrome Background

The monochrome background of the walls of the tablinum is painted using the fresco technique as seen by the depth of penetration of pigment into the plaster in these areas. The red and yellow backgrounds appear to be applied across the upper and lower registers of the wall in blocks of color using brushes, then smoothed or polished. Traces of a thin pink color are visible at the edges of the wall paintings where the background monochrome color would have been built up (fig. 1.33). The side panels of the lower section on the east and west walls are red (fig. 1.34); the central panels, now partially red, were likely originally yellow, as were the upper walls. Areas of the east wall, in the central panel, in the upper register, and portions of the base of the wall are yellow, suggesting that certain areas were originally painted yellow and have been converted to red. Evidence of this color change can be seen on the east wall, along the upper north end of the room, and in the central panel, where yellow and red fragments are intermixed—an indication of the conversion of yellow iron oxide (yellow ocher) to red iron oxide in the presence of heat. This brings into question the original color scheme of the room. There are several pieces of evidence to support the hypothesis that the central panels, the upper registers, and portions of the base of the wall originally had a yellow monochrome background. The primary example is seen on the central panel of the east wall, where a number of areas show a gradation from yellow to red within the same fragment (fig. 1.35). Additionally, there is a visible difference in the red tones of the side panels and those of the central panels.

FIGURE 1.34 (LEFT).
Monochrome red, yellow, and black backgrounds were applied in the fresco technique to blocks of color on different parts of the walls. The side panels of the lower east and west walls are red.

FIGURE 1.35 (RIGHT).
Alteration of yellow to red on individual pieces of plaster, indicating a transformation of yellow ocher to red oxide due to the heat of the eruption of Mount Vesuvius in 79 CE.

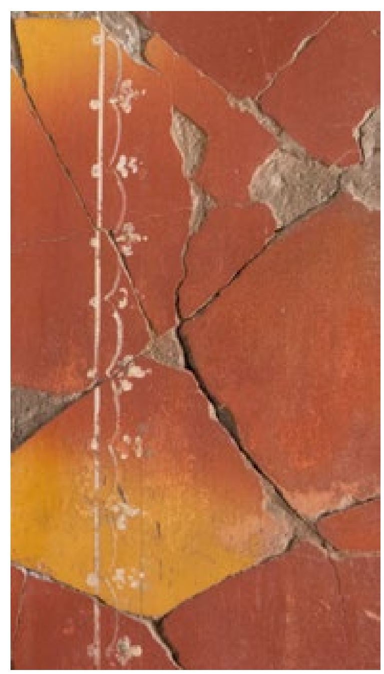

FIGURE 1.36A.
Detail of the decorative border, east wall, over a yellow background with traces of red (identified as cinnabar) in the semicircles.

FIGURE 1.36B.
Detail of the corresponding decorative border, west wall, over a red monochrome background altered from yellow, with traces of color (likely cinnabar turned gray-white) in the semicircles.

Another clue is the decorative border of flowers and semicircles framing the rectangular scenes on the central panels of the east and west walls. The border is a decoration outlined in white with semicircles filled in with red (cinnabar) and accents of green. This color contrast would be vivid and evident on a yellow background but not as effective on a red background (figs. 1.36a and 1.36b).

The monochrome background of the base of the east wall, lower south wall, vertical bands, and frieze is black. The black was likely mixed with a size or glue as described by Vitruvius.[41] The base of the wall is intact only in small areas at the south end of the east wall. From the traces of paint remaining in that area, the black appears to be thinly applied directly over a gray plaster layer.

Decorative Elements

Decorative elements are painted directly over the monochrome background to suggest architectural elements and perspectives on the upper walls. They also appear as decorative borders around the monochrome panels in the lower section of the east and west walls, bands of color on the central south wall, geometric patterns and floral designs along the base of the wall, and the intricate decoration of the vertical bands. Preparatory incisions used to lay out this decoration can be seen as straight lines and compass arcs and holes (fig. 1.37). Many of the decorative elements are repeating or geometric patterns that were laid out in the fresh plaster prior to execution. This type of decoration is thickly painted likely with lime, showing clear impasto. Decorative border details appear to be quickly executed in single brushstrokes.

Vertical Bands

The decorative elements on the vertical bands are built up over a black monochrome background, which in places is applied over the red or yellow of the side and central panels and covers the seam between these panels (fig. 1.38). This black appears to have been smoothed or polished before the application of the decoration. On the vertical bands, the paint of the decorative elements is thickly applied in multiple layers and shows clear impasto, with intricate designs defined by quick, individual brushstrokes and fine detail.

FIGURE 1.37.
Detail of the decorative border, showing compass arcs and holes used to lay out the decorative patterns.

FIGURE 1.38.
Detail of vertical band, showing decoration that is thickly applied and built up to create fantastic floral and grotesque designs.

Figurative Painting

Figurative paintings include the medallions, rectangular scenes, frieze, and figures on the upper walls. The figures and scenes are delicately painted, with careful detailed hatching, modeling, and draperies. The paint stratigraphies in the different areas are built up differently according to location.

Figures on Upper Walls

The figures on the upper walls are painted directly over the monochrome background. Freehand incisions can be seen in places, which loosely provide placement of the figures on the background plaster[42] (fig. 1.39). The figures are executed using a buildup of paint layers to indicate skin tone, clothing, and drapery (fig. 1.40).

FIGURE 1.39.
Area of upper wall, showing freehand incisions used to lay out the figures. The paint layer has been almost completely lost, and the incision outlining the outstretched arms of the figure is visible.

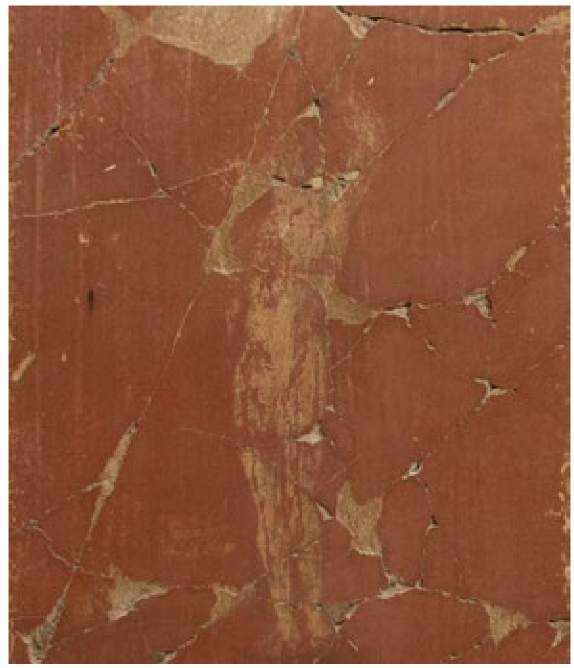

FIGURE 1.40.
Figures on the upper wall are painted directly onto the monochrome background with a buildup of paint.

Medallion Paintings

The four medallions with bacchante busts are painted over the red monochrome background on the two side panels of the east and west walls. A compass incision into the red monochrome background denotes the circumference of the circles. A light-blue background, composed of Egyptian blue mixed with lime white, appears to have been applied over the entire surface defined by the circular incision.[43] This layer serves as a preparation under the figurative painting and as a background around the figures. A thin white border outlines the circle. The figures are built up of multiple layers of paint,[44] showing thick impasto in different areas of the paintings. Hair, skin, and clothing are painted in intricate detail: fine hatching for the facial features, and a refined technique to depict the drapery of the clothing and details of the hair (fig. 1.41).

FIGURE 1.41.
A medallion painting featuring a bacchante, finely executed on a light-blue ground applied over a monochrome background. Hatching and a buildup of colors are used to create facial features, skin tone, and other details.

Rectangular Scenes

As described earlier in the section "Iconographic Description of the Wall Paintings," the two central rectangular paintings show mythological scenes. The scenes are carefully executed, each with a complex iconographic scheme and detail in the figures, drapery, and landscape of the paintings. From limited sampling, a thin white preparation can be seen under the paint layers. It appears that the pigments were mixed with a binder for the design layers, as there is a thick impasto, particularly in the figures. The figures exhibit a buildup of paint for shading and modeling of skin tone and drapery of clothing. The background of each scene is more loosely painted with thinner paint layers to suggest landscape and sky (fig. 1.42).

FIGURE 1.42.
Rectangular scenes are painted over a thin white preparation, with quick, loose brushstrokes to depict the background, and fine detailing for the figures.

FIGURE 1.43.
The frieze is painted over an added band of plaster on a black background with fine figurative painting and details in the landscape. An egg-and-dart border, thickly applied with rapid brushstrokes, completes the lower edge (detail, west wall).

Frieze

The frieze, which also includes fine figurative paintings, is painted over an additional tinted horizontal plaster band. The edges of the frieze plaster are finished and concealed with a layer of paint, creating decorative borders. The figures are painted with a buildup of multiple layers to show detail, while the landscapes and backgrounds are quickly sketched using individual brushstrokes. The egg-and-dart motif that extends along the bottom of the frieze is a thickly applied bodied paint (fig. 1.43).

Description of the Mosaic Pavement

The tablinum preserves a mosaic pavement consisting of a central marble pavement in *opus sectile* surrounded by a black-and-white mosaic in *opus tessellatum* (fig. 1.44). The central section is composed of a rectangular emblem using red African breccia and yellow marble slabs (*giallo antico* from Chemtou, Tunisia)[45] in geometric forms to create

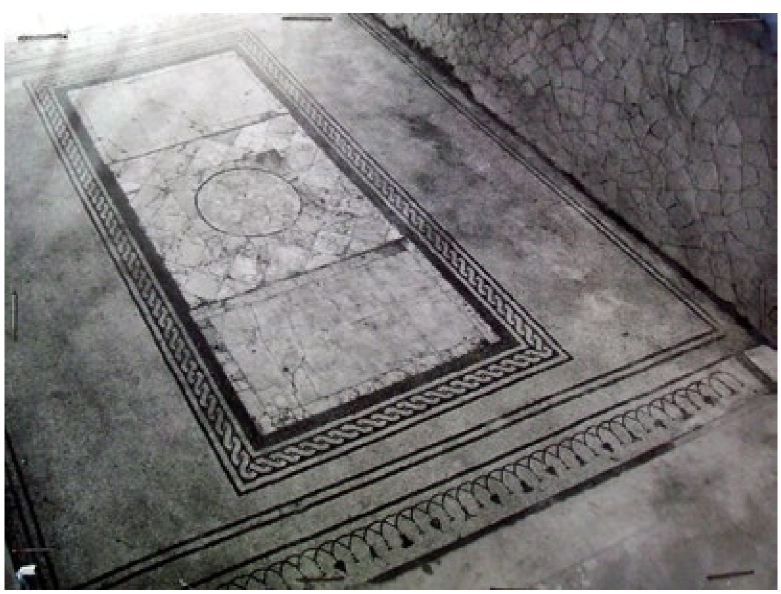

FIGURE 1.44.
Mosaic pavement in the tablinum of the House of the Bicentenary at the time of excavation in 1938. The mosaic comprises a rectangular marble pavement in *opus sectile* with a disk in the center, and is surrounded by a black-and-white decoration in *opus tessellatum.*
Photo: Maiuri 1958, 230, fig. 180.

FIGURE 1.45.
Central design of the mosaic pavement, showing a sophisticated geometric pattern of rhomboids in different colored stones. (Historical Archives of the Soprintendenza Pompei, Foglia, 15020b)

sophisticated patterns. The central panel is divided into three sections, measuring in total approximately 1.45 × 3.28 m. The two outer sections are composed of slabs of African breccias, and the central section consists of a disk surrounded by rhomboids in an ornate grid pattern (fig. 1.45) and resembles a polychrome carpet framed by a band of red marble surrounded by a black- (volcanic stone) and-white decorative border with a black-and-white rope motif in *opus tessellatum*, and a stylized border at the north and south ends. The different marbles used in the central *opus sectile* emblem have not been identified, though they do include *giallo antico*.

According to Maiuri, "the panel is divided into three sections framed by bands of red marble: the two side sections are composed of two slabs of African breccia, while the central section is a circular disk filled by a dense grid decorated with squares and surrounded by a band with a decorative diamond pattern" (*Il pannello è diviso in tre specchi riquadrati da fasce di marmo rosso: i due specchi estremi [sono] formati da due lastroni di breccia Africana, mentre lo specchio central racchiude, tra una fascia di rombi, un disco circolare riempito da un fitto reticolato ornate di borchie*) (Maiuri 1958, 230).

Acknowledgments

The authors would like to thank the Herculaneum Conservation Project (HCP) and the Parco Archeologico di Ercolano (formerly the Soprintendenza Pompei) for their generous sharing of information, historical photographs, and archives with the team. Combined, their knowledge of Herculaneum and the House of the Bicentenary greatly helped the project team to better understand the history of the site, the house, and the tablinum. Thanks go

to Thomas Roby for information on the mosaic pavement. Likewise, a debt of gratitude is owed to Professor Giorgio Torraca, scientific consultant to HCP, and Giacomo Chiari, former head of the Science department, GCI, for their guidance and inspiration in the development of the project and the study of the materials, techniques, and conservation issues of the tablinum.

Notes

1 Some areas of the site have been excavated since 1961, but 1927–61 was the most intensive time of excavation under Maiuri.

2 The information in this report is a combination of bibliographic research from Maiuri's monograph on the site, *Ercolano: I nuovi scavi* (1958); the excavation journal (*Giornale dei lavori*) and excavation diary (*Diario di scavo*); recent publications, including Guidobaldi and Esposito, *Herculaneum: Art of a Buried City* (2013); and visual examination, non-invasive diagnostic investigation, and material analysis.

3 The House of the Bicentenary was excavated two hundred years after the first formal excavation of the site, hence the name.

4 In the section on the House of the Bicentenary in the *Diario di scavo*, Maiuri notes that over the period of early excavation of the site of Herculaneum, the House of the Bicentenary was referred to by a number of variations, including "*casa 25, Decumano Massimo insula V,*" "*casa 26, Decumano Massimo insula V,*" and "*casa 27, Decumano Massimo insula V.*" Il n. 25 corrisponde ad *Insula* V, n. 17–18, il n. 26 ad *Insula* V, n. 16, il n. 27, infine, ad *Insula* V, n. 15.

5 Maiuri 1958, 228–32.

6 Maiuri 1958, 222.

7 See Guidobaldi and Esposito (2013, 247) for a description of the tablets.

8 The cruciform element (Maiuri 1958, 227) has since been reinterpreted as an element of a wooden fixture. Guidobaldi and Esposito 2013, 248.

9 The following is the description of the tablinum by Maiuri from the *Diario di scavo*, as it was found at the time of excavation and reconstruction:

> The tablinum of the House of the Bicentenary is rectangular and measures 4.17 m long by 5.5 m wide. The opening to the room facing the atrium is 4 m high, while the opposite one is 2.93 to 2.80 m wide. The pilasters of this room are of *opus mixtum*, and the first layer of tuff is in rows. The height of the base is 0.42 m and the plaster is black with small lozenges of blue. Above it is a band of yellow 0.28 m high. The central register is red on the sides and in the middle, yellow. On the red stucco there are two medallions with portraits 0.329 m. in diameter. On the yellow panel, the east has a rectangular painting 1.08 m high by 0.81 m wide with the mythological subject of Mars and Venus, and on the west with Pasiphaë and Daedalus. Dividing the central register and the upper walls is a frieze on a black background .39 m high with paintings of hunting scenes, warriors, and cupids playing at target. The upper wall background color has changed from yellow to red with architectural perspectives and other elements. The floor in the center has a rectangle 3.38 m by 1.43 m with a design in polychrome marble, and a border of black and white tesserae, forming (fuseruola?) and ogivale etcetera. The masonry is in *opus reticulatum*. (18 January 1939)
>
> [Il tablino della Casa del Bicentenario è a forma rettangolare e misura m. 4.17 di lunghezza per 5.05 di larghezza Il vano d'ingresso che affaccia nell'atrio è alto m. 4, mentre quello opposto è largo m. 2.93 per 2.80. I pilastri di quest'ultimo vano sono di opera mista, ed il primo di conci di tufo posti a filare. L'altezza dello zoccolo è di m. 0.42 e lo stucco è a fondo nero con piccoli quadretti di azzurro. Sopra una fascia di giallo alta m. 0.28. Il campo centrale è ai lati rosso e al centro di giallo. Sullo stucco rosso vi sono due medaglioni del diametro di m. 0.329 con ritratti.

Sul giallo, quello ad est vi è un quadro alto m. 1.08 per 0.81 di larghezza con il soggetto mitologico di Marte e Venere, e sopra quello ovest Pasife con Dedalo. Divide il campo centrale con quello terminale una fascia di nero alta m. 0.39 con dipinti di scene di caccia, guerrieri, e di amorini che giocano al bersaglio. L'ultimo riquadro è di giallo cambiato in rosso con disegni di prospettive e altro. Il pavimento al centro tiene un rettangolo di m. 3.38 per 1.43 di marmi policromi posti a disegno, e lateralmente di tessere bianche e nere intersecate da formare (fuseruola?) ogivale eccetera. La muratura è di opera reticolato. (18 gennaio 1939)]

10 Maiuri 1958, 230.

11 There are several areas of yellow monochrome background on the east wall, including the upper wall, the central rectangular panel, and portions of the base of the wall. The presence of yellow indicates that this was likely the original background color in these areas and that the change to red was caused by the high temperatures reached during the eruption of Mount Vesuvius. Several fragments exhibit a gradation of yellow to red, evidence of this transformation. At temperatures above 250°C, yellow ocher pigment ($Fe_2O_3 \cdot n\ H_2O$, hydrated iron oxide, limonite) converts by heat to red ocher pigment (Fe_2O_3, anhydrous iron oxide). See chapter 5 in this volume, also the experimental study by Rickerby (1991) and the article by Baraldi and Bensi (2006) on this phenomenon. Visual examination and material analysis show that the two side panels of the lower register of the wall were likely originally red; the central panels and the upper walls were likely originally yellow.

12 The two decorative vertical bands on the east wall terminate at the base of the egg-and-dart decoration of the frieze directly above it. On the west wall, the vertical bands appear to extend into the zone of the egg-and-dart motif and terminate at the top of this design. Further investigation is warranted to determine if the egg and dart originally continued along both walls or if the two walls were treated slightly differently.

13 According to Guidobaldi and Esposito, the frieze "appears to have been conceived independently from the middle zone (lower wall), with which it is not perfectly aligned, although it is also divided into three sections" (2013, 250).

14 This and the following descriptions of the wall paintings are from Maiuri (1958, 230–32). See also Guidobaldi and Esposito (2013, 248–50) for a detailed description of the iconography of the tablinum wall paintings.

15 It has been hypothesized that the figure of Mars may be a portrait of the owner of the House of the Bicentenary, as seen in his contemporary hairstyle and personalized features (Zanker 2002, 125).

16 There are slightly different interpretations of this scene. Maiuri interpreted it as Pasiphaë pointing out the cow, which she would like Daedalus to model: "Pasifae vestita di chitone ceruleo indica a Dedalo la giovenca bella che l'artista deve prendere a modello" (Maiuri 1958, 231). The scene is interpreted by John K. Papadopoulos as "Pasiphaë (chiton and himation) stands in an open field pointing out bull to Daidalos who stands to right. The bull stands out among other cattle by his size. In background above, a satyr looks on from behind a grotto" (*Lexicon Iconographicum Mythologiae Classicae* [*LIMC*] 1994, book 7, 1, 195). Upon visual examination, it seems that the LIMC interpretation of the bull vs. cow is correct.

17 Guidobaldi and Esposito 2013, 250.

18 The description of the scheme along the base of the walls differs in Maiuri's *Diario di scavo* and his later publication, *Ercolano: I nuovi scavi*. In the former, Maiuri describes the base of the wall as "a black plaster base with small blue squares. Above this is a yellow band" (n.d.-a, 28). In the latter reference, he describes it as a "black base with foliage clusters surmounted by an upper band in red" (1958, 230). Indeed, based on visual examination of the lower east wall, there are traces of red at the north end of the tablinum and traces of yellow at the same height at the south end, suggesting a transformation of yellow to red due to heat from the volcanic eruption.

19 See also Piqué, MacDonald-Korth, and Rainer (2015) for a discussion of the original materials and techniques of the tablinum wall paintings.

20 See Vitruvius (1960[1914], book 7, 206–7) for a description of Roman wall painting materials and techniques.

21 For a description of the tuff used at Herculaneum, see Cinque, Irollo and Camardo 2009.

22 Maiuri n.d.a, 20.

23 “The pilasters of [the south wall opening] are in *opus mixtum*. The first layer is tuff blocks in a row” (*I pilastri di quest’ultimo vano sono di opera mista, ed il primo di conci di tufo posti a filare*) (Maiuri n.d.a, 20). Maiuri uses the term *opus mixtum,* sometimes used in place of the more specific term *opus vittatum,* consisting of parallel horizontal courses of tuff blocks alternated with bricks.

24 Maiuri states that “for the [restoration of buildings], he used the same materials in tuff and brick, and to clearly distinguish the reconstructed masonry from the original, in general, where this was originally in *opus reticulatum*, adopting a type of *opus incertum* with mortar joins in lime, in such a way as to harmonize the color and still distinguish the different texture of the construction” (*Per quanto riguarda la tecnica del restauro, special cura si è posta, pur usando gli stessi materiali in tufo e laterizio, nel distinguire nettamente le murature di rifacimento da quelle originarie, adottando generalemente, là dove prelevava l’opera a reticolato, un tipo di opera incerta a giunti listati leggermente di calce, in modo da armonizzare per il colore e distinguersi per la diversa tessitura della costruzione*) (Maiuri 1958, 22).

25 For a full description of the remounting and reconstruction materials and techniques used by Maiuri and his team, see Gittins et al., this volume.

26 See, for example, 1 giugno 1938, *Restauro stucchi Umberto Scavone:* “Completed the removal of plaster belonging to number 26 ground floor with the collection of fragments and recomposition in the gymnasium area of the workshop” (Ultimato o smontaggio stucchi appartenente al numero 26 vano terraneo con la raccolta di frammenti e ricomposizione nella palestra dell’officina).

27 According to Mora, Mora, and Philippot, the entire wall would have been covered with a coarse plaster of lime and sand, or pozzolana (*arriccio*). The painting would have been executed on a fresh *intonaco,* or fine plaster layer. “Usually three *pontate* are visible, separated by two horizontal joins and corresponding to the decorative system on the wall” (1984, 97). This technique of plastering is documented in the House of the Dioscuri, a similar house in Pompeii (De Carolis and Corsale 2011, 484).

28 Plaster characterization was carried out as part of this project, and details of this analysis can be found in Graves, Piqué, and Rainer, this volume.

29 It has been noted that the overall thickness of plaster on the east wall, which is thought to be largely reconstructed, measures approximately 4 to 5 cm. The thickness of the west wall is approximately 6 to 7 cm thick and has large areas of plaster without breaks, suggesting that they remained in situ during excavation and restoration.

30 Due to the remounting technique used by Maiuri—in which fragments were likely shaved to level them and modern plaster layers were added to the backs of fragments—combined with the inaccessibility to the lower plaster layers in areas that may have remained in situ, the precise thickness of all plaster layers is unknown.

31 It is not possible to determine with certainty the full thickness of the lowest layers due to the complex layering of original and remounted plasters and inaccessibility to these layers.

32 Based on visual examination and comparison with other, similar wall paintings in Pompeii and at the Domus Aurea, it has been proposed that double layers of plaster may have been applied wet on wet. Vitruvius describes the plaster technique as follows: “apply a rough rendering coat to the walls, and afterwards, when the rendering coat gets pretty dry, spread upon it the layers of sand mortar, exactly adjusted in length to rule and line, in height to the plummet, and at the angles to the square. The stucco will thus present a faultless appearance for paintings. When it gets pretty dry, spread on a second coat and then a third” (1960[1914], book 7, chap. 3, p. 206).

33 Mora, Mora, and Philippot (1984) describe that in Roman wall painting, the last, very thin layer of rendering was tinted before application of the colored background. It is interesting to note that in the case of the tablinum, only the upper register of the south wall and the lower register of the east and west walls appear to have a pink-tinted plaster layer, suggesting that they were likely considered primary presentation zones. The monochrome background of the upper register of the east and west walls is applied directly over a fine white plaster; the lower south wall color is applied over a white plaster with brick dust; the base of the east wall is painted directly over a fine gray plaster layer, which appears not to have been polished or smoothed.

34 It should be noted that this is an exterior wall that leads to the peristyle garden, which would have been exposed to exterior conditions. Mora, Mora, and Philippot (1984) refer to Vitruvius's specification that in damp places, brick dust is added to the plaster. Vitruvius states, "in apartments which are level with the ground, apply a rendering coat of mortar, mixed with burnt brick instead of same, to a height of about three feet above the floor" (1960 [1914], book 7, chap. 3, p. 208).

35 This type of execution for large figurative scenes is described in Mora, Mora, and Philippot: "In general . . . the 'pictures' were executed in situ, either on the fresh intonaco of the pontata, or on a new intonaco inserted ad hoc into the wall . . . . The intonaco already covered with paint was cut along the desired line, the cuts being perpendicular to the surface of the wall, and the fresh intonaco was applied slightly overlapping the completed painting so that the joins were hidden" (1984, 99).

36 In different locations along the three walls, the uppermost tinted plaster of the frieze visually appears to be a range of tones from yellow to orange to red to brown, depending on location. On the east wall, north end, there are areas of yellow tinted plaster under the frieze; at the south end, the tinted plaster appears red; along the south wall, it appears orange to brown; and along the west wall, it appears red at the south end and orange at the north end.

37 Elevated amounts of calcium (identified as both calcium carbonate and calcium sulfate) have been identified in the paint layers, suggesting that lime and possibly gypsum may have been used as paint binders with or without the addition of organic binders. No organic binder in the tablinum paintings has been positively identified to date. This can be due to several factors: no organic binder was originally used; organic binder was used but has deteriorated over time and/or due to heat from the eruption and subsequent burial; and/or organic binder was used and is present but in such small amounts that it is not detectable.

38 Pigments used in Roman painting have been extensively studied and the literature includes Pliny and Vitruvius as primary sources as well as historic and recent investigations, on both inorganic and organic pigments, including Chaptal (1809), Davy (1815), Augusti (1967), Béarat et al. (1997), Siddall (2006), Baraldi et al. (2007), Piovesan et al. (2011), Maguregui et al. (2012), and Corso et al. (2013).

39 Piqué et al. 2007.

40 As described in Mora, Mora, and Philippot, referencing Tertullian's *De idolatria*, the work of plastering, applying monochrome backgrounds, and general decoration would have been carried out by the *albarius tector*, whereas the figurative paintings would have been executed by the *pictor* (Mora, Mora, and Philippot 1984, 104).

41 Vitruvius describes the preparation of soot black using burnt resin or splinters of pitch pine, mixed with size, as a black used for fresco painting (1960 [1914], 218).

42 Mora, Mora, and Philippot state, "Small figures isolated on a background, requiring a more careful portrayal were often sketched with a very summary, incised drawing before being painted with a brush" (1984, 100).

43 This was observed using visual induced luminescence photography, which can identify Egyptian blue, carried out by Giacomo Chiari, former head of Science, GCI.

44 To date, binding media has not been positively identified for the paint used in any of the figurative painting techniques.

45 Roby 2011.

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APPENDIX 1.1

Graphic Documentation: Overall Walls and Figurative Scenes

Casa del Bicentenario, Tablinum, East Wall - Overall

Casa del Bicentenario, Tablinum	PROJECT **Herculaneum Project**	PARTNERS SP, HCP	PROJECT MANAGER Leslie Rainer	DATE RECORDED -----	**EW**
The Getty Conservation Institute	LOCATION Herculaneum, Italy	COPYRIGHT GCI	RECORDED BY -----	LAST REVISED 2017/05	SCALE 1:25

Casa del Bicentenario, Tablinum, East Wall - East Medallion 1 (North) [EM1]

Casa del Bicentenario, Tablinum	PROJECT	PARTNERS	PROJECT MANAGER	DATE RECORDED	EM1
The Getty Conservation Institute	**Herculaneum Project**	SP, HCP	Leslie Rainer	-----	
	LOCATION	COPYRIGHT	RECORDED BY	LAST REVISED	SCALE
	Herculaneum, Italy	GCI	-----	2017/05	1:2

Casa del Bicentenario, Tablinum, East Wall - East Scene 2 (Center) [ES2]

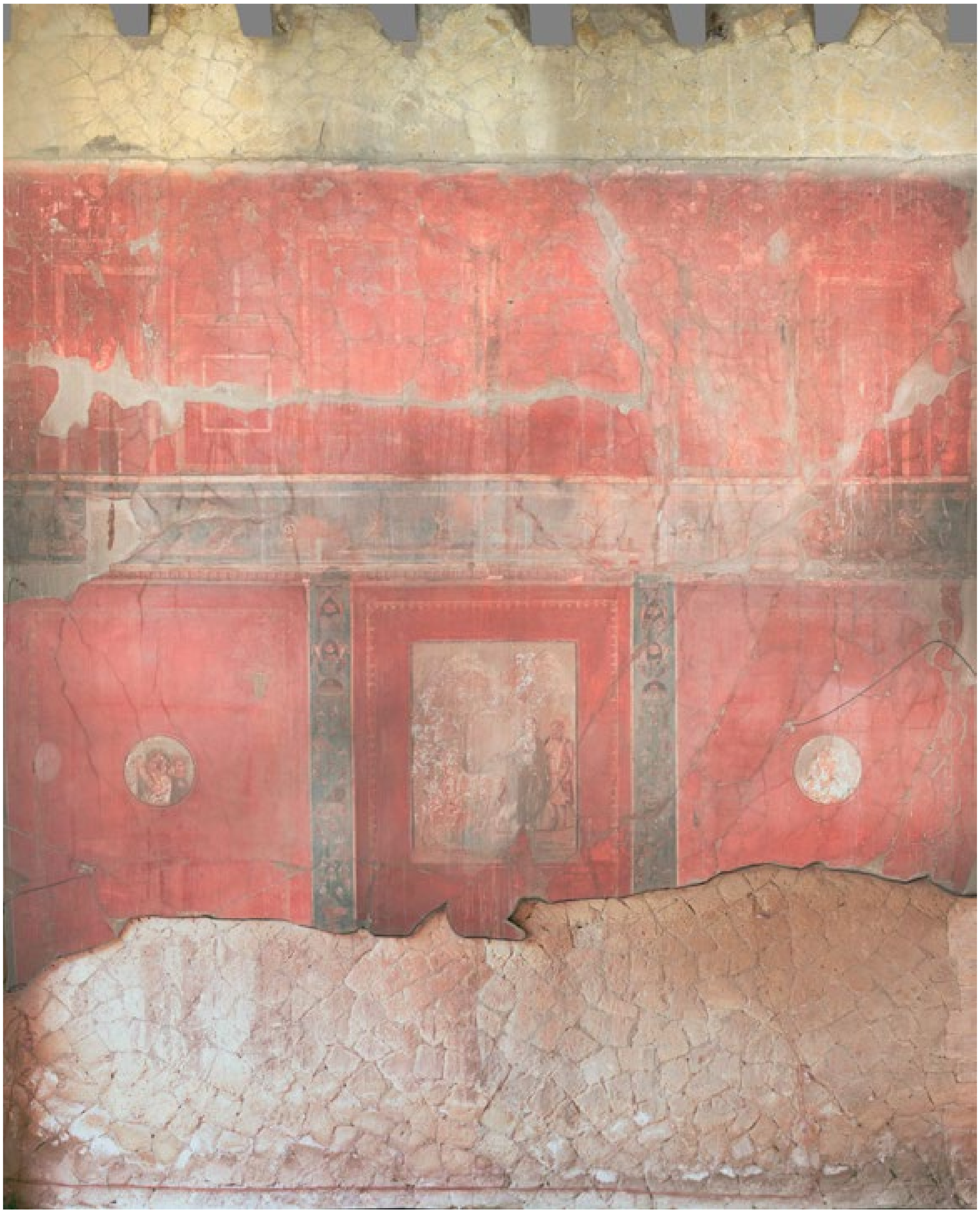
Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY -----	DATE RECORDED ----- LAST REVISED 2017/05	**ES2** SCALE 1:5

Casa del Bicentenario, Tablinum, East Wall - East Medallion 3 (South) [EM3]

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY -----	DATE RECORDED ----- LAST REVISED 2017/05	**EM3** SCALE 1:2

Casa del Bicentenario, Tablinum, South Wall - Overall

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT Herculaneum Project LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY -----	DATE RECORDED ----- LAST REVISED 2017/05	SW SCALE 1:25



Casa del Bicentenario, Tablinum, West Wall - Overall

Casa del Bicentenario, Tablinum	PROJECT	PARTNERS	PROJECT MANAGER	DATE RECORDED	WW
The Getty Conservation Institute	**Herculaneum Project**	SP, HCP	Leslie Rainer	-----	
	LOCATION	COPYRIGHT	RECORDED BY	LAST REVISED	SCALE
	Herculaneum, Italy	GCI	-----	2017/05	1:25

Casa del Bicentenario, Tablinum, West Wall - West Medallion 1 (South) [WM1]

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY -----	DATE RECORDED ----- LAST REVISED 2017/05	**WM1** SCALE 1:2

Casa del Bicentenario, Tablinum, West Wall - West Scene 2 (center) [WS2]

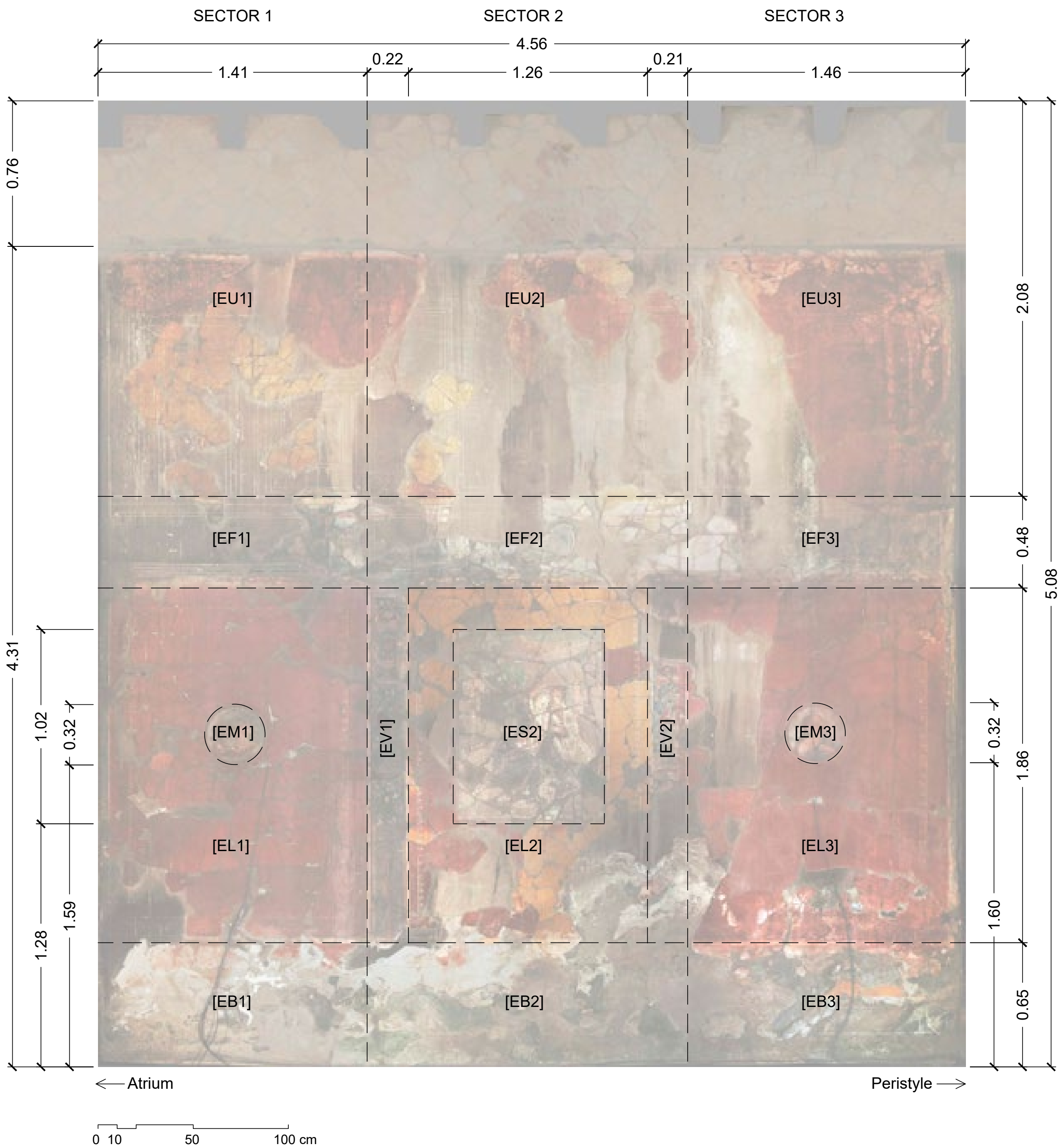
Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY -----	DATE RECORDED ----- LAST REVISED 2017/05	**WS2** SCALE 1:5

Casa del Bicentenario, Tablinum, West Wall - West Medallion 3 (North) [WM3]

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY -----	DATE RECORDED ----- LAST REVISED 2017/05	**WM3** SCALE 1:2

APPENDIX 1.2

Graphic Documentation: Overall Maps with Dimensions and Wall Sections



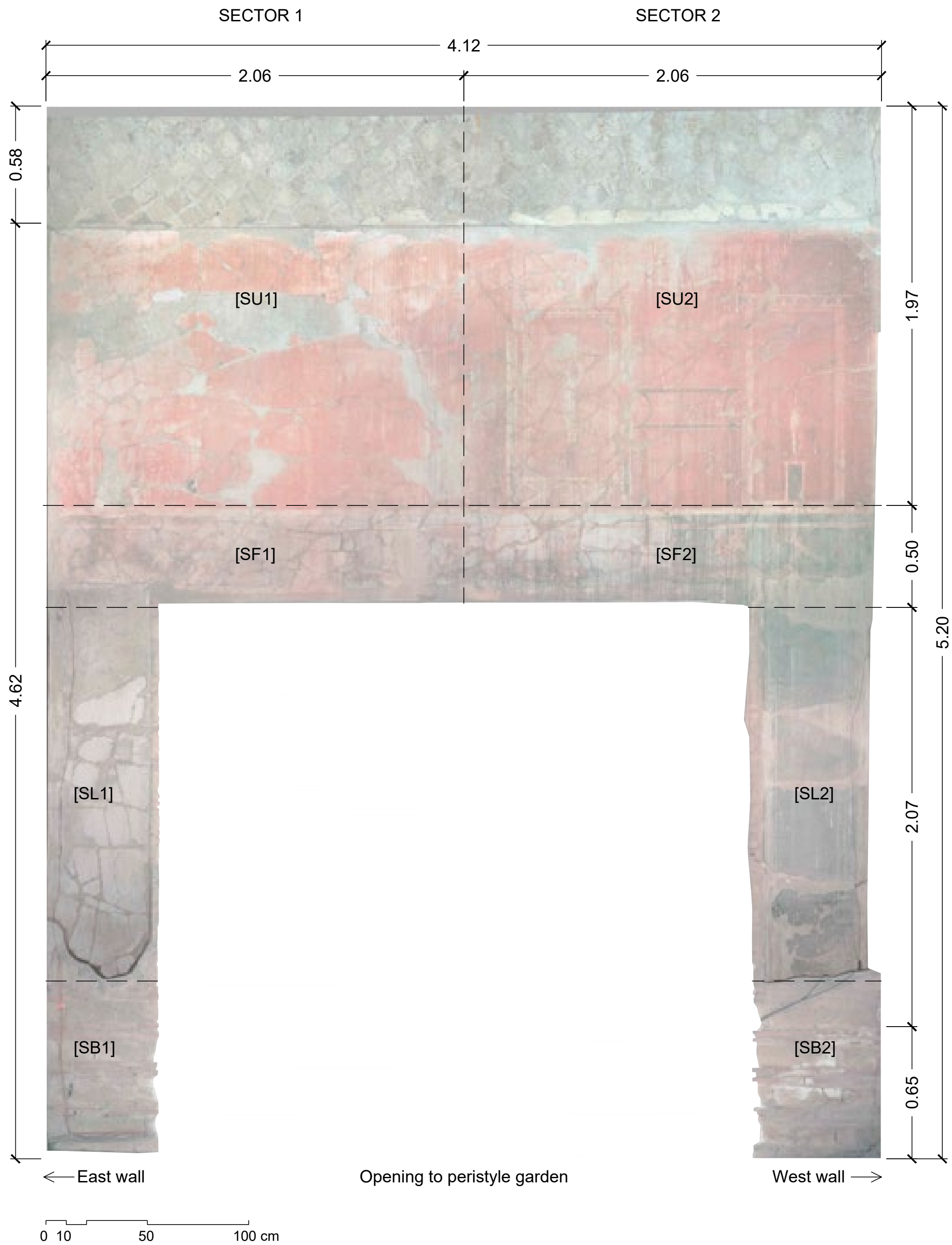
Casa del Bicentenario, Tablinum, East Wall - Overall

WALL SECTIONS:

[EU] East Wall Upper
[EF] East Wall Frieze
[EL] East Wall Lower
[EV] East Wall Vertical Bands
[EB] East Wall Base

Figurative Scenes:
[EM1] East Medallion 1 (North)
[ES2] East Scene 2 (Center)
[EM3] East Medallion 3 (South)

Casa del Bicentenario, Tablinum	PROJECT	PARTNERS	PROJECT MANAGER	DATE RECORDED	EW
The Getty Conservation Institute	Herculaneum Project	SP, HCP	Leslie Rainer	-----	
	LOCATION	COPYRIGHT	RECORDED BY	LAST REVISED	SCALE
	Herculaneum, Italy	GCI	-----	2017/05	-----

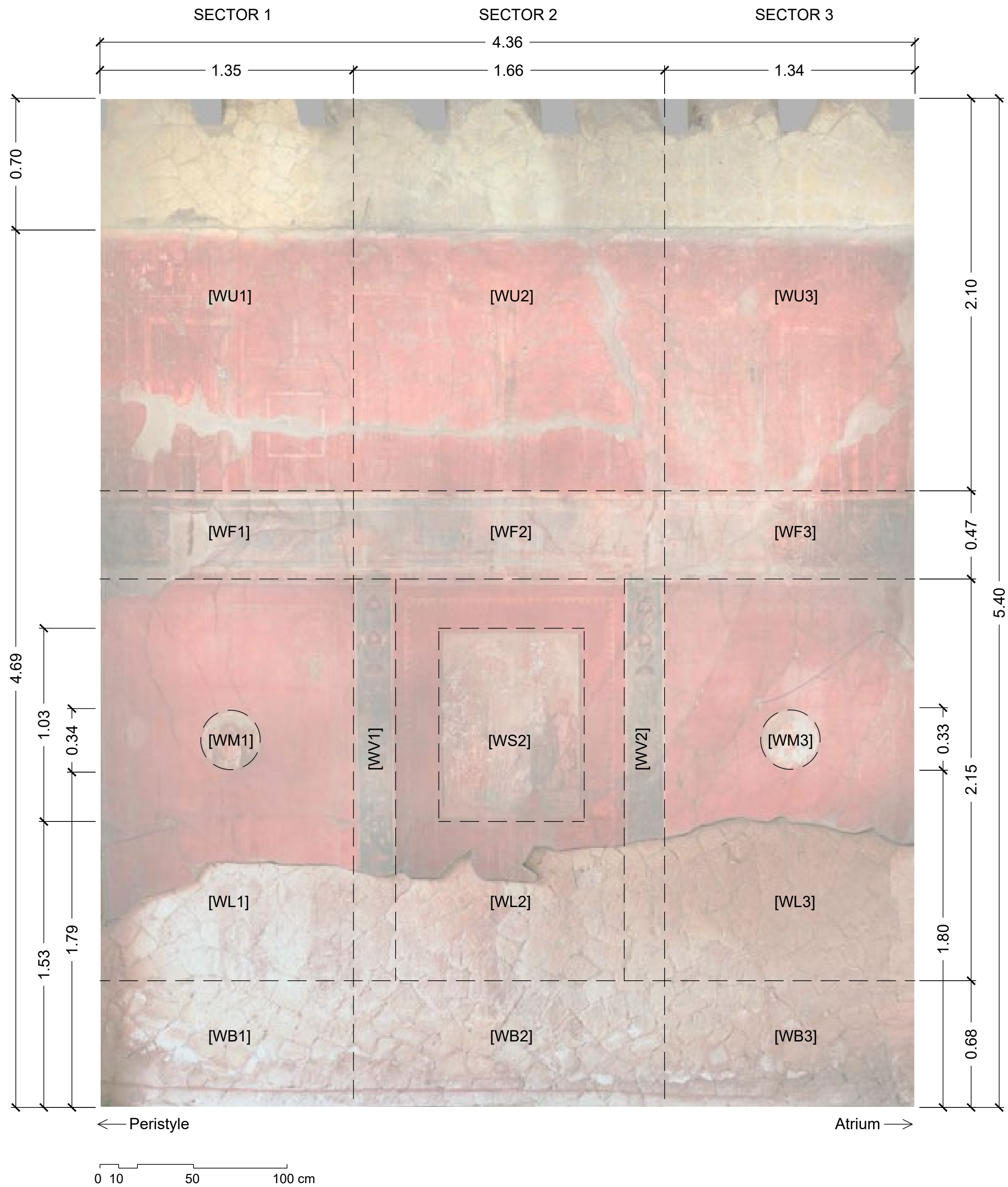


Casa del Bicentenario, Tablinum, South Wall - Overall

WALL SECTIONS:

[SU] South Wall Upper
[SF] South Wall Frieze
[SL] South Wall Lower
[SB] South Wall Base

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT Herculaneum Project LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY -----	DATE RECORDED ----- LAST REVISED 2017/05	SW SCALE -----



Casa del Bicentenario, Tablinum, West Wall - Overall

WALL SECTIONS:

[WU] West Wall Upper
[WF] West Wall Frieze
[WL] West Wall Lower
[WV] West Wall Vertical Bands
[WB] West Wall Base

Figurative Scenes:
[WM1] West Medallion 1 (South)
[WS2] West Scene 2 (Center)
[WM3] West Medallion 3 (North)

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY -----	DATE RECORDED ----- LAST REVISED 2017/05	**WW** SCALE -----

CHAPTER 2

Reconstruction and Remounting Materials and Techniques of the Wall Paintings in the Tablinum of the House of the Bicentenary

Mark Gittins, Maria Luigia Bonaschi, Francesca Piqué, and Leslie Rainer

Introduction

The House of the Bicentenary (Casa del Bicentenario), including the tablinum, was excavated in 1938–39 as part of the "New Excavations" under the supervision of Amedeo Maiuri. The techniques and methodology employed by Maiuri during the excavation and subsequent reconstruction, as well as the conservation of the paintings, have determined not only how the architectural surfaces in the tablinum have been presented over the last eighty years but also many aspects of their present condition.

The techniques used by Maiuri have been studied throughout the project, both through the sources available (publications and photographs) and through direct observation of the works in situ and scientific analyses of their components. (See Graves, Piqué, and Rainer, this volume.)

The Sources

Ercolano: I nuovi scavi (Amedeo Maiuri)

In his *Ercolano: I nuovi scavi (1927–1958)*, Amedeo Maiuri (1958) sets out a comprehensive methodological approach to the study and excavation of the archaeological site of Herculaneum during his time as superintendent and director of works there. In the monograph on the site and its excavation, he states that the excavations carried out under his direction adopted more rigorous (and difficult) procedures than earlier digs at Herculaneum and Pompeii due to "the scientific methods that are a requirement of the modern study of antiquity" (*le esigenze scientifiche che lo studio delle antichità oggi impone*).

While Maiuri makes some general references as to how this modern approach must be achieved, he does not go into great detail concerning the methods employed other than to indicate that, despite the scale of the problems faced, the result must be essentially minimal and respectful of the original materials. In the case of architectural structures, "while using the same materials, tuff and brick, special care was taken to clearly differentiate the reconstructed walls from the originals" (*I nuovi scavi* p. 22; *speciale cura si è posta, pur usando gli stessi materiali in tufo e laterizio, nel distinguere nettamente le murature di rifacimento da quelle originali*).

A similarly minimalist approach was employed to restore the paintings: in the "frescoed areas the reconstructed wall sections are left without plasters, or, if a rough plaster was applied, its only purpose was to provide a schematic layout of the wall [decoration] using white lines, which was sometimes necessary to show the design of the wall" (*I nuovi scavi*

p. 22; *I rifacimenti murari sono lasciati senza intonaco o, quando vi si è sovrapposto un intonaco grezzo, ciò è stato fatto solo al fine di rappresentare il disegno schematico della parete a lineole bianche, provvedimento necessario, a volte, per presentare il disegno decorative di un parete*).

Giornale dei lavori degli scavi di Ercolano

Limited information about the day-to-day work carried out during the excavations can be gleaned from the *Giornale dei lavori degli scavi* (Maiuri n.d.-b), in which individual workers recorded operations carried out in daily entries. The section of the journal describing the House of the Bicentenary (see appendix 2.1) takes the form of sporadic entries every few days or weeks, briefly describing operations related to the excavation and reconstruction of the house, together with the name and job title of one of Maiuri's workers, presumably whoever was responsible for the particular task.

Despite the limited information it contains, the *Giornale* provides some valuable insight into how the work on the house was structured, though there is little detail concerning the work on the tablinum itself: it is first mentioned on 15 June 1938, with several entries over two months, from 9 July to 9 September 1938, and then once more, on 27 December 1938.

While the bulk of the *Giornale* describes work to stabilize, demolish, and reconstruct the architectural structures, it is clear that this work went on simultaneously with both the excavation and the restoration of mosaics and paintings.

The *Giornale* and the Wall Support

The original wall support principally consists of tuff blocks. When sound, this was conserved by Maiuri's team, but it was often repaired or replaced; for example, the *Giornale* entry of 5 August 1938 states, "Tablinum western part continue work on supporting the *opus incertum* wall and demolishing the degraded wall" (*Tablino lato ovest continua incasso di muratura ad opera incerta con demolizione della muratura marcita*).

As suggested by the above quotes from Maiuri, new construction is usually easy to distinguish from the original Roman work, employing a lighter, yellower, more friable tuff constructed in *opus incertum*.

That the *Giornale* is incomplete is shown by the modern reconstruction work in the tablinum carried out between the upper border of the paintings and the modern wood ceiling, where there is a roughly 80-cm-high band of visible wall. The *Giornale* entry of 27 December 1938 states that this upper part of the east wall (which is almost all modern tuff) was reconstructed to hold cross beams (*Tablino lato est ricostruito una sopraelevazione di muratura ad opera incerta per imposta di travi*). The *Giornale* says nothing about reconstruction on the south wall, which is principally composed of original Roman tuff, but neither does it mention reconstruction work on the upper part of the west wall, which is obviously entirely modern: the only comment is "west side 8 holes made for holding beams" (*lato ovest fatto 8 buchi per le tenute dei travi*).

The lower parts of the south and west walls, mostly reconstructed, have been left bare of plaster, up to a height of 100–145 cm. The lower portion of the pilasters is in *opus vittatum* (in part original Roman construction and partially reconstructed); the lower west wall is reconstructed in *opus incertum*, both using tuff blocks that are lighter in color than the original Roman tuff.

All work on the walls, whether reinforcement or demolition and reconstruction, is attributed to *muratori* (masons).

The *Giornale* and the Wall Paintings

The wall paintings in the tablinum, and the site of Herculaneum as a whole, were subjected to a number of operations as part of Maiuri's excavation and restoration process, and indeed many have been transferred to new supports and remounted on the walls.

Unfortunately, the *Giornale* says less about the treatment of the paintings in the tablinum than it does about the architectural elements. However, looking at the entries for the House of the Bicentenary as a whole suggests some trends that can be supported by observation of the wall paintings in situ.

It can be noted that there are only a limited number of operations described during work on the house from April 1938 to January 1939. Restoration of plasters (*restauro stucchi*)[1] is mentioned fourteen times[2] and detaching plasters (*smontaggio stucchi*) nine times, recomposition (*ricomposizione*) of plasters seven times, and collecting and transporting plaster fragments only one time each.

Although it is clear that this can be considered by no means an accurate quantitative evaluation of treatment processes carried out on the paintings, perhaps their relative frequency suggests that the detachment and reattachment of damaged and probably fractured wall paintings may have been more common than the collection, reconstruction, and remounting of fragments collected from the ground. A contemporary photograph from the site shows that fragment collection and reconstruction was part of standard working practice (fig. 2.1).

According to entries in the journal, the bulk of the operations on the tablinum occurred between June and September 1938, with numerous mentions of repairs to the walls, but there are only two direct references to the work carried out on the wall paintings. Entries on 9 and 11 July record only the number of square meters of plaster restored (*restaurato mq 1.15 di stucchi del tablino di detta casa 27*), giving a very scant idea of the complete work carried out on the wall paintings in this room.

References to the restoration of wall paintings in the various rooms of the house, however, provide a fairly comprehensive idea of the type of work carried out on plasters and wall paintings and by whom. Operations on the wall paintings were carried out by a team of workers from different trades, including plasterers (*stuccatori*), plaster restorers (*restauratori*

FIGURE 2.1.
Reassembly of fragments at the site of Herculaneum, 1935. (Historical Archives of the Soprintendenza Pompei, Maiuri, inv. C2649)

stucchi), stone carvers (*marmisti*), paintings conservators (*conservatori dipinti*), and varnishers (*verniciatori*). The main restoration work appears to have been carried out by the *restauratore stucchi*, whose entries frequently record detaching and restoring (painted) plasters (*smontato e restaurato . . . stucchi*), though detachments were twice recorded as being executed by a stone carver (*marmista*).The last mention of work by the *restauratore stucchi* in the entries on the House of the Bicentenary is on 2 January, four months after the previous recorded treatment, where the restorer is described as having "detached and restored (*smontato e restaurato*) 8.5 square metres of *stucchi*." On the other hand, toward the end of treatment, on 12 November 1938 and 18 January 1939, a *stuccatore* (plasterer) is recorded as "continuing to place *stucchi* on the upper and ground floors with roughing out (?) an architrave and laying on *tonachino* (plaster)" (*continua la messa in opera degli stucchi al piano superior piano terraneo con abbozzi di architrave e messo a tonachina*).

An entry on 9 February 1939 describes the process of recomposition of fragments carried out by the workshop of frescoed plaster restoration (*Officina restauro stucchi affrescati*). It is described as the recomposition of plaster pieces with a cement backing (*ricomposto frammenti di stucco bianco a lastroni con soletta di cemento sull'estradosso*). The remounting of fragments (entry for 21 February) is described as follows: "completed the work of putting into place the plasters with a liquid cement mortar and reinforcement of intonaco" (*ultimato . . . lavoro di messa in opera degli stucchi con beveraggio di cemento fino con malta e finimenti di intonaco*).

A *conservatore dipinti* is mentioned on 9 September 1938 as having "started work on *incrostazione* and spreading wax on the frescoed walls" (*iniziato lavoro di incrostazione e spalmatura cera alle pareti affrescate*) and then, fourteen days later, as "finished work of spreading wax on the frescoed walls of the Casa del Bicentenario" (*ultimato lavoro spalmatura di cera alle pareti affrescate*), suggesting his particular job here involved cleaning and/or consolidation and coating the paintings in wax.[3]

Maiuri's *Diario di scavo*

Maiuri's excavation diary (*Diario di scavo* [Maiuri n.d.-a]) provides brief notes on the progress of the excavation (see appendix 2.2). While the diary does not make any direct reference to the actual remounting of wall painting fragments, it does give a sense of the excavation sequence and what was found on the walls at the time of excavation.

The first entry referencing the tablinum is dated 14 June 1938, "Excavation of the tablinum of house number 27 and of the atrium of 31, both sites on the Decumanus Maximus Insula V" (*E incominciato lo sterro del tablino della casa 27 e dell'atrio di quella 31, ambedue poste sul Decumano Massimo Insula V*). The entry for 15 June is the first reference to the wall paintings. "The tablinum of house number 27, the west wall conserves much plaster with a red background with small animal figures" (*Il tablino della casa 27. La parete ovest conserva molto stucco a fondo rosso con piccole figure di animali*). This likely refers to the upper register of the wall paintings and perhaps the frieze. By 20 June, the south and east walls had begun to be uncovered: "Continue the excavation of the tablinum of House number 27. The south and east walls have much red plaster" (*Le pareti sud ed est conservano molto stucco rosso*). The entry of 18 July describes the medallion painting on the east wall, south end; the entry for 25 July describes the central rectangular scene on the west (described as east in the entry) wall with Daedalus and Pasiphaë. After that entry, there are no more references in the diary to the wall paintings, and it seems that excavation of the tablinum was completed by 29 October 1938. The next entry describing the tablinum and the wall paintings is 18 January 1939, when the room is described in detail. No mention

FIGURE 2.2.
Photograph of the central section of the west wall during excavation. Wood supports with cushioning material have been placed against the walls and shored up. Temporary rough fills run along the bottom of the plasters to hold them in place. (Historical Archives of the Soprintendenza Pompei, Maiuri, A2621)

is made of the remaining scene and medallions—neither when they were found nor in what condition. These entries give an idea of the speed with which the room was excavated and the condition of the wall paintings at the time of excavation. The fact that the east wall medallion and the west wall central rectangular scene were described in such detail upon discovery suggests that perhaps these areas were more or less intact when found, or that this is simply an inconsistency in the recording of the work. The assumption that the west wall central rectangular scene was found still on the wall is further substantiated by the historical photograph from the Soprintendenza Pompei archives of this scene being supported by wood props during excavation and reconstruction (fig. 2.2).

Historical Photographs

Further insight into the excavation, remounting, and reconstruction process can be seen in historical photographs of the work in progress (see fig. 2.2). Most images that have been found in the archives of the Soprintendenza Pompei, however, show the wall paintings, and indeed the house, once excavation and reconstruction had been completed.

Observation of the Works In Situ

Today the paintings in the tablinum have several different characteristics. In some areas, they are made up of large unbroken areas of sound paint that appear to be still attached to the walls by the original techniques[4] employed two thousand years ago. In other parts, the

FIGURE 2.3.
Reassembled wall painting fragments, upper west wall. Some pieces lie close together, and the joins between them are not filled; some are farther apart, with restoration mortar applied to fill the gaps.

paintings are composed of numerous fragments, more or less densely clumped together, at times with large lacunae filled with restoration mortar (fig. 2.3).

The form in which the paintings survived affected how they were treated during their restoration in 1938, and was closely linked to their location. Graphic documentation was carried out in situ to map evidence of remounting and reconstruction in order to better understand the techniques and extent of the 1938 interventions. (See appendix 2.3.)

East Wall

It is quite likely that a significant proportion of the underlying tuff wall support of the east wall was replaced, as there are large losses in the original plaster, and most of the surviving plaster has been remounted. Additionally, the other side of the wall, in the adjoining ambiente 9, is largely composed of modern *opus incertum*,[5] though a large area of this wall (ambiente 9) is original Roman tuff constructed in *opus reticulatum* (fig. 2.4).

FIGURE 2.4.
Rear of east wall in adjoining ambiente 9. Darker portions at left are original Roman tuff.

FIGURE 2.5.
East wall. Yellow shading indicates original Roman plasters.

The east wall retains less original plaster than the other two walls, with the most severe losses in the upper register (approx. 70%) and the monochrome background of the middle of the lower register (fig. 2.5). About half the plaster is missing from the base of the wall.

The central section has a high proportion of small losses between adjoining pieces of plasters, while the joins between one fragment and another are rarely even and close fitting, suggesting they suffered further damage after the initial break prior to remounting. This wall also contains the few fragments where the yellow pigment goethite has survived the heat-generated transformation into red hematite, suggesting these fragments were more protected from the heat of the eruption (and thus separated) from their neighbors, which have undergone the color transformation (fig. 2.6). A similar transformation is apparent in the central scene, where a piece of drapery that is yellow on one fragment is red and brown on adjoining fragments (fig. 2.7). These fragments with untransformed yellow pigment are concentrated in the center of the wall and at the north end of the upper register.

FIGURE 2.6.
East wall. A fragment with yellow goethite pigment adjoins other fragments where the pigment has been transformed into red hematite.

FIGURE 2.7.
East wall. In the central scene, the same piece of drapery is yellow on one fragment, brown on another, and red on another.

FIGURE 2.8.
East wall. Lower register (raking light), showing principally yellow fragments somewhat irregularly fitted together.

The reconstruction of fragmented wall paintings is especially difficult when the fragments do not contain parts of an image or decorative elements as a guide and when pieces do not have clear, well-defined edges. This may explain why the surviving remounted parts of this section of the wall generally consist of fairly large pieces from the figurative scene and its borders, whereas the surrounding areas, which would have consisted principally of monochrome background with few distinctive graphic elements, have been left largely unreconstructed. The only significant monochrome area that is reconstructed at the center of the register is made up of yellow fragments (fig. 2.8).

These factors (worn fragment edges, fragments with yellow pigment side by side, fragments with red and yellow pigment, little reconstruction of plain red fragments) suggest that much of the central and upper parts of the wall collapsed, and the fragments now on the wall were collected from the ground and reassembled.

On the other hand, the plaster along the southern edge of the east wall (fig. 2.9) is made up on the whole of quite large fragments that fit closely together. This, together with the reasonably good condition of the corresponding wall in ambiente 9 (see fig. 2.4), suggests that the plasters here may have still been in place at the time of excavation and been in whole or in part detached and remounted, as evidenced by the pattern of cracking and fragmentation.

The left-hand northern portion of the lower register appears to be an intermediate situation. Here there are clusters of larger fragments with narrow cracks and few losses, and

FIGURE 2.9.
East wall. Map of fragments.

FIGURE 2.10.
South wall. Map of fragments.

FIGURE 2.11.
West wall. The yellow outline indicates an area without significant fractures. The thicker blue lines indicate cracks. The thin lines indicate fragments.

others that seem less well inserted and with small irregular losses along joins, suggesting that part of the wall was still in situ and part of it was not, and that some parts of the plasters were detached in smaller clusters and then remounted on the wall.

South Wall

The upper register of the south wall (fig. 2.10) is principally composed of medium to large fragments, the western half and the underlying frieze for the most part fitting closely together. The eastern third is instead composed of a much more loose-fitting group of fragments surrounded by a large loss, suggesting perhaps that these were more damaged and detached than fragments in the western part. Although (like the west wall) the monochrome background in the upper register is now entirely red, it is likely the original color scheme incorporated yellow (like the east wall), but here all the original yellow goethite has been converted to red hematite. This suggests that no fragments were protected from the heat of the eruption, and may imply that fewer fragments fell off this wall and were buried.

The plasters of the lower register pilasters are made up of several large islands of close-fitting smaller fragments, suggesting they were detached and remounted in sections.

West Wall

Like the south wall, the monochrome background of the west wall (fig. 2.11) is now entirely red; however, it is most likely that the original color scheme incorporated panels of both yellow and red in the upper and lower sections, and the central panel may likely have had a yellow background like the east wall. This again suggests that no fragments were protected from the heat of the eruption, and may also imply that fewer fragments fell off this wall and were buried.

Here the map of plaster fragments falls roughly into three distinct areas.

In the first area, the plaster in the upper south portion of the wall is separated from the other plasters by a large horizontal loss. Although this portion includes large fragments, it has many more small fragments and small losses than the other areas of plaster.

In the second area, the right-hand, northern third of the wall is broken up by curved vertical cracks running from top to bottom, suggesting that the underlying wall was pushed up at one point. A similar damage pattern can be seen in other buildings in Herculaneum.

However, the third and most notable area is the central-southern section of the lower wall: it contains a single piece of plaster (area outlined in yellow in fig. 2.11) with only a few cracks (indicated by the thicker lines), suggesting that this plaster is the only part of the tablinum not to have been reattached in the 1938 treatment. This idea is further supported by the absence of any traces of backing plaster used to remount fragments (see next section); the upper border of this section of original Roman plaster is not flat and is higher than the adjacent plasters of the upper section and right-hand section, and the original plaster overall is thicker in this area than in any other area in the tablinum.

Further evidence can be found in a photo from the excavation (see fig. 2.2) showing the central part of the west wall supported by temporary props, a procedure that, on the basis of other photographs from the archives of the excavation, seems to have been employed when plasters and walls were still standing but considered to be unstable.

There are, however, traces of backing plaster in some of the cracks in the lower plasters shown in this photograph, suggesting that some of these smaller pieces may have been detached and/or reassembled and reattached (see discussion below).

Techniques Employed for Remounting Fragments

Treatment of the Roman Plasters during Excavation

As previously mentioned, it is probable that in the tablinum three types of treatments were executed by Maiuri's team on the original Roman plasters:

1. Consolidating stable plasters in situ
2. Detaching unstable plasters found in situ, then remounting them on the walls
3. Collecting fragments, reassembling them, and remounting them on the walls

In the first treatment, where plasters were left in situ, it has not been established whether Maiuri and his team stabilized the original plasters using anything more than an injection grout and/or new plaster borders to anchor the original plasters. (See fig. 2.2, where a rough mortar border has clearly been temporarily added along the lower edge of the plasters on the wall. This was then replaced by a sloped mortar edging.)[6] However, there are also holes in the tuff support below the lower border of the west wall paintings, which may have held pins to support the edges of the plaster fragments.

In the second treatment, when the plasters were to be detached, they were presumably faced prior to removal and to assist with their successive treatment, although so far no trace has been found on the paint surfaces of materials being used either as adhesive or as the facing itself (facings made of canvas or similar materials frequently leave trace impressions of the cloth weave on plaster surfaces).

In examples so far observed both in the tablinum and in other areas of the site, it appears that Roman plasters had their deeper coarse gray plaster layers removed prior to applying the various restoration mortars used to reattach the plasters to the wall (Roman paintings in the tablinum presumed not to have been detached are about 7–8 cm thick; reattached Roman paintings, including restoration mortars, are about 3–4 cm thick).

When fallen fragments were collected and remounted, they would probably have received similar treatment, albeit after having been first reassembled faceup. After this, they would have had a facing applied, and then been turned over and, similarly to the detached plasters, had their original thickness reduced by removing plaster layers before applying a backing plaster in preparation for remounting on the wall.

As mentioned above, the pieces that show signs of having been collected and reassembled (broken, rounded edges, less well-fitting joins with other pieces, more numerous smaller losses in the plasters, discontinuities in the condition of the paint layer) often have fairly well-defined figurative or decorative elements on them, which would have facilitated the reassembly of fallen fragments.

Remounting of the Roman Wall Paintings: Backing Plaster, Anchoring Mortar, Pins, and Grouting Mortar[7]

Prior to remounting the reassembled fragments and probably the detached wall paintings, it appears that Maiuri's team assembled the pieces into clusters, or islands, of several pieces. These islands were held together by a cement-based backing plaster, which consisted of a fluid dark mortar composed of lime and CAC (calcium-aluminate cement).[8]

On the basis of observation of the plasters in place and remounted plasters in other areas of the site, the pieces used to make up an island were probably shaved down on the reverse, then placed side by side facedown on a flat surface. The backing plaster was poured over the back of the pieces (*soletta di cemento sull'estradosso*), forming a continuous layer of cement plaster 1–2 cm thick (fig. 2.12).

Once set, this formed a rigid support, holding the pieces together in an "island," which could then be attached to the wall. Traces of backing plaster can be seen in examples of deteriorated wall paintings at the site, which have left this layer exposed (fig. 2.13).

In the tablinum, it is difficult to separate out these individual islands of fragments among the larger areas of remounted wall paintings, though there are a few areas where such groups are discernible (fig. 2.14; see also figs. 2.9–2.11).

These islands frequently have small losses or gaps between fragments. In some cases, the backing plaster seeped into small cracks or gaps between fragments to form flat cement plugs at the level of the paint layer. In some areas of remounted plaster, there are many of these plugs (fig. 2.15).

In general, Maiuri's team did not fill any losses in the plaster up to the level of the paint, preferring to fill them 2–3 mm lower than the paint surface (fig. 2.16). They must have used a system to avoid the cement backing plaster from flowing through to the level of the paint

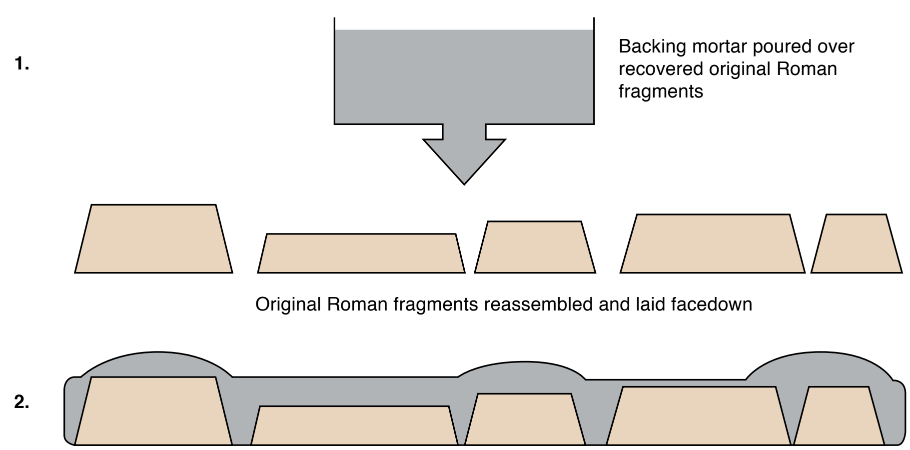


FIGURE 2.12.
A hypothetical method for constructing the fragment islands.

FIGURE 2.13.
A remounted section of plaster from another area of the site that has lost almost all the Roman plaster, exposing the backing plaster and leaving an imprint of the original Roman plaster fragment (shown by the yellow dashed line).

FIGURE 2.14.
Areas of close-fitting pieces on the east wall that likely make up fragment islands, outlined in yellow.

FIGURE 2.15.
Cement plugs that have formed around a fragment.

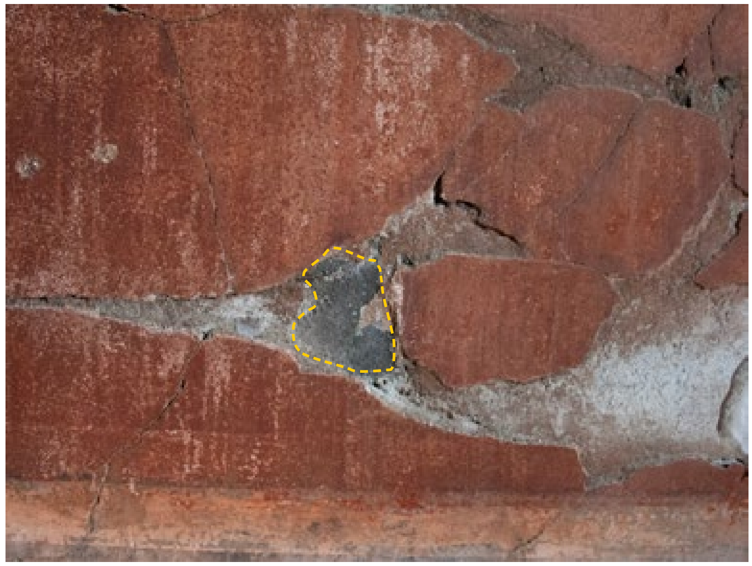


FIGURE 2.16.
Tablinum, south wall. A loss in the middle of a recomposed fragment island. Water damage has eroded the upper fill, exposing the underlying dark-gray backing plaster holding the separate surrounding fragments together, seen in the area inside the yellow dashed line.

where there were larger cracks and more significant losses between fragments. It is likely this was achieved with a technique still used in modern times: placing a thin temporary fill into the gaps between fragments, which allows the backing plaster to flow over the back of and between the fragments, but stops it from reaching the level of the paint layer.

An anchoring mortar, very similar in appearance and composition to the backing plaster, would have been applied to the wall to adhere the recomposed fragments. The island of fragments assembled on the backing plaster would have been positioned on the wall at that point and held in place by metal pins inserted into the wall along the edge of the fragments until the anchoring mortar had set (fig. 2.17). Clear traces of this anchoring mortar can be seen where it has splashed onto the tuff walls above the upper border of the plasters (fig. 2.18). It is likely the pins were removed or cut where possible once the anchoring mortar had set (fig. 2.19).

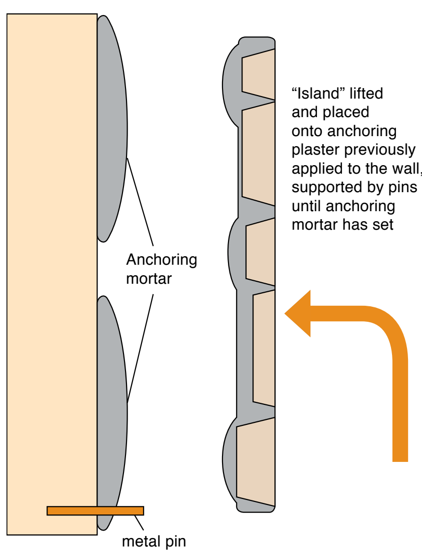


FIGURE 2.17.
A hypothetical system for remounting fragment islands on walls.

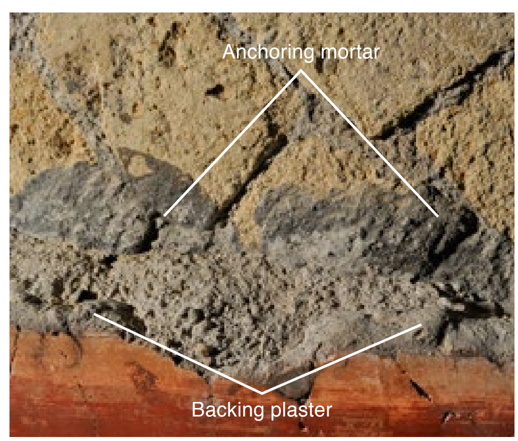


FIGURE 2.18.
View of the top of the wall where anchoring mortar has splashed onto the tuff wall and has also largely overflowed over the backing plaster along the edge of the painting fragments.

FIGURE 2.19.
Anchoring mortar around the edge of a piece of exposed backing plaster that has lost the original Roman plasters. The holes indicate the locations of pins that may have been removed once the anchoring mortar had set.

Some fragment plates appear to have been aligned during mounting by the use of guidelines drawn on the paint surface: on the northern vertical band on the east wall, a pencil line is drawn down the central axis of the band (fig. 2.20). This, together with a plumb line, may have helped to achieve the correct vertical orientation of the pieces making up the vertical band.

In some cases, along the lower borders of the remounted fragments, there are drip marks or traces of a gray friable plaster, or grouting mortar (*beveraggio di cemento fino con malta*), which appears to have been poured behind the remounted fragments to fill areas not attached by the anchoring mortar.

FIGURE 2.20.
Pencil line running down the center of the vertical band (east wall, north end), likely added to help align fragments during the remounting process.

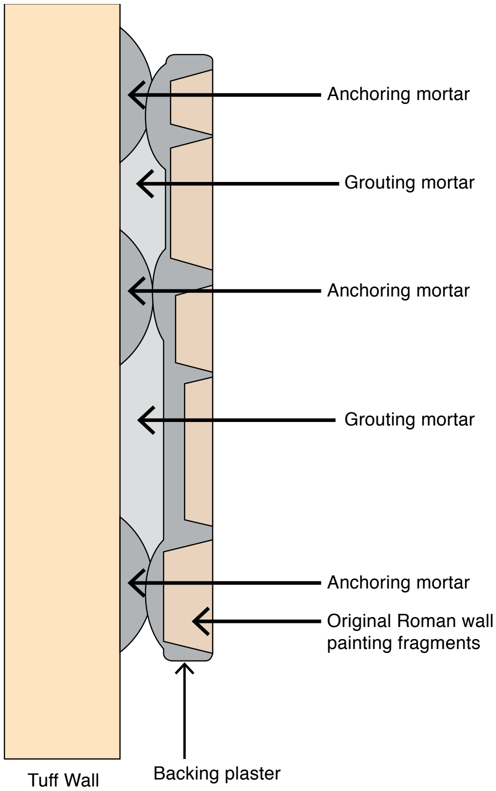


FIGURE 2.21.
Schematic of reattached wall painting showing remounting mortars.

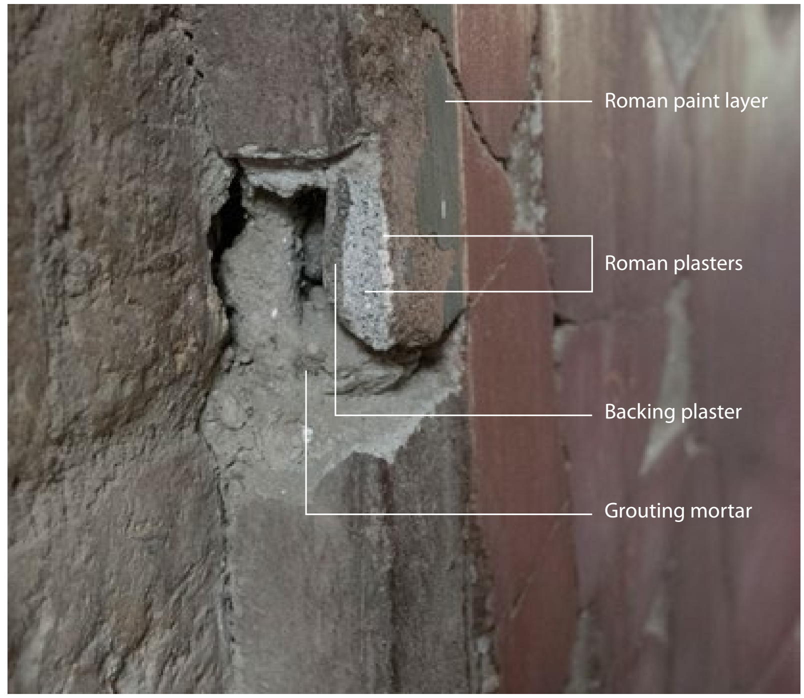


FIGURE 2.22.
Tablinum, east wall. A cross section of remounted plaster showing Roman painted plasters, and dark-gray restoration backing plaster. Underneath this is the light-gray grouting mortar used to fill the void between the backing plaster and the wall.

At the conclusion of this phase in the reconstruction of the plasters, the wall would have been composed of original plasters remaining in situ together with recomposed or detached fragment islands, which had been remounted. The stratigraphy of the remounted plasters would thus have been:

- thinned Roman plasters,
- cement (CAC)/lime backing plaster,
- cement/lime grouting mortar, and
- cement (CAC)/lime anchoring mortar,

with iron pins around the edges holding the pieces up on the walls (figs. 2.21 and 2.22).

Thus, each restored wall would have had more or less connected islands of reconstructed or remounted plasters or original plasters left in place, surrounded by areas of bare walls, while each island itself would have contained a mix of smaller and larger losses, described in the following section.

The Filling of Losses in Maiuri's Reconstruction Plasters

After original plasters had been reattached to the wall, there remained four basic types of losses:

1. Small cracks and very small losses along joins within original reattached plaster fragment islands

2. Small to medium losses inside original reattached fragment islands, generally with the backing plaster underneath
3. Large to very large losses between fragment islands
4. Extensive areas of loss with no surviving original plaster

These various types of losses were treated in different ways by Maiuri's team, but fairly strict criteria were used in each of the different cases, based on a consistent underlying principle of minimal intervention: original materials were always distinguished from restoration materials, and reconstruction work, when undertaken, was clearly visible and deliberately schematic. The treatments are described below.

Small Cracks and Small Losses along Join Lines

These areas were left unfilled, even if they were often quite deep. The deeper losses (0.5 –1 cm) are visible from a distance and are characteristic of Maiuri plasters, which have not been subjected to later treatment (when wall paintings have had more modern, post-1938 treatments, these deeper losses are often filled).

However, in some places they were filled—presumably accidentally—by the CAC-based cement backing plaster, which flowed through and formed small cement plugs that sometimes cover part of the original paint (see fig. 2.15), and that are flat and plane with the surface.

Small to Medium Losses Inside Original Wall Painting Fragments, with Backing Plaster Underneath

These areas were filled with a fairly coarse-grained pale gray fill plaster with dark inclusions, composed of a lime binder with black volcanic sand as an aggregate. The fill is always slightly lower than the surrounding original wall painting surface to distinguish the loss from the original material, and it appears that the fills were colored to match the surrounding paint.

There are many examples of fills of this type, particularly on the west wall, that are still in good condition and that clearly have been tinted red to match the monochrome background. In other areas, on the east wall and, in particular, in the figurative scene, the situation is less clear due to the much poorer condition of the fills due to wear, waxing, and accumulated grime. However, it appears there are traces of coloration that may be similar to the surrounding original wall paintings even when the fill is not red, but it is difficult to be certain at the present moment. This plaster can be referred to as rough fill.

Large to Very Large Losses between Groups of Fragments: Filling Plaster, Gray Finishing Plaster, or White Finishing Plaster and Gray Lime Wash

In these cases, isolated islands of original or remounted plasters, 4–6 cm thick, were applied on a bare tuff wall. To join these islands, a gray fill plaster was applied over the tuff that was only slightly less thick than the original or remounted plasters. This filling plaster appears to have been a coarse-grained lime/sand/pumice mixture applied in a single thick layer to within a few millimeters of the level of the original plasters. The finishing of this material, however, appears to vary according to the purpose and size of the fill.

Where the losses are relatively limited in size, such as on the south wall (about 20%) or the central part of the west wall (less than 10%), it appears that the coarse gray fill is covered by a thin layer of fine gray plaster, which appears to be similar to the rough fill material used for the small to medium losses described above. This is applied to bring the level of the fill to approximately 2 mm lower than the original paint layer. On the south and west walls, this fine gray plaster was tinted to match the surrounding plaster in both the larger and the smaller fills (fig. 2.23).

On the other hand, when there were very large losses between various fragment islands, as, for example, on the east wall of the tablinum, Maiuri adopted the procedure described in his *Nuovi scavi* mentioned earlier: "si è sovrapposto un intonaco grezzo . . . solo al fine di rappresentare il disegno schematica della parete a lineole bianche" (p. 22), that is, a "schematic drawing on the wall with white lines" delineating the basic layout of the decoration, applied on reconstruction plasters, and used to connect surviving decorative elements on the various pieces of original painting. He frequently employed this minimal reconstruction technique in many other areas at both Herculaneum and Pompeii (fig. 2.24).

To make white lines stand out against the gray plasters, it appears Maiuri's team adopted a variant of the classic *sgraffito* technique. After the fill plaster was applied to the

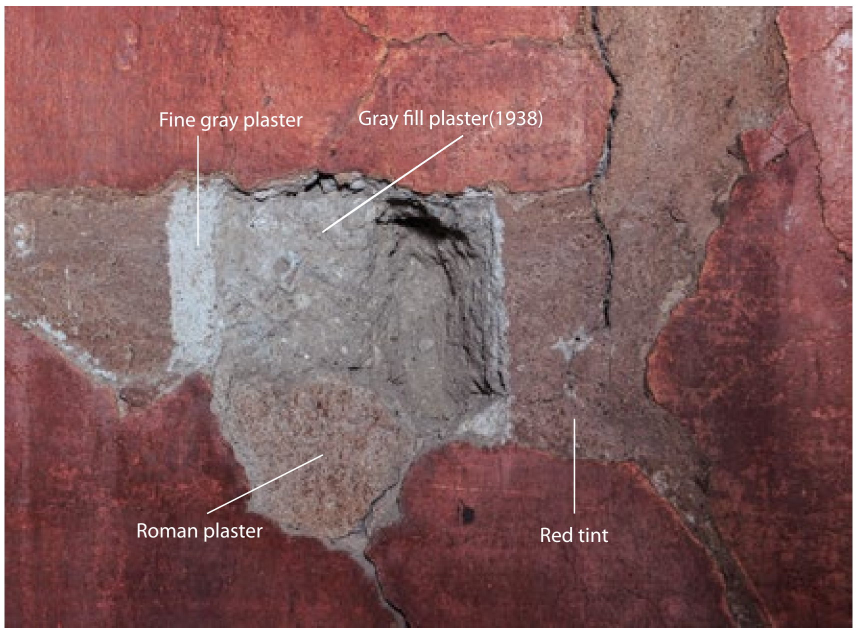


FIGURE 2.23.
The layers of restoration fills in losses in the original wall paintings on the south and west walls.

FIGURE 2.24.
Example from another area at the site, showing the different approaches used by Maiuri for the treatment of major lacunae: losses between islands of Roman plaster are filled with a gray lime-wash plaster with connecting design elements sketched in by white incisions. Instead, where there are no connecting islands, the walls are left as bare tuff (mostly modern) (Casa del Bel Cortile, Herculaneum).

FIGURE 2.25.
Reconstruction of the basic design of architectural elements on the upper east wall by Maiuri's team in area of large loss made by incising a line through a gray lime wash applied to the surface to reveal the thinly applied fine white lime plaster below.

FIGURE 2.26.
Flaking paint and plaster expose the stratigraphy of the reconstruction plaster in a loss on the east wall: gray lime wash over a thin white plaster covering a thick layer of gray fill plaster.

FIGURE 2.27.
Central section, east wall, 1938, just after restoration and before the *sgraffito* design was incised in the reconstruction plaster surrounding the original fragments. (Historical Archives of the Soprintendenza Pompei, Maiuri, C2782)

FIGURE 2.28 (RIGHT).
Central section, east wall, 1983, showing the *sgraffito* design in the reconstruction plaster surrounding the central rectangular scene. (Historical Archives of the Soprintendenza Pompei, Maiuri, D29302)

large areas of loss, it was covered with a thin (1–2 mm) white plaster layer. This, in turn, was covered with a coat of gray-tinted lime wash. The line drawings re-creating the outlines of the decorations were then incised in the surfaces, breaking through the gray covering tint and exposing the white plaster underneath. This created an effect of white lines on a gray background (figs. 2.25–2.26).

FIGURE 2.29.
Overall of west wall of the tablinum, showing the approach used by Maiuri for the treatment of major lacunae with no fragment islands, leaving the bare tuff (mostly modern) along the base of the wall.

This technique is seen in two historical photographs of the east wall that show the wall paintings during reconstruction in 1938 with a large fill (fig. 2.27) surrounding original plaster fragments and the central rectangular scene and, much later, in 1983, with the incised *sgraffito* design (fig. 2.28).

However, in some areas, most notably where the fills are relatively small, a fine gray plaster was used under the gray wash instead of the fine white plaster, even when lines are incised.

Extensive Areas of Loss with No Surviving Original Plaster

In the case of extensive areas with no surviving fragments, such as in the lower parts of the west wall and south wall, Maiuri did not apply any reconstruction plaster, leaving bare the (often reconstructed) underlying wall (fig. 2.29).[9]

The Use of Edging Plasters *le Scarpette*

On both the upper and lower borders of the original and reconstructed plasters, where bare tuff wall begins, a sloped edging plaster was applied. Some of the plaster strip along the upper border has remained in situ and appears to be similar to the rough fill (fig. 2.30).

Along the lower edge of the west wall, all of the 1938 edging plaster was removed in a subsequent treatment and was replaced with plaster borders perpendicular to the wall plane. However, the location of the original mortar edging can still be clearly seen as a lighter-colored strip on the tuff wall extending the length of the lower border (fig. 2.31).

FIGURE 2.30.
Coarse-grained mortar edging partially covering both anchoring mortar and backing plaster.

FIGURE 2.31.
Lower edge, west wall. The lighter-colored strip (outlined by the yellow dashed line) is the location of the first sloped edging plaster.

Conclusion

The information gleaned through a careful examination of the wall paintings and through research into Maiuri's method of reattaching wall paintings at the site, combined with a reading of the historic references, provides insight into the methods and materials used to reconstruct the wall paintings in the tablinum of the House of the Bicentenary. The careful selection of materials similar to the original Roman plasters, and the approach that Maiuri and his team took to reintegrating losses following a principle of minimal reintegration and use of materials similar to the originals, demonstrates Maiuri's progressive ideas of conservation and the scientific rigor that he describes in his monograph on Herculaneum, *Ercolano: I nuovi scavi* (1958). Research into the materials and techniques used in the tablinum of the House of the Bicentenary can be useful in understanding his approach to the conservation and reconstruction of wall paintings in other houses at the site. Further study into the evolution of the materials and techniques used by Maiuri over three decades of excavation at Herculaneum would shed additional light on the excavation and conservation history of the site.

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The authors would like to acknowledge the staffs of the Herculaneum Conservation Project (HCP), and of the Parco Archeologico di Ercolano and its previous iterations, and conservator colleagues for the valuable knowledge they shared on the excavation of the site, the House of the Bicentenary, and the tablinum, through the use of archival material, historical photographs, and other references. We are especially grateful to Domenico Camardo, archaeologist, HCP, for his generous sharing of information on the process of excavation and the materials used.

Notes

1 Often the *Giornale* uses the word *stucco* (plaster), but from the context it is clear this usually refers to wall paintings. *Tonachino* is also used, perhaps also indicating plasters in general.

2 It is probable that several of these mentions refer to the same treatment taking place over several days: on three different dates from 2 to 20 May, the same phrase is used: "Restaurato mq 22 di stucchi appartenente all'ambiente terraneo 25" (restored 22 sq m of plasters in ground floor room [of] 25).

3 The application of wax could have served to consolidate or fix the paint, which may have been powdering or flaking, to saturate the colors, or as a protective layer, or indeed all of these.

4 See Rainer and Piqué, this volume, for a description of original materials and techniques.

5 The modern tuff additions are deliberately distinguished by Maiuri from the older tuff blocks, as mentioned previously.

6 In various other locations at Herculaneum, plasters have clearly been stabilized with iron T or butterfly pins, both left in sight and initially concealed under fills, though it is not clear whether these are part of Maiuri's original treatment or a subsequent maintenance/restoration treatment. Private conversations with other conservators suggest that at least at Pompeii at the beginning of the twentieth century, poured brick-dust mortars were used to consolidate frescoes, and starting in the 1920s cement-based mortars appear to have been used for the same purpose. The authors have had experience with other wall paintings in Italy where casein and cement were used to consolidate wall paintings in the early twentieth century.

7 See the glossary at the end of this volume for definitions and illustrations of the different terms used here.

8 Graves, Piqué, and Rainer, this volume.

9 The losses in the lower part of the east wall were not left as bare tuff because, in contrast with the west and south walls, about 50% of the original wall paintings survived apparently still attached to the wall, although in a fragmentary state.

References

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APPENDIX 2.1

Giornale dei lavori degli scavi di Ercolano: Raccolta delle notazioni riguardanti la Casa del Bicentenario

Note: The material in this appendix is taken from the administrative archive of the Soprintendenza Pompei and was digitized and transcribed by the Herculaneum Conservation Project. (Courtesy HCP and the SP)

Giornale dei lavori degli scavi di Ercolano:

Raccolta delle notazioni riguardanti la Casa Del Bicentenario

Note: Asterisks refer to operations carried out on wall paintings in the House of the Bicentenary.

1 dicembre 1937

Stuccatore Giuseppe De Luca

Iniziato il restauro di una cassa di legno carbonizzato che trovasi al piano superiore della casa a graticcio all'angolo del decumano maggiore. (ambiente n. 24 casa n. 23)

7 gennaio 1938

Stuccatore Giuseppe De Luca

Iniziato il lavoro di magistero per smontaggio di un quadro affrescato appartenente alla parete nord del piano superiore, ambiente n. 24 della casa n. 23 sul decumano maggiore. Lo stesso quadro è in officina per restaurarlo.

11 gennaio 1938

Muratore Luca De Crescenzo

Casa n. 25 lato sud ovest (decumano maggiore) iniziato la ricostruzione e restauro al pilastro ad opera mattoni.

12 gennaio 1938

Muratore Luca De Crescenzo

Casa n. 25 lato sud ovest continua la ricostruzione del pilastro che fa squarcio di vano ed iniziato a lavorare i blocchi per lo stesso pilastro.

17 gennaio 1938

Muratore Luca De Crescenzo

Casa n. 25 lato nord ovest, continua la ricostruzione di pilastro con blocchi originali, e con appresature ad opera incerta.

18 gennaio 1938

Muratore Luca De Crescenzo

Casa n. 25 lato sud, continua la ricostruzione di pilastro ad opera listato con blocchi originali, che fa squarcio di due vani, e iniziato l' incasso del pilastro ad opera mattoni al lato nord della stessa casa.

20 gennaio 1938

Muratore Luca De Crescenzo

Casa n. 25, lato sud est, portato a termine l'incasso di muratura ad opera mattoni, misura m 0.65 × 0.65 × 0.35.

21 gennaio 1938

Muratore Luca De Crescenzo

Casa n. 25, lato est, iniziato l'incasso di muratura ad opera incerta e iniziato la messa in opera di due travate di ferro che fanno da architrave di vano.

22 gennaio 1938

Muratore Luca De Crescenzo

Casa n. 25, portata a termine la messa in opera le travate di ferro di m 4.50 per 0.16 con tre tirantini e riempimento di muratura che fa da architrave di detto ambiente e iniziato la sopraelevazione di muratura ad opera incerta sovrastante dell'architrave.

27 gennaio 1938

Muratore Luca De Crescenzo

Casa 25 lavorato per l'armaggio d'anditi amaggiore altezza occorrenti per la sopraelevazione di pilastri e muri e lavorati i blocchi originali per il pilastro.

2 febbraio 1938

Stuccatore Giuseppe De Luca

Iniziato il restauro di un arario in legno carbonizzato rinvenuto al piano superiore della casa attigua al quadro a mosaico che si scava con fondi della Banca d'Italia.

4 febbraio 1938

Muratore Luca De Crescenzo

Casa 25 ambiente terraneo in corso di scavo, lato nord est portato a termine l'incasso di cunicolo ad opera incerta misura m 1.80x1.10x0.80.

5 febbraio 1938

Muratore Luca De Crescenzo

Casa 26 lato sud est iniziato l'incasso di pilastro ad opera listata sottostante al pavimento originale. Ambiente interno della stessa casa lato ovest ripreso l'incasso di muratura ad opera incerta con demolizione e sterramento. Casa 26 lato sud est iniziato l'incasso di pilastro ad opera listata, con pietre tufo e mattoni che fa squarcio di vano.

8 febbraio 1938

Muratore Luca De Crescenzo

Casa 26 lato sud ovest portato a termine la ricostruzione di pilastro ad opera listata con pietre tufo e mattoni che fa squarcio di vano, misura m 1.80x0.55x0.40. Lavorato per la forma a cassonetto soprastante il detto vano, con armaggio di ferro che resta in anima nella travata di cemento armato.

9 febbraio 1938

Muratore Luca De Crescenzo

Casa 25 ambiente 1 lato ovest ripreso l'incasso di muratura ad opera incerta con demolizione e sterramento. Casa 26 lato sud lavorato e fatto il gettito di cemento e lapillo nell' architrave, misura m 3.10 per 0.40 per 0.28.

29 febbraio 1938

Muratore Luca De Crescenzo

Casa 27 lato sud ambiente 1 lato sud est portato a termine la ricostruzione del seguito del pilastro che fa squarcio di vano ad opera listata, con tufo e mattoni misura m 3.10 per 0.55 per 0.43.

7 marzo 1938

Muratore Luca De Crescenzo

Casa 25 ambiente 1 lato sud del messo in opera un architrave di legno pino di m 1.20 per 0.10 per 0.42 sul vano di finestra e iniziato la ricostruzione di muratura opera incerta.

11 marzo 1938

Muratore Luca De Crescenzo

Casa 25 ambiente 1 lato est portato a termine l'incasso di muratura ad opera incerta misura m 3.30 per 3.40 per 0.25. Casa 27 portato a termine la ricostruzione di pilastro ad opera listata con pietre tufo e mattoni che fa squarcio di vano misura m 3.15 per 0.70 per 0.45.

14 marzo 1938

Muratore Luca De Crescenzo

Casa 25 ambiente interno che comunica con l'atrio lato ovest, portato a termine la ricostruzione di pilastro che fa squarcio di vano ad opera listata misura m 2.70 per 0.45 per 0.45.

18 marzo 1938

Muratore Luca De Crescenzo

Casa 25 ambiente 1 lato sud ricostruito l'importa (?) del vano che accede al numero 2 e e messa in opera architrave di legno pino di m 1.60 per 0.12 per 0.40 e iniziato la sopraelevazione di muratura opera incerta. Ambiente interno posto alle spalle della casa 25 che comunica con l'atrio lato nord portato a termine l'incasso di muratura ad opera incerta, misura m 2.60 per 1.25 per 0.45. Casa 27 soprastante del vano d'ingresso ricostruito una sopraelevazione di muratura ad opera incerta che fa piano di travi misura m 3 per 0.40 per 0.20 piano superiore della stessa casa iniziato il restauro murario all'intelaiata divisoria.

21 marzo 1938

Muratore Luca De Crescenzo

Atrio che trovasi alle spalle della casa 25 lato est, iniziato l'incasso di muratura ad opera listata che fa squarcio di vano. Casa 27 lavorato per sterramento sottostante al pavimento originale per la messa in opera travi per sostenere pavimento originale.

22 marzo 1938

Muratore Luca De Crescenzo

Casa 25 ambiente 1 lato sud est, continua la sopraelevazione di muratura opera incerta. Ambiente 2 lato ovest della stessa casa continua l'incasso di muratura ad opera incerta. Atrio che trovasi alle spalle della casa 25 ambiente non numerato che comunica con l'altro portato a termine l'incasso della ricostruzione di pilastro ad opera listata che fa squarcio del vano, misura m 2 per 0.10 per 0.60 per 0.45 casa 27 messa in opera un trave di legno pino di metri sei per 0.10 per 0.22 e iniziato la messa in opera di solarini di legno castagno sottostante del pavimento originale.

23 marzo 1938

Muratore Luca De Crescenzo

Casa 25 ambiente 1 lato sud portato a termine la sopraelevazione di muratura ad opera incerta, lavorato ai due lati e fino all'impronta del piano superiore, misura m 3.70 per ? per 0.40 ricostruito un pilastro ad opera listata con pietre tufo e mattoni che fa squarcio di finestra, misura 1.45 per 0.60 per 0.40, messi in opera una architrave di legno pino di m 1.60 per 0.12 per 0.40 soprastante al finestrino. Iniziato il secondo pilastro ad opera listata che fa squarcio di vano. Ambiente 2 della stessa casa lato ovest continua l'incasso di muratura ad opera incerta.

25 marzo 1938

Muratore Luca De Crescenzo

Casa 25 ambiente 1 lato sud portato a termine i due pilastri del piano inferiore di opera listata che forma squarcio di vano. Il primo misura m 2.10 per 0.60 per 0.40, il secondo pilastro misura m 2.10 per 0.90. Tra il pilastro e la parete continua la muratura ad opera incerta, lavorato su due lati. Atrio lato est posto alle spalle della casa 27, portato a termine l'incasso di cunicolo misura m 3.20 per 1.10 per 0.45.

29 marzo 1938

Muratore Luca De Crescenzo

Casa 25 ambiente 1 lato ovest ripreso la sopraelevazione di muratura ad opera incerta. Ambiente 2 lato est della stessa casa ripreso l'incasso di muratura ad opera incerta con demolizione della muratura marcita e sterramento. Ambiente 1 lato est continua l'incasso di muratura ad opera incerta con demolizione e sterramento. Atrio lato est della casa 27 ripreso l'incasso di muratura ad opera incerta e pilastro che fa squarcio di vano ad opera listata.

23 aprile 1938

Muratore Luca De Crescenzo

Casa 25 ambiente 1 del piano superiore iniziato la ricostruzione di intelaiata alla beneventana ad opera incerta con demolizione della muratura marcita. Casa 26 ambiente 1 lato est continua l'incasso di muratura ad opera incerta. Casa 27 ambiente 1 lato ovest continua incasso di muratura ad opera incerta. Atrio lato nord a appartenente alla casa 27 iniziato il secondo pilastro ad opera listata che fa squarcio di vano.

25 aprile 1938

Muratore Luca De Crescenzo

Ricostruito una chiusura a stipo una forma vano ad opera incerta, lavorato a due facce misura m 1 per 0.65 per 0.12. Piano superiore portato a termine la ricostruzione di muratura ad opera incerta, della intelaiata la beneventana che fa divisoria dell'ambiente, misura m 2.80 per 1.30 per 0.12.

28 aprile 1938

Restauro stucchi Umberto Scavone

* Smontato e restaurato mq 5 stucchi appartenente all'ambiente terraneo 25 e trasportato frammenti dallo scavo in corso.

29 aprile 1938

Muratore Luca De Crescenzo

Casa 25 ambiente 1 piano superiore portato a termine la forma delle travate di cemento armato e fatto armaggio ferro tondo che resta in anima nella travata e fatto gettito di cemento e lapillo misura m 4.50 per 0.32 per 0.40. Ambiente 2 piano superiore lato sud ovest continua incasso di pilastro di sostegno al muro dell'atrio. Casa 26 ambiente 1 lato est muro che comunica con la casa 25 portato a termine tutto il muro ricostruito ad opera incerta sino al piano superiore, muro del pianterreno m 4.60 per 3.40 per 0.65 misura del piano superiore 4.50 per 3.80 per 0.35. Misura del pilastro di blocco che fa squarcio di due vani superiore m 3.10 per 035 per 0.40.

30 aprile 1938

Muratore Luca De Crescenzo

Casa 25 ambiente 1 piano superiore imposti al lato sud i buchi per la messa in opera i travi per la copertura di detto ambiente, ambiente 2 di detta casa piano superiore lato sud ovest continua incasso di pilastri nella croce del muro, per sostegno al muro dell'atrio.

2 maggio 1938

Restauratore stucchi Umberto Scavone

* Restaurato mq 22 di stucchi appartenente all'ambiente terraneo 25 e smontato stucchi appartenente all'intelaiata del piano superiore 25.

6 maggio 1938

Muratore Luca De Crescenzo

Casa 25 ambiente 2 lato nord armaggio di andito e fatto sei buchi e messo in opera tre travi di legno pino e murato ai due lati.

13 maggio 1938

Muratore Luca De Crescenzo

Casa 25 piano superiore messa in opera una mensola di piastrelle di m 0.80 per 0.16 occorrente per ricostruire una parte di intelaiata. Ambiente 2 piano superiore con continua la sopraelevazione di muratura opera incerta. Secondo piano della stessa casa lato ovest portato a termine la sopraelevazione di muratura ad opera incerta che fa da parapetto di detto ambiente misura m 4.20 per 0.35 per 0.35.

18 maggio 1938

Muratore Luca De Crescenzo

Casa 25 piano superiore messo in opera una mensa è murato occorrente per ricostruire una parte di pavimento lungo il muro dell'ambiente e fatto la forma per il gettito di cemento e lapillo. Casa 26 e 27 piano superiore lungo il muro di facciata portato a termine la ricostruzione di muratura ad opera incerta con inquadrature di mattoni dei buchi delle tenute dei travi misura m 5.40 per 0.45 per 0.25.

Restauro stucchi Umberto Scavone

* Restaurato mq 22 di stucco appartenente all'ambiente terraneo 25.

20 maggio 1938

Muratore Luca De Crescenzo

Casa 25 piano superiore sul fronte di facciata lato sud est iniziato la ricostruzione di un avanzo di intelaiata alla beneventana lavorato a patto due facce.

Restauro stucchi Umberto Scavone

* Restaurato mq 22 di stucco appartenente all'ambiente terraneo 25.

21 maggio 1938

Muratore Luca De Crescenzo

Casa 25 ambiente 1 piano superiore sul fronte di facciata lato sud est portato a termine la ricostruzione di avanzo di intelaiata alla beneventana, lavorato ai due lati, misura m 3.50 per 0.35 per 0.11. Ambiente 2 della stessa casa piano superiore a lato sud messa in opera una architrave di legno pino di m 1.25 per 0.40 per 0.10 che fa architrave di finestra che dà luce al detto ambiente e continua la sopraelevazione di muratura ad opera incerta per raggiungere il piano della copertura lavorato i due lati.

23 maggio 1938

Muratore Luca De Crescenzo

Casa 25 entrata della scalinata messo in opera due stipiti di legno pino che fanno squarcio della scala e dell'ambiente murato con 8 staffe. Ambiente 2 piano superiore lato sud della stessa casa portato a termine la sopraelevazione di muratura opera incerta sino al piano della copertura misura m 3.90 per 1.50 per 0.10 e iniziato la messa in opera i travi per la copertura di detto ambiente con trasporto dei travi.

25 maggio 1938

Muratore Luca De Crescenzo

Casa 25 ambiente 1 piano superiore nello di facciata lato sud ovest portato a termine la ricostruzione di intelaiata alla beneventana sorge fuori misura 3.40 per 0.40 per 0.12 lavorato due facce. Ambiente 2 della stessa casa piano inferiore lato ovest che comunica con l’atrio portato a termine la sopraelevazione di muratura ad opera incerta sino al piano della copertura del parapetto del secondo piano di detto ambiente misura m 5.10 per 1.90 per 0.45, lavorato ai due lati.

28 maggio 1938

Muratore Luca De Crescenzo

Ambiente post est dell’atrio casa 27 iniziato sopraelevazione di muratura opera incerta per raggiungere il piano della tettoia.

Restauro stucchi Umberto carbone

* Smontato e restaurato mq 3 di stucchi appartenente al numero 26.

31 maggio 1938

Muratore Luca De Crescenzo

Casa 25 ambiente 2 lato est lavorato per apertura di un finestrino per dare luce al detto ambiente misura m 0.80 per 0.80 per 0.40. Lo stesso ambiente secondo piano fatto una spianata di malta sottile fracassata sul masso misura m 4.45 per 3.90.

1 giugno 1938

Muratore Luca De Crescenzo

Casa 26 piano superiore muro di facciata lato sud est portato a termine il seguito del pilastro che fa squarcio di vano con blocchi originali lavorati misura m 2.30 per 0.44 per 0.30.

Restauro stucchi Umberto Scavone

* Ultimato o smontaggio stucchi appartenente al numero 26 vano terraneo con la raccolta di frammenti e ricomposizione nella palestra dell’officina.

4 giugno 1938

Muratore Luca De Crescenzo

Casa 27 ambiente 1 lato sud iniziato la messa in opera due pezzi di ferro trave di m 2 per per 0.14 occorrenti per architrave di vano che accede all’atrio. Casa 27 piano d’superiore muro di facciata lato sud portato a termine la ricostruzione di pilastro ad opera listata con pietre tufo e mattoni che fa squarcio di vano misura m 2.35 per 0.60 per 0.45.

11 giugno 1938

Muratore Luca De Crescenzo

Casa 26 iniziato la messa in opera i travi per la copertura di parte del piano superiore. Atrio lato est armaggio d’andito è iniziata messa in opera le travate che fanno da architrave di vano. Casa 27 piano superiore ricostruito la cunetta occorrente per il rifiuto dell’acqua che proviene dalla tettoia misura m 3.70 per 0.20 per 0.20 intonacate a a cemento e arena misura m 3.70 per 0.60.

24 giugno 1938

Muratore Luca De Crescenzo

Secondo ambiente posto ad est dell’atrio appartenente alla casa 27 lato nord ripreso e portato a termine l’incasso di muratura ad opera incerta con demolizione e sterramento, misura m 3.10 per 1.10 per 0.30.

28 giugno 1938

Muratore Luca De Crescenzo

Ambiente posto ovest dell’atrio che all’ingresso alla casa 27. Portato a termine la ricostruzione di muratura ad opera incerta lato est e ovest sino al piano della tettoia, misura m 5.90 per 1.20 per 0.40. Ambiente posto ovest dell’atrio lato sud si continua l’incasso di muratura ad opera incerta. Casa 26 piano superiore se continua la ricostruzione di intelaiata alla beneventana ad opera incerta. Casa 27 portato a termine la sopraelevazione di muratura ad opera incerta con inquadrature di mattoni attorno ai buchi dei travi misura m 2.40 per 0.25 per 0.35.

4 luglio 1938

Muratore Luca De Crescenzo

Al quinto cardine Decumano maggiore lato sud, insula V casa 26 piano inferiore si continua la ricostruzione di avanzo di intelaiata alla beneventana. Al lato nord, con ingresso della casa 27, iniziato la ricostruzione del pilastro ad opera listata che fa squarcio di vano lato nord est.

Restauro stucchi Umberto Scavone

* Restaurato stucchi mq 11 appartenente all'atrio 27 e propriamente l'ultimo ambiente che trovasi sul lato sud est e del pilastro del vano di entrata lato nord ovest.

5 luglio 1938

Muratore Luca De Crescenzo

Atrio lato sud con l'ingresso della casa 27 iniziato la ricostruzione di pilastro ad opera listata che fa squarcio di vano con demolizione della muratura marcita.

6 luglio 1938

Muratore Luca De Crescenzo

Quinto cardo Decumano maggiore lato sud casa 26 piano inferiore, portato a termine la ricostruzione delle intelaiata alla beneventana ad opera incerta lavorato due facce (magistero) misura in giro completo m 7.50x2.40x0.10. Atrio lato nord a appartenente alla casa 27 riformo l'incasso di pilastro ad opera listata che fa squarcio del 3 vano.

7 luglio 1938

Muratore Luca De Crescenzo

Casa 26 piano superiore iniziato le forme degli avanzi del pavimento. Atrio lato nord appartenente alla casa 27 portato a termine la ricostruzione di pilastro ad opera listata che fa squarcio del 3 vano del lato nord ovest, misura sino all'imposta m 2.45 per 20.55 per 0.45. Lato sud est dello stesso atrio assicurazione di punta dell'e armaggio di andito e ripreso l'incasso di pilastro ad opera listata che fa squarcio di vano con demolizione del pilastro marcito.

8 luglio 1938

Muratore Luca De Crescenzo

Casa 26 piano superiore completato le forme degli avanzi del pavimento occorrente per lo gettato di cemento e lapillo.

Stuccatore Giuseppe De Luca

* Messa in opera stucchi nel grande atrio casa 27.

9 luglio 1938

Muratore Luca De Crescenzo

Casa 26 piano superiore lavorato per armaggio di ferro tondo negli avanzi del pavimento di cemento armato. Atrio lato sud con ingresso della casa 27 portato a termine la ricostruzione del pilastro ad opera listata che fa squarcio di vano, misura sino all'impronta delle travate m 4.10 per 0.60 per 0.45.

Restauro stucchi Umberto Scavone

* Restaurato mq 8 di stucco appartenente al vestibolo dell'amb. 27 atrio e restaurato mq 1.15 di stucchi del tablino di detta casa 27 che trovasi sul decumano maggiore.

11 luglio 1938

Restauro stucchi Umberto Scavone

* Restaurato stucchi mq 9 appartenente ambiente del piano superiore e restaurato mq 1.15 di stucchi del tablino di detta casa 27.

Stuccatore Giuseppe De Luca

* Continua messi in opera degli stucchi nel grande atrio casa 27.

13 luglio 1938

Muratore Luca De Crescenzo

Casa 26 piano superiore continuano i muri di coccio presto cemento e lapillo e battuto degli avanzi di pavimento intorno all'intelaiata. Atrio lato nord messo in opera due pezzi di travate di m 1.50 per 0.14 con due tirantini e riempimento di muratura che fa da architrave del vano III con incassatura soprastante misura m 1.60 per 0.45 per 0.20.

Restauro stucchi Umberto Scavone

* Restaurato mq 9 stucchi appartenente all'ambiente del piano superiore soprastante al numero 28, e smontato e trasportato nella palestra dell'officina stucchi appartenenti al secondo ambiente di detta casa 28 piano superiore.

14 luglio 1938

Muratore Luca De Crescenzo

Casa 26 piano superiore portato a termine tutti gli avanzi di pavimento intorno alla intelaiata alla beneventana con cemento lapillo e cocciopesto battuto, lavori di restauro magistero. Atrio lato sud con ingresso della casa 27 ripreso la continuazione della messa in opera due travate di m 5.10 per 0.18 con quattro tirantini e con tre tegole che fanno da forma permanente e con incasso soprastante ad esso, con muratura ad opera incerta misura m 5.30 per 0.45 per 0.30.

18 luglio 1938

Muratore Luca De Crescenzo

Casa 26e 27 muro di facciata piano superiore messo in opera al piano del solarino 20 staffe che restano in anima nella soletta di cemento armato che fa da sporgente di avanzi di pavimento e iniziato gettito di cemento e lapillo lungo la superficie del muro di dette case. Atrio lato nord ovest portato a termine l'incasso di muratura ad opera listata che misura m 3.50 per 1.10 per 0.35.

20 luglio 1938

Muratore Luca De Crescenzo

Par casa 26 e 27 piano superiore della superficie dei vani di facciata portato a termine il mano dell'avanzo di pavimento con cemento e lapillo e superfici di cocciopesto battuto e governato misura m 6.70 per 0.70 per 0.18. Atrio lato ovest sud portato a termine incasso di muratura ad opera listata che fa squarcio di vano misura m 2.50 per 0.40 per 0.45.

21 luglio 1938

Muratore Luca De Crescenzo

Casa 26 e 27 piano superiore smontaggio delle forme della soletta lungo il muro di facciata e iniziata la messa in opera i tronchi di travi carbonizzati originali nei buchi dei detti travi (magistero). Atrio lato sud ovest con ingresso della casa 27 iniziato il secondo pilastro di sostegno alla architrave ad opera listata che fa squarcio di vano con demolizione della muratura marcita, e con sterramento ambiente posto sud di detto atrio lato ovest, iniziato l'incasso di muratura ad opera incerta con demolizione della muratura marcita e con sterramento. Detto atrio lato ovest portato a termine la chiusura di cunicolo ad opera incerta misura m 2 per 1 per 0.45.

29 luglio 1938

Muratore Luca De Crescenzo

Ambiente post est dell'atrio lato sud portato a termine la sopraelevazione di muratura opera incerta sino al piano dei travi misura m 4 per 0.55 per 0.30. Alto ambiente dello stesso atrio lato ovest ripreso l'incasso di muratura opera incerta.

5 agosto 1938

Muratore Luca De Crescenzo

Casa 27 atrio lato ovest portato a termine incasso di pilastro ad opera listata che fa squarcio di vano misura m 1.70 per 0.45 per 0.50. Tablino dell'atrio lato ovest continua incasso di muratura ad opera incerta essendo esso rasato da cunicoli. Ambiente posto di una a sud dell'atrio parete lato nord ripreso e portato a termine incasso di muratura ad opera incerta con demolizione sterramento misura m 4x1.70x0.20.

8 agosto 1938

Muratore Luca De Crescenzo

Casa 27 atrio lato ovest continua incasso di muratura del pilastro opera listata che fa squarcio di vano misura m 1.40 per 0.45 per 0.65.

Stuccatore Giuseppe De Luca

* Continua la messa in opera degli stucchi nel grande atrio casa 27.

13 agosto 1938

Muratore Luca De Crescenzo

Casa dell'atrio 27 atrio lato ovest portato a termine la ricostruzione di due pilastri di muratura ad opera listata che fanno squarcio di vano di centro e, misura fino all'imposta dell'architrave il primo pilastro misura m 2.60 per 0.55 per 0.45, il secondo pilastro misura m 2.60 per 0.55 per 0.45. Messo in opera due pezzi di travate m 1.60 per 0.14 con due tirantini e riempimento di muratura, che fa da architrave e con incassatura soprastante di esso. Tablino lato ovest continua incasso di muratura ad opera incerta con demolizione della muratura marcita.

17 agosto 1938

Muratore Luca De Crescenzo

Casa dell'atrio. Atrio lato ovest portato a termine la messa in opera due pezzi di ferro trave di m 1.60 per 0.14 con due tirantini e riempimento di muratura che fa da architrave soprastante del vano, ricostruito. Due pilastrini ad opera listata che fanno squarcio di finestra misura non 0.40 per 0.45 per 0.50.

18 agosto 1938

Muratore Luca De Crescenzo

Casa dell'atrio 27 parete ovest iniziato portato a termine incasso di muratura opera incerta tra i due pilastri di due vani misura m 2.95 per 1.60 per 0.35. Tablino dell'atrio lato sud portato a termine incasso di muratura opera incerta misura m 3.20 per 3.10 per 0.20. Tablino dell'atrio lato sud portato a termine incasso di muratura opera incerta con demolizione della muratura marcita e con sterramento misura 6.40 per 5 per 0.40.

24 agosto 1938

Muratore Luca De Crescenzo

Casa dell'atrio 27 atrio lato sud ovest, continua l'incasso di pilastro opera listata con pietre tufo e mattoni un che fa squarcio di due vani.

Marmista Luigi De Francescantonio

* Iniziato smontaggio alle pareti di stucco della Casa del Bicentenario Decumano superiore lato sud.

29 agosto 1938

Muratore Luca De Crescenzo

Casa dell'atrio 27 atrio parete ovest portato a termine la messa in opera due ferri trave di m 4.05 per 0.18 con tre tirantini e riempimento di muratura che fa da architrave di vano, iniziato incasso di muratura ad opera incerta sovrastante di esso. Tablino lato est, portato a termine l'incasso di muratura ad opera incerta con demolizione e sterramento misura m 8 per 1.70 per 0.30.

Marmista Luigi De Francescantonio

* Eseguito smontaggio alle pareti di stucco della Casa del Bicentenario.

1 settembre 1938

Muratore Luca De Crescenzo

Casa dell'atrio 27, ambiente superiore posto sud dell'atrio portata a termine l'incasso di intelaiata la beneventana ad opera incerta misura m 1.40 per 1.10 per 0.12, ricostruito un altro incasso di pilastro ad opera listata che fa squarcio di vano misura m 1.15 per 0.45 per 0.40. Ambiente posto ovest dell'atrio parete nord imposto l'incasso di muratura ad opera incerta presso pilastro. Tablino lato sud est imposta incasso di pilastro ad opera listata con pietre tufo e mattoni che fa squarcio di vano.

Restauro stucchi Umberto Scavone

* Ricomposto e restaurato mq 10 di stucchi appartenente all'atrio della casa 27.

5 settembre 1938

Muratore Luca De Crescenzo

Casa dell'atrio 27 atrio parete sud ovest, portato a termine l'incasso di muratura ad opera listata soprastante dell'architrave. Misura m 2.10 per 2.45 per 0.40. Tablino lato ovest portato a termine incasso di muratura ad opera incerta con demolizione e sterramento misura m 5.50 per 3.10 per 0.40. Tablino lato sud est portato a termine incasso di pilastro ad opera listata che fa squarcio di vano con pietre tufo e mattoni misura m 2 è.10 per 0.70 per 0.45.

9 settembre 1938

Muratore Luca De Crescenzo

* Casa dell'atrio 27 tablino lato sud armaggio di andito e imposto incasso di muratura ad opera incerta.

Conservatore dipinti Luigi Fusco

* Iniziato lavoro di incrostazione e spalmatura cera alle pareti affrescate della casa del Bicentenario n. 26 e 27.

Restauro stucchi Umberto Scavone

* Ricomposto e restaurato mq 10 di stucchi appartenente all'atrio della casa 27.

Stuccatore Giuseppe De Luca

Continua messa in opera di stucchi appartenenti atrio 27.

14 settembre 1938

Verniciatore Espedito Fusco

* Iniziato lavoro pitturazione di travetti solarini e alle mura beneventane dei piani superiori e all'architrave con spalmatura di pittura ad olio alle pareti affrescate della casa del Bicentenario 26 e 27.

20 settembre 1938

Muratore Luca De Crescenzo

* Con un un'un casa dell'atrio un 27 ambiente post est dell'atrio o parete est, iniziato chiusura di cunicolo ad opera incerta.

Restauro stucchi Umberto Scavone

* Ultimato la ricomposizione ed il restauro di mq 10 di stucchi appartenente all'atrio della casa 27.

23 settembre 1938

Conservatore dipinti Luigi Fusco

* Ultimato lavoro spalmatura di cera alle pareti affrescate delle case del Bicentenario e di quella che si scava con fondi della Banca d'Italia e ultimazione della bottega 25 Decumano maggiore.

27 settembre 1938

Muratore Luca De Crescenzo

Casa dell'atrio 27 piano superiore messo in opera un trave di legno pino di m 4.20 per 0.23 per 0.12 in canna lato nel sotto pavimento e murato ai due lati, occorrente per ricostruire su di esso intelaiata alla beneventana.

28 settembre 1938

Muratore Luca De Crescenzo

Casa dell'atrio 27 ambiente attiguo al tablino parete nord è, assicurazione di puntellatura a catasta e sterramento occorrente per trovare l'impronta di pilastro essendo esso tutto traforato da cunicolo. Casa 28 piano superiore lato sud, iniziato incasso di pilastro ad opera listato.

29 settembre 1938

Muratore Luca De Crescenzo

* Casa dell'atrio Bicentenario 27 ambiente lato sud del tablino parete nord del iniziato la ricostruzione del pilastro che fa squarcio di vano ad opera listata con pietre tufo e mattoni. Casa 28 piano superiore lato sud est portato a termine la ricostruzione di incasso di pilastro ad opera listata incerta, misura m 2.20 per 0.60 per 0.40.

1 ottobre 1938

Muratore Luca De Crescenzo

* Casa dell'atrio Bicentenario ambiente lato ovest del tablino parete nord iniziato incasso di pilastro ad opera listata che fa squarcio di vano. Ambiente 29 piano superiore messo in opera un armaggio di legno castagno di m 3 per 2 per 0.10 occorrente per la intelaiata la beneventana.

3 ottobre 1938

Muratore Luca De Crescenzo

* Casa dell'atrio 27 ambiente posto ovest del tablino ricostruito incasso di pilastro ad opera listata che fa squarcio di vano misura m 2.20 per 0.50 per 0.40, messi in opera due ferro trave di m 3 per 0.18 con tre tirantini, per sostegno del muro sovrastante. Casa n.28 e 29 piano superiore, iniziato ricostruzione di intelaiata la beneventana ad opera incerta che fa divisoria di stanze.

5 ottobre 1938

Muratore Luca De Crescenzo

Casa 28 e 29 piano superiore portato a termine la ricostruzione di intelaiata la beneventana ad opera incerta che fa divisoria di ambiente misura m 3 per 2 per 0.10.

8 ottobre 1938

Muratore Luca De Crescenzo

* Casa dell'atrio 27 ambiente posto a ovest del tablino parete nord, continua sopraelevazione di muratura opera incerta, con demolizione della muratura marcita. Altro ambiente posto est del tablino parete nord portato a termine ricostruzione di pilastro ad opera listato che fa squarcio di vano sino all'impronta dell'architrave misura m 2.20 per 0.45 per 0.45, ricostruito l'incasso di muratura opera incerta presso alla detto pilastro misura m 2.80 per 0.60 per 0.35. Casa 28 parete sud esterna, lavorato per l'armaggio di andito e ricostruito l'incasso di muratura ad opera reticolata per sostegno del pilastro soprastante, misura m 1.10 per 0.55 per 0.35.

12 ottobre 1938

Muratore Luca De Crescenzo

* Casa dell'atrio 27 ambiente posto sud dell'atrio parete ovest armaggio di andito e continua l'incasso di muratura ad opera incerta con demolizione della muratura marcita. Ambiente posto ovest del tablino parete nord portato a termine l'incasso di muratura ad opera incerta del piano di architrave con demolizione della muratura marcita misura m 4.20 per 3.10 per 0.35. Casa 28 piano superiore si continua lo sterro e iniziato la messa in opera i travi e fori 4 devono ricavarne l'intelaiata.

13 ottobre 1938

Muratore Luca De Crescenzo

Casa dell'atrio 27 ambiente posto sud dell'atrio parete ovest continua incasso di muratura ad opera incerta con demolizione della muratura marcita. Casa 28 piano superiore lato ovest iniziato sopraelevazione di pilastro che fa squarcio di vano ad opera listato. Lo stesso ambiente superiore, portato a termine la messa in opera un trave di legno pino di m 3.63 per 0.20 per 0.12. Altro trave per sostegno di una intelaiata m 2.20 per 0.20 per 0.10. Un altro trave di m 2.10 per 0.26 per 0.10. Un altro trave di m 3.20 per 0.25 per 0.10 soprastante ad essi sono stati messi in opera due armaggi di intelaiata alla beneventana.

19 ottobre 1938

Muratore Luca De Crescenzo

Casa dell'atrio 27 ambiente posto sud dell'atrio parete ovest continua l'incasso di muratura con opere incerta con demolizione della muratura marcita. Casa n. 26-27-28 piano superiore lato esterno portato a termine la ricostruzione dei tre architravi di cemento armato misurano m 9.40 per 0.45 per 0.30. Casa 28 piano superiore lato est portato a termine la ricostruzione dell'intelaiata alla beneventana ad opera incerta misura m 2.50 per 2.30 per 0.30.

Restauro stucchi Umberto Scavone

Smontato e restaurato stucchi appartenente al piano superiore soprastante al numero 29 del decumano maggiore.

Stuccatore Giuseppe De Luca

Lavorato per il restauro di una cancellata in legno carbonizzato appartenente ad una finestra che trovasi sopra un vano dell'atrio 27 sul Decumano maggiore e continua messa in opera stucchi piani superiori casa 28.

24 ottobre 1938

Muratore Luca De Crescenzo

Casa dell'atrio 27 atrio lato nord continua incasso di muratura ad opera incerta con demolizione della muratura marcita. Ambiente posto sud dell'atrio parete sud iniziato incasso di muratura lo per incerta con pilastro che fa squarcio di finestra. Ambiente posto ovest del tablino parete ovest, continua ricostruzione di pilastro opera incerta che fa squarcio di vano. Casa 28 piano superiore parete nord portato a termine ricostruzione del intelaiata la beneventana ad opera incerta lavorato due facce, misura m 2.40 per 1.90 per 0.10 massimo magistero.

27 ottobre 1938

Muratore Luca De Crescenzo

Casa dell'atrio 27 continua la ricostruzione di muratura opera incerta ai due lati della parete e rimanendo il voto per il gettito di cemento armato atrio lato nord. Ambiente posto sud dell'atrio lato sud portato a termine la ricostruzione di muratura ad opera incerta ai due lati della parete rimanendo il vuoto, per lo gettito di cemento armato. Ambiente posto ad est del tablino parete est continua incasso di muratura ad opera incerta con demolizione e sterramento. Due operai hanno lavorato a portare i rottami di mattoni per l'impasto di calcepesto per il muri degli ambienti della casa 28 piani superiori.

29 ottobre 1938

Muratore Luca De Crescenzo

Casa dell'atrio 27, atrio lato nord, continua sopraelevazione di muratura ad opera incerta nei due lati della parete rimanendo il vuoto in mezzo per il gettito di cemento armato. Ambiente posto sud dell'atrio parete sud messa in opera due ferro trave di m 2.05 per 0.10 con due tirantini e riempimento di muratura che fa da architrave di finestra con incassatura soprastante ad opera incerta misura m 1.50 per 0.25 per 0.40. Il ambiente posto ad est del tablino parete est continua incasso di muratura ad opera incerta. Casa 25 porta d'ingresso messo in opera le bocchette dei saliscendi del cancello.

2 novembre 1938

Muratore Luca De Crescenzo

Casa dell'atrio 27 ambiente posto sud del tablino del peristilio parete ovest sul continua la ricostruzione del pilastro ad opera incerta che fa squarcio di vano. Casa 28 piani superiori, iniziato e portato a termine i massi di coccio pesto battuto, in parte intorno alla parete che nell'assieme misurano 4.10 per 1.40 per 0.15. Atrio della casa 27 lato nord continua sopraelevazione di muratura ad opera incerta, lavorato i due lati, rimanendo il vuoto in mezzo occorrente per il gettito di cemento armato, occorrente per sgravare il peso alla parete sottostante.

3 novembre 1938

Muratore Luca De Crescenzo

Casa dell'atrio 27 atrio lato nord, lavorato per l'armaggio di ferro tondo a gabbietta, lungo il vuoto del muro per il gettito di cemento armato. Ambiente posto sud del tablino lato ovest, sud, portato a termine ricostruzione del pilastro opera incerta che fa squarcio di vano misura m 2.20 per 0.50 per 0.40, ricostruito soprastante di esso una travata di cemento armato di m 2.80 per 0.40 per 0.25. Casa 28 piano superiore, iniziato la sopraelevazione della intelaiata la beneventana in giro alla stanza.

12 novembre 1938

Muratore Luca De Crescenzo

Casa dell'atrio 27. Ambiente posto assoluto del tablino delle peristilio lato sud est, portato a termine incasso di pilastro opera listata con pietre tufo e mattoni che fa squarcio del colonnato misura m 1.50 per 0.40 per 0.30. Ambiente posto a nord dell'atrio parete est, iniziato incasso di muratura opera incerta. Casa 28 ambiente 1 lato ovest iniziato incasso

di pilastro che fa squarcio di vano opera listata. Casa 29 ambiente 1 lato nord, l'assicurazione di un avanzo di masso originale con gattoni di ferro murati di sotto.
Stuccatore Giuseppe De Luca
* Continua messa in opera di stucchi della casa del Bicentenario piano superiore e terraneo. Iniziato smontaggio di una chiusura a cancello a rombi che forma un tramezzo di legno carbonizzato che trovasi vano alla destra di detta casa.

14 novembre 1938
Muratore Luca De Crescenzo
Casa dell'atrio 27 ambiente posto nord dell'atrio parete est portato a termine incasso di muratura opera incerta misura m 2.50 per 0.90 per 0.15 e. Di ambiente casa 28 lato ovest continua incasso di pilastro che fa squarcio di vano ad opera listata. Casa numero 29 e 30 piano superiore, tirati su e messo in opera il blocco di pietra originali e prosegue l'incasso di muratura ad opera incerta presso di esso lato ovest.

18 novembre 1938
Muratore Luca De Crescenzo
Casa dell'atrio 27. Ambiente posto ovest dell'atrio parete nord, continua incasso di muratura opera incerta. Casa 29 ambiente 1 lato nord assicurato un avanzo originale con staffa murata.

21 novembre 1938
Muratore Luca De Crescenzo
Casa dell'atrio 27 ambiente posto ovest dell'atrio, parete nord, portato a termine incasso di muratura opera incerta con demolizione della muratura marcita, misura m 4 per 4.20 per 0.35 e iniziato una fodera di rafforzamento opera incerta alla lato ovest dello stesso ambiente. Casa 28 ambiente 1 lato est, ricostruito un incasso di muratura ad opera incerta con demolizione della muratura marcita misura m 4 per 4.10 per 0.35.

26 novembre 1938
Muratore Luca De Crescenzo
Casa dell'atrio 27 ambiente posto a ovest dell'atrio parete ovest continua incasso di muratura ad opera incerta, l'del detto lavoro è occorso armaggio di andito. Casa 28 ambiente 1 lavorato per assicurazione il restauro murario della intelaiata la beneventana, messo in opera due tirantini con due dadi con assicurazione della intelaiata, messo in opera un trave di legno pino di m 3.50 per 0.11 per 0.11 che fa da sostegno del trave dell'ambiente superiore e di angolo dell'intelaiata v. Casa 29 lato ovest portato a termine incasso di muratura opera incerta che fa pari con l'ambiente 30 misura m 3.40 per 2.20 per 0.40.

30 novembre 1938
Muratore Luca De Crescenzo
Casa dell'atrio 27 ambiente post posto ovest del tablino lato e parete Ester ripreso incasso di muratura opera incerta. Ambiente posto ovest dell'atrio parete sud ovest, continua incasso di muratura opera incerta. Ambiente posto nord dell'atrio parete est iniziato incasso di muratura opera incerta essendo esso marcito. Casa 29 ambiente 1 lato sud ripreso incasso di muratura e pilastro ad opera listata che forma faccia di finestra e stipo.

3 dicembre 1938
Muratore Luca De Crescenzo
Casa dell'atrio 27 ambiente posto ovest del tablino parete est, ripreso incasso di muratura ad opera incerta e messo in opera un trave di legno pino di m 3.90 per 0.14 per 0.12 p, per

sostegno della cassa di scala e che fa divisoria con la intelaiata la beneventana. Casa 28 ambiente 1 lato sud portato a termine restauro dell'incasso dell'intelaiata la beneventana che fa divisoria dell'ambiente, misura m 1.70 per 1.65 per 0.12. Casa 29 ambiente 1 lato sud continua incasso di muratura ad opera incerta e opera listata.

6 dicembre 1938

Muratore Luca De Crescenzo

Casa del Bicentenario. Ambiente attiguo tablino piano superiore a, cassa di scala, lavorato per l'assicurazione di esso con architrave di sostegno è murato. Ambiente posto ovest dell'atrio parete sud, continua incasso di muratura ad opera incerta. Ambiente casa 28 portato a termine ricostruzione della intelaiata la beneventana ad opera incerta che fa divisoria tra l'ambiente e cassa di scala, misura m 1.70 per 1 per 0.10 detto ambiente ricostruito lavorato a due facce, a lato sud ricostruito una chiusura di intelaiata la media altezza ad opera incerta misura m 0.95 per 0.50 per 0.12. Casa 29 ambiente 1 lato sud e continua incasso di muratura ad opera incerta ed opera listata.

7 dicembre 1938

Muratore Luca De Crescenzo

Casa del Bicentenario ambiente attigua tablino piano superiore parete est continua incasso di muratura ad opera incerta con demolizione e sterramento. Ambiente posto nord dell'atrio parete ovest, iniziato incasso di muratura ad opera incerta con demolizione della muratura marcita. Casa 29 ambiente 1 lato sud portato a termine l'incasso di muratura ad opera incerta e listata che forma squarcio di finestra misura sino all'imposta degli architravi m 4 per 2.10 per 0.60, messo in opera tre architravi di legno pino 2 di m 0.95 per 0.25 per 0.10, 1 di m 1.30 per 0.20 per 0.10 con incassatura sovrastante.

14 dicembre 1938

Muratore Luca De Crescenzo

Casa del Bicentenario ambiente posto ovest dell'atrio parete sud continua incasso di muratura opera incerta con demolizione e sterramento. Lo stesso ambiente lato ovest, ripreso incasso di muratura ad opera incerta con demolizione e sterramento. Casa 29 e 30 continua la sopraelevazione del muro divisorio ad opera incerta.

20 dicembre 1938

Muratore Luca De Crescenzo

Casa del Bicentenario ambiente attigua al tablino parete ovest, ripreso incasso di muratura ad opera incerta parete est dello stesso ambiente, ripreso incasso di muratura opera incerta con demolizione e sterramento. Giardino lato ovest appartenente alla stessa casa continua ricostruzione di pilastro ad opera incerta che fanno squarcio di finestra e messo in opera un architrave di legno pino m 1.85 per 0.30 per 0.10 e ricostruito l'incasso di muratura soprastante. La stessa casa piano superiore iniziato murare i travi.

22 dicembre 1938

Muratore Luca De Crescenzo

Casa del Bicentenario ambiente attiguo tablino continua incasso di muratura opera incerta la pretesto è demolito muratura marcita e rinforzata con cemento e arena. Giardino appartenente a stessa casa lato ovest continua il lavoro del incasso di muratura mattoni per l'incasso di una travata carbonizzato. Lato sud dello stesso giardino portato a termine incasso di muratura opera incerta, essendo esso da Satana cunicoli, misura m 2.10 per 1.70 per 0.30. Ambiente della alla sinistra dell'atrio iniziato la messa in opera i travi per la copertura.

27 dicembre 1938

Muratore Luca De Crescenzo

Casa del Bicentenario ambienti 26-27-28 piano superiore lavorato per smontaggio della andito al lato nord e armaggio di anditi con manganello al lato sud, occorrente per murare i travi, portata a termine la parte nord, misura m 9 per 0.40 per 0.40 e continua lato sud. Ambiente non numerato attigua al tablino parete est iniziato incasso di muratura ad opera incerta. Giardino appartenente alla stessa casa lato ovest continua incasso di muratura ad opera incerta che fa squarcio di finestra. Giardino lato sud ovest continua incasso di pilastro che fa squarcio e angolo ad opera listata con tufo e mattoni. Tablino lato est ricostruito una sopraelevazione di muratura ad opera incerta per imposta di travi misura m 30 per 0.40 per 0.40 lato ovest fatto 8 buchi per le tenute dei travi.

2 gennaio 1939

Muratore Luca De Crescenzo

Casa del Bicentenario ambiente attiguo tablino continua ricostruzione di intelaiata la beneventana ad opera incerta che fa divisoria della cassa di scala. Ambiente della sinistra dell'atrio portato a termine la messa in opera i travi della tettoia e murati ai due lati misura della muratura ad opera incerta dei due lati m 7.80 per 0.30 per 0.20. Ambiente non numerato posto ovest dell'atrio, parete nord iniziato incasso di muratura ad opera incerta. Ambiente della casa 29 lato sud e continua incasso di muratura ad opera incerta con demolizione della muratura marcita.

Restauratore stucchi Umberto Scavone

* Smontato e restaurato mq 8.50 di stucchi appartenente all'ambiente in fondo all'atrio della casa Bicentenario non ancora del tutto scavata.

10 gennaio 1939

Muratore Luca De Crescenzo

Casa del Bicentenario ambiente dell'ala sinistra dell'atrio piano superiore, portato a termine sopraelevazione di muratura ad opera incerta che fa da parapetto di detto ambiente lato est lato sud. Lato est misura m 3.50 per 0.50 per 0.40, lato sud misura m 4 per 0.45 per 0.30 portato a termine il masso di lapillo e malta di detti ambienti misura m 3.80 per 3.50 per 0.10.

18 gennaio 1939

Stuccatore Giuseppe De Luca

* Continua il restauro chiusura cancelli a rombi di legno carbonizzato appartenente al vano alla destra casa del Bicentenario, e continua la messa in opera degli stucchi al piano superiore piano terraneo con abbozzi di architrave e messo a tonachina.

Muratore Luca De Crescenzo

Secondo cubicolo posto ovest dell'atrio parete sud est, portato a termine incasso di muratura ad opera incerta, misura m 5 per 3.10 per 0.20. III cubicolo come sopradetto, parete nord del piano superiore, continua incasso di muratura ad opera incerta.

24 gennaio 1939

Muratore Luca De Crescenzo

Casa del Bicentenario, ambiente attigua al tablino cassa di scala, continua ricostruzione di intelaiata che fa divisorio cassa di scala e corridoio. Corridoio lato ovest, continua incasso di muratura ad opera incerta con demolizione della muratura marcita. Secondo cubicolo posto ovest dell'atrio parete est che fa fronte sull'altro, continua incasso di muratura ad opera incerta. III cubicolo parete nord che fa fronte con muro dell'ambiente 29, lavorato per

l'armaggio di andito a maggiore altezza occorrente per continuare la sopraelevazione sino l'imposta dei travi della copertura.
Restauro stucchi Umberto Scavone
* Continua il lavoro di smontaggio restauro di stucchi appartenente alla scalinata e corridoio attiguo tablino nella casa del Bicentenario.

30 gennaio 1939
Muratore Luca De Crescenzo
Casa del Bicentenario giardino ripreso e portato a termine incasso di pilastro ad opera listata con tufo e malta che fa angolo, misura m 2.30 per 1 per 0.40. Casa numero 26-27-28 del piano superiore, portato a termine la spianata di malta sottile fracassata sui massi del pavimento, misura m 9.60 per 6.30.

1 febbraio 1939
Officina fabbri Carlo Olivieri
Costruzione di una travata di ferro tondo per cemento armato dell'architrave della casa numero 13 col numero vecchio 29.
Stuccatore Carlo Losa
* Continua il lavoro. Un della messa in opera di lastroni di stucco affrescate alle pareti degli ambienti numero 7 della casa del Bicentenario. Iniziato la messa in opera del cassone di stucco fondo bianco appartenente all'ambiente 5 della suindicata casa.
Officina restauro legno carbonizzato Giuseppe De Luca
Lavorato per continuare il restauro del cornicione soprastante della chiusura tramezzo della vano ala destra casa Bicentenario.
Officina restauro stucchi affrescati Umberto Scavone
* Ricomposto frammenti di stucco bianco a lastroni con soletta di cemento sull'estradosso di mq 1.50 appartenente all'ambiente 5 che trovasi nell'atrio della casa del Bicentenario.
Verniciatore Espedito Fusco
Imprimitura di telaio a graticcio e accenno solarino e travetti di sostegno del piano superiore che trovasi nella casa 28 (provvisorio) e numero 14 permanente. Imprimitura di telaio a graticcio dell'ambiente 37 e 14 casa del Bicentenario.
Muratore Luca De Crescenzo
Casa del Bicentenario con numero vecchio 27 e con numero nuovo 15. Ambiente 7 ultimata intelaiata ad opera graticcio, lavorato ai due lati, che fa divisoria della cassa di scala e corridoio. Misura del primo piano m 4.80 per 3.10 per 0.20, misura del piano superiore. M 2.20 per 1.40 per 0.20. Cubicolo numero 4 lato sud iniziato la chiusura di cunicolo borbonico ad opera incerta, la stessa parete che fa divisoria col cubicolo numero 5. Continua l'incasso a di muratura ad opera incerta essendo essa marcita. Casa con numero vecchio 29 con numero 13 piano superiore, lavorato a completare l'armaggio di ferro tondo, occorrente per la travata di cemento armato che fa da architrave di vano, e fatto il gettito di cemento e lapillo e ultimato misura m 4.30 per 0.43 per 0.43.

4 febbraio 1939
Muratore Luca De Crescenzo
Casa del Bicentenario. Piani superiori ambiente 13 ultimato la messa in opera di travi sostegno del solarino e murato ai due lati ad opera incerta lato sud, misura della muratura m 4 per 0.70 per 0.25; lato nord misura della muratura m 4 per 0.43 per 0.43.

6 febbraio 1939

Officina falegname Gennaro Cozzolino

Messi due listoni per portare a maggiore spessore intelaiata alla beneventana del corridoio laterale del tablino casa del Bicentenario; il primo m 2.10 per 0.05 per 0.14, il secondo m 1.70 per ettaro.05 per 0.10.

Muratore Luca De Crescenzo

Un operaio lavora nell'ambiente 4 lato ovest e ha terminato incasso di muratura ad opera incerta, essendo esso marcito e devastato con demolizione delle murature marcite. Un'altro ha iniziato il restauro delle colonne del peristilio di detta casa e continua a fornire mattoni occorrenti per le colonne. Tablino 8 piano superiore è stato fatto una spianata di malta sottile fracassata nel masso del pavimento misura m 4.50 per 4.20. Lo stesso lavoro si è fatto nell'ambiente 3 misura m 3.80 per 2.15.

7 febbraio 1939

Officina restauro legno carbonizzato

Lavorato per continuare il restauro del cornicione soprastante della chiusura tramezzo del vano ala destra casa del Bicentenario.

Stuccatore Carlo Losa

* Ambiente 7 messa in opera degli stucchi e ambiente 5 smontaggio stucchi e trasportato nell'officina restauro.

9 febbraio 1939

Officina falegname Gennaro Cozzolino e A. Pezzella

Ultimato il lavoro di copertura di travi e solarino del piano superiore della casa col numero vecchio di scavo 29 e quello nuovo 13 decumano maggiore, copertura composta di 8 travi e solarino di mq 18.79 compreso lo sfondo che di mq 1.37.

Officina restauro stucchi affrescati Umberto Scavone

* Ricomposto frammenti di stucco bianco lastrone con soletta di cemento su l'estradosso in mq 1.05 appartenente all'ambiente 5 che trovasi nell'atrio della casa Bicentenario.

10 febbraio 1938

Officina falegname

Prosegue la costruzione della chiusura di un cancello a forma romboidale e di due pilastrini di legno faggio evaporato scavato e scorniciato con basso rilievo del cubicolo ala destra del triclinio casa del Bicentenario.

17 febbraio 1939

Muratore Luca De Crescenzo

Un muratore lavora nell'ambiente posto ovest del numero 7 lato sud e ha iniziato l'incasso di muratura ad opera incerta essendo esso rasato da cunicoli Borbonici sino al muro del piano superiore. Il secondo e il terzo lavorano continuare la messa in opera i platò di legno pino che le travate di ferro sulle intercolonne del peristilio di detta casa e iniziato la sopra-elevazione di muratura ad opera incerta soprastante all'architrave essendo esso rasato da cunicoli Borbonici.

Officina fabbro Carlo Olivieri

Costruiti sette tirantini con filettature per le travate del peristilio casa Bicentenario.

Officina restauro stucco

* Ricomposto frammenti di stucco a lastroni con soletta di cemento sull'estradosso di mq 1 appartenente ambiente 4 della casa del Bicentenario.

Stuccatore Carlo Losa

* Continua il restauro del cornicione con un fregio a rombi esagonali soprastante al vano ala destra dell'atrio. Ultimato il lavoro di tonaca con piccoli frammenti di stucchi ambiente 14 e smontaggio di stucchi ambiente non numerato. Ultimato il cenno di copertura del piano superiore della casa 13 Decumano maggiore. Il trave misura 4.30 per 0.12 per 0.20, il solarino mq 250.

21 febbraio 1939

Muratore Luca De Crescenzo

Un muratore lavora al lato ovest del giardino della casa del Bicentenario ed ha ultimato l'incasso di muratura ad opera incerta che fa da parapetto e pilastri che fanno squarcio di muratura e del parapetto, misura m 1.90 per 0.25 per 1.25, i due pilastri che fanno squarcio di finestra ad opera incerta il primo misura m 1.20 per 0.40 per 0.25, il secondo misura m 1.10 per 0.45 per 0.25, messo in opera una architrave di legno pino m 1.55 per 0.14 per 0.10 che fa da architrave di detta finestra incassatura sovrastante dell'architrave, ricostruita ad opera incerta misura m 1.90 per 0.30 per 0.20, costruito soprastante di detta muratura un'incasso mattoni torniti al lato est nord del peristilio. Il terzo lavora nell'ambiente del giardino parete ovest e continua il restauro murario delle colonne.

Conservatore pareti affrescate Luigi Fusco

Ultimato nell'ambiente 5 della casa del Bicentenario lavoro di messa in opera degli stucchi con beveraggio di cemento fino con malta e finimenti di intonaco parete nord mq 7.30, parete sud mq 6.20, parete est m 2.80, parete ovest scoperto e ultimato architrave di ingresso e architrave della finestra.

1 marzo 1939

Muratore Luca De Crescenzo

Con muratore lavora nell'ambiente 5 piano superiore e iniziato la ricostruzione dell'intelaiata ad opera graticcio. Il secondo lavora nell'ambiente posto ovest del giardino di detta casa è iniziato incasso di pilastro opera incerta che fa squarcio di finestra che comunica col giardino. Il terzo ha ultimato gli incassi di colonne lato est del giardino essendo rasato da cunicoli Borbonici, la prima misura m 1.45 per diametro 0.30, la seconda misura m 1.80 per 0.38 di diametro, la terza misura 1.60 per diametro 0.38. Il quarto ha ricostruito una chiusura di cunicolo borbonico ad opera incerta nell'ambiente lato ovest del peristilio, misura m 1.90 per 1 per 0.10.

8 marzo 1939

Muratore Luca De Crescenzo

Un muratore lavora negli ambienti 4 e 5 lato ovest del piano superiore che ha costruito una travata di cemento armato, occorrente per sgravare peso al muro sottostante, misura m 7 per 0.30 per 0.20 e continua la ricostruzione di muratura ad opera incerta per raggiungere il piano di copertura di detto ambiente, il secondo lavora nell'ambiente posto a sud del giardino di detta casa, parete ovest continua l'incasso di muratura ad opera incerta. Il terzo lavorato a montare la forma della travata di cemento armato della casa 13 piano superiore e montaggio di andito nell'ambiente posto ovest del numero 7 in corso di sterro.

17 marzo 1939

Muratore Luca De Crescenzo

Un muratore lavora negli ambienti 4 e 5 piani superiori e continua la sopraelevazione di muratura ad opera incerta per raggiungere il piano di copertura di detto ambiente, il secondo lavora nell'ambiente 17 lato sud è iniziato il restauro murario della intelaiata ad opera graticcio. Il terzo iniziato l'armaggio di andito lato esterno della casa lato sud sui piani superiori, occorrente per l'intonaco degli architravi e per pitturare i travi.

28 marzo 1939

Muratore Luca De Crescenzo

Un muratore lavora nell'ambiente 4 lato sud, armaggio di andito, e ricostruito una sopraelevazione di muratura ad opera incerta misura m 3.90 per 0.30 per 0.25, il secondo lavoro nell'ambiente 17 lato ovest e continua incasso di muratura ad opera incerta.

Officina falegname Gennaro Cozzolino

Ultimata la scalinata della casa del Bicentenario ambiente 11; fatto una architrave di m 0.80 per 0.44 per 0.08 occorrente per finestra dell'ambiente 6 lato sud casa del Bicentenario.

6 aprile 1939

Muratore Luca De Crescenzo

Un muratore lavora nell'atrio lato ovest e continua la sopraelevazione di muratura ad opera incerta occorrente per raggiungere all'altezza originale. Il secondo lavora nell'ambiente 15 e continua ricostruzione di pilastro ad opera listata che fa squarcio di vano e messo in opera due travate di ferro di m 2.30 per 0.14 con due tirantini e riempimento di muratura che fa da architrave di detto vano. Il terzo lavora nello stesso ambiente piano superiore ed ha ultimato ricostruzione di muratura opera listato che fa squarcio di vano del lato est, misura sino all'imposta m 1.80 per 0.40 per 0.35. Il quarto lavora nell'ambiente 17 e continua il restauro e ricostruzione della intelaiata ad opera graticcio che fa divisoria di detto ambiente da quello della casa 17 quinto cardo.

24 aprile 1939

Muratore Luca De Crescenzo

Un muratore lavora negli ambienti 4 e 5 piani superiori e l'ultimato il masso di lapillo e malto misura m 8.10 per 4 per 0.18. Il secondo lavora nell'ambiente 11 del piano superiore ha ultimato il lacertino di cemento e malto sui coppi della tettoia e iniziato una sopraelevazione di muratura ad opera incerta a lato sud della tettoia. Il terzo lavora nell'ambiente 15 piano superiore ad opera graticcio e misura m 1.65 per 0.70 per 0.14.

2 maggio 1939

Stuccatore Carlo Losa

* Iniziata la messa in opera stucchi nell'ambiente 9 casa Bicentenario; ultimato lavoro di garage messa in opera dei blocchetti di coccio presto originali, messo nei buchi dei blocchi di legno carbonizzato, calce pesto m 8.20 per 0.25 ambiente 5.

Muratore Luca De Crescenzo

1 muratore lavora nell'ambiente 6 e continua la messa in opera della trabeazione originale che fa divisoria di detto ambiente. Il secondo lavoro nell'ambiente 9 e continua incasso di muratura ad opera reticolato soprastante all'architrave e che fa parte dell'atrio con demolizione della muratura marcita. Il terzo continua a fare le garage sugli ambienti di detta casa occorrenti per la tenuta dell'asfaldo.

15 maggio 1939

Stuccatore Carlo Losa

* Iniziato assicurazione stucchi ambiente 13 casa Bicentenario.

Muratore Luca De Crescenzo

Si lavora nell'atrio lato est e, ripreso sopraelevazione di muratura opera incerta per raggiungere il piano della copertura, per detto lavoro è occorso armaggio di andito. Un secondo lavoro nell'ambiente 16 lato ovest e ha ripreso l'incasso di pilastro opera listata che fa squarcio di vano, il terzo continua la messa in opera i travi solarini di sostegno al pavimento originale nell'ambiente della croce. Il quarto lavora negli ambienti superiori 8 e 10 a murare le garage delle tenute di asfalto.

APPENDIX 2.2

Casa del Bicentenario (V,15) *Diario di Scavo* excerpt

Note: The material in this appendix is taken from the administrative archive of the Soprintendenza Pompei and was digitized and transcribed by the Herculaneum Conservation Project. (Courtesy HCP and the SP)

Casa del Bicentenario (V,15)

DIARIO DI SCAVO

(excerpt with tablinum references)

Note: Asterisks refer to operations carried out in the tablinum of the House of the Bicentenary.

PREMESSA

Nell'edizione definitiva degli scavi effettuati dal Soprintendente Amedeo Maiuri, imprescindibile punto di partenza per qualunque discorso scientifico sulla città antica, è fissato per ogni edificio della città la precisa localizzazione topografica, data dal numero romano dell'*Insula* e dal numero arabo del vano di accesso. E' del tutto evidente, a chi abbia una purché minima nozione di tecnica di scavo nell'area vesuviana, che questa numerazione può essere stabilita soltanto a scavo finito; per questo motivo, ogniqualvolta ci si accinge ad analizzare i dati contenuti nei Diari di Scavo ed i Giornali dei Lavori degli anni '20-'30, si resta inizialmente perplessi di fronte a localizzazioni topografiche assolutamente altre rispetto a quelle oggi definite. E' necessario un paziente lavoro d'analisi per raccogliere dati che spesso solo l'archeologo può percepire. Nel presente, la Casa del Bicentenario, nota con la collocazione topografica di Insula V, nn. 15-16, nei diari è indicata di volta in volta come "*casa 25, Decumano Massimo insula V*", "*casa 26, Decumano Massimo insula V*", "*casa 27, Decumano Massimo insula V*". Il n. 25 corrisponde ad *Insula* V, n. 17-18, il n. 26 ad *Insula* V, n. 16, il n. 27, infine, ad *Insula* V, n. 15. Gli ambienti superiori della casa sono attribuiti, nei Diari, ad altre case, come la casa 24 (vedi i primi di ottobre del 1937 e fine aprile 1938, quivi le tavolette cerate del processo di Giusta). Infine bisogna far cenno alla famosa stanzetta del piano superiore ove fu rinvenuta la "croce", ed è necessaria una premessa. Negli stessi anni di scavo della casa del Bicentenario, è in corso lo scavo ed il restauro di un'abitazione indicata, nei Diari e nei Giornali, come "casa posta a nord di quella di Poseidone. Scavo con fondi privati" e talvolta come "casa della Banca d'Italia". E' la splendida Casa del Bel Cortile. Ebbene, il 28 gennaio 1938, nella parte del Diario di Scavo di quest'edificio, si legge: "*In un ambiente del piano superiore della casa a nord di quella di Poseidone, e precisamente quello adoperato come ripostiglio, sulla parete ovest sopra stucco a fondo bianco vi è incisa una croce etc.*" Evidentemente, mentre era in corso di scavo il piano superiore, si era giunti sopra la casa del Bicentenario senza avvedersi della distinzione.

L'edificio verrà chiamato Casa del Bicentenario per la prima volta, nei Diari di Scavo, il 29 settembre 1938, quando solo la zona dell'atrio e, in parte, il tablino, era stato scavato. Pochi giorni prima erano stati inaugurati i nuovi scavi in occasione dei duecento anni dalla scoperta di Ercolano.

Però, nei Giornali dei Lavori, il 24 agosto 1938, il marmista Luigi De Francescantonio inizia lo smontaggio degli stucchi della "Casa del Bicentenario Decumano superiore lato sud". Negli stessi Giornali, nelle settimane precedenti, la casa era talvolta indicata come casa dell'atrio n. 27.

GIUGNO 1938

3 giugno. Sospeso temporaneamente lo sterro a nord del IV cardine si è ripreso nell'atrio della casa 27. Un grande ambiente posto nell'angolo sud est è incominciato a svuotarsi.
7 giugno. Nell'ambiente 4 della casa 27, sul pavimento del piano terraneo, a m. 0.80 dalla parete sud, e a 0.37 dalla soglia del vano si è sterrato:

Bronzo. Erma di Ercole con basetta a forma circolare. L'altezza complessiva è di m. 0.13. Inventario n. 1917.
Bronzo. Statuetta di Diana alta m. 0.06. Inventario n. 1918.
* 14 giugno. È incominciato lo sterro del tablino della casa 27 e dell'atrio di quella 31, ambedue poste sul Decumano Massimo Insula V.
* 15 giugno. Il tablino della casa 27, la parete ovest conserva molto stucco a fondo rosso con piccole figure di animali.
* 20 giugno. Continua lo sterro del tablino della casa 27. Le pareti sud ed est conservano molto stucco rosso. Nessun trovamento.

LUGLIO 1938
* 8 luglio. Presso la soglia del tablino della casa 27, Decumano Massimo Insula V, si è raccolto un fondo di vaso aretino con un graffito nella parte esterna e un bollo in quella interna. Il graffito:

Il bollo:
* 18 luglio. Il vano di tablino della casa 27, Decumano Massimo Insula V, è alto m. 4.15 è largo m. 4.80. I pilastri sono di opera mista. Sulla parete est lo stucco è a fondo rosso. A m. 2.10 di altezza dal pavimento nella stessa parete vi è dipinto un quadretto di forma circolare con una bellissima figura di donna. È un ritratto.
19 luglio. Nell'ambiente ad est del tablino della casa 27, sul pavimento a m. 1.20 dal vano e a 0.94 dalla parete est si è sterrato:
Terracotta. Lucerna monolichne lunga m. 0.08 e del diametro di m. 0.05. Inventario n. 1935.
Bronzo. Anforetta con le anse distaccate. È discretamente conservata. La sua altezza è di m. 0.31 e il diametro m. 0.10. Inventario n. 1936.
21 luglio. Presso la parete est dell'atrio della casa 27 a m. 2.30 dalla parete sud e a 1.40 dal vano della parete est si è sterrato:
Terracotta. Fritillo alto m. 0.16 e del diametro alla bocca di m. 0.04. Inventario n. 1937.
22 luglio. Nella casa 27 si è sterrato:
Bronzo. Piatto fondo del diametro di m. 0.18 e alto m. 0.05. Inventario n. 1938.
* 25 luglio. Sulla parete est del tablino della casa 27, Decumano Massimo Insula V, vi è dipinto un quadro largo m. 0.80. Si osserva un uomo, una donna, tre mucche e un ariete. La donna con la mano destra indica all'uomo animali, mentre l'uomo tiene il braccio destro piegato in alto e la mano è poco lontana dal mento. L'uomo è in atto di pregare. Il tutto è di discreta fattura.

AGOSTO 1938
3 agosto. Nel tablino della casa 27, sul pavimento si è sterrato:
Bronzo. Moneta di modulo medio del diametro di m. 0.025 e dello spessore di m. 0.02. È molto corrosa. Inventario n. 1941.
Terracotta. Bruciaprofumo ben conservato. È alto m. 0.085 e del diametro di m. 0.15. Inventario n. 1942.
* 12 agosto. Per restauri alle pareti del tablino della casa 27 è stato sospeso lo sterro in detto sito e si è intensificato all'estremità nord del IV cardine.
* 29 agosto. Si lavora sia nel tablino della casa 27 che all'estremità del IV cardine lato nord.

SETTEMBRE 1938

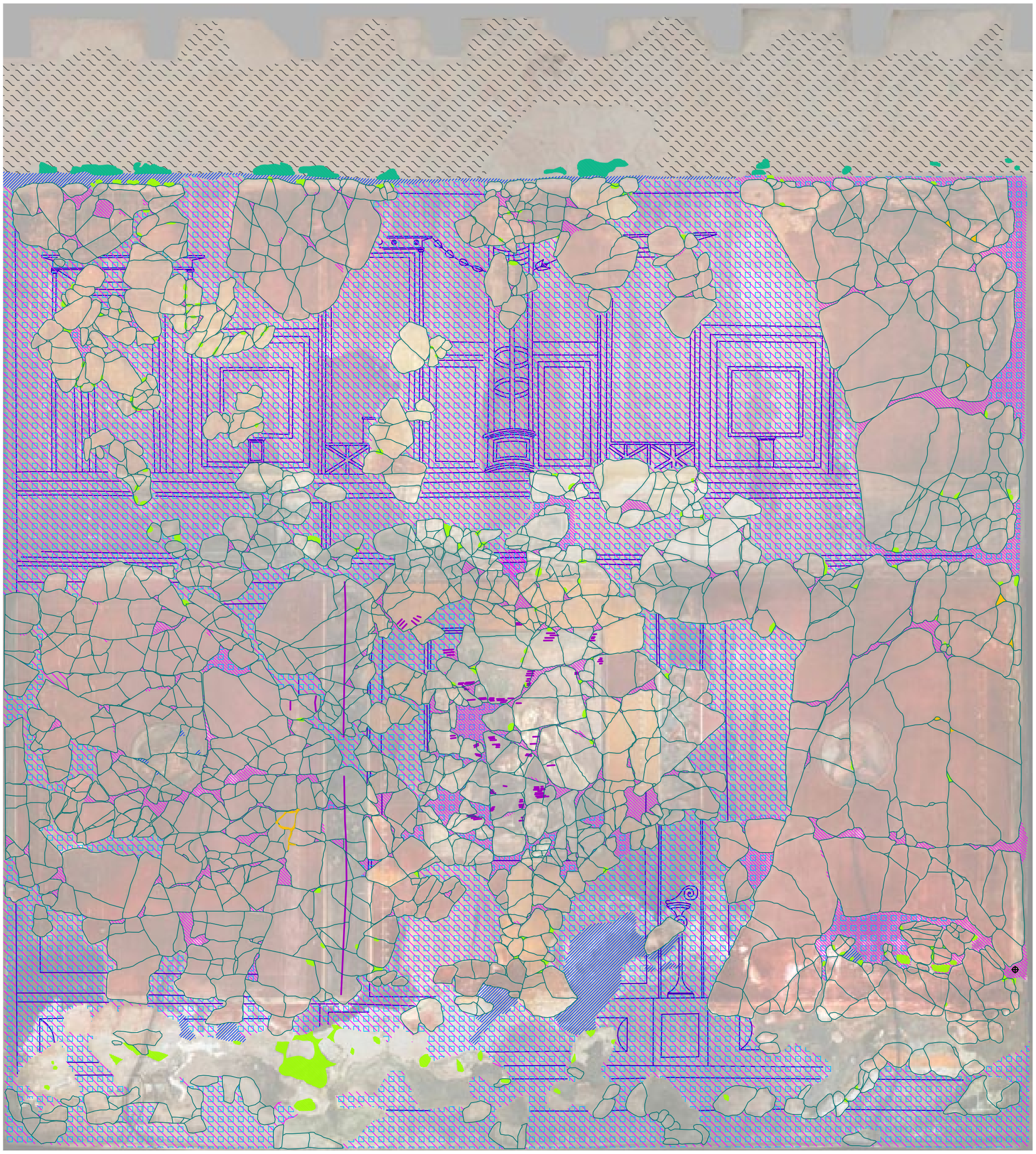
* 2 settembre. Sulla parete sud del tablino della casa 27 vi è un vano di comunicazione. Le misure di esso saranno segnate a sterro ultimato.
7 settembre. Nelle ore antimeridiane si è lavorato sia nella casa 27 che in quella 31, ambedue poste sul Decumano Massimo Insula V. In quelle pomeridiane è incominciato la nettezza degli scavi.
18 settembre. Il IV cardine, incominciato a sterrarsi nel 1928, è terminato oggi.
* 25 settembre. Festa per il bicentenario degli scavi ed inaugurazione dei nuovi edifici.
* 29 ottobre. L'intercolumnio del peristilio della Casa del Bicentenario al lato nord è chiuso con un basso podio di muratura. La sua altezza è di m. 0.60 per 0.20.

GENNAIO 1939

* 18 gennaio. Il tablino della Casa del Bicentenario è a forma rettangolare e misura m. 4.17 di lunghezza per 5.05 di larghezza. Il vano d'ingresso che affaccia nell'atrio è alto m. 4, mentre quello opposto è largo m. 2.93 per 2.80. I pilastri di quest'ultimo vano sono di opera mista, ed il primo di conci di tufo posti a filare. L'altezza dello zoccolo è di m. 0.42 e lo stucco è a fondo nero con piccoli quadretti di azzurro. Sopra una fascia di giallo alta m. 0.28. Il campo centrale è ai lati rosso e al centro di giallo. Sullo stucco rosso vi sono due medaglioni del diametro di m. 0.329 con ritratti. Sul giallo, quello ad est vi è un quadro alto m. 1.08 per 0.81 di larghezza con il soggetto mitologico di Marte e Venere, e sopra quello ovest Pasife con Dedalo. Divide il campo centrale con quello terminale una fascia di nero alta m. 0.39 con dipinti di scene di caccia, guerrieri, e di amorini che giocano al bersaglio. L'ultimo riquadro è di giallo cambiato in rosso con disegni di prospettive e altro. Il pavimento al centro tiene un rettangolo di m. 3.38 per 1.43 di marmi policromi posti a disegno, e lateralmente di tessere bianche e nere intersecate da formare (fuseruola?) ogivale eccetera. La muratura è di opera reticolato.
* 23 gennaio. Per urgenti lavori di restauri alle pareti, lo sterro è stato sospeso nella Casa del Bicentenario e ripreso a nord del Decumano Massimo.

APPENDIX 2.3

Graphic Documentation: Reconstruction and Remounting Techniques (1938)



Casa del Bicentenario, Tablinum, East Wall - Overall

RECONSTRUCTION AND REMOUNTING MATERIALS AND TECHNIQUES (1938)

Opus *incertum* tuff	Grouting mortar	Reconstruction plaster	Tool and pencil marks	Metal element
Opus *vittatum* tuff and bricks	Backing plaster	Limewash	Remounted fragment	Unfilled area
Anchoring mortar	Rough fill	Incisions	Edging	

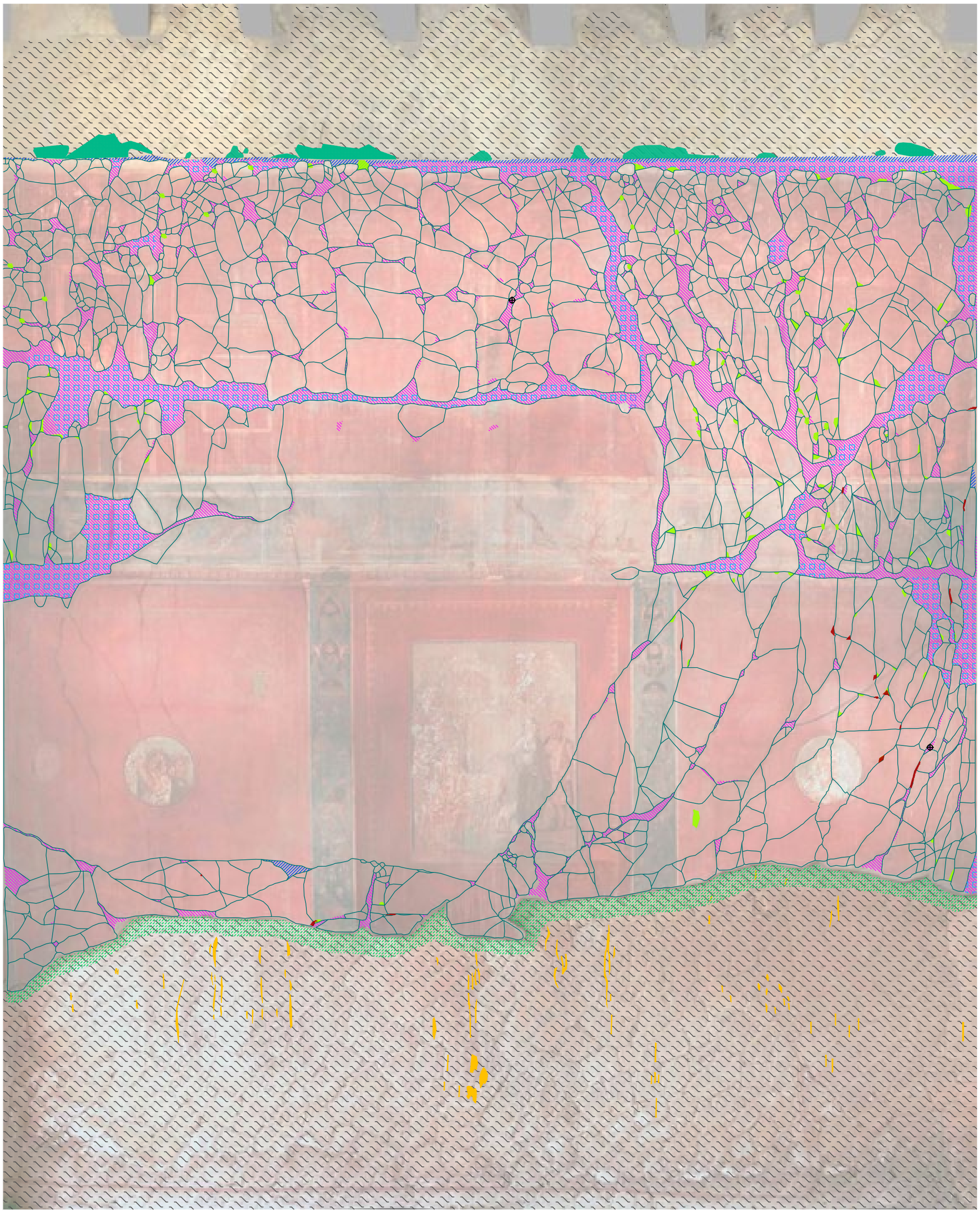
Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY -----	DATE RECORDED 2013-2014 LAST REVISED 2017/05	**EW** SCALE 1:25

Casa del Bicentenario, Tablinum, South Wall - Overall

RECONSTRUCTION AND REMOUNTING MATERIALS AND TECHNIQUES (1938)

Opus *incertum* tuff
Grouting mortar
Reconstruction plaster
Tool and pencil marks
Metal element
Opus *vittatum* tuff and bricks
Backing plaster
Limewash
Remounted fragment
Unfilled area
Anchoring mortar
Rough fill
Incisions
Edging

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY -----	DATE RECORDED 2013-2014 LAST REVISED 2017/05	**SW** SCALE 1:25



Casa del Bicentenario, Tablinum, West Wall - Overall

RECONSTRUCTION AND REMOUNTING MATERIALS AND TECHNIQUES (1938)

- Opus *incertum* tuff
- Opus *vittatum* tuff and bricks
- Anchoring mortar
- Grouting mortar
- Backing plaster
- Rough fill
- Reconstruction plaster
- Limewash
- Incisions
- Tool and pencil marks
- Remounted fragment
- Edging
- Metal element
- Unfilled area

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY -----	DATE RECORDED 2013-2014 LAST REVISED 2017/05	**WW** SCALE 1:25

CHAPTER 3

Previous Interventions (1939–2011) to the Tablinum of the House of the Bicentenary

Leslie Rainer and Kiernan Graves

Introduction

The tablinum of the House of the Bicentenary was excavated and reconstructed by archaeologist Amedeo Maiuri and his team in 1938. Their work included the removal of hardened volcanic material that had buried the house, structural work, and the reassembly, restoration, and remounting of wall painting fragments (Maiuri n.d.). The report "Reconstruction and Remounting Materials and Techniques of the Wall Paintings in the Tablinum of the House of the Bicentenary" (Gittins et al., this volume) details the work completed by the Maiuri team. In 2011, the Getty Conservation Institute initiated a collaborative pilot project with the Herculaneum Conservation Project and the Soprintendenza Pompei to study and conserve the architectural surfaces of the tablinum in the context of broader plans for the conservation of the House of the Bicentenary by the site authority. Between 1939 and 2011, the condition of the excavated wall paintings deteriorated rapidly, and a number of post-1938 interventions were undertaken to stabilize the paintings during the intervening years (fig. 3.1). As very few of these treatments were documented, this report will present the evidence and information gathered during the project to record and shed light on events that took place after the 1938 excavation and before the conservation interventions.

FIGURE 3.1.
Southeast corner of the tablinum, showing post-1938 fills along the base of the wall, drips down the surface, and fallen debris from a large hole in the roof.

The post-1938 interventions have been recorded by the project team since 2011, beginning with digital photography[1] and graphic mapping of the wall paintings (see appendix 3.1) and mosaic pavement.[2] An illustrated glossary, developed by the project team and located at the end of this volume, includes a section on previous interventions as well as representative images and symbols for all interventions.

Structural Interventions

A cement slab roof was placed over the tablinum at some time in the past; the exact date is unknown, but it was likely at the time of excavation or shortly thereafter as part of the reconstruction of the house. Over time, the cement roof began leaking, which led to infiltration of rainwater. The infiltration continued, presumably over a long period of time, though to date no records have been found that give any detail or information about leaks or the specific damage they caused. However, there is visual evidence of damage in the form of eroded plaster and drips down the surface of the walls in specific locations (see fig. 3.1).

In 2011, a large hole in the roof was documented by the project team in the southeast corner of the tablinum (fig. 3.2) which allowed infiltration of rainwater and debris to fall down

FIGURE 3.2 (ABOVE LEFT).
View of roof of the tablinum in 2008, showing pooled rainwater (indicated by white arrow) on the surface.

FIGURE 3.3 (ABOVE RIGHT).
Temporary metal roof installed over the tablinum in 2011 to address water infiltration from leaks in roof.

FIGURE 3.4 (RIGHT).
View of new slab roof of the tablinum, constructed in 2011 prior to the start of the project to protect the architectural surfaces in the tablinum.

the wall paintings and onto the floor, and a temporary sheet metal roof was installed over the tablinum (fig. 3.3) by the Herculaneum Conservation Project (HCP) and the Soprintendenza Pompei. Shortly after this, and prior to the start of conservation of the wall paintings and mosaic pavement of the tablinum, the HCP and the Soprintendenza built a new slab roof over the tablinum (fig. 3.4).

Wall Paintings

The present wall painting stratigraphy is largely the result of the intervention under Maiuri in 1938, when the house was excavated and wall paintings were remounted on reconstructed walls or restored in situ. However, various subsequent interventions that have affected the wall paintings were undertaken by Maiuri's team over time until his retirement in 1961, and afterward by site custodians. These modifications included one or more campaigns of grouting, addition of several types of repair materials, and periodic application of coatings.

Fills, Repair Materials, and Grouts

A wide, sloped mortar edging that extended along the lower edge of the west wall fragments, applied during the 1938 reconstruction (fig. 3.5), was replaced during a later intervention at some time prior to 1978 (fig. 3.6). This repair is especially evident along the bottom edge of the plaster on the west wall, where the current edging runs perpendicular to the surface of the wall painting; traces of an earlier, wider sloped edging can be seen below it (fig. 3.7 and 3.7 detail).

FIGURE 3.5.
Historical photograph of the tablinum west wall, showing a wide sloped mortar edging along the lower edge of the wall paintings. (Maiuri 1958, 231)

FIGURE 3.6.
Photograph from 1978 showing the replaced mortar edging along the bottom of the wall paintings on the west wall of the tablinum. (Historical Archives of the Soprintendenza Pompei, Maiura, D29303)

At least two hard cementitious washes in either a dark gray or dark purple have been applied over the 1938 original light-gray incised plaster fills (fig. 3.8). Incisions were recut into the secondary repair materials in order to preserve the 1938 incised designs and complete the Roman decorative elements (fig. 3.9). Hard, gray fills, which appear to be post-1938 interventions, are present along the base of the east wall and extend to the ground level. Salt efflorescence occurs in these areas. Analysis has identified the repair material as cementitious and containing sodium sulfate salts. These fills cover original Roman plaster fragments in almost all cases (fig. 3.10).

Based on visual evidence, such as grouting injection holes and possible grouting material, it is thought that at least two grouting campaigns were undertaken since 1938 (figs. 3.11 and 3.12).

FIGURE 3.7.
Photograph from 2011 showing the lower border of the wall paintings on the west wall. Traces of a wider edging border, lighter in color, are evident below the wall paintings along the tuff wall. Detail on right shows edging material.

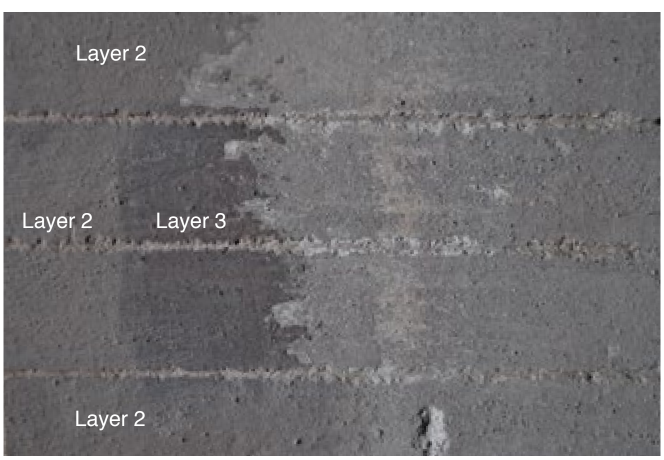


FIGURE 3.8.
Example of the hard, dark-colored cementitious washes applied over the 1938 light-gray plaster repairs.

FIGURE 3.9.
Maiuri-era incisions that had been covered by a later wash were reinscribed in a later intervention.

FIGURE 3.10.
Base of east wall, showing hard, gray cementitious fills visible as islands within the Maiuri-era reconstruction plaster. Many of these fills cover original Roman plaster fragments as seen in the areas within the dashed yellow lines.

FIGURE 3.11.
Grouting injection hole punctured through a 1938 fill, indicating that at least one grouting campaign had been carried out since that time.

FIGURE 3.12.
Evidence of possible grouting material that is compositionally different from the 1938 grouting mortar.

Retouching

Some evidence of retouching can be seen in areas of loss to the paint layers (fig. 3.13). However, it is not known when the retouching was done, or if it was done during multiple campaigns of intervention.

Surface Coatings

Oral histories report that beeswax and paraffin wax were applied on the paintings of the tablinum since excavation until the 1980s as restorative and protective layers.[3] Sometime

FIGURE 3.13.
Lower left corner of rectangular scene on the west wall, showing areas of retouching, notable in losses in the animals and along the ground below them, evident particularly by the absence of the lower brown border. It is not known if this was done as part of the 1938 intervention or post-1938.

FIGURE 3.14.
Rectangular scene on the west wall as seen under UV light, showing different types of organic materials fluorescing on the surface. In the darker areas, coatings may not necessarily have been applied; rather, the pigment may be quenching the fluorescence.

after, Paraloid B-72 reportedly was tested on one or all medallions and rectangular scenes in the tablinum (Zolfo 2012, 2013, pers. comm. with GCI project team).

Examination by UV light shows the presence of fluorescing materials on the surface of the wall paintings (fig. 3.14). This is likely related to the presence of restoration materials applied repeatedly to the surface and, in some cases, preferentially on the figurative scenes, vertical bands, and frieze. A difference in surface sheen is visible in images from 1992 in the Foglia photographic archive, where these areas appear glossier and more saturated compared to the surrounding monochrome areas (fig. 3.15). In situ and laboratory analysis confirms the presence of organic materials on the surface of the wall paintings, including beeswax and/or synthetic resins.[4] Further information on the analysis can be found in Graves, Piqué, and Rainer in this volume.

Pre-2008 Sampling

Areas of plaster measuring approximately 2 × 4 cm were removed from the wall during a previous sampling campaign in 2004.[5] Three sample locations of this size and type can be seen on the east and west walls (fig. 3.16).

Mosaic Pavement

There is little information concerning previous interventions on the mosaic pavement. However, the pavement has had recent interventions, including reintegration with tesserae (Roby 2011). Francesca Piqué reported that she filled losses with lime and sand mortar prior to 2011 to stabilize the edges of the mosaic where the tesserae are particularly vulnerable due to people passing from the tablinum into the peristyle garden (fig. 3.17). The HCP oversaw limited stabilization of the mosaic floor in preparation for installation of the scaffolding in the tablinum in 2013.

FIGURE 3.15.
View of tablinum from atrium, showing glossy, saturated areas in the medallions and the rectangular scene, 1992. (Foglia Archive, Soprintendenza Pompei, inv. 14973b)

FIGURE 3.16.
Evidence of plaster sample that was removed from the east wall in 2004, prior to the GCI project.

FIGURE 3.17.
Mortar fills and reintegrated tesserae can be seen along the edge of the mosaic pavement where losses occur due to foot traffic through the tablinum to the peristyle garden.

Acknowledgments

The authors would like to acknowledge colleagues and partners from the HCP and the Parco Archeologico de Ercolano and its previous iterations for their knowledge regarding past interventions in the House of the Bicentenary, particularly Giuseppe Zolfo, former head of the restoration laboratory of Herculaneum, and custodians at the site, as well as project team members, for their insight and investigations into previous interventions in the tablinum and in other houses at the site.

Notes

1 Detailed digital photography of the walls in sections was carried out by the GCI team to be used for baseline documentation of the condition of the wall paintings prior to conservation. Massimo Brizzi, a consultant to the Herculaneum Conservation Project, provided overall rectified photographs to use as base images for the subsequent condition mapping. AutoCad software was used for the mapping of the wall paintings. The mosaic was mapped by hand drawings.

2 Due to the protection covering the mosaic pavement at the time of inspection by Thomas Roby in 2011, the full mosaic could not be examined. However, representative areas were mapped over a scale drawing of the pavement. A full examination will be carried out when the floor protection is removed.

3 Custodians of the site have indicated that paraffin was used in previous treatments. Guards and custodians at Pompeii report the use of beeswax as a protective restoration material (Casoli et al. 2006). According to Giuseppe Zolfo (2012, 2013, pers. comm.), the application of wax was discontinued in the 1980s.

4 In situ portable FTIR and laboratory-based FTIR show the presence of beeswax and/or (acrylic or vinyl) synthetic resins. Gypsum was also identified (Piqué et al. 2007). Gas chromatography-mass spectroscopy also showed that the upper layer of deposit over the surface contains beeswax and paraffin. In some samples, Irganox was found. Irganox has been used in conservation materials to protect against thermo-oxidative degradation. Analysis by μ-Raman spectroscopy showed the presence of another organic material, presently unidentified, in the cracks of a sample taken from the rectangular scene on the east wall.

5 Sampling was carried out by Cerminari Laboratories. No report has been found from this campaign.

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APPENDIX 3.1

Graphic Documentation: Previous Interventions


Casa del Bicentenario, Tablinum, East Wall - Overall
PREVIOUS INTERVENTIONS (1939-2011)
Post-1938 tuff
Fill
White grouting mortar
Injection hole
Lime/cement wash
Traces of 1938 edging
Edging
2004 Sample location (pre-GCI)
INTERVENTIONS (DATE UNKNOWN)
Reintegration
Coating: wax
Coating: other
Casa del Bicentenario, Tablinum
The Getty Conservation Institute
PROJECT
Herculaneum Project
LOCATION
Herculaneum, Italy
PARTNERS
SP, HCP
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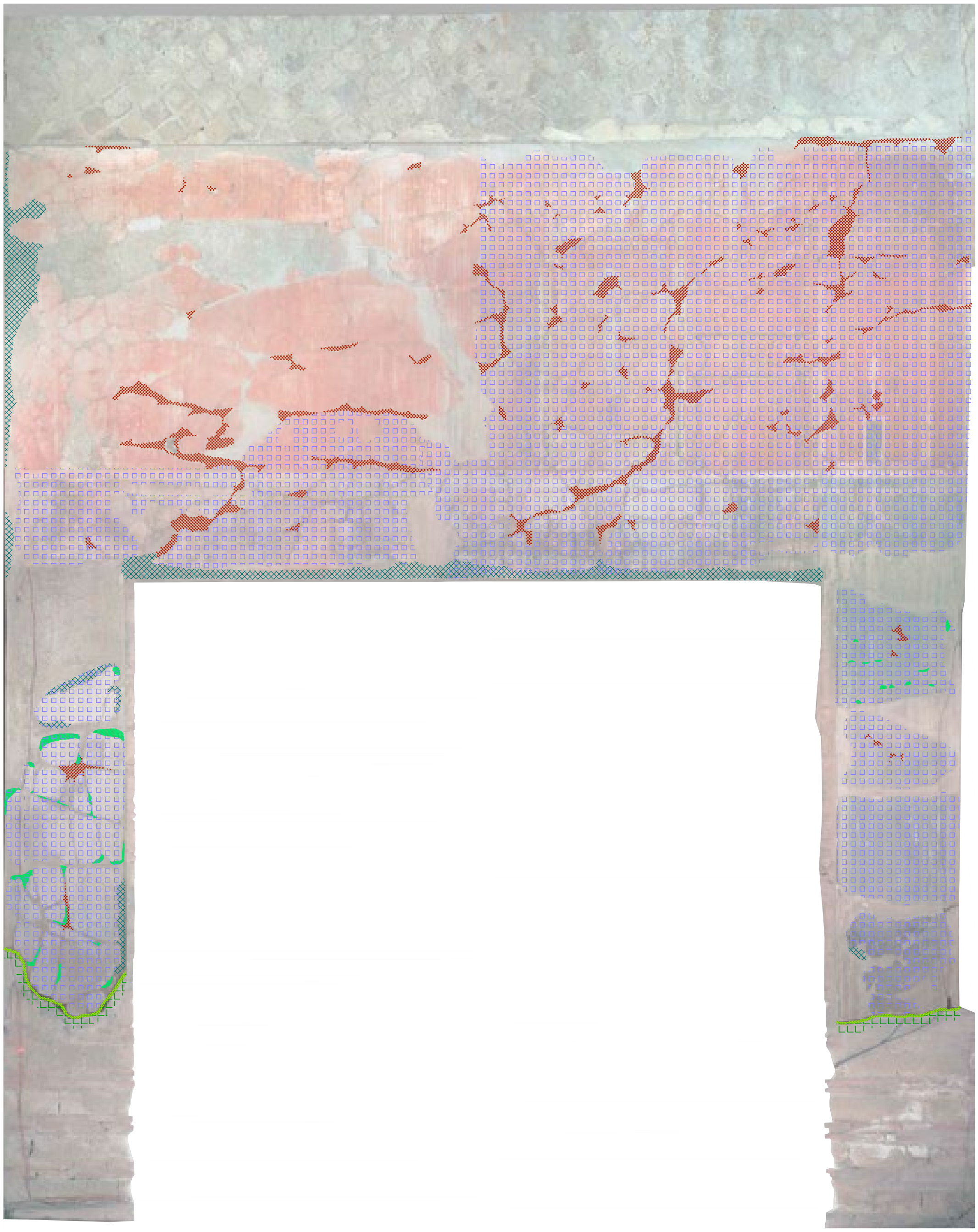

Casa del Bicentenario, Tablinum, South Wall - Overall

PREVIOUS INTERVENTIONS (1939-2011)

- Post-1938 tuff
- Fill
- White grouting mortar
- Injection hole
- Lime/cement wash
- Traces of 1938 edging
- Edging
- 2004 Sample location (pre-GCI)

INTERVENTIONS (DATE UNKNOWN)

- Reintegration
- Coating: wax
- Coating: other

Casa del Bicentenario, Tablinum	PROJECT **Herculaneum Project**	PARTNERS SP, HCP	PROJECT MANAGER Leslie Rainer	DATE RECORDED 2013-2014	**SW**
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Casa del Bicentenario, Tablinum, West Wall - Overall

PREVIOUS INTERVENTIONS (1939-2011)

- Post-1938 tuff
- Fill
- White grouting mortar
- Injection hole
- Lime/cement wash
- Traces of 1938 edging
- Edging
- 2004 Sample location (pre-GCI)

INTERVENTIONS (DATE UNKNOWN)

- Reintegration
- Coating: wax
- Coating: other

Casa del Bicentenario, Tablinum	PROJECT Herculaneum Project	PARTNERS SP, HCP	PROJECT MANAGER Leslie Rainer	DATE RECORDED 2013-2014	WW
The Getty Conservation Institute	LOCATION Herculaneum, Italy	COPYRIGHT GCI	RECORDED BY -----	LAST REVISED 2017/05	SCALE 1:25

CHAPTER 4

Environmental Assessment of the Tablinum of the House of the Bicentenary

Shin Maekawa

Introduction

Since 2011, the Getty Conservation Institute (GCI), in collaboration with the Herculaneum Conservation Project (HCP) and the Parco Archeologico di Ercolano (PA-ERCO), formerly under the Soprintendenza Pompei, has been carrying out a research project to address conservation issues of ancient Roman wall paintings. The research focuses on developing methodologies to conserve the wall paintings with an emphasis on flaking and powdering paint in figurative scenes, a typical condition at the site and in the greater Vesuvian archaeological region. These wall paintings were uncovered in the 1930s and have been periodically treated to date. The project has involved a comprehensive diagnostic study of flaking and powdering paints in figurative scenes in the tablinum, a reception room opening onto the peristyle garden of the House of the Bicentenary (Casa del Bicentenario), a noble residence of grand proportions, with wall paintings of great artistic and archaeological significance at the site of Herculaneum.

The archaeological site is located in the modern city of Ercolano, at the western base of Mount Vesuvius along the coast of the Mediterranean Sea in the Campania region of southern Italy (fig. 4.1). The modern city sits on top of the volcanic tuff layer that completely

FIGURE 4.1.
Aerial photo of the area surrounding Herculaneum. (Imagery © 2013 Cnes/Spot Image. DigitalGlobe. GeoEye. Map data © 2013 Google)

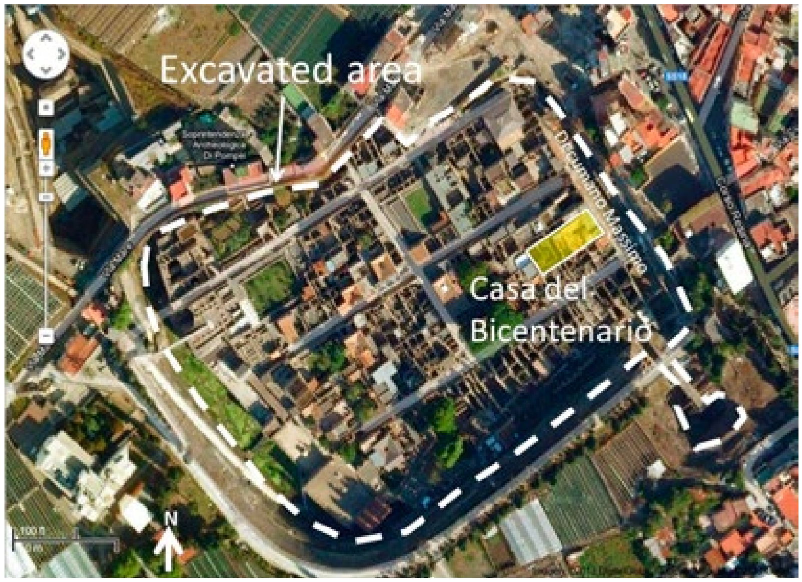


FIGURE 4.2.
Aerial photo of the archaeological site of Herculaneum. (Imagery DigitalGlobe. GeoEye. Map data © 2013 Google)

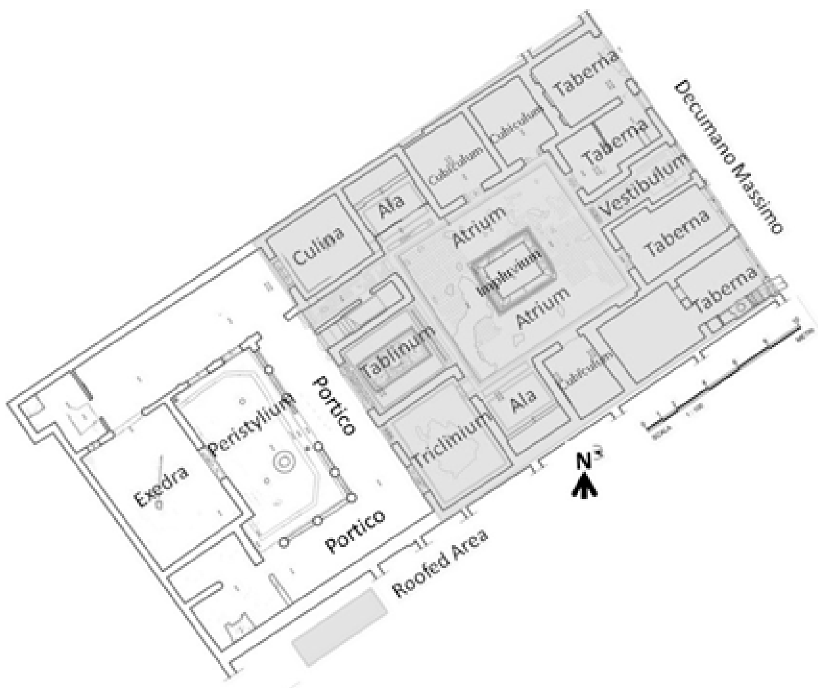


FIGURE 4.3.
Floor plan of the House of the Bicentenary. Source: Amedeo Maiuri, *Ercolano: I nuovi scavi (1927–1958)*, vol. 1 (Rome: Istituto Poligrafico dello Stato, 1958), 222.

buried the Roman city of Herculaneum, the result of the flow and subsequent deposit of hot pyroclastic material from the eruption of Mount Vesuvius in 79 CE. The excavated site is located in a large open pit 200 m long, 150 m wide, and 20 m deep, on a slope approximately one km from the current shoreline of the Bay of Naples (fig. 4.2).

The House of the Bicentenary (40° 48.375′N, 14° 20.889′E, Elevation: 20 m) is located close to the northeastern quadrant of the nearly square excavation pit and oriented along the northeast–southwest axis. The entrance to the house, at the northeastern end, is open to the Decumanus Maximus (a Roman main street), and the peristyle garden is at the southwestern end, which shares a boundary wall with another house (fig. 4.3). The tablinum is located at the southwestern end of the atrium, and the northeastern end of the portico of the peristyle garden. A variety of modern roofs cover the house from the northeastern end to the southwestern end of the tablinum, including rooms to both the northwest and southeast of the tablinum. The portico and peristyle garden have no roofing and are exposed. However, the ground soil of the portico is sloped toward the edges of the garden, where an open drain empties into an underground channel that leads to a street northwest of the house. In this report, Mt. Vesuvius is considered as north, and the walls of the tablinum are labeled east, south, and west.

Climate of Naples

A continuously operating weather station is located at Naples Capodichino Airport, and its historical climate data are published. Thirty-year averages of climate parameters are listed in table 4.1. Based on the data, the climate of Naples is characterized by mild, wet winters and warm, dry summers and classified as a Mediterranean climate (*Csa*) by the Köppen-Geiger climate classification system. Other cities along the Bay of Naples, including Ercolano, have a similar climate.

TABLE 4.1. Historic averages of temperature, humidity, dew point temperature, and rainfall of Naples.

Parameter	Month												
	1	2	3	4	5	6	7	8	9	10	11	12	Annual
Temperature (°C)	8.2	8.8	10.6	13.2	17.4	20.9	23.6	23.7	20.8	16.7	12.3	9.3	15.5
Humidity (% RH)	75	73	71	70	70	71	70	69	73	74	76	75	72.3
Dew point temperature (°C)	4	4	6	8	12	16	18	18	16	13	8	5	11
Rainfall (mm)	104.4	97.9	85.7	75.5	49.6	34.1	24.3	41.6	80.3	129.7	162.1	121.4	1006.6

Source: Weather base (http://www.weatherbase.com/weather/weather.php3?s=98261&cityname=Naples-Campania-Italy&units=metric) 30-year stats.

Objectives

As the condition assessment of the wall paintings was carried out, environmental monitoring tasks were developed to assess environmental conditions at the Herculaneum site, including the tablinum of the House of the Bicentenary and its wall paintings. The aim was to identify environmental threats to the preservation of the paintings and to develop and test several strategies for improvement of environmental protection. Specific issues to be investigated regarding the wall paintings are as follows:

- Impact of wall moisture
- Condensation
- Impact of direct and indirect solar radiation
- Short-term and seasonal humidity and temperature variations
- Wind erosion

Method

Prior to the current environmental monitoring installation in the House of the Bicentenary, preliminary monitoring was initiated by Leslie Rainer and Francesca Piqué in November 2008. Five independent temperature and humidity data loggers (Hobo Prov2) were placed throughout the house (main entrance, atrium, tablinum, and peristyle garden) to record temperature and humidity variations and investigate sources of high humidity affecting the wall paintings in the tablinum. Data were downloaded roughly twice a year for analysis. Results indicated that the climatic conditions in the interior of the house have large fluctuations and are strongly influenced by the sharp variation of the external climate (Herculaneum Project Campaign Report [internal report], September 2010).

A solar-powered, autonomous environmental monitoring station, which measures the climate of the site and the environmental conditions of the wall paintings in the tablinum, was installed at the House of the Bicentenary on 15 November 2011, while the Hobo Prov2 data logger system remained in operation. The monitoring station has been equipped with Internet Protocol (IP)-based communication devices linked to the base station computer in the Environmental Studies Laboratory at the GCI through the HCP's local area network (LAN) at the site. Data are autonomously downloaded to the base computer at 15-minute intervals. An extranet site (http://extranet.getty.edu/gci/weather/herc.html) has been established to post current as well as past environmental conditions.

Outside Parameters and Sensor Locations

Monitored parameters for the site climate include temperature, humidity, rainfall, solar radiation, wind speed, and wind direction. Sensors, a monitoring station, and Wi-Fi communication equipment are installed outside the House of the Bicentenary (fig. 4.4). The wind sensor (Wind Monitor, R. M. Young Inc.) is installed on the tablinum roof, where it is less disturbed by wind around surrounding structures, resulting in better capture. Because the circulation area between the tablinum and the peristyle garden has an archaeological foundation for a mosaic floor, the ground soil could not be disturbed in order to install a soil moisture sensor in depth. Instead, the soil moisture sensor was placed on top of the ground soil and covered with a 10 to 15 cm pile of soil 20 to 30 cm southwest from the end of the tablinum's west wall. Manufacturer and model names of the sensors are listed in appendix 4.1 at the end of this report.

FIGURE 4.4.
Left: Solar panel, rain gauge, solar radiation sensor, temperature and humidity monitors, and monitoring station are mounted on scaffolding supporting the original columns surrounding the peristyle garden. *Center:* A wind speed and wind direction sensor is mounted on a 9-foot-high tripod on the roof of the tablinum. *Right:* A Wi-Fi receiver is mounted on top of the scaffolding in the peristyle garden.

Parameters and Sensor Locations in the Tablinum

Parameters for the environment of the wall paintings include sixteen surface temperature sensors at various vertical and horizontal locations on the surface of the paintings, sixteen temperature and humidity sensors at the core of the tablinum walls, four surface temperature sensors of medallions, and time-of-wetness of walls at six locations, which were installed in November 2011. Both the station and the data logger systems have been operating since installation. Locations of these sensors are described below.

Surface Temperature of Wall

A total of sixteen surface-mount temperature sensors are adhered to lacunae of wall paintings at approximately 100 cm and 400 cm from the south (peristyle garden) end of the tablinum's east and west walls at approximately 40 cm, 100 cm, 180 cm, and 300 cm from the ground as shown in figure 4.5.

Wall Core Temperature and Humidity

A total of sixteen miniature (5 mm diameter) subsurface temperature and humidity sensors are inserted from the reverse sides of the wall paintings (from the triclinium for the east wall and from the staircase wall for the west wall) to the center core (20 cm deep). They are positioned at approximately 100 cm and 400 cm from the south (peristyle garden) end on the walls and approximately 40 cm, 100 cm, 180 cm, and 300 cm above the ground floor as shown in figure 4.6.

Temperature of Medallions

A total of four non-contact-type temperature sensors (infrared radiometers) are mounted on horizontal scaffolding bars placed approximately 30 cm from the walls to measure the surface temperature of four medallion paintings that are the focus of the present study (fig. 4.7).

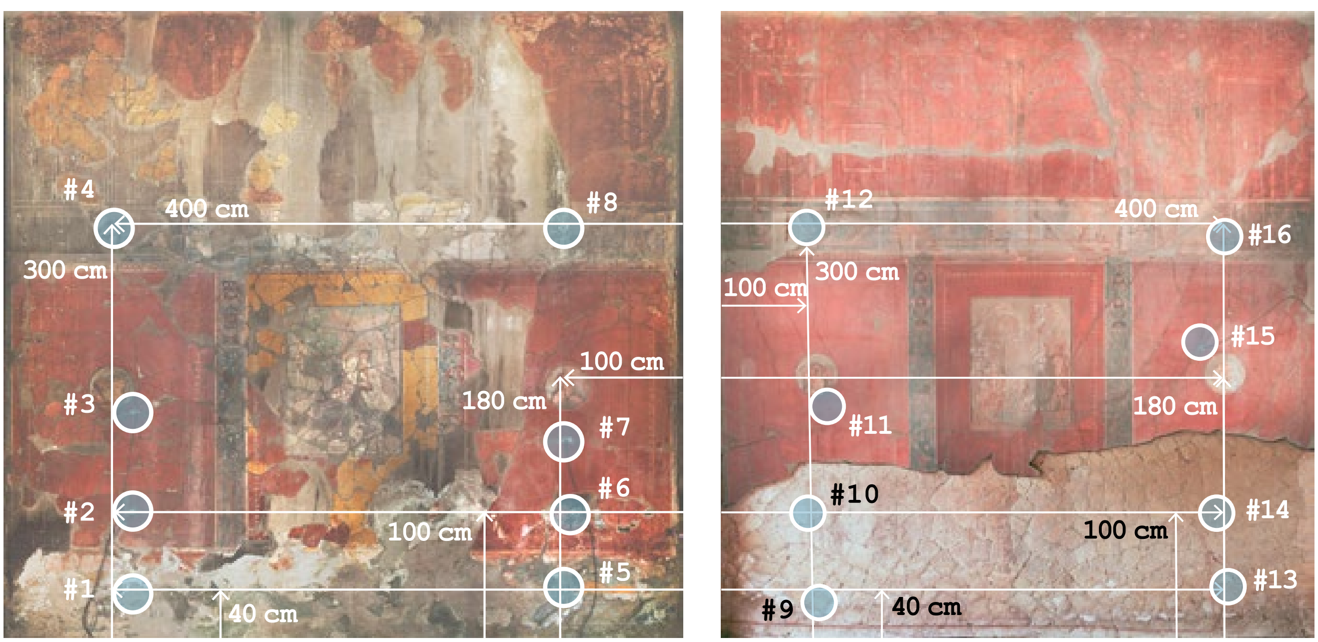


FIGURE 4.5.
Locations of surface-mount temperature sensors adhered to lacunae of wall paintings on the east wall (*left*) and west wall (*right*).

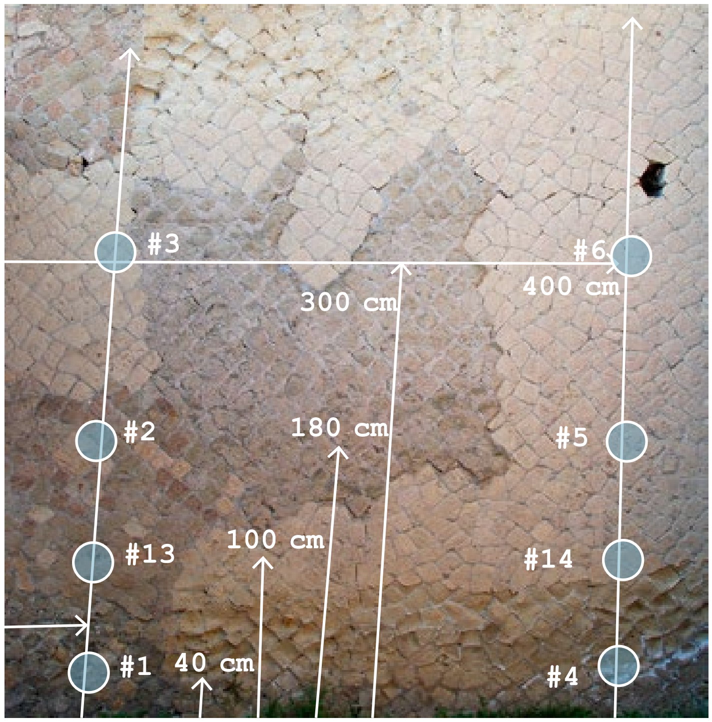


FIGURE 4.6.
Locations of the wall core (20 cm deep) temperature and humidity sensors in the triclinium's west wall (reverse side of the tablinum east wall). Additional sensors (#7–12, 15, and 16) are inserted in the wall of the staircase (reverse side of the tablinum west wall). This photo was taken before a temporary roof was placed over the triclinium.

FIGURE 4.7.
One of four IR sensors installed near the tablinum walls targeting a medallion painting (*left*). Locations and identification numbers for IR sensors on the east wall (*center*) and west wall (*right*).

Time-of-Wetness

Custom-made time-of-wetness sensors, consisting of pairs of stainless steel pins (1⁄16-inch diameter and 1 inch long) wired to the monitoring station, were installed in holes 1 inch apart and ½-inch deep, drilled into a lacuna of wall paintings in the tablinum with a metal-filled epoxy adhesive. The sensors measure electrical resistance of the wall material between the pins. Six sensors, four on the east wall and two on the west wall, are installed in lacunae of the wall paintings. The following locations were selected (fig. 4.8):

- Approximately 100 cm (#1) and 160 cm (#2) from the ground along the axis atrium side medallion on the east wall
- Approximately 100 cm (#3) and 150 cm (#4) from the ground along the axis garden side medallion on the east wall

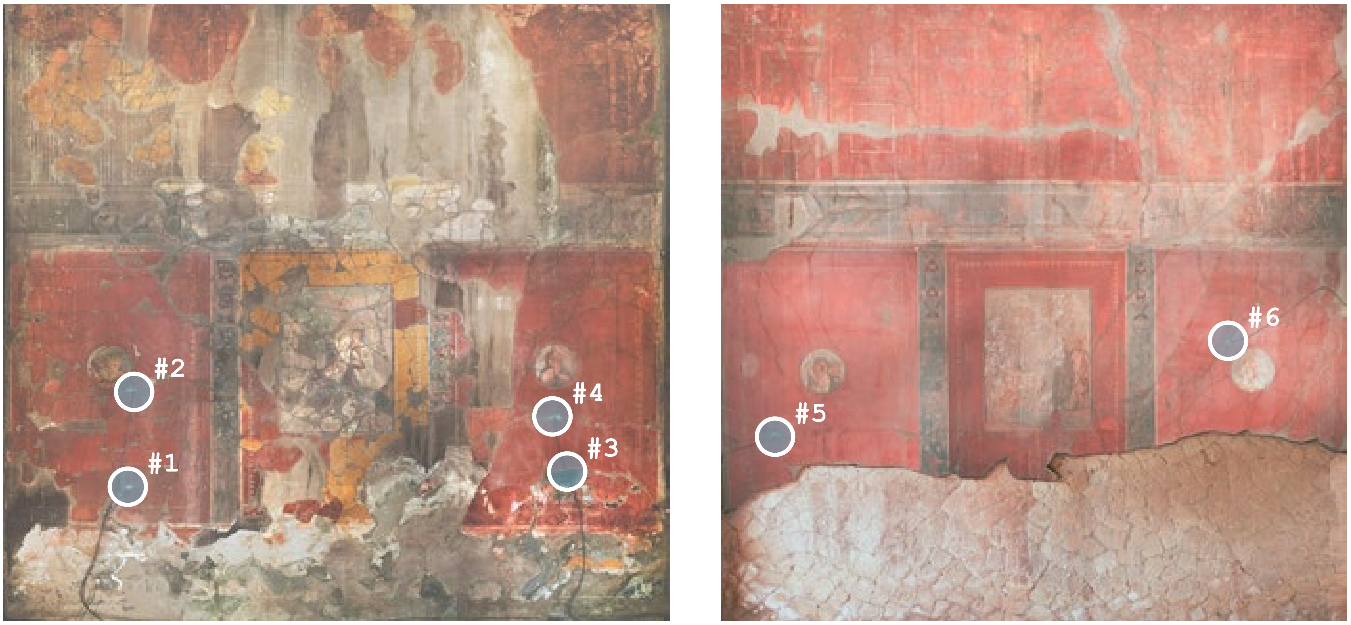


FIGURE 4.8.
Locations and identification numbers for time-of-wetness sensors on the east wall (*left*) and west wall (*right*).

- Approximately 150 cm from the ground near the garden side medallion on the west wall
- Approximately 180 cm from the ground near the atrium side medallion on the west wall

Air Movement in the Tablinum

An ultrasonic wind sensor is used for measuring air speed and direction in the tablinum. The sensor has a set of acoustic transmitters and receivers on each of three antennas protruding from the sensor housing. The sensor measures time of flight of ultrasonic pulses traveling from one transducer to the other two transducers. Air movement impacts time of flight for the ultrasonic pulse to reach the receivers. This is converted to the speed and direction of the air. The advantage is that the sensor does not have a moving part and thus has better capacity to measure a lower minimum air speed than mechanical sensors. The sensor also requires less maintenance than mechanical units.

Three ultrasonic wind sensors were individually mounted on 5-foot-high tripods and positioned in the tablinum. Between 13 October and 10 November 2011, the sensors were arranged symmetrically with respect to the atrium-garden axis of the room (two were positioned at the south end adjacent to the walls, and one was placed in the middle) to measure the symmetry/asymmetry of airflow pattern in the tablinum (fig. 4.9a). Between 18 November 2011 and 17 May 2012, the wind sensors were positioned diagonally to measure effects on airflow pattern of the opening to the garden as well as the atrium (fig. 4.9b). After 25 May 2012, the wind sensors were positioned in a narrow corridor between the tablinum and the culina that connected the atrium to the garden; in the center of the tablinum; and at the doorway opening connecting the atrium and the triclinium (figs. 4.9c, 4.9d, and 4.9e).

FIGURE 4.9.
Photos showing two arrangements of three wind sensors in the tablinum. Prior to 25 May 2012, sensors were arranged (a) symmetrically and (b) diagonally. After 25 May, sensors were positioned (c) in a narrow corridor connecting the atrium to the garden, (d) in the center of the tablinum, and (e) at the doorway opening connecting the atrium and the triclinium.

This arrangement measured relative airflow changes through the tablinum, triclinium, and the corridor after a screen door was installed.

Chronology of Tablinum Modifications

Results of the environmental monitoring can be impacted by installation of various elements of the building envelope as well as by placement of furniture in the space. It is important to note the chronology of such changes.

The triclinium, a room adjacent to the east wall of the tablinum, was exposed to the elements until summer 2011. A modern roof made of uninsulated and corrugated aluminum strips was installed by the HCP at approximately 5 m from the mosaic pavement prior to installation of the environmental monitoring station in November 2011.

A tri-level scaffolding system, consisting of approximately 1-m-wide sheet metal floors supported by a steel pipe structure, was installed along the tablinum walls in late May to early June 2013 for conservation of the wall paintings.

A large wood-frame screen door, consisting of four large panels of a translucent white netting fabric for construction debris containment (see appendix 4.3), was installed in the opening to the peristyle garden on 2 August 2013. The screen fabric was replaced by a similar netting fabric with reflective fibers in October 2014.

Results

Site (Outside) Climate

Monthly and annual averages of temperature, humidity, dew point temperature, rainfall (monthly total), solar radiation, and wind speed from 2012 to 2014 are listed in table 4.2.

TABLE 4.2. Monthly averages and annual averages of temperature, humidity, dew point temperature, rainfall (totals), solar radiation, and wind speed in 2012–14.

Parameter	Month in 2012/2013/2014													
	Year	1	2	3	4	5	6	7	8	9	10	11	12	Annual
Temperature (°C)	2012	9.5	8.5	14.2	15.5	18.8	24.5	26.8	27.9	23.2	20.2	16.3	10.2	17.9
	2013	10.3	9.1	12.7	17.1	19.6	22.0	26.3	27.2	23.7	20.2	15.1	11.5	17.8
	2014	11.9	12.9	12.7	15.7	18.4	23.4	24.5	25.9	23.2	20.4	17.0	11.7	18.2
Humidity (% RH)	2012	63	69	60	72	68	64	63	58	65	70	74	73	67
	2013	76	73	73	66	62	65	60	58	61	75	76	78	69
	2014	82	80	74	73	71	67	69	66	66	66	71	73	72
Dew Point Temperature (°C)	2012	2.4	2.6	5.7	10.2	12.5	17.1	18.9	18.4	15.8	14.5	11.5	5.3	11.3
	2013	6.0	4.3	7.8	10.2	11.9	14.8	17.6	18.0	15.3	15.3	10.8	7.6	11.6
	2014	8.7	9.2	7.8	10.6	12.9	16.6	16.6	18.9	18.9	13.4	11.7	6.8	12.7
Rainfall (mm)	2012	17.8	102.9	14.2	138.2	64.8	0.00	35.8	19.6	121.2	100.3	108.7	164.4	887.9
	2013	184.4	107.7	118.9	47.2	59.7	32.0	8.1	15.7	39.9	201.4	153.2	83.8	1025.1
	2014	168.7	137.4	102.4	127.3	44.7	56.1	58.9	0.0	74.7	5.3	57.2	123.4	956.1
Solar Radiation (kW/m^2)	2012	0.085	0.100	0.18	0.18	0.25	0.29	0.28	0.26	0.17	0.13	0.075	0.061	0.17
	2013	0.063	0.092	0.13	0.22	0.25	0.30	0.28	0.25	0.20	0.14	0.077	0.071	0.17
	2014	0.059	0.100	0.16	0.19	0.25	0.29	0.27	0.26	0.19	0.14	0.089	0.066	0.17
Wind Speed (m/s)	2012	0.80	1.00	0.76	0.76	0.70	0.70	0.75	0.65	0.66	0.68	0.78	0.85	0.76
	2013	0.80	0.85	1.00	0.83	1.10	0.83	0.77	0.72	0.75	0.58	0.94	0.71	0.82
	2014	0.89	0.77	0.75	0.62	0.47	0.53	0.70	0.59	0.50	0.42	0.40	0.40	0.59

Temperature

Annual average exterior/outside temperatures were 17.9°C, 17.8°C, and 18.2°C in 2012, 2013, and 2014, respectively. These temperatures were more than 2°C to 3°C higher than the historical average of Naples, 15.5°C. The maximum temperature was 35.2°C at 12:15 p.m. on 6 August 2012 and 35.4°C at 2:30 p.m. on 31 July 2013. Annual minimum temperatures of 1.2°C, 1.7°C, and –1.6°C were recorded at 5 a.m. on 15 February 2012, at 4:15 a.m. on 7 February 2013, and at 7:30 a.m. on 31 December 2014, respectively. Freezing temperatures were recorded only once and lasted for approximately 12 hours during the evening and early morning of 30–31 December 2014. Monthly average temperatures had a typical sinusoidal shape, with the highest temperatures in August and the lowest in February. Daily temperature variations averaged about 6°C and ranged from 1°C on a rainy winter day to 11°C on a sunny spring day.

Humidity

Annual average humidity measurements were 67%, 69%, and 72% RH in 2012, 2013, and 2014, respectively. These values were lower than the historical average humidity of Naples, 72% RH. Humidity higher than 95% RH was recorded daily between September and April. Lowest humidity values, between approximately 17% and 23% RH, were recorded between January and April. The monthly average remained between approximately 57% and 83% RH for the remainder of the year.

High daily averages of at least 75% RH occurred in winter months, December through February. The highest monthly average was 75% RH in November, and the lowest was 58% RH in August. Average daily variation was about 25% RH, with the highest, 57% RH, on a hot, dry summer day in June, and the lowest, 5% RH, on a cool, rainy day in December.

Dew Point Temperature

Vapor in moist air condenses at its dew point temperature. The higher the dew point temperature, the higher the moisture content of the air. Annual average dew point temperatures were 11.3°C, 11.6°C, and 12.7°C in 2012, 2013, and 2014, respectively. These values were similar to the historical average of dew point temperature of Naples, 11°C. The highest recorded dew point temperature was 24.5°C on 15 June 2012; the lowest was –11.7°C on a dry, cold day, 26 January 2012. Daily average dew point temperatures higher than 15°C were recorded in June, July, and August; those lower than 7°C were recorded between December and March.

Rainfall

Annual rainfall totals were 887.9 mm, 1025.1 mm, and 956.1 mm in 2012, 2013, and 2014, respectively. These values were similar to the historical average of the annual total rainfall in Naples, 1006.6 mm. Rain fell throughout the year in Herculaneum, though significantly more rainy days and higher monthly totals were recorded between September and April than during the rest of the year (May through August). The highest monthly total rainfall of 201.4 mm was recorded in October 2013. Lower monthly totals were recorded in summer—June, July, and August. Annual maximum 15-minute rainfalls were 12.19 mm at 2:30 to 2:45 p.m. on 22 May 2012 and 19.3 mm at 6:00 to 6:15 a.m. on 6 October 2013 (also 18 mm in November 2011). Maximum daily rainfall totals were 45.72 mm on 22 May 2012 and 98.30 mm on 6 October 2013.

Solar Radiation

Annual totals of solar radiation were 1530 kWh/m^2, 1480 kWh/m^2, and 1515 kWh/m^2 in 2012, 2013, and 2014, respectively. These values were approximately 17% less than that of Los Angeles, 18,000 kWh/m^2. The maximum daily average was 0.28 kWh/m^2 in June. Minimum values of 0.015 kWh/m^2 were recorded on rainy days in winter months.

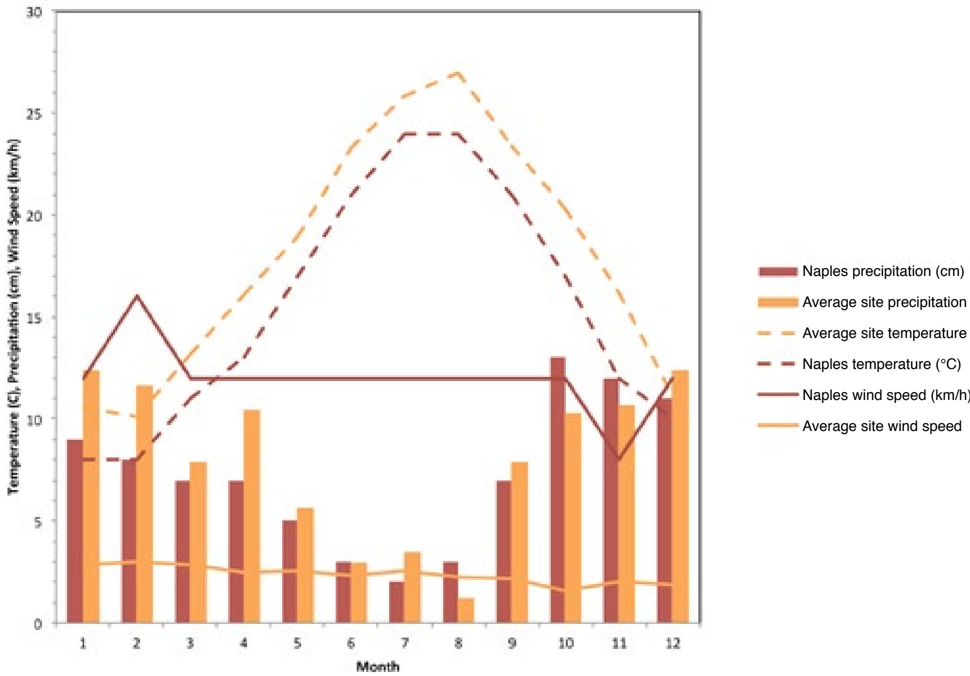
Comparison of Climate at Herculaneum and Naples

Temperature, rainfall, and wind speed data collected at the site of Herculaneum are compared to those of Naples in figure 4.10. Although rainfall varied from year to year, both the rain pattern and annual totals at the site of Herculaneum were very similar to those of Naples. At the site, temperatures were 2°C to 3°C higher than those of Naples, while wind speeds were only 25% of those in Naples. This may be due to the site being in a 20-m-deep excavation pit that protects the site from wind, resulting in higher temperatures, which in turn result in lower humidity, since dew point temperatures at the site were virtually the same as those of Naples.

Soil Moisture

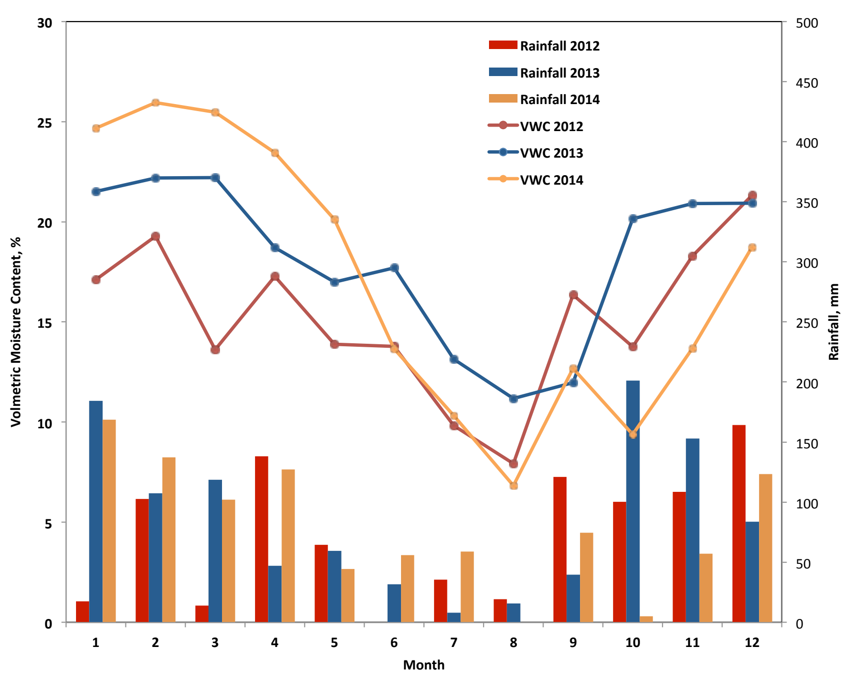
Annual averages of volumetric water content (VWC) of soil were 15%, 18%, and 17% in 2012, 2013, and 2014, respectively (fig. 4.11). A higher annual rainfall in 2013 may have resulted in a higher annual average of VWC. Maximum peaks were 35%, 37%, and 42% in 2012, 2013, and 2014, respectively. Lowest values were 6%, 8%, and 6% in 2012, 2013, and 2014, respectively. The VWC value spiked during rain events and asymptotically

FIGURE 4.10
Comparisons of monthly averages (2012–14) of temperature, precipitation, and wind speed recorded at the House of the Bicentenary and Naples.



decayed toward pre-event levels following the rain events. The peaking coincided with rainfall intensities (15-minute rainfall total), and decay rates varied significantly depending on weather conditions following the periods of rainfall. No prolonged accumulation of moisture was recorded during the three years, indicating good water-draining characteristics of the volcanic soil at the site. Soil moisture remained from 16% to 24% VWC between September and March, and 20% to 6% VWC between April and August, which followed the annual rainfall pattern. This indicates that it is possible to maintain 10% VWC or lower throughout the year by protecting the soil from the seepage of rainfall.

FIGURE 4.11.
Monthly averages of volumetric water content at Herculaneum, 2012–14.



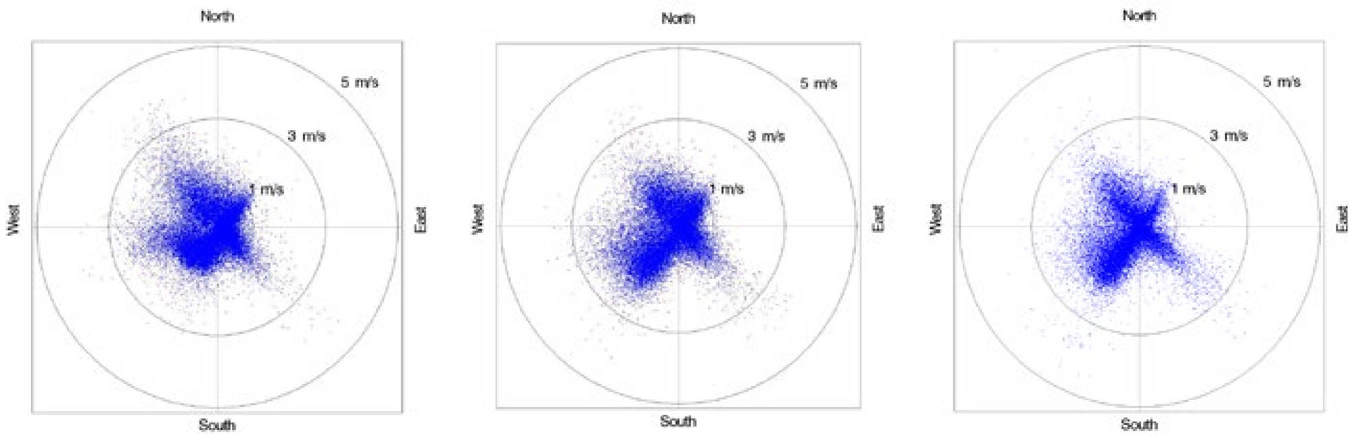


FIGURE 4.12.
Annual winds for 2012 (*left*), 2013 (*center*), and 2014 (*right*), plotted in wind vectors (direction and speed). Each blue dot represents a set of the 15-minute average wind speed and direction.

Wind Direction and Speed

Wind vectors of 15-minute data were plotted for 2012, 2013, and 2014. As shown in figure 4.12, wind patterns for those three years were very similar. The predominant (common) wind was from the southwest, with a speed of less than 3 m/s. Wind from the northeast was mostly less than 1 m/s, as if it were blocked by Mount Vesuvius situated in that direction. Some scattered high-speed winds from the northwest and southeast were occasionally recorded. Annual average wind speeds were 0.76 m/s, 0.82 m/s, and 0.59 m/s in 2012, 2013, and 2014, respectively. These values were only 18% to 25% of the historical average wind speed of Naples, 3.3 m/s. Maximum recorded speed was 4.2 m/s, 4.1 m/s, and 6.3 m/s for 2012, 2013, and 2014, respectively. Of wind speeds, 95% were less than 1.8 m/s. Daily wind speed typically ranged from 0 to 2.2 m/s. Higher, more variable wind speeds were recorded in winter between November and March. Typically, wind speed was lower, 0.3 to 0.5 m/s, in the evening than in the daytime, which ranged from 0.7 to 1.0 m/s.

Wind direction normally changed over a day from the onshore direction, southwest (200 to 240° clockwise from north), at 1 to 2 m/s, during the day to the offshore direction, between east and south (90°N to 180°N), at less than 1 m/s during the night. The direction was more consistent during the day than in the evening. This seemed to follow the daily heating and cooling cycle of Mount Vesuvius. The directional variation increased during winter months, as

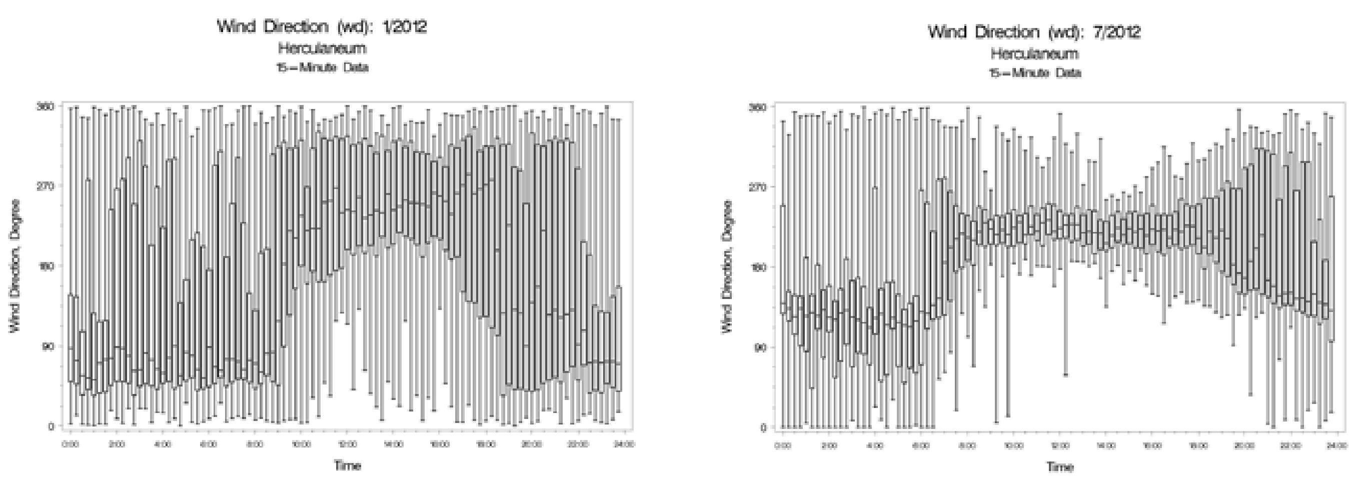


FIGURE 4.13.
Box and whisker plots of average 24-hour variations of wind direction in January 2012, a typical winter day, and July 2012, a typical summer day. Each square represents the mid-50% of data, and the whiskers represent lower and upper 25% of data at a fixed time (15-minute interval) of day in July 2012. The line in the square represents the median (mid-value of data). Short horizontal bars at top and bottom indicate maximum and minimum values, respectively.

frequent passing of storm systems impacted site wind patterns (fig. 4.13). Occasional strong winds of 2 to 4 m/s from the northwest (270°N to 360°N) were recorded throughout the year.

As described above, the majority of rainfall occurs between October and March in Herculaneum. During rainfall events, the wind was variable. Wind speed ranged between 0 and 4 m/s, and directions varied between southeast (120°N) and north (0 or 360°N) for winds above 1 m/s (fig. 4.14). However, the most common winds were less than 1 m/s from southeast directions during rainfalls. Rainfalls combined with 1 to 3 m/s winds can blow from a wide direction between southeast and northwest. The lowest number of rain-wind events was recorded from the northeast, indicating that the presence of Mount Vesuvius shields the site from strong wind coming from that direction.

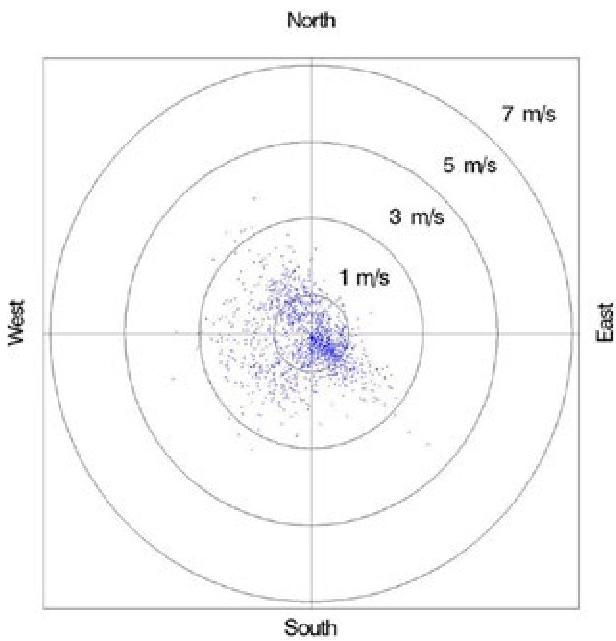


FIGURE 4.14.
Outside wind speeds and directions during rainfall events over the monitored period, between November 2011 and February 2013.

Tablinum Interior

Wall Temperatures

Annual averages, maximums, and minimums of surface temperatures at sixteen measured locations on the tablinum walls are listed in table 4.3. Annual average temperatures of wall surfaces were similar at each location during the three years, with less than 1°C difference from measurements of air temperature. Seasonal and daily changes of the air temperature were tracked, but with variations less than those of the air, except for areas 40 to 180 cm high along the garden sides on both the east and west walls, where and when sunlight directly irradiated them. In general, the peristyle garden sides of both the east and west walls were a few tenths of a degree Celsius warmer than the atrium sides, and higher locations had higher temperatures. Temperature differences between 40 cm and 300 cm from the floor ranged from 0.4°C to 0.6°C. As an exception, a sensor location at 100 cm from the floor on the garden side of the west wall averaged a few tenths of a degree Celsius lower than the adjacent 40 cm location. The reason is unknown.

Maximum temperatures were strongly influenced by solar heating resulting from direct sunlight irradiating specific locations on the walls. On the peristyle garden sides, up to 180 cm from the floor (height of the medallions) the temperature was affected by direct sunlight.

TABLE 4.3. Annual averages, maximums, and minimums of wall surface temperatures. Values are indicated as 2012/2013/2014 values.

	Average			
Height from floor	**East Wall**		**West Wall**	
	Atrium side	**Garden side**	**Garden side**	**Atrium side**
300 cm	18.5/18.3/18.8	18.7/18.5/18.8	18.6/18.4/18.8	18.4/18.2/18.6
180 cm	18.3/18.1/18.4	18.7/18.4/18.6	18.7/18.3/18.5	18.3/18.1/18.4
100 cm	18.2/18. 0/18.3	18.6/18.2/18.4	18.7/17.6/17.6	18.1/17.9/18.2
40 cm	17.9/17.7/17.9	18.3/17.9/18.1	18.1/17.9/18.1	17.6/17.4/17.6

	Maximum			
Height from floor	**East Wall**		**West Wall**	
	Atrium side	**Garden side**	**Garden side**	**Atrium side**
300 cm	31.6/32.8/56.2*	32.2/32.7/29.3	32.1/32.5/29.1	31.2/32.5/28.5
180 cm	31.5/32.9/28.9	37.1/35.7/29.6	33.1/33.9/32.2*	30.9/32.4/34.6*
100 cm	30.8/32.1/28.1	34.6/35.0/29.9	34.2/30.1/27.4	30.6/32.0/28.2
40 cm	34.0/32.1/27.4	34.5/33.8/28.5	37.6/32.9/28.3	29.6/31.4/26.9

* Measurements were affected by fieldwork.

	Minimum			
Height from floor	**East Wall**		**West Wall**	
	Atrium side	**Garden side**	**Garden side**	**Atrium side**
300 cm	4.1/5.5/2.2	4.2/5.6/2.3	4.0/5.5/2.2	4.1/5.5/7.4
180 cm	3.9/5.2/2.0	4.1/5.4/1.9	3.7/5.2/1.6	4.1/5.5/2.3
100 cm	4.0/5.4/2.2	3.8/5.3/1.7	3.5/5.0/1.8	3.8/5.3/1.8
40 cm	3.8/5.4/2.1	4.0/5.5/2.5	3.5/4.9/1.5	3.7/5.2/1.8

The highest temperature, 37.6°C, was recorded at the 40 cm height on the garden side of the west wall. Between 3°C and 6°C temperature spikes resulted from direct sunlight irradiated on the peristyle garden sides of the wall surfaces. The screen door reduced direct sunlight; as a result, maximums of 2014 were 2°C to 5°C lower than those of the previous two years. This reduction is observed even on the atrium side of the walls.

Minimum temperatures of all locations were similar. The lowest temperature in 2012 was 3.5°C, recorded at the 40 cm and 100 cm heights on the garden side of the west wall. In 2013, the lowest temperature was 4.9°C, recorded at the same location. At the end of 2014, the outside temperature fell below the freezing temperature for a 12-hour period; however, the wall surfaces remained above the freezing temperature. The lowest wall temperature of 1.5°C was recorded at the 40 cm height on the garden side of the west wall during that period.

Averages and maximums of rolling 24-hour variations of surface temperatures of the tablinum walls are listed in table 4.4. Minimums of the variations are not provided in the table, as they were near zero and will not be pertinent for conservation. As expected, temperature variations were smaller on the atrium side than on the garden side. Values for 2012–13 can be considered as conditions before installation of the screen door. (Actual installation was on 2 August 2013.) Values for 2014 represent conditions after installation. In 2012–13, the largest variations were recorded on the garden side of the west wall due to heating from direct and indirect sunlight of the area. During this period, direct sunlight

TABLE 4.4. Averages and maximums of 24-hour variations of wall surface temperatures between 2012 and 2014.

	2012–13 (average/maximum)			
	East Wall		West Wall	
Height from floor	Atrium side	Garden side	Garden side	Atrium side
300 cm	2.7/7.5	2.8/6.0	2.7/6.7	2.4/7.6
180 cm	2.8/8.3	3.9/12.4+	5.5/23.5+	2.3/7.5
100 cm	2.5/7.1	4.1/11.4+	5.8/20.6+	2.9/6.6
40 cm	2.9/8.8	3.5/9.4	6.3/20.8+	3.0/9.2

+ Affected by direct projection of sunlight.

	2014 (average/maximum)			
	East Wall		West Wall	
Height from floor	Atrium side	Garden side	Garden side	Atrium side
300 cm	2.5/40.0*	2.2/7.1	2.2/7.5	2.0**/5.1**
180 cm	2.5/7.9	2.8/7.3	3.4/16.7*	2.1/12.1*
100 cm	2.0/7.1	3.1/7.7	2.8/8.5	2.4/7.5
40 cm	2.2/7.3	2.4/6.9	3.1/9.0	2.2/7.5

* Affected by GCI fieldwork. ** Sensor malfunctioned since 5 Sept. 2014.

heated the east wall only briefly in late summer afternoons. The largest amount of heating was recorded on the west wall, and the maximum variation was more than 20°C as a result.

Reductions of the average 24-hour variations were documented in the 2014 data over the 2012–13 data at all measured locations. Large maximums at lower portions of the east and west walls in 2012 and 2013 were not present in 2014. This was a direct effect of the screen door that blocked direct projection of the sunlight. Large maximums in 2014 were affected by task lighting used during fieldwork in October and November, noted with a single asterisk (*) in table 4.4. Other maximum values in 2014 were similar to those in 2012 and 2013 and were the result of overnight temperature changes that occurred in fall.

Medallion Surface Temperature and Humidity

Annual average temperatures of medallion surfaces are listed in table 4.5. Annual averages of all medallions were 18.3°C, 18.2°C, and 18.3°C in 2012, 2013, and 2014, respectively. Annual average temperatures of individual medallions were similar to one another (less than 0.5°C difference from one another); however, medallions on peristyle garden sides were more influenced by the outside climate.

TABLE 4.5. Annual averages, maximums, and minimums of medallion temperatures in 2012/2013/2014.

	Medallion (2012/2013/2014)			
	East Wall		West Wall	
Annual Stats (°C)	Atrium side	Peristyle side	Peristyle side	Atrium side
Average	18.2/17.9/18.2	18.6/18.2/18.3	18.4/18.1/18.3	18.1/17.7/18.3
Maximum	30.8/32.2/28.8	32.7/37.6/31.7	32.7/33.7/32.1	30.6/32.1/32.3
Minimum	4.1/5.4/2.1	4.0/5.3/1.6	3.6/5.1/1.3	3.9/5.3/2.0

Annual maximum temperatures were 32.7°C for the garden side and 30.8°C for the atrium side in 2012. In 2013, annual maximum temperatures were consistent at 32.2°C and 32.1°C on the atrium side of both walls, as well as at 33.7°C on the peristyle garden side of the west wall. The maximum temperatures recorded on the atrium side of the east wall were 32.7°C and 37.6°C in 2012 and 2013, respectively. High temperatures, 33°C to 37.6°C, were recorded between 29 July and 2 August 2013, when the screen door was installed. These may be a result of the sunlight reflecting off metal scaffolding surfaces and directly projecting onto the medallion surface. In spite of the screen door installation, annual maximum temperatures of 2014 were similar to those of previous years.

Annual minimum temperatures were similar at all medallion surfaces at 3.6°C to 4.1°C in 2012 and 5.1°C to 5.4°C in 2013. The sub-zero air temperature period at the end of 2014 caused annual minimum temperatures to drop to 1.3°C to 2.1°C. A large thermal mass of the walls prevents medallions and wall surfaces from reaching freezing temperatures.

Monthly average temperatures of medallion surfaces are plotted in figure 4.15. The temperatures ranged from about 9°C in January to 29°C in August. High temperatures were recorded during June, July, and August, and low temperatures were observed in December, January, and March. Medallions on the peristyle garden side were warmer than those on the atrium side during summer months, and cooler during winter months due to the outside air.

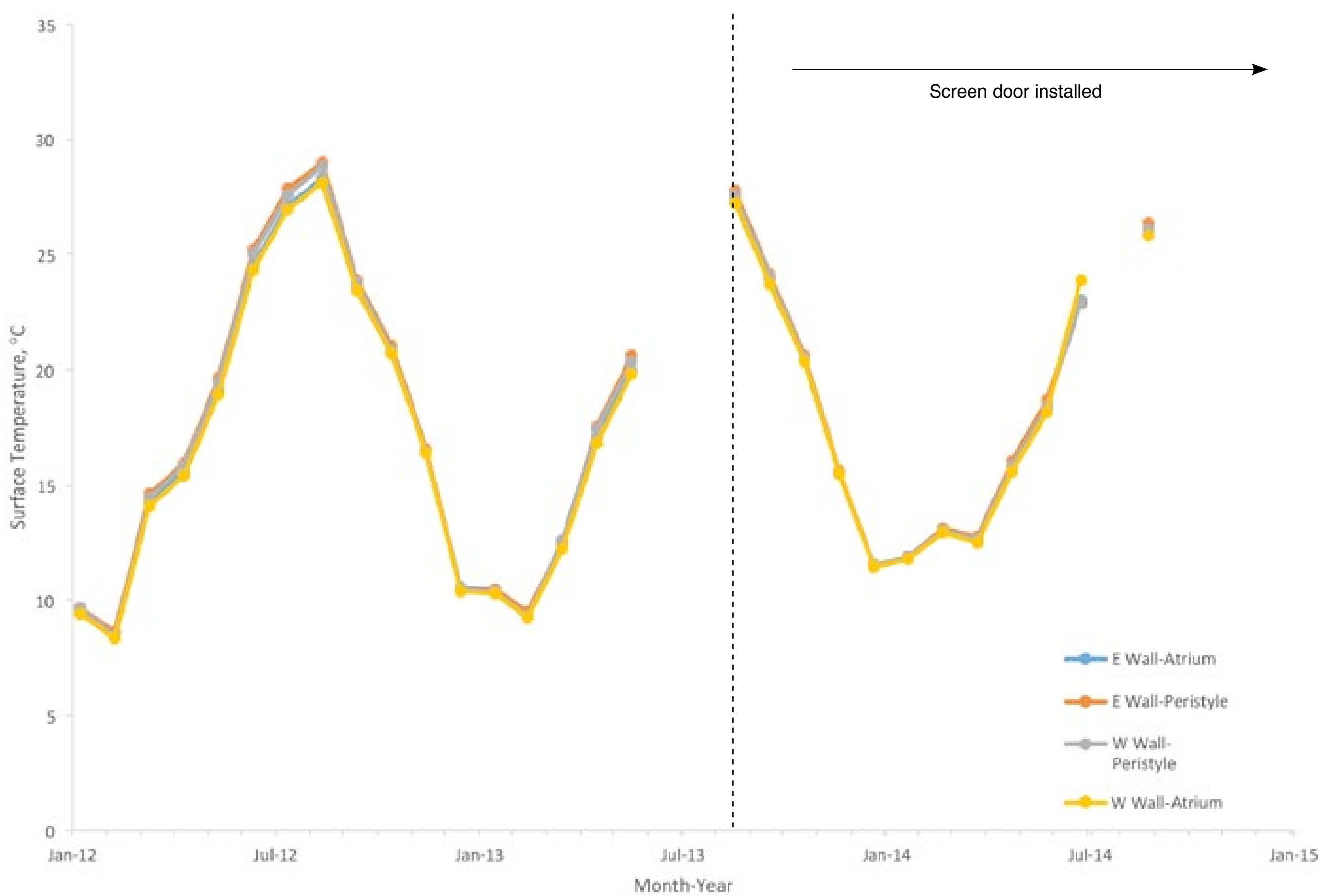


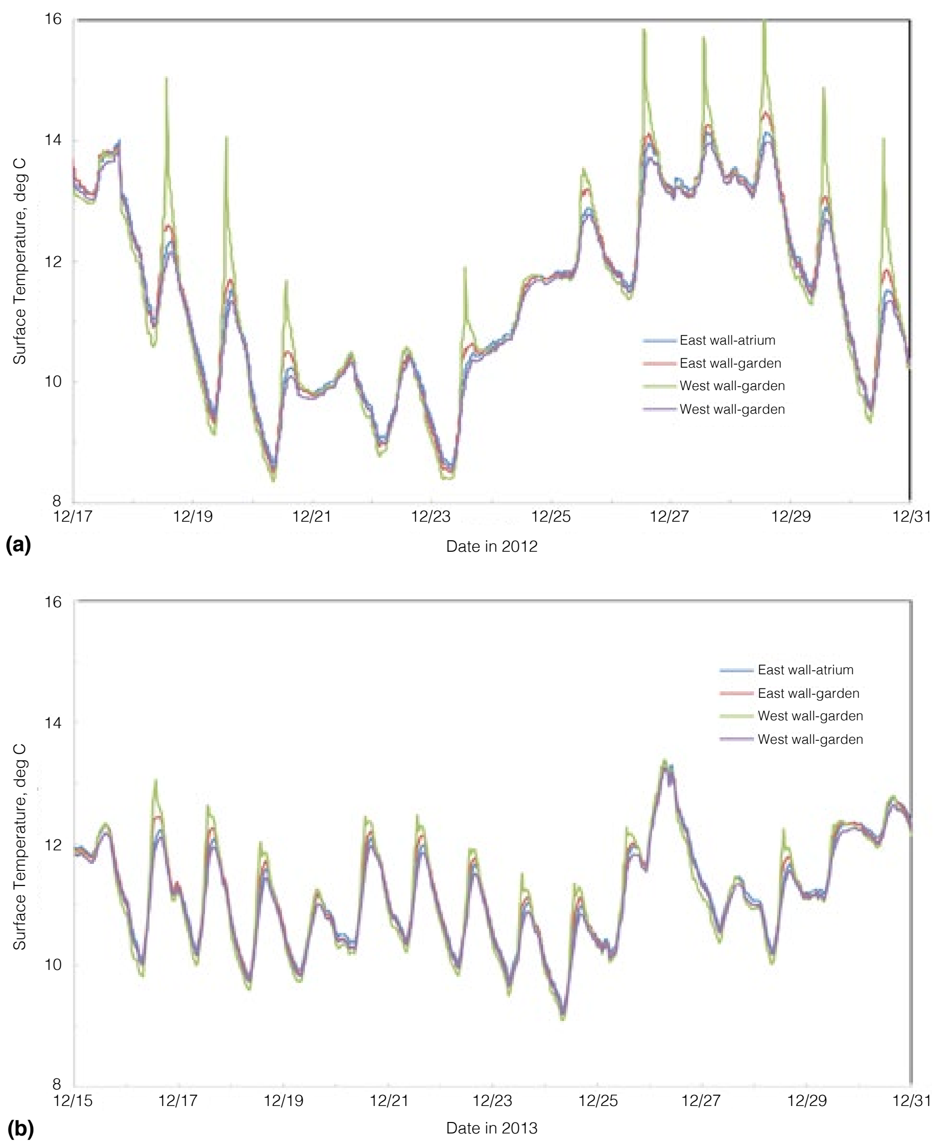
FIGURE 4.15.

Monthly average temperatures of medallion surfaces. Data for June and July 2013 and July–December 2014 are missing, as sensors were removed during the respective fieldwork.

Impact of Screen Door on Medallion Temperatures

Temperatures of the four medallions between 17 December and 31 December 2012, prior to installation of the screen door, are plotted in figure 4.16a. The temperature of the medallion on the peristyle garden side of the west wall (green line) shows daily spikes of 1°C to 5°C above those of medallions on atrium sides on a sunny day. These temperature spikes were the result of heating by direct sunlight projected onto the walls and medallions. Depending on cloud cover and wind condition, spikes between 1°C and 5°C can be the result of direct sunlight on the medallion surface. This heating produced 5% to 25% RH reduction of local humidity on the medallion surface. For medallions to be subjected to direct sunlight, the sun has to be at a certain position to the building structures surrounding the medallions. The peristyle garden side of the west wall receives sunlight throughout the year; however, the east wall receives it only in summer, when the sun sets on the northwest horizon. Figure 4.16b shows temperatures of the medallion surfaces during the same month (December) in 2013, after the screen door had been installed. Large temperature spikes found prior to installation were reduced to less than 1°C, indicating the efficacy of the screen door in blocking direct sunlight from interior wall surfaces and medallions in winter months.

FIGURE 4.16.
Surface temperatures of four medallions (a) before installation of the screen door and (b) after installation.



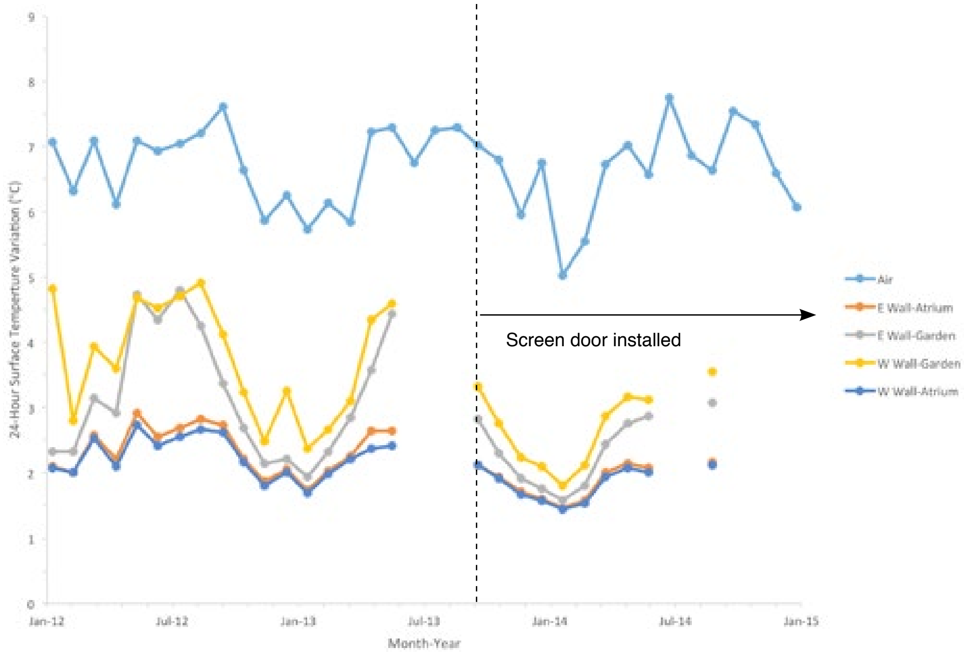


FIGURE 4.17.
Monthly averages of 24-hour temperature variations at medallion surfaces in 2012–14. Infrared temperature sensors were dismounted from installed locations, and no temperature data of the medallions were recorded July–August 2013 and July–December 2014 due to work being performed in the tablinum.

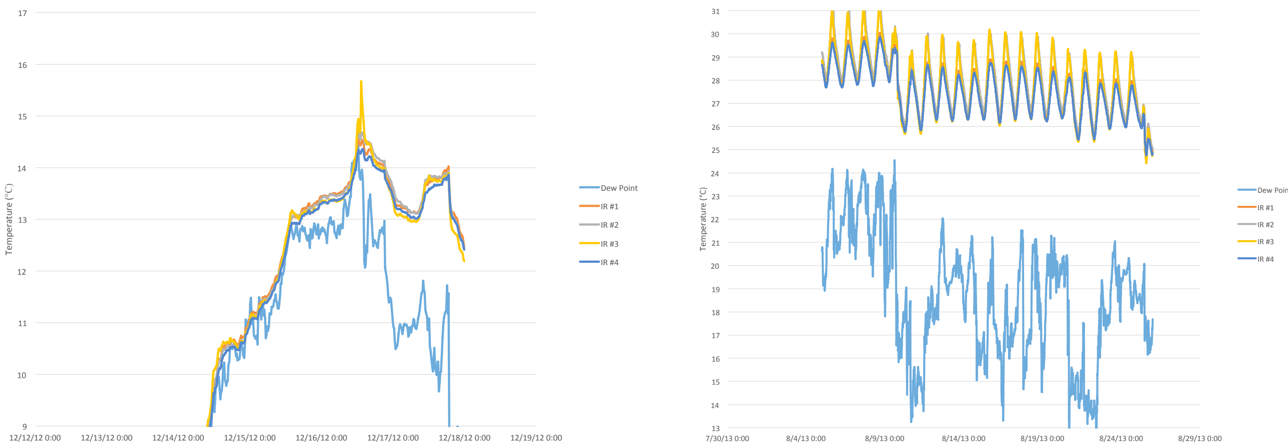
Monthly averages of 24-hour variations of surface temperatures on medallions and variations of air temperatures in 2012–14 are plotted in figure 4.17. Prior to installation of the screen door, variations of air and medallion temperatures during summer months were larger than those in winter months. Medallions on the garden sides had larger variations than those on the atrium side throughout the year, as described earlier. On the garden side, daily variations peaked at 4°C to 5°C in summer but fell to less than 3°C in winter. Variations on the atrium side remained smaller and stable, between 1.5°C and 3°C, throughout the year.

After installation of the screen door, 24-hour temperature variations of medallions were reduced by varying degrees throughout the year depending on their location. On the garden side, variations were reduced to less than 4°C. In addition, variations that existed in December at the garden side medallion on the west wall were reduced to less than 2°C.

Condensation on Medallion Surfaces

Dew point temperature of the air was compared to medallion temperatures in order to identify the environmental condition that allowed condensation to occur on medallion surfaces. Condensation is possible when surface temperature is equal to or less than the dew point temperature of the adjacent air.

Surface temperatures of medallions remained higher than dew point temperatures of the air for the majority of the year. Figure 4.18b shows a typical summer condition in which medallion temperature remained several degrees higher than dew point temperature. During winter months with continuous or intermittent rainfall over several days, medallion temperature sometimes fell closer to dew point temperature, and in a few occurrences dew point temperature exceeded medallion temperature. However, such a condition was documented only several times over the monitored period. One of the occurrences, dated 14–16 December 2012, is charted in figure 4.18a. Similar conditions were recorded for 6 December 2012 and three times the following year, 20 January, 23–24 February, and 2 December, all during the cool, rainy winter season.



(a) (b)

FIGURE 4.18.
(a) In December 2012, during several occurrences of intermittent rainfall, dew point temperatures remained close to or exceeded medallion temperatures (wall surface temperatures), creating a potential condensation condition. (b) During August 2013, medallion temperatures remained several degrees higher than dew point temperatures.

Time-of-Wetness

Due to the large variations among installed time-of-wetness sensors, responses of the sensors were difficult to interpret and thus were not utilized for the current report. A discussion of the sensor readings and their discrepancies is provided in appendix 4.2.

Wall Core Temperatures

Annual averages, maximums, and minimums of wall core temperatures at sixteen measured locations in the tablinum walls are listed in table 4.6. Core temperatures ranged from 4.9°C to 30.7°C throughout the monitored period. Temperatures of the east wall were 0.5°C to 1°C higher than those of the west wall. Temperatures at 40 cm from the base of the wall were approximately 1°C lower than those at 300 cm heights. Garden sides were warmer than atrium sides for both walls in winter, but by only a few tenths of a degree Celsius. The core temperatures followed changes in air temperature throughout the year with fewer extremes. The temperature of both the east and west wall core was warmer than that of air and surface. Short-duration temperature spikes, resulting from direct sunlight on wall surfaces, were not evident in wall core temperatures. Rolling 24-hour variations ranged between 0.1°C and 3.8°C, and their annual averages were between 0.6°C and 1.6°C. As expected, wall core temperatures were more stable than surface temperatures, which in turn were more stable than the air temperature.

TABLE 4.6. Annual average wall core temperatures in 2012/2013/2014.

	Average			
	East Wall		West Wall	
Height from floor	Atrium side	Garden side	Garden side	Atrium side
300 cm	19.4/19.2/19.6	19.3/19.0/19.5	18.1/18.0/18.3	18.1/17.9/18.3
180 cm	19.3/19.1/19.5	19.1/18.9/19.3	19.1/19.0/19.4	17.9/17.8/18.2
100 cm	18.4/18.2/18.5	18.3/18.1/18.2	18.2/17.9/18.2	*/17.8*/17.9
40 cm	18.1/17.9/18.3	18.5/17.7/17.9	17.5/17.2/17.4	16.8/17.0/17.4

*Includes faulty sensor responses.

Wall Core Humidity

Annual averages of wall core humidity are listed in table 4.7. Humidity in the wall core remained at saturation humidity, 100% RH, at all 40 cm height locations throughout the entire 2012–14 period. During 2011–12, humidity values at all 100 cm height locations remained above 95% RH. However, core humidity values decreased to the low 90s in 2013 and the mid-80s in 2014 except for the garden side of the east wall, which remained at 100% RH. At the height of the medallions and scenes, 180 cm from the ground, core humidity values were approximately 70% RH except, again, on the garden side of the east wall, which remained higher, at 85% RH, in 2012. These core humidity values decreased to the low 60s in 2013–14. At 300 cm from the ground, core humidity remained at 60% to 70% RH throughout the monitored period.

Consistently higher humidity values were recorded at the 100 cm, 180 cm, and 300 cm heights on the garden side of the east wall compared to respective height locations on both the east and west walls. This indicates the possibility of a higher ground soil moisture in the area. Volumetric moisture content of the soil was measured only at the garden side of the base of the west wall. A comparative monitoring of the soil moisture at the garden side of the base of the east wall may confirm the speculation.

TABLE 4.7. Annual average wall core humidity in 2012/2013/2014.

	Average Humidity (2012/2013/2014)			
	East Wall		**West Wall**	
Height from floor	**Atrium side**	**Garden side**	**Garden side**	**Atrium side**
300 cm	63/66/68	73/68/69	69/70/68	66/68/70
180 cm	67/69/74	85/78/69	66/68/70	70/72/73
100 cm	96/95/91	100/100/98	98/91/89	100/93/85
40 cm	100/100/100	100/100/100	100/100/100	100/100/100

The culina, a room at the northwest side of the tablinum, has been roofed for many years. Furthermore, there has been no known rainwater infiltration in the tablinum's west wall and its foundation. On the other hand, a temporary roof was installed over the triclinium (southeast side of tablinum) in the fall of 2011. Until that point, the room and walls were exposed to the weather and collected rainwater, which drained to the garden through the base of the tablinum's east wall. Some of the water that puddled in the room may have penetrated into the ground under both the triclinium and tablinum and contributed to the higher humidity recorded at the garden side of the east wall. However, installation of the temporary roof eliminated this water infiltration and has resulted in reduced humidity levels in the east wall, especially at 100 cm, 180 cm, and 300 cm locations on the atrium side in 2013 and 2014.

Monthly variations of wall core humidity values over the 2012–14 period are plotted in figure 4.19. Seasonal variations are seen at all heights except at the 40 cm locations from the floor. At other locations except at the 100 cm height on the garden side of the east wall, lowest values were recorded during the July–August period, and higher values were documented during the December–May period. These indicated a delay of one to two months from the annual rainfall pattern at the site. Although average humidity values at 180 cm and 300 cm heights indicate little change, annual peak (max) values were lower in 2013 and 2014 than in 2012, suggesting that the walls continue to dry. Core humidity readings

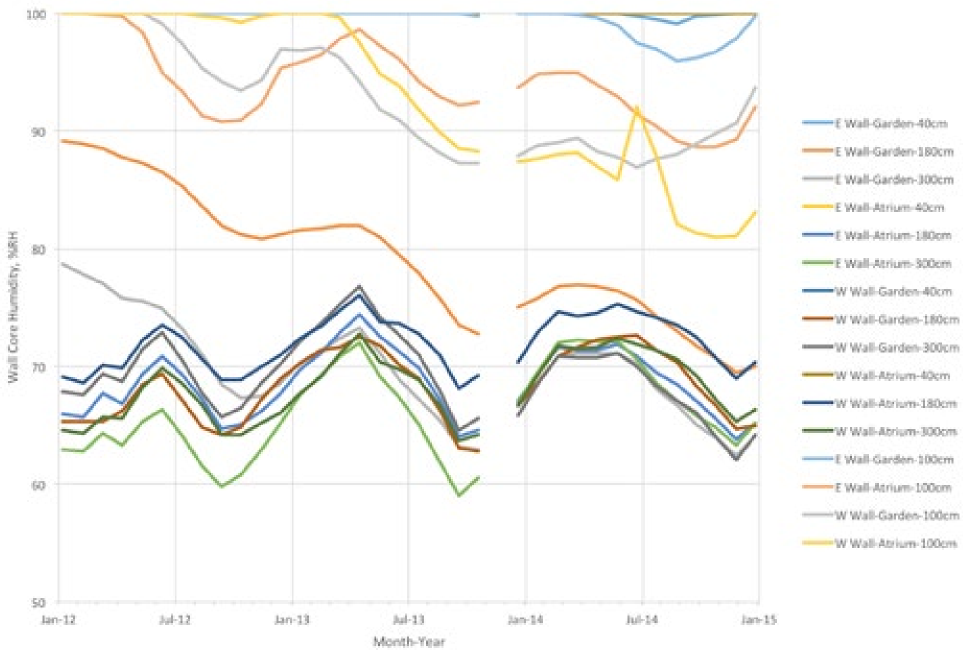


FIGURE 4.19.
Monthly averages of wall core humidity during 2012–14.

were very stable throughout the locations. Rolling 24-hour variations were virtually nonexistent, about 1% RH.

Salt Crystallization

Sodium and sulfate have been commonly found in the ground soil surrounding the House of the Bicentenary. Chemical analyses identified white efflorescence found below the 100 cm height on tablinum walls as sodium and sulfate (major components). A phase diagram of the binary sodium sulfate–water system is shown in figure 4.20. Sodium sulfate is in the solution phase in an environment above 95% RH for less than 30°C. The solid phase of sodium sulfate can be present in the form of thenardite (Na_2SO_4) or mirabilite ($Na_2SO_4 \bullet 10H_2O$) below the humidity level for temperatures below 32.4°C. Above this temperature, the solid form is present only in thenardite for humidity less than approximately 90% RH.

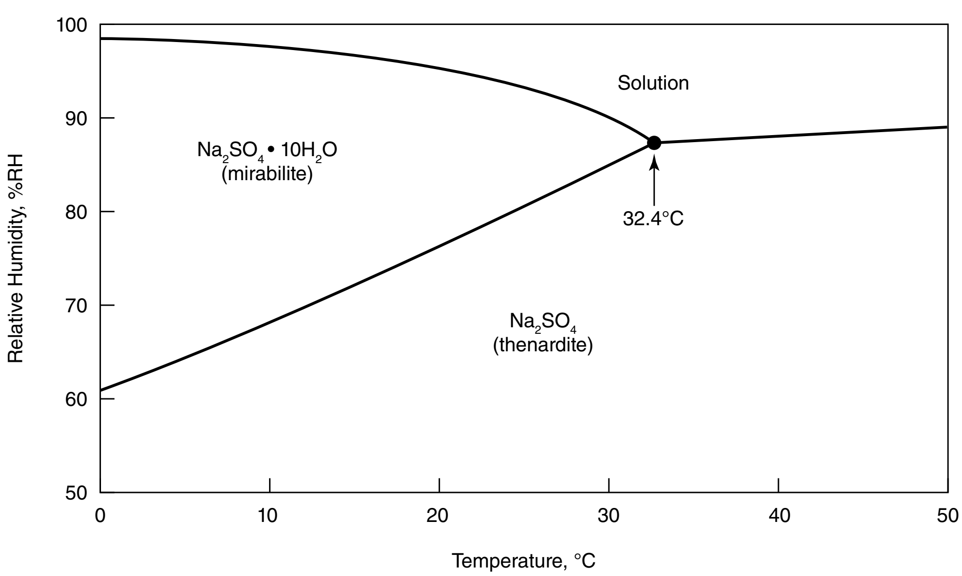


FIGURE 4.20.
Phase diagram of the binary sodium sulfate–water system.

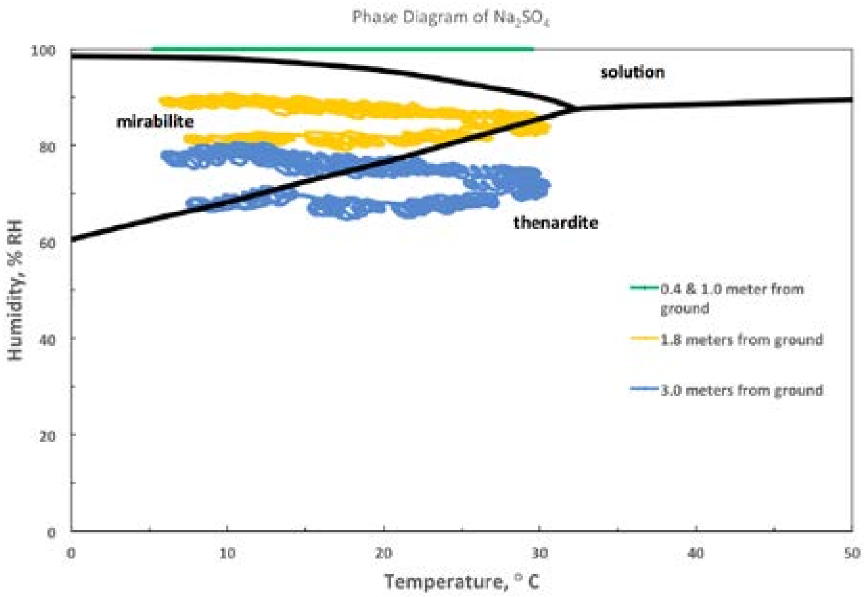


FIGURE 4.21.
Wall core temperature and humidity in the garden side of the east wall at 0.4 m, 1.0 m, 1.8 m, and 3.0 m heights from the ground in 2012, plotted over the phase diagram from fig. 4.20. Humidity at the 0.4 m and 1.0 m locations was 100% RH throughout the year.

The molecular weight of thenardite is 142.04 mg, and that of mirabilite is significantly heavier at 322.20 mg due to the attachment of ten water molecules. In situ crystallization of either thenardite or mirabilite in pores of stones and plasters will result in damage to the materials. The transformation between thenardite and mirabilite also will result in damage to materials due to the large molecular weight and volume differences.

In the ground and the wall core up to approximately 100 cm height, temperature and humidity remain at 5°C to 30°C and 100% RH throughout the year (fig. 4.21). This allows the sodium sulfate salt to remain in the solution phase, to be transported from the ground soil into the tablinum walls, and to be distributed to base portions of the walls to about 100 cm height by capillary rise. In the wall core between 100 cm and 180 cm from the ground, the sodium sulfate solution transforms to the solid phase, either mirabilite or thenardite, depending on the temperature and humidity in the walls. The transformation between mirabilite and thenardite takes place in the materials in the core and on or near the wall surfaces with the seasonal variation of temperature and humidity, and results in damage to wall materials. Above these heights, the salt remains in the solid phase and therefore cannot be transported to higher locations in the wall or closer to surfaces. However, if the sodium sulfate salt is present at heights of 1.8 m and above, the transformation between mirabilite and thenardite takes place daily or seasonally, resulting in damage to wall materials.

Although no rainwater infiltration from the top of the wall has been recorded during the monitored period, the salt can be solubilized and transported to higher locations of the wall if rainwater saturates the walls from the top. This may result in salt damage at higher locations. Similar concerns are raised if the moisture content of soil adjacent to the tablinum walls increases from poor rainwater drainage.

Once the solution phase of sodium sulfate is transported to above ground via capillary rise, the salt in wall cores is transported toward wall surfaces by the drying effect at the surfaces. As the tablinum air is dryer than the wall cores below about 100 cm from the ground, moisture is lost to the air and the salts crystallize either in situ in the walls or on the wall surfaces. As shown in figure 4.22, salt can be present as mirabilite or thenardite in the tablinum air and transforms between the phases as the room environment changes. This transformation also results in deterioration of the materials if it occurs in situ.

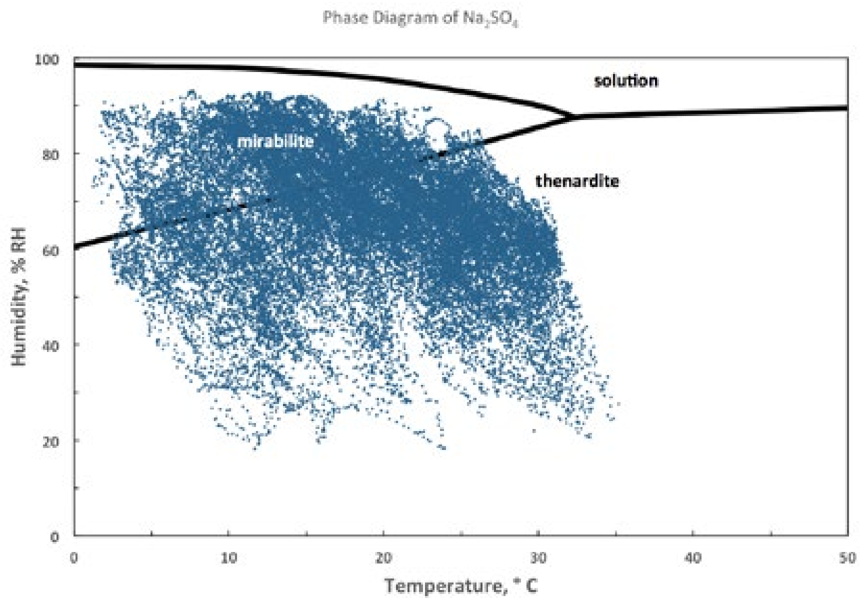


FIGURE 4.22.
Air temperature and humidity of the tablinum air (measured in the garden) in 2012.

Air Movement in the Tablinum

Annual averages of the outside wind and indoor air speeds in the tablinum, triclinium, and corridor of the House of the Bicentenary for the 2012–14 period are listed in table 4.8. The 2013 indoor data were partially affected by the installation of scaffolding around walls and screen door (see appendix 4.3) at the south end of the tablinum in July–August 2013. The 2014 indoor data include impacts of the scaffolding and screen door for the entire year.

TABLE 4.8. Annual averages of the outside wind and indoor air speeds in the House of the Bicentenary.

	2012	2013	2014
Outside	0.76 m/s	0.82 m/s	0.59 m/s
Tablinum	0.50 m/s	0.35 m/s	0.17 m/s
Triclinium	0.51 m/s	0.62 m/s	0.63 m/s
Corridor	0.48 m/s	0.67 m/s	0.74 m/s

Annual averages of the indoor air speeds were between 60% and 66% of those of the outside wind in 2012, before installation of the screen door. The highest air speed of 6.5 m/s was recorded in the tablinum at 3 a.m. on 27 February 2012; however, the outside wind speed was only 2 to 3 m/s from between west and north, 280°N to 350°N. A similar high air speed, 6.3 m/s, was recorded on 22 February 2012, when the outside wind was 2 to 3 m/s from 320°N to 70°N. Reasons for the amplification of the air speeds are not known, though certain directional (outside) winds can blow through buildings and accelerate to higher speeds as the result of wall and opening orientations. Ninety-five percent of the time (95th percentile value), air speed was less than 1.3 m/s in 2012.

Indoor air speed in the tablinum was significantly reduced after the screen door was installed. The presence of the screen door reduced the annual average air speed to only 29% of the outside wind in 2014. The highest air speed recorded was 2.5 m/s, and the 95th percentile value of the air speed was less than 0.5 m/s in 2014, again a significant reduction. However, this reduction was accompanied by increased indoor air speeds, 108% and 127% of the outside wind speed, in the triclinium and the corridor, respectively, in the same year.

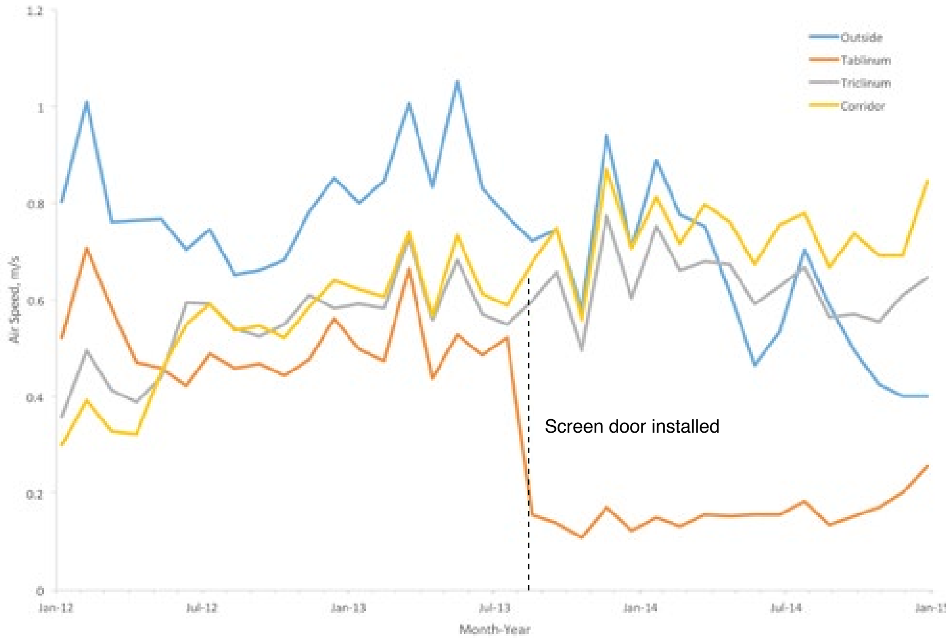


FIGURE 4.23.
Monthly averages of indoor air speeds and outdoor wind speeds at the tablinum.

Monthly averages of indoor air speeds are plotted along with those of the outside wind in figure 4.23. The averages of all three indoor air speeds followed the seasonal trend of the outside wind with 30% to 50% reduction before the screen door was installed in August 2013. The screen door reduced air speed in the tablinum by an additional 30%, and high air speed events were eliminated as the air speed became stable. However, the air speeds in the triclinium and the corridor increased beyond those of the outside wind.

Driving Rain

Air speeds and directions in the tablinum during rainfall events before installation of the screen door are plotted in figure 4.24. Air movements during rainfall were dominated along the atrium–garden axial direction. More than 75% of air speed measurements recorded during rainfall were less than 1 m/s. Air movements from the atrium side were mostly less

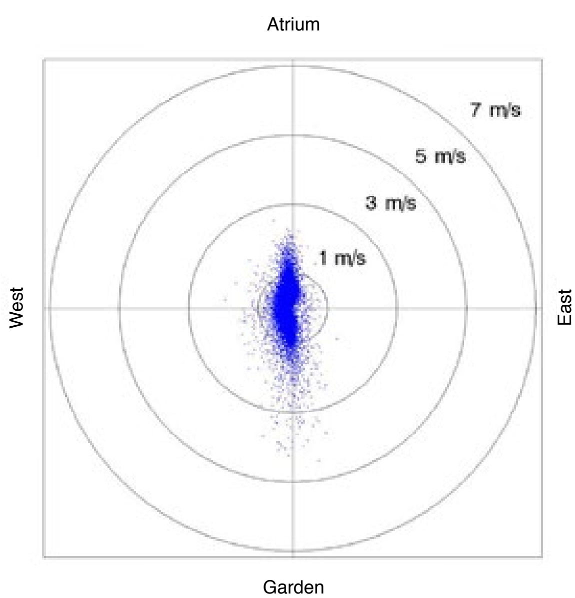


FIGURE 4.24.
Wind speeds and directions at the center of the tablinum during rainfall events between May 2012 and February 2013. The wind sensor's north–south axis was oriented parallel to the tablinum walls, not to the magnetic or true north–south.

than 2 m/s, but faster (2 to 4 m/s) air movements from the peristyle garden side were frequently recorded during rainfall. The wind-driven rain can infiltrate the tablinum walls and floor from the garden opening.

Airflow Distribution in the Tablinum

Airflow distribution in the tablinum was examined using three ultrasonic wind sensors in the room between 13 October 2011 and 17 May 2012 (see figs. 4.9a and 4.9b). During the initial period, 13 October to 10 November 2011, the three wind sensors were used to examine the symmetry of the wind in the tablinum. Results were plotted in wind roses in the top row of figure 4.25. At the center, the airflow remained in the atrium–garden axial direction. Higher flow speeds, 1 to 4 m/s, were recorded from the garden, but winds from the atrium were mostly less than 1 m/s with a maximum of less than 2 m/s. Between the southeast and the southwest corners, no symmetry was observed in airflow pattern. At the southeast corner, flow speeds were mostly less than 1 m/s more than the airflow from the atrium direction. The location appeared to be blocked from outside winds and subjected to an eddy-like backflow. The southwest corner had higher and more defined directional winds compared to the southeast corner.

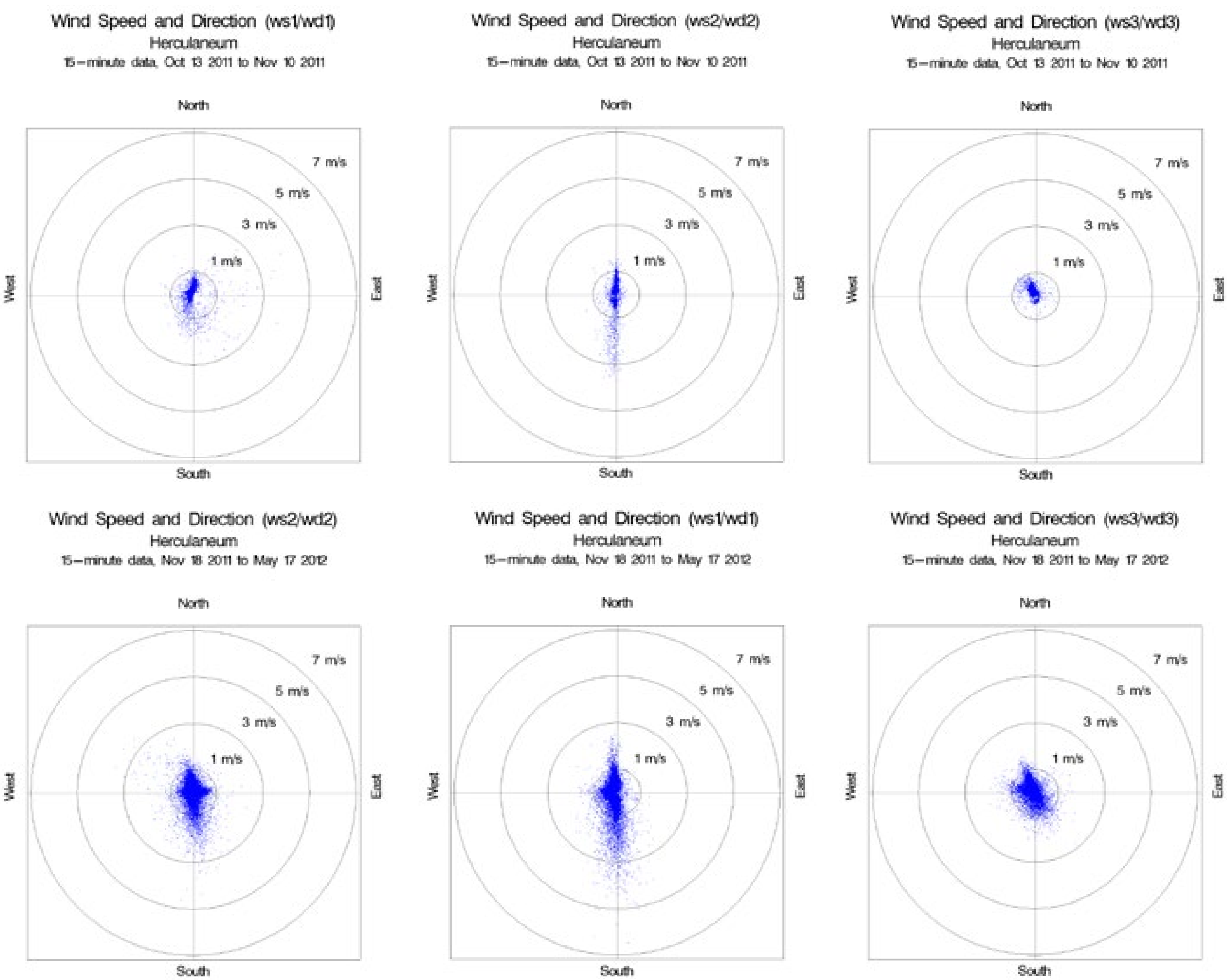
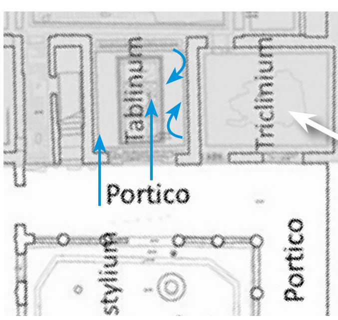


FIGURE 4.25.
Top row: Comparison of wind speeds and directions measured using a symmetrical sensor arrangement (see fig. 4.9a). Locations were the southwest corner (*right*), the center (*middle*), and the southeast corner (*left*) of the tablinum. *Bottom row:* Comparison of wind speeds and directions measured using a diagonal sensor arrangement (see fig. 4.9b). Locations were the southwest corner (*right*), the center (*middle*), and the northeast corner (*left*).

Between 18 November 2011 and 17 May 2012, we examined the variation of wind at the southwest corner, center, and northeast corner. Resulting data are plotted in the bottom row of figure 4.25. At the southwest corner, the dominant wind was along the atrium–garden axis at less than 1 m/s. Higher-speed and scattered-direction winds were recorded from atrium–east wall–garden directions. The proximity to the outside resulted in higher winds from the atrium side. Obviously, the west wall side was protected by the presence of the wall structure. At the central position, the majority of winds lined up closely along the atrium–garden axis. Winds from the atrium side were mostly less than 1 m/s, but those from the garden side ranged to 4 m/s. Winds were significantly reduced, mostly less than 1 m/s, and were limited to the atrium–garden direction at the northeast corner location. Figure 4.26 shows an estimated airflow pattern in the tablinum based on the above observation. Although air speeds may have been lowest along the east wall, the flow could be highly turbulent, possibly resulting in higher surface stress as well as moisture transfer.



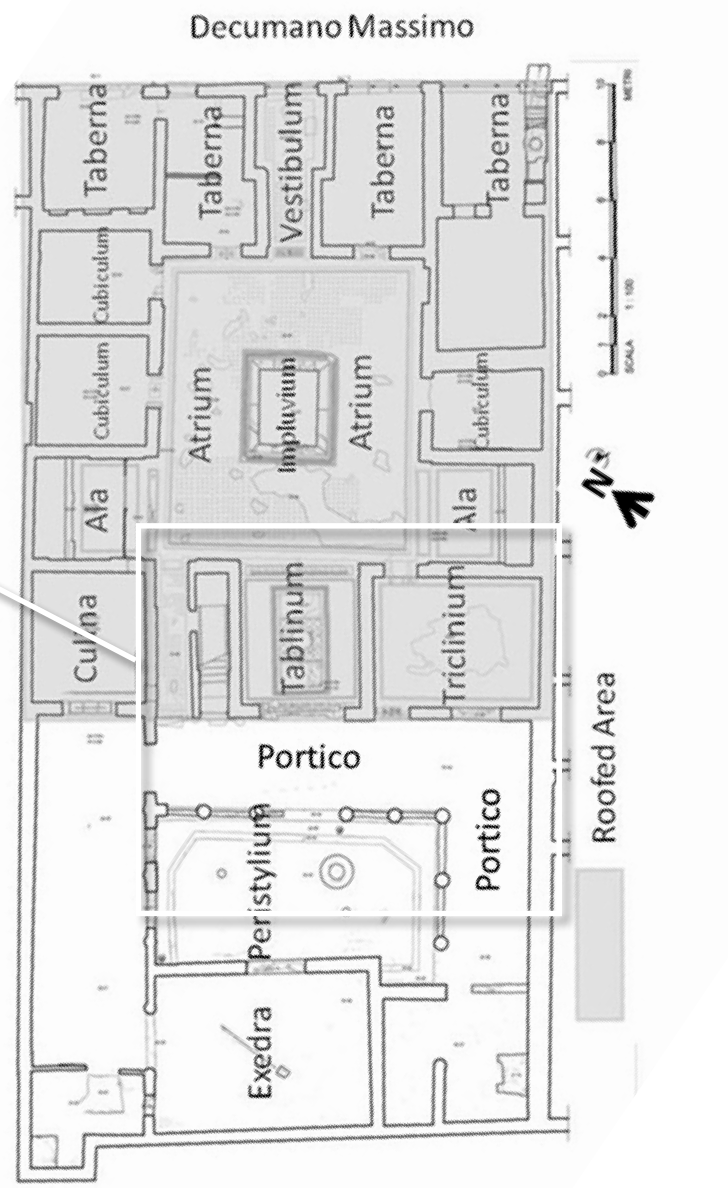


FIGURE 4.26.
Estimated airflow pattern in the tablinum without the screen door.

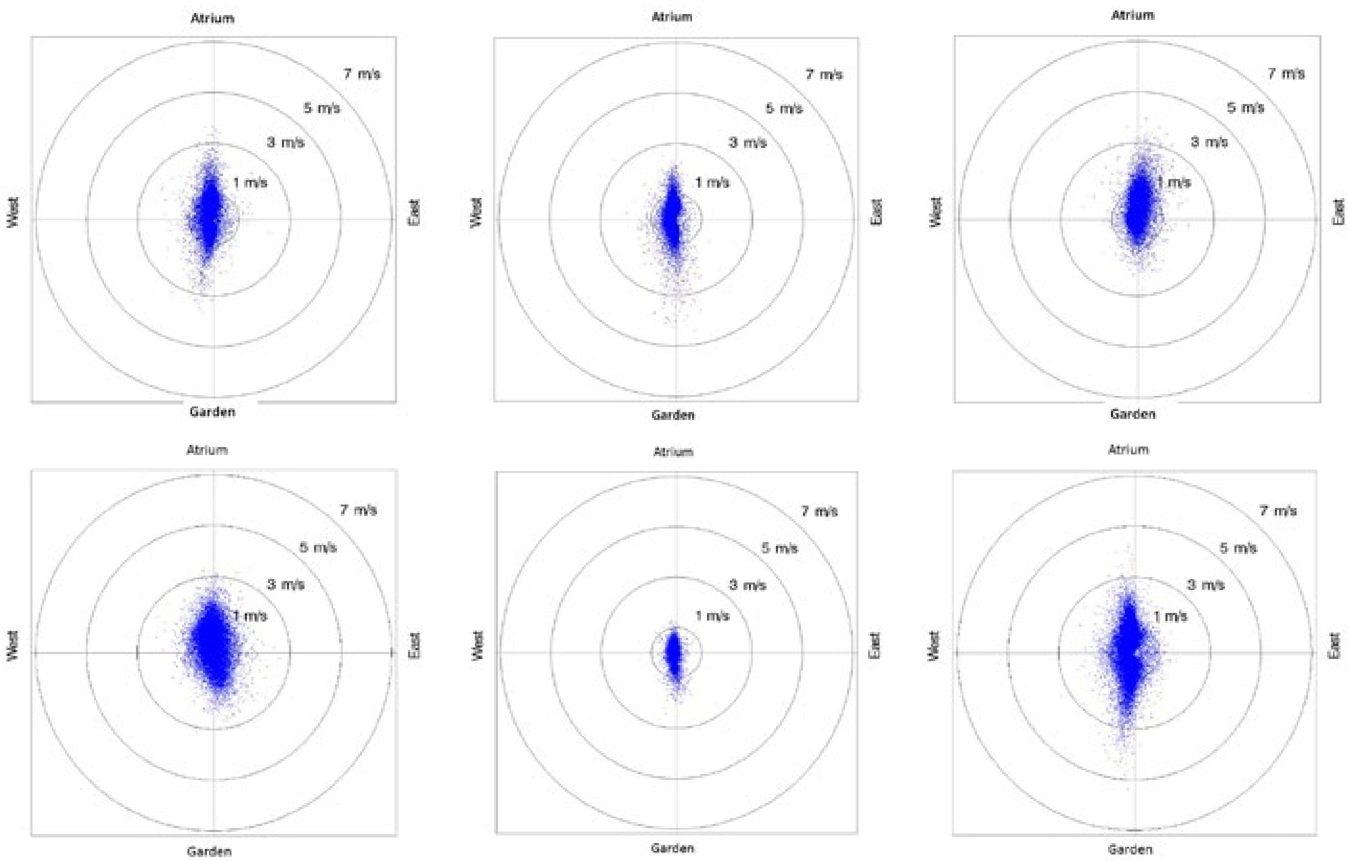


FIGURE 4.27.
Top row: Comparison of air movement before installation of the screen door (25 May 2012–12 February 2013) in three areas connecting the atrium and the peristyle garden, the hallway west of the tablinum (*left*), in the tablinum (*center*), and the doorway between the atrium and the triclinium (*right*). *Bottom row:* Air movements after installation (1 January–31 December 2014).

Impact of the Screen Door on Airflow

Figure 4.27 shows wind roses comparing patterns of air movements at three south end locations of the atrium, the corridor west of the tablinum, at the center of the tablinum, and near the atrium doorway in the triclinium before (top) and after (bottom) installation of the screen door. Prior to installation, all three locations show dominating air movement along the atrium–garden axis with the majority at less than the 3 m/s speed and maximum about 4 m/s. Airflow speeds higher than 3 m/s were recorded from the atrium direction at the corridor and triclinium, but in the tablinum the high-speed air came from the direction of the garden. These results indicate that the tablinum allows more wind entering from the garden than from the other two locations. This is due to large, unrestricted air passage through the tablinum.

After installation of the screen door, air speed was reduced to mostly less than 1 m/s in the tablinum as expected, but airflow increased in both the corridor and the triclinium. The presence of the screen door in the tablinum forced more air to flow through adjacent, less restricted openings. The higher air speeds in the corridor and triclinium can lead to faster moisture loss as well as shear stress on wall and floor surfaces.

Air Temperature in the Tablinum

Prior to installation of the screen door, temperature and humidity were similar to that of the outside, since the outside air flows freely into and out of the tablinum. However, after installation, the air change between the outside and the tablinum became restricted, and a separate microenvironment was created in the tablinum.

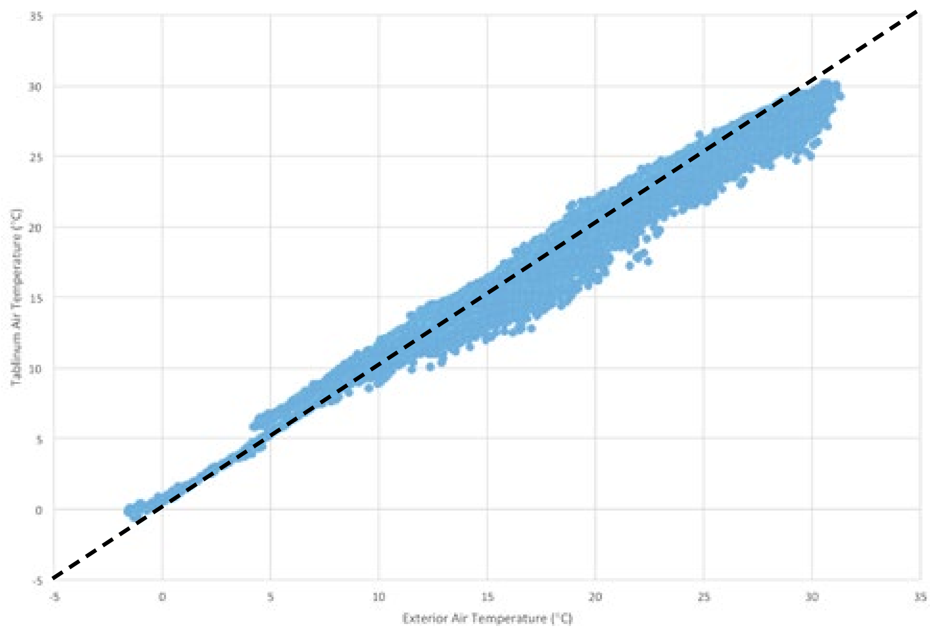


FIGURE 4.28.
Comparison of the outside air temperature and the temperature inside the tablinum in 2014 (after installation of the screen door).

Figure 4.28 compares the temperature of the outside air and of the inside of the tablinum in 2014. Data points above the dotted diagonal line (outside air temperature equals tablinum air temperature) indicate that the temperature inside the tablinum was warmer than the outside, and the temperature outside the tablinum was warmer than the inside for data points below the dotted line. The majority of data points are above the dotted line for the outside temperature below 12°C. At the other end, data points are below the dotted line above 22°C. These indicate that the tablinum remains warmer inside than outside for the outside temperature below 12°C and cooler for the outside temperature above 22°C. The outside temperature and the tablinum temperature are similar for the range between 12°C and 22°C.

Comparison of the outside humidity and the humidity inside the tablinum in 2014 is shown in figure 4.29. Data points above the dotted diagonal line (outside humidity equals

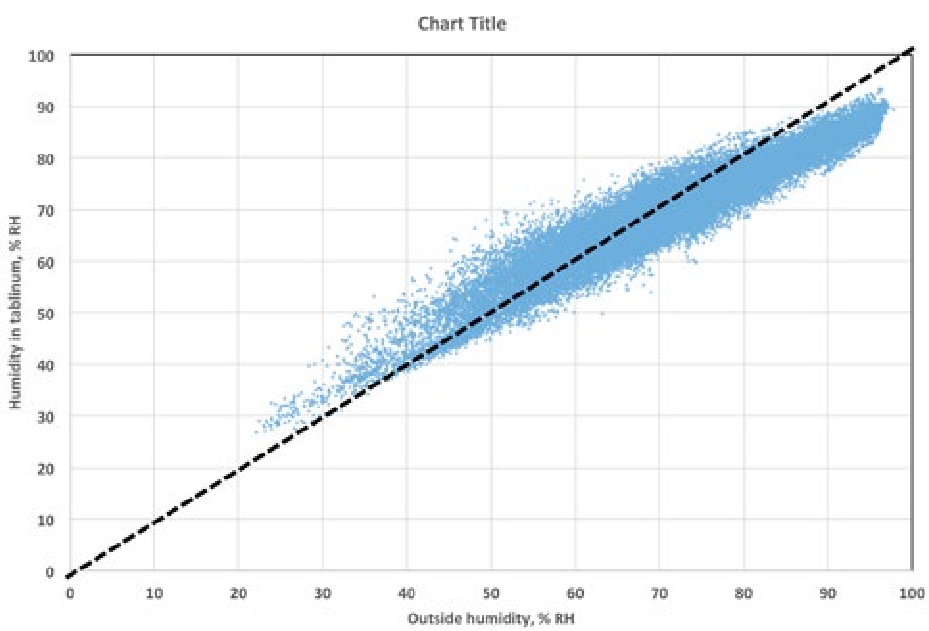


FIGURE 4.29.
Comparison of the outside humidity and humidity inside the tablinum in 2014.

tablinum humidity) indicate that the inside of the tablinum was more humid than the outside, and the outside humidity was more humid than the inside of the tablinum for data points below the dotted line.

The tablinum humidity was more stable than the outside humidity and tended to be less humid when the outside humidity was above 70% RH. Below outside humidity of 65% RH, the tablinum humidity was generally higher than that of the outside. This indicates that the tablinum's (and the house's) wall and floor surfaces buffered the humidity in the room.

The above comparisons of air temperature and humidity indicate that the screen door moderated the outside conditions and provided more stable environmental conditions in the tablinum. The screen door limited solar heating and cooling in the tablinum and provided appropriate amounts of ventilation to prevent heat accumulation from a possible greenhouse effect.

Summary

The climate of the archaeological site of Herculaneum and the environmental conditions of the wall paintings in the tablinum of the House of the Bicentenary were monitored starting November 2011 using a custom-designed, solar-powered autonomous monitoring station. Three-year data from 2012, 2013, and 2014 were analyzed to characterize the environmental conditions affecting the conservation of the wall paintings and develop physical protections that are locally sustainable for long-term conservation. The 2014 data were also analyzed to evaluate the efficacy of a protective screen door on the peristyle garden side of the tablinum.

Climatic conditions at the site of Herculaneum, recorded outside of the House of the Bicentenary, showed a cool, humid winter and a hot, dry summer. It rained throughout the year, with an annual total of approximately 1000 mm per year; however, the majority of rainfall was recorded between September and May. High-intensity (both 15-minute and 24-hour) rainfall events were recorded during the high rainfall months. A diurnal wind pattern, onshore during the day and offshore at night, was identified throughout the year. The site is protected from the wind and heat loss due to its location in the excavation pit as well as by the presence of Mount Vesuvius on the site's northeast quadrant. Although rainwater drained relatively well, soil moisture varied with monthly rainfall patterns and remained high during the high rainfall season.

Temperatures of wall paintings in the tablinum, including medallions, followed daily and seasonal changes of the outside air temperature. However, the variations were reduced due to a large thermal mass of supporting walls. Wall paintings at the peristyle garden end of the west wall were subjected to daily solar heating and the projection of direct sunlight. This direct sunlight projected onto wall paintings on the east wall only during summer months. Although direct projection of sunlight onto wall surfaces was eliminated after installation of the screen door at the garden end of the tablinum, heating on the outside surfaces of the walls continues. External shading of the walls, such as an awning on the portico area, may reduce the heating.

Prior to the environmental monitoring, daily wet-dry cycles due to nighttime condensation and daytime drying were thought to be one of the deterioration mechanisms for the medallions. The monitoring identified that a condition conducive to the occurrence of condensation occurred only a few times over the entire monitored period. The walls normally remained warmer than the dew point temperature of the air at night and in the early morning due to their large thermal mass and to protection by the roof from nighttime radiation cooling.

During 2012, high humidity conditions, above 95% RH, were maintained in wall cores below the 100 cm height from the ground. This indicated high moisture content of the soil in the ground surrounding the walls. High humidity can cause in situ crystallization of sodium sulfate salts, such as thenardite and mirabilite, in the walls below the 100 cm height. It is essential to reduce the moisture content of the soil surrounding the walls to protect the base of the walls from salt damage. Since sodium chloride (halite) is not present in the wall, salt damage is unlikely to occur at heights above 100 cm.

Temporary roofing was installed over the triclinium during the summer of 2011. This resulted in gradual drying of soil surrounding tablinum walls. This drying was documented at all 100 cm height locations of the walls. Except at the garden side location on the east wall, the wall core humidity was reduced to 80% to 90% RH by the end of 2014. Further reduction may be achieved by improving rainwater drainage from the ground soil of the portico. The use of synthetic drain strategies, such as geo-membrane systems, can achieve reduction with minimum impact to the archaeology of the area.

Due to the presence of the east and west walls, air movements in the tablinum are restricted to directions parallel to the walls, although variations were recorded at the garden end. The air speed followed that of the outside but was reduced to 50% to 70% of the outside wind. Airflow was highest at the center of the tablinum. The area adjacent to the west wall had higher airflow than that of the east wall, which was protected from the southeast wind. This air speed was further reduced to less than 10% of the outside wind, mostly less than 0.2 m/s, after installation of the screen door. However, air speed increased in both the corridor and the triclinium as a result of air blockage in the tablinum. This can lead to surface stress and increased moisture loss at surfaces in these rooms. Similar screen doors will reduce air speed in the openings.

During the majority of rainfall events, air speeds were less than 2 m/s in the tablinum, indicating the limited occurrence of driving rain prior to installation of the screen door. However, the screen door has significantly reduced the potential damage from events of driving rain.

Acknowledgments

The author would like to acknowledge the following colleagues for their support and assistance. The installation and local operation of the environmental monitoring station was supported by the HCP and by Dr. Ascanio D'Andrea and Alessandra de Vita of the HCP. Special acknowledgments go to Vincent Beltran, assistant scientist at the GCI, who processed and plotted environmental data and created an extranet site for autonomous data posting.

APPENDIX 4.1

Monitoring Equipment

Monitoring Equipment

A complete description of the environmental monitoring station is found in the installation report for the environmental monitoring station at the House of the Bicentenary (Shin Maekawa, 19 April 2012). The following are sensors used in this study.

Tablinum exterior

Wind sensor (1): R. M. Young wind anemometer
Rainfall (1): Texas Electronics Inc. TE525 rain gauge
Temperature and humidity (1): Vaisala HMP 45C temperature and humidity sensor
Soil moisture (1): Campbell Scientific Inc. CS650 soil water content reflectometer
Solar radiation (1): Licor 200S pyranometer

Tablinum interior

Air temperature and humidity (1): Rotronic H1S temperature and humidity sensor
Wall core temperature and humidity (16): Rotronic miniature temperature and humidity sensors
Surface temperatures of medallions (4): Campbell Scientific Inc. SI-111 infrared radiometers
Surface temperatures of walls (16): Omega Engineering E-type surface mounting thermocouples
Air speed and direction (3): Handar 425A ultrasonic wind sensor
Time of wetness of walls (10): GCI custom-built sensors

APPENDIX 4.2

Custom-made Time-of-Wetness Sensors

Custom-made Time-of-Wetness Sensors

Depending on the material, resistance ranges from several hundred to several thousand ohms when the material is dry. When the material becomes wet or highly humid, resistance is drastically reduced to near zero ohms. The same measurement principle is used for measuring driving rain for building facades and sculptures as well as for condensation on plant leaves in botanical science. Duration of the material's wet condition can be identified by adding time of low resistance. This measurement technique was successfully used at the archaeological site of Copán, Honduras, for monitoring rainwater infiltration into the perimeter of the Hieroglyphic Stairway.

Of the six time-of-wetness sensors installed in lacunae of the tablinum walls, three sensors—#1, #3, and #4—produced consistent responses to the moisture changes of environment/wall material. However, all three had large variations in responses, as follows:

#1 less than 20 for possible wetting, 50 to 580 for dry
#3 less than 20 for possible wetting, 500 to higher than 7999 (out-of-range) for dry
#4 less than 20 for possible wetting, 100 to higher than 7999 (out-of-range) for dry

Responses of these three sensors during the condensation event of 14–16 December 2012 (see the section titled, "Condensation on Medallion Surfaces" in this chapter) are shown in figure 4.2.1. Resistance values of sensors #1, #3, and #4 reached 50 ohms, 680 ohms, and 250 ohms, respectively, at 6 p.m. on 14 December, and 16 ohms, 101 ohms, and 62 ohms, respectively, at 12:30 p.m. on 16 December. These results illustrate the difficulty in determining the precise time of condensation. Similarly, difficulty was experienced in determining the moment of drying. Resistances of sensors #1, #3, and #4 returned to 26 ohms, 480 ohms, and 85 ohms, respectively, at 9 a.m. on 18 December (fig. 4.2.2).

The differences in responses may be due to the following:

- Quality of sensor contacts
- Local salt content of the wall materials
- Actual salt content
- Temperature variations

Due to the large variations, responses of the sensors were not utilized for the current report.

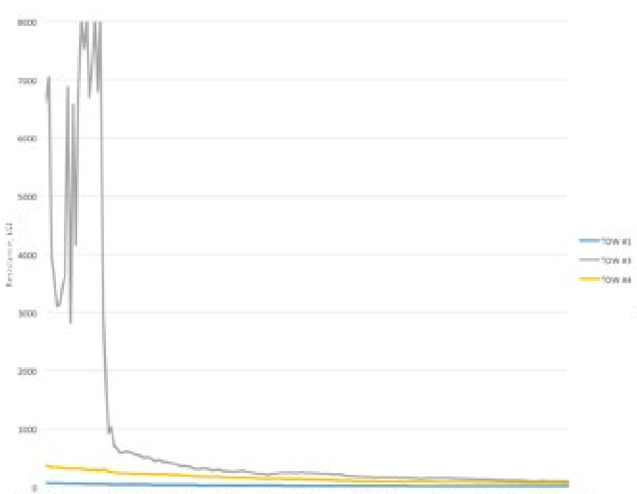


FIGURE 4.2.1.
Responses of time-of-wetness sensors during likely condensation event based on the surface temperature–dew point temperature relationship.

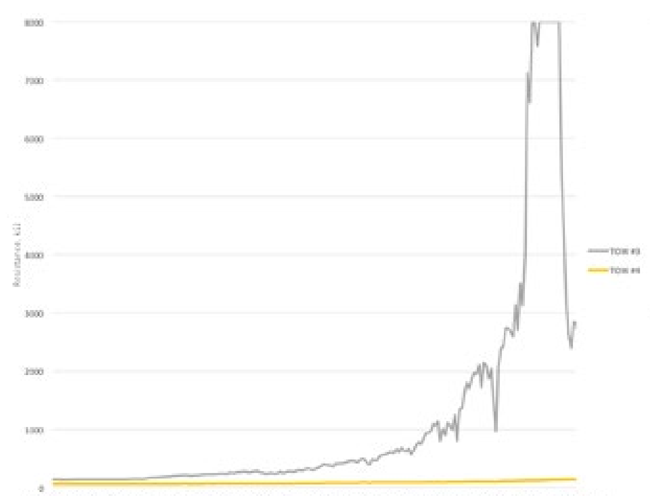


FIGURE 4.2.2.
Responses of time-of-wetness sensors during likely condensation event based on the surface temperature–dew point temperature relationship.

APPENDIX 4.3

Performance of Screen Door and Fabric

Performance of Screen Door and Fabric

A large screen door was installed on the peristyle garden side of the tablinum on 2 August 2013 (fig. 4.3.1). Because no filler/sealant material was used to install the door casing, gaps of 5 to 10 cm are present between the door casing and the outer wall of the tablinum. The door consists of four independent panels. Two panels on each side are connected to each other by sets of hinges. Two outer panels are connected to side casings also by sets of hinges. The door swings outward at the center. Since individual panels can be locked to the threshold and lintel, single or multiple panels can be opened depending on need. There is a lockable handle and doorjamb on the center panels. A white construction netting material (fabric #1), locally purchased, was installed on the panels to allow airflow.

FIGURE 4.3.1.
Photos of screen doors viewed from the peristyle garden (*left*) and from inside the tablinum (*center*), and the screen fabric (*right*) installed on the peristyle garden side of the tablinum.

Direct and through-the-screen-door solar radiation was measured using a pyranometer at the Herculaneum site on 23 October 2014. Fabric #1 allowed transmission of only between 2.3% and 4.7% of direct radiation energy.

Fabric #1 was also tested at the GCI for photospectral (between 300 nm and 700 nm) transmission. Wavelengths of less than 380 nm were UV light, and wavelengths between 380 nm and 700 nm were visible light. Amounts of photometric transmission varied depending on the tension applied to the fabric. The void area increased as the tension increased. Ten measurements (ten different locations of a 2 × 2-inch area) were performed with no tension applied to the fabric. Results are summarized in figure 4.3.2. In the UV range, the transmission averaged 38% with a range of 32% to 43%. In the visible light range, the transmission averaged 62% with a range of 50% to 70%. Higher transmission percentages were measured at longer wavelengths (red side), and lower transmission percentages were recorded at shorter wavelengths (blue side). This resulted in a slightly yellowish tint of the transmitted light.

Radiometric and photometric transmissions indicated that fabric #1 (white netting fabric) provided good protection from harsh solar radiation, especially in the UV range, while allowing a large amount of visible light to pass through it. The transmitted light has a slightly creamy color.

The void (area not covered by the fabric thread) of fabric #1 (white fabric) was measured to characterize the fabric for its ability to block or reduce airflow through it. First, the fabric was photographed in color at several different magnifications with a dark blue background; the images were then reduced to black and white with no gray scale (fig. 4.3.3). Then, the total area covered by black pixels was measured to determine the percent void area. Results ranged from 17% to 19%. Similar to the photometric transmission measurement, the percent of void area increased with tension applied to the fabric.

In October 2014, the netting of the screen door was replaced with TENAX LUMINAX (fabric #2), a knitted silver metallic fabric with a rated shading of 50%. Fabric #2 was also

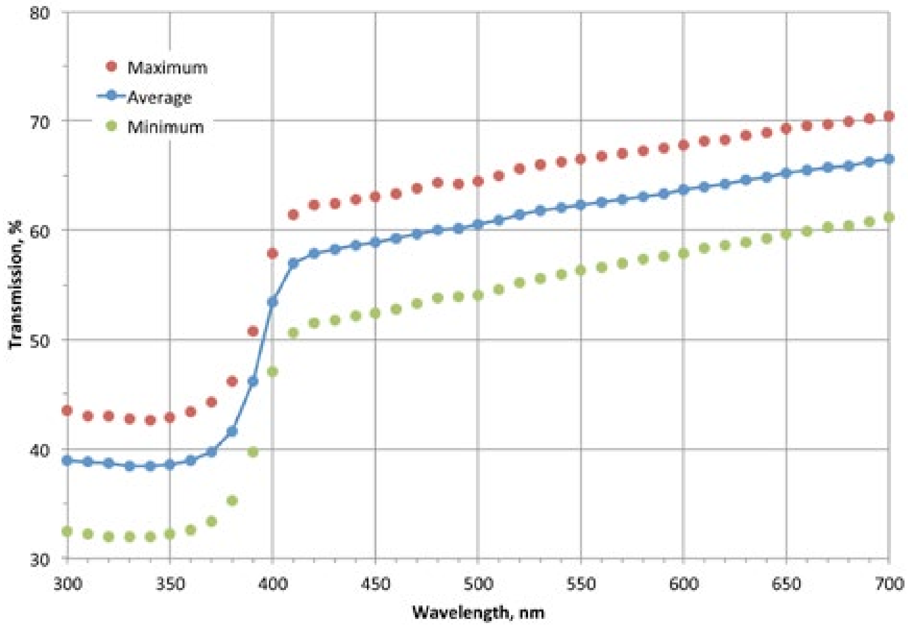


FIGURE 4.3.2.
Results of photometric transmission measurements of the construction containment fabric (fabric #1).

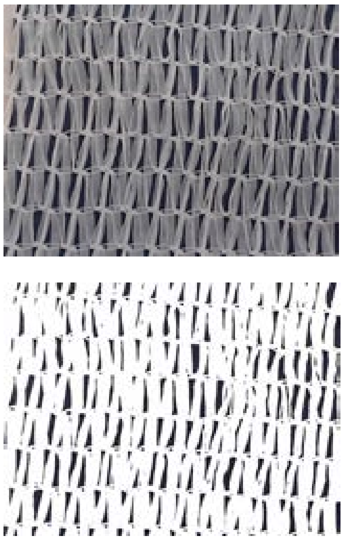


FIGURE 4.3.3.
Photos of the construction fabric with dark-blue background (*top*) and graphically reduced to two colors (black and white) (*bottom*).

tested at the GCI for photospectral (between 300 nm and 700 nm) transmission. Similar to the previous material, amounts of photometric transmission varied depending on the tension applied to the fabric. Again, the void area increased as the tension increased. Ten measurements (ten different locations of a 2 × 2-inch area) were performed with no tension applied to the fabric. Results are summarized in figure 4.3.4. The UV transmission, which averaged 42% with a range of 37% to 70%, was 4% higher than for fabric #1. The visible light transmission, averaged 56% with a range of 47% and 71%, was 6% lower than for Fabric #1. Transmission percentages were flat over the entire visible range, indicating simple reduction of light intensity with no color alteration.

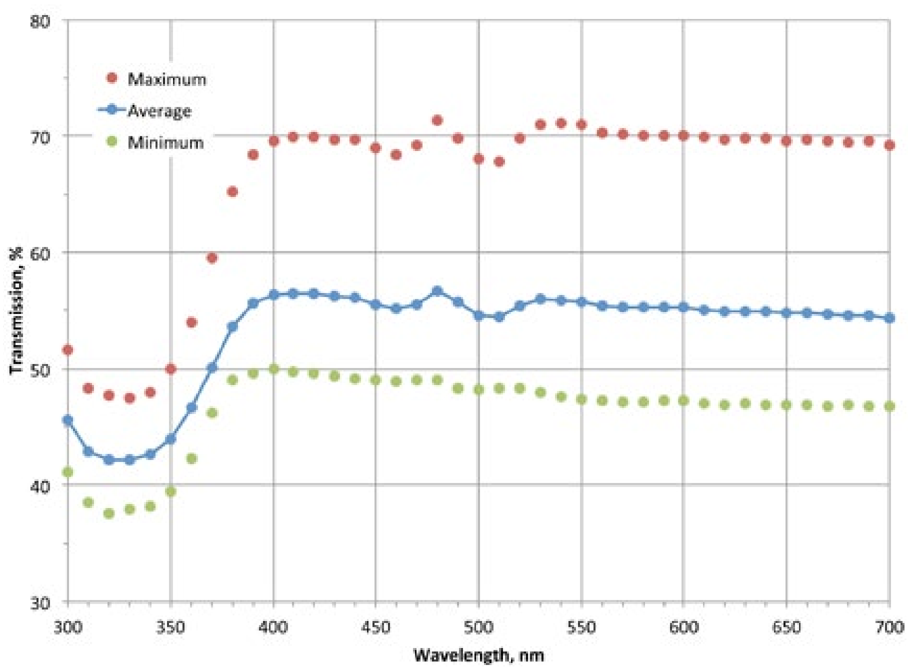


FIGURE 4.3.4.
Results of photometric transmission measurements of TENAX LUMINAX (fabric #2).

The same photographic analysis was performed to determine the void ratio of TENAX LUMINAX (shading 50%). Results ranged from 25% to 26%, which was noticeably larger than that of the white netting, which ranged from 17% to 19%. Therefore, LUMINAX provided more airflow while reducing light transmission than the white construction netting fabric.

APPENDIX 4.4

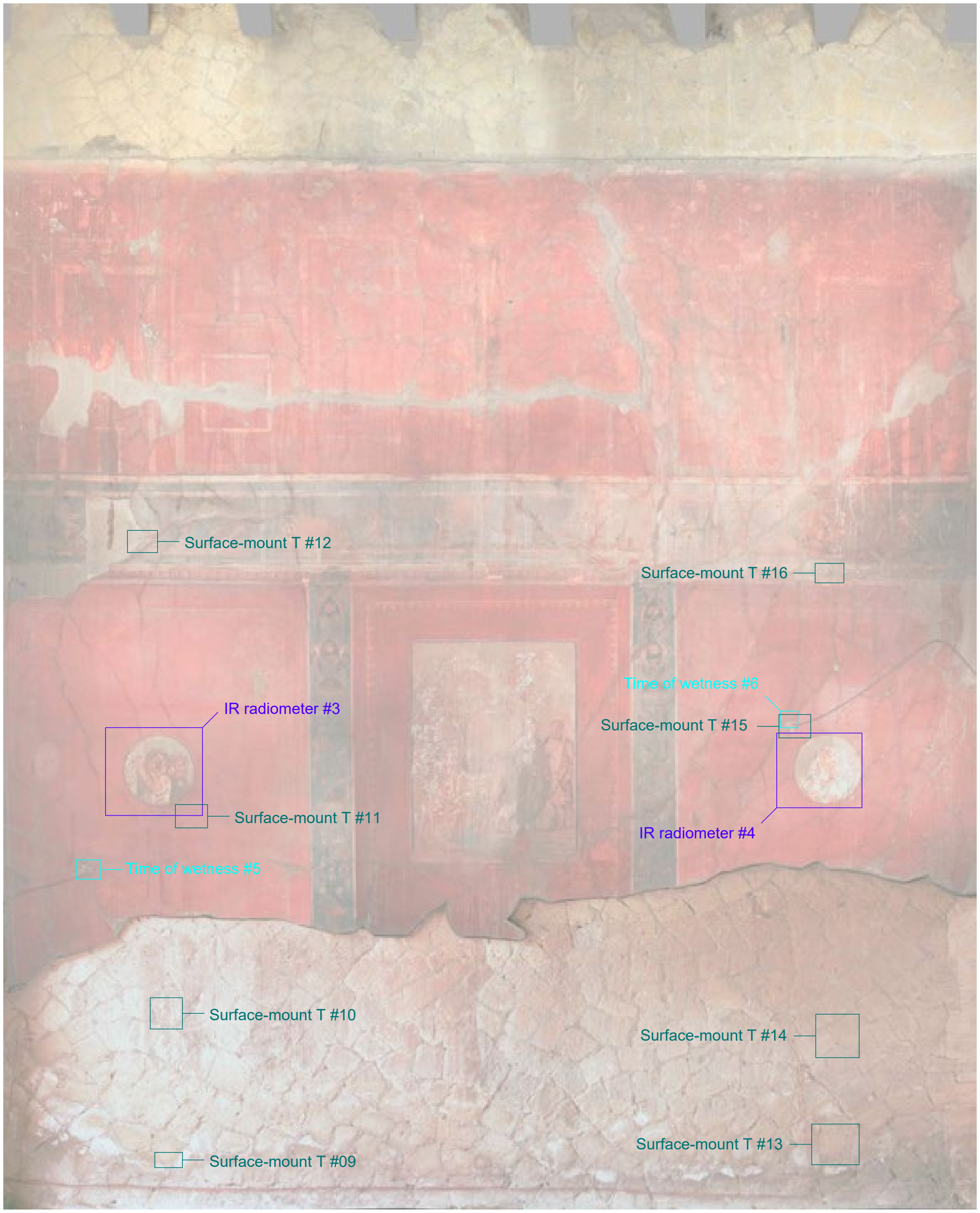
Sensor Locations

Casa del Bicentenario, Tablinum, East Wall - Overall

SENSOR LOCATIONS

- Surface-mount
- IR Radiometer
- Time of wetness

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY -----	DATE RECORDED 2011 LAST REVISED 2017/05	**EW** SCALE 1:25



Casa del Bicentenario, Tablinum, West Wall - Overall

SENSOR LOCATIONS

- Surface-mount
- IR Radiometer
- Time of wetness

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY -----	DATE RECORDED 2011 LAST REVISED 2017/05	**WW** SCALE 1:25

CHAPTER 5

Scientific Report on the Wall Paintings in the Tablinum of the House of the Bicentenary

Kiernan Graves, Francesca Piqué, and Leslie Rainer

With contributions from Giorgio Torraca, Giacomo Chiari, Beril Biçer-Simsir, David Carson, Art Kaplan, Lionel Keene, Herant Khanjian, Emily MacDonald-Korth, Shin Maekawa, Joy Mazurek, Alan Phenix, Michael Schilling, Ivana Angelini, Gilberto Artioli, Giulia Caneva, Ilaria Catapano, Lorenzo Crocco, Maurizio de Gennaro, Gianluca Gennarelli, Arlen Heginbotham, Nicola Masini, Ippolito Massari, Alessandro Massari, Michele Secco, Maria Sileo, Francesco Soldovieri, and Marco Tescari

Executive Summary

The tablinum, or reception room, of the House of the Bicentenary at the archaeological site of Herculaneum contains wall paintings that are highly refined and among the most celebrated at the site. Excavated in 1938, the paintings deteriorated over the following decades. Their superb quality combined with their rapid deterioration compelled scientific research into the original materials of the wall paintings and their condition, along with complementary studies of the restoration materials used since excavation and deteriogens.

The study was initiated by Professor Giorgio Torraca, Arcotech scientific consultant to the Herculaneum Conservation Project (HCP) 2003–2010.[1] The work was continued by the Getty Conservation Institute (GCI) in a collaborative project with HCP and Soprintendenza Archeologica di Pompei (SAP)[2] starting in 2008. The GCI project began by assisting with scientific research, and in 2011 was expanded to include a full conservation program of the architectural surfaces of the tablinum. The investigations were conducted with the support of the GCI Science department and external laboratories. The research and analysis done by both non-invasive and laboratory-based methods provided a number of results, including identification of six unique plaster stratigraphies, using a combination of four types of plaster; identification of four unique decorative types with specific paint stratigraphies, using a variety of pigments and pigment mixtures; identification of original yellow pigment that was altered to red from the heat of the eruption; identification of five types of restoration plasters; and characterization of a number of materials present on the surface, both organic and inorganic, which were intentionally added or accumulated naturally over time.

The four original Roman plasters are (1) gray plaster composed of lime and volcanic sand, (2) gray-orange plaster composed of lime, crushed brick, and volcanic sand, (3) fine white plaster composed of lime and crystalline calcite, likely crushed marble, and (4) tinted plaster composed of lime, crushed marble, and pigment to color the plaster. The location and function of each unique plaster stratigraphy is believed to be based on two factors. One is practical problem solving, such as the addition of crushed brick (*cocciopesto*) to plasters applied to the pilasters flanking the entrance to the peristyle garden to increase their resistance to water, and the application of a separate plaster for the frieze plaster to mask a plaster join. The other factor is aesthetics, such as the final layer of fine white

plaster that was tinted with red ocher, possibly to imbue a richer color in areas thought to be presentation areas.

The palette employed by the Roman artists was not exhaustively studied, as this research was never intended as a full technical study. However, the research identified carbon black, green earth, Egyptian blue, cinnabar, red ocher, yellow ochers (possibly from different geological sources), lime white, and possibly shell white. Two yellow ochers are differentiated from each other by the presence of lead found only in the yellow pigment applied to the upper register. Using XRF and XRD analysis, areas that were originally yellow but transformed to red by the heat of the eruption in 79 CE were distinguished from areas of red pigment intentionally used by the Romans.

Typically, the paints either were applied on fresh plaster and bound into the calcium carbonate lime matrix in areas of monochrome background where use of the fresco technique is evidenced, or were applied in multiple layers over the monochrome background or bare plaster. In some cases, where, due to the high concentrations of calcium carbonate, it appears that the paints were applied with a lime binder. Historical writings suggest that an organic binding medium would have been used to apply carbon black; however, none has been detected, though the nature and long physical history of the paintings should be noted as a caveat. In some upper layers of red, green, and blue decoration, calcium and sulfate have been mapped in an equal and even distribution throughout discrete layers. This could suggest the original utilization of gypsum as an intentional binding medium or extender in addition to the lime. Results are inconclusive, as calcium and sulfate have also been mapped in other patterns, suggesting that the presence of these elements is due to deterioration.

Five types of plaster or grouting materials used in previous interventions were also identified. Four of these were used during the 1938 excavation and one was used more recently. The four used in 1938 were predominantly lime based and found to be compatible with the original Roman plasters, which has contributed to the long-term stability of this intervention. Both beeswax and paraffin were identified on the surface of all samples analyzed. In a few samples taken from the most highly decorated areas, known components of modern synthetic adhesives were identified, but the precise materials could not be specified. Other superficial materials identified were calcium oxalates, gypsum crust, calcium carbonate crust, cyanobacteria (present as green, black, and blue biofilms), and a pink biopatina thought to be the genus *Rubrobacter*. The primary salt species found both on the surface and within the plaster was sodium sulfate, concentrated along the base of the walls up to approximately 100 cm.

The analytical research undertaken in the tablinum of the House of the Bicentenary to identify original and non-original materials, combined with the understanding of the environmental conditions, advanced the development of appropriate conservation measures to prevent further deterioration. Additionally, the results of this study contributed to a deeper understanding of deterioration agents and mechanisms causing damage to the tablinum wall paintings and other Roman paintings in the Vesuvian region.

Introduction

The tablinum, or reception room, of the House of the Bicentenary at the archaeological site of Herculaneum contains some of the most celebrated wall paintings at the site. Well preserved when excavated in 1938, the paintings suffered progressive deterioration in subsequent years. Their rapid deterioration prompted a focused scientific study of the wall paintings and their condition. In the context of the GCI project, in partnership with PA-ERCO and the HCP, a study of architectural surfaces in the highly decorated tablinum was carried out to better understand and characterize original materials and technique, identify restoration materials, and assess condition and causes of deterioration. The analytical work was undertaken in collaboration with a number of institutions and laboratories in the United States and Italy.

Background

Relevant to the GCI's project, a body of exceptional Roman wall paintings was discovered at Herculaneum. Of notable significance are the paintings in the tablinum of the House of the Bicentenary, discovered in 1938 by archaeologist Amedeo Maiuri. The walls of the tablinum are decorated with fields of monochrome background color embellished with delicate architectural, floral, or figurative elements, including centrally located figurative scenes in either a rectangular or a round format, imitating portable painting.

Due to the superior artistic quality of the wall paintings in the tablinum, they are considered emblematic of the site. On account of their perilous state of deterioration, the paintings became the focus of scientific investigations. The diagnostic study of the deterioration phenomenon of flaking paint occurring in the figurative scenes was initiated in 2006 by Giorgio Torraca.[3] The results of the investigations conducted prior to the GCI partnership (2006–8) will not be outlined in detail as part of this report, as they were previously published (see Piqué et al. 2007).

In 2008, the GCI partnered with the HCP to further develop and carry out scientific study under the direction of Giacomo Chiari, former head of the GCI Science department, and Professor Torraca. In 2011, the scope expanded to develop a focused field project that incorporated a comprehensive conservation plan for the architectural surfaces of the tablinum of the House of the Bicentenary. The project included a full study of the architectural surfaces and a pilot project to conserve them. The resulting scientific investigations informed the development of passive measures and remedial interventions to stabilize the wall paintings and mosaic pavement, though to date, analysis has been focused on the wall paintings.

Approach to Scientific Investigations

Scientific investigations were undertaken to understand the painting technique and to contribute to the development of the tablinum conservation plan. The approach was comprehensive and included background research, condition assessment and monitoring, environmental monitoring, and analytical investigations—prioritizing non- or minimally invasive methods wherever possible, followed by implementation and treatment monitoring.

Background research included the collection of historical records (archival photographs, excavation records, and information on previous interventions) and a review of relevant literature. Very little written documentation recording past treatments and maintenance interventions was found. However, what is known from visual evidence and oral histories is noted throughout the report where applicable (see Piqué, MacDonald-Korth, and Rainer 2015; Rainer and Piqué, this volume; Gittins et al., this volume; Rainer and Graves, this volume, and Rainer, this volume, for more information). Two references written by Roman authors that give direct insight into the materials and methods of Roman wall painting are Vitruvius (*The Ten Books on Architecture*) and Pliny (*Natural History*). Both writings specifically mention Pompeii and wall painting techniques used there. Modern sources that use analysis to understand Roman methods are extensive and begin with Chaptal (1809), Davy (1815), and Laurie (1910). Augusti (1967) presents a seminal and exhaustive analytical survey of original materials of Pompeii and, with Delamare (1982), begins a period of more intensive analytical research that gains momentum at the turn of the twenty-first century—of note is the work published in the proceedings for the 1996 international workshop held in Fribourg (Béarat et al. 1997)—and continues to the present, resulting in numerous published studies of original Roman painting techniques. Background research was followed by extensive visual examination of the tablinum, as well as other Roman houses in Herculaneum and the Vesuvian region, to contextualize the technique and condition phenomena.

Scientific investigations first used non-invasive techniques, which could be performed on site, followed by representative sampling and laboratory analysis. When viable, portable instruments were brought to the site to collect data in situ. The non-invasive methods informed sampling of the wall paintings in the tablinum. Samples were also taken from other houses at Herculaneum with comparable painting technique and/or conditions, as well as from untreated wall painting fragments from site storage. These samples were valuable for a better understanding of Roman wall painting techniques across the site without contamination from restoration materials.[4]

In order to understand the issue of flaking paint, which rapidly led to significant loss, a majority of early samples were taken from areas of concentrated deterioration; these areas were most frequently seen in the rectangular scenes and medallions. Additional research focused on the characterization of the painting stratigraphy and the composition of materials found in different layers. To this end, a selection of samples of paint and plaster was taken from diverse locations throughout the tablinum to represent each painting stratigraphy and to identify and understand the distribution of the deteriogens present. Other samples included micro-scrapings of original materials, previous intervention materials, salt efflorescence, and microbiological growth. All samples were selected to be representative of the query, while their locations were selected to minimize impact on the paintings, and micro-samples were taken from the edges of losses and in zones of least importance. Samples were taken over a number of campaigns as research expanded and new questions arose. This information, combined with an understanding of environmental conditions such as temperature, relative humidity, solar exposure, and moisture movement was fundamental to understanding the deterioration mechanisms acting on the paintings (see Massari and Massari 2011; Maekawa, this volume; and Rainer, this volume).

Research Methods

A wide array of analytical and investigation techniques were used to study the paintings in situ and samples collected from the site. These techniques include technical photography, reflectance transformation imaging (RTI), endoscopy, portable and laboratory-based Fourier transform infrared spectroscopy (FTIR), X-ray fluorescence (XRF), infrared thermography (IRT), ground penetrating radar (GPR/georadar), laser speckle interferometry, microscopy (in situ digital and laboratory-based optical with reflected visible and ultraviolet light (RL-OM)), environmental scanning electron microscopy-energy dispersive X-ray spectroscopy (ESEM-EDS), X-ray diffraction (XRD), gas chromatography–mass spectrometry (GC-MS), μ-Raman, enzyme-linked immunosorbent assay (ELISA), and ion chromatography (IC) (table 5.1).

TABLE 5.1. Analytical techniques for study of the wall paintings and samples.

Technique	Purpose	Laboratory	Year
Technical Imaging	Identification of pigments, and presence of organic materials	Piqué-Verri GCI	2006 2014
RTI	Documentation of decorated surface	GCI	2008
Endoscopy	Identification and characterization of stratigraphy and plaster delamination	GCI	2015
Portable FTIR	Identification of pigments, surface accumulation, and presence of organic materials	UNI PG	2006–2007
Portable XRF	Identification of pigments and possibly surface accumulation	UNI PG GCI (two separate instruments)	2007 2015
Portable XRD (TERRA)	Identification of pigments, surface accumulation, and deteriogens	GCI	2008
IRT	Location/characterization of voids and/or metal pins/anchors	CNR_IBAM	2015
GPR	Location/characterization of voids and/or metal pins/anchors	CNR_IREA	2014–2015
Laser speckle interferometry	Location/characterization of voids	GCI	2010
In situ microscopy (VIS/UV)	Characterization of stratigraphy, plasters, pigments, and surface accumulation	GCI	2008–2015
Microscopy (PLM, VIS, UV)	Characterization of stratigraphy, plasters, pigments, and surface accumulation	GCI CIRCe	2008–2017
SEM-EDS	Identification of plasters and pigments; characterization of surface accumulation and stratigraphical layers; elemental maps on cross sections	GCI CIRCe	2008–2015
μ-FTIR (laboratory instrument)	Identification of pigments, surface accumulation, and other deteriogens	GCI	2008–2015
XRD (laboratory instrument)	Identification of inorganic materials (original and non-original) present	GCI CIRCe	2010–2014
GC-MS	Identification of organic materials (original and restoration) present	GCI UniPI	2007–2015
Py-GC-MS	Identification of organic materials, in particular original red colorants	GCI	2016
μ-Raman	Identification of pigments	CIRCe	2015–2016
ELISA	Identification of binding media	GCI	2010
IC	Identification of salt species	GCI	2010 2016
Biogrowth analysis	Identification of microorganisms	Uni Roma Tre	2014–2016

In Situ Analytical Methods

Technical Photography[5]

A variety of technical imaging techniques were used in the tablinum of the House of the Bicentenary. The techniques employed to capture and process the images were based on research undertaken through the GCI Organic Materials in Wall Painting project (Piqué and Verri, 2015) and other publications (Aldrovandi et al. 2005; Verri 2009; Dyer, Verri, and Cupitt 2013; Verri and Saunders 2014; Chiari, forthcoming). A Sony Nightvision DSC828 digital camera was mainly used for all photographic imaging (exceptions are listed below under the individual techniques), with modifications of the light sources and filters. In all cases, a Gretag gray Macbeth scale was used as a standard of reference to allow for correction of the spectral distribution of the light sources and exposure compensation. For the UV photography, a Spectralon (99% reflectance in the 400–700 nm range) was used as a reference standard for evaluation of stray ambient light. False-color IR and UV images were obtained after the photo capture using Adobe Photoshop software.

Visible Imaging (VIS)

VIS, visible light capture, used halogen lights (1000 W halogen lamp) and Quantum QF8C Xenon flash as the light sources, an IDAS_UIBAR visible bandpass filter in front of the camera lens, and a digital camera. This capture was performed with incident and raking light.

Visible Induced Luminescence (VIL)

This infrared imaging technique used a visible light and a Quantum QF8C Xenon flash as light sources, a Schott RG830 UV/visible light blocking filter in front of the camera lens, and a digital camera capable of recording IR radiation in the 800–1000 nm range. The strong response to visible radiation of Egyptian blue allows the characterization of its spatial distribution and the detection of small quantities of pigments within a painted scheme in the near infrared (maximum peak 910 nm) when excited with visible light (maximum absorption 637 nm) (Accorsi et al. 2009; Verri 2009). In some instances, the technique was carried out using a regular photography flash, equipped with a short pass filter to block the infrared component. The technique, now widespread, was used for the first time in Herculaneum (Chiari 2017). This analysis was undertaken using a Canon G9 digital camera, modified to remove the IR blocking filter installed in digital cameras.

Infrared Reflected (IRR)

IRR is an infrared imaging technique using both halogen lights and a Quantum QF8C Xenon flash as the light sources, a Schott RG830 UV/visible light blocking filter in front of the camera lens, and a digital camera capable of recording IR radiation in the 800–1000 nm range (modified Nikon D700).

Ultraviolet Reflected (UVR)

This ultraviolet imaging technique used both UV lamps and a Quantum QF8C Xenon flash (modified with a DUG11X filter) as the light sources, a DUG11X UV bandpass filter in front of the camera lens, and a digital camera capable of recording IR radiation in the 800–1000 nm range (modified Nikon D700). A pair of Wood lamps with Schott DUG 11 excitation filters, necessary in order to eliminate the visible parasitic light, was used as the ultraviolet radiation source.[6] The reflected UV was eliminated with a Schott 418 emission filter positioned in front of the lens.

Reflectance Transformation Imaging (RTI)[7]

An imaging technique for enhancing and documenting the fine texture of objects, RTI was developed by the Hewlett-Packard (HP) laboratories (http://www.hpl.hp.com/research/ptm/ri.html) and originally was referred to as polynomial texture mapping (PTM). To obtain the desired RTI image, a series of images is captured. The camera must be kept motionless in front of the object, while the light source (a lamp or a flash) is moved at regular intervals, allowing for multiple pictures to be taken with incident light at various angles. The computer can deduce the light position analyzing the small spot produced on a shiny sphere inserted in the imaging field. The HP Fitter software can produce an RTI image on which the direction of the light can be varied on the computer screen with a touch of the mouse. This technique, which evidences texture, is particularly useful to show three-dimensional conditions of paint and can be used for condition monitoring over time.

In Situ Digital Microscopy[8]

The microscope used was a digital USB Dino-Lite Am4515zt Edge Microscope with a polarizer function and a magnification range of 20×–220× with visible and UV LED illumination.

Endoscopy[9]

An XL Vu video probe borescope was used to investigate plaster stratigraphy in different areas of the walls, where deep losses could be used to probe lower plaster layers. The XL Vu borescope is a battery-operated fiber-optic video scope with LED illumination, which was used with a wide-angle tip with a focal range of 20 mm to infinity.

X-ray Fluorescence Spectroscopy (XRF)[10]

Non-invasive analysis of original and added materials conducted in 2006 used an X-ray fluorescence spectrometer with a tungsten X-ray anode (EIS Ltd.) coupled with a silicon drift detector (SDD) with a resolution of 150 eV at 5.9 KeV. The X-ray beam was collimated to a spot of 0.4 cm in diameter. The incident beam was orthogonal to the surface of the painting, while the signal fluorescence was collected at an angle of 45°. During analysis, the spectra were corrected for the efficiency curve of the detector and results were reported as counts per second (cps).

Analysis was conducted in 2015 using a Bruker TRACeR handheld ED-XRF with Rh anode and an SDD detector. Spectra were collected at 1 mA/40 kV and 25 mA/15kV. Spectral deconvolution and peak area determination for the TRACeR spectra were done off-site using PyMca software (Solé et al. 2007), available at http://sourceforge.net/.

Infrared Thermography (IRT)[11]

To detect voids between layers and other anomalies in the plaster layers, thermographic imaging was performed with a FLIR SC660 microbolometer that acquires images in the long-wave spectral band between 7.5 and 13 micrometers with temperature resolution of <45 mK, IR resolution 640 × 480 pixels. The investigations were conducted on the paintings through the passive method, using the transient thermal technique (heat flow variable in the time domain), and through the active method, monitoring the transient variation of temperature induced on the surface by an appropriate artificial heat produced by the absorption of light emitted by halogen lamps. Additional processing based on statistical analysis of multitemporal datasets was performed to emphasize thermal anomalies.

Ground Penetrating Radar (GPR)[12]

Non-invasive subsurface investigations were performed with the K2-RIS GPR device designed by IDS Systems Engineering SpA, equipped with a shielded antenna system operating at a nominal central frequency of 2 GHz. The GPR data were processed using a microwave tomographic approach, based on a linear model of the scattering phenomenon, developed at IREA-CNR. This approach is capable of providing high-resolution images of the surveyed region at different depths.

Laser Speckle Interferometry[13]

The custom-built laser speckle interferometry system was used to detect voids. The system was based on a 1200 mW Class IV 532 nm laser dispersed through a 60× microscope objective. The excitation was obtained by a loud modulated sound produced by commercial speakers. Data collection was done using a monochrome camera operating at 20 frames per second in conjunction with a custom-made acquisition software package (Keene and Chiang 2009).

Laboratory-based Analytical Methods

Optical Microscopy[14]

At the GCI, samples selected for examination as cross sections and thin sections were mounted in Technovit 2000 LC resin (a UV-curing acrylic) and polished by hand without liquid lubricant. The prepared cross sections were examined under visible light (crossed polarizing filters) and by ultraviolet light using Leica DM4000 and Olympus BH-2-RFCA microscopes. Digital images were captured using a Diagnostic Instruments Flex camera with the Leica and a Canon EOS D5 Mark II camera with the Olympus.

When mounted and examined by CIRCe, the polished sections were obtained by vacuum impregnating portions of the materials with epoxy resin and sectioning them orthogonally to the surface. Samples containing paint layers were analyzed by means of confocal laser scanning microscopy (CLSM), using an Olympus LEXT OLS4100 laser scanning digital microscope.

At Roma Tre University, observation of the morphological characteristics of the samples of microbiological growth was performed using a Wild M3 stereomicroscope with an objective at 40× magnification (Olympus BX41).

Scanning Electron Microscopy (SEM)[15]

At the GCI, environmental scanning electron microscopy with energy-dispersive X-ray spectroscopy (ESEM-EDS) was performed on selected cross sections using a Philips XL30 ESEM-FEG instrument fitted with an Oxford INCA EDS analysis system. EDS analysis was done under standard ESEM conditions: H_20 mode, 10 mm, 20kV accelerating voltage, 0.8–1.0 torr water vapor. ESEM-EDS analysis is capable of providing data on the elemental composition of target sites in samples; target sites may be single points or larger areas of interest, and provision exists within the INCA software for mapping of the distribution of specific elements. ESEM-EDS analysis allows identification of the elemental composition of the sample and visualization of the distribution of elements within the sample. In many instances, the presence and/or combination of indicative elements can, by inference, provide a reliable indication for the identification of a constituent pigment.

At CIRCe, SEM was performed using a CamScan MX2500 scanning electron microscope equipped with a LaB6 cathode and a four-quadrant solid-state BSE detector for imaging. The analytical conditions were accelerating voltage 20 kV, filament current 1.80A, emission current 20 microA, and aperture current 300 nA, with a working distance of 20–30 mm. Furthermore, SEM-EDS was used for chemical microanalysis, mounting a Sapphire

Detector composed by a LEAP+ Si(Li) crystal and a Super UltraThin Window. Qualitative interpretation of spectra and semiquantitative chemical analysis were performed through SEM Quant Phizaf software.

At Roma Tre University, samples of the microbiology were spurred with gold under vacuum using K550 units (Emitech Technologies Ltd., Kent, England) and observed using an XL30 SEM microscope (FEI Company, Eindhoven, Netherlands). SEM-EDS was used to characterize the chemical nature of the substrate and its change in composition due to the presence of microbiological organisms.

Micro-Fourier Transform Infrared Spectroscopy (μ-FTIR)[16]

Analysis was performed on the samples using a 15× Schwarzschild objective, attached to a Bruker Hyperion 3000 FTIR microscope and purged with dry air. The samples were analyzed individually using a transmitted infrared beam with the aperture set to 200 × 200 micrometers. Polarizing filters were used to enhance sample contrast and assist in targeted analysis of the various components. Identification of the infrared spectral data was performed with the help of in-house generated reference libraries.

For each sample, selected particles were placed on a diamond window and flattened using a metal roller. The samples were analyzed using a 15× Cassegrain objective attached to a Bruker Hyperion 3000 FTIR microscope housing a liquid nitrogen-cooled midband MCT detector, and purged with dry air. The spectra are the sum of sixty-four scans at a resolution of 4 cm^{-1}. Reference spectra from the infrared spectral database were utilized in the identification process.

X-ray Diffraction Spectroscopy (XRD)[17]

The white plaster layer was separated from any surrounding material and ground to an even consistency using a mortar and pestle. Powder X-ray diffraction analysis was performed in 2008 using a Bruker D5005 Theta-Theta diffractometer equipped with Cu tube and secondary monochromator, set at 40 kV and 20 mA. The diffractograms, when needed, were processed following the Rietveld method to obtain quantitative data (program Quanto; Altomare et al. 2001). In 2016, a Rigaku Miniflex 600 XRD was used with the following acquisition settings: tube settings of 40kV and 15 mA, 10 deg/min scan speed, 0.02 degree step width, and a scan range of 3°–75° 2-Theta.

At CIRCe, the analysis was carried out after micronization of the materials by a McCrone micronizing mill, using a plastic jar with agate grinding elements and ethanol 99% as micronizing fluid. Data were collected using a Bragg-Brentano Theta-Theta diffractometer (PANalytical X'Pert PRO, Cu Kα radiation, 40kV and 40mA) equipped with a real-time multiple strip detector (X'Celerator by PANalytical). Divergence and antiscattering slits of ½ degree and 1 degree, respectively, were mounted in the incident beam pathway. The pathway of the diffracted beam included a Ni Filter, a soller slit (0.04 rad), and an antiscatter blade (5 mm). Data acquisition was performed by operating a continuous scan in the 3–80 range with a virtual step scan of 0.02. Diffraction patterns were interpreted with X'Pert HighScore Plus 3.0 software by PANalytical, qualitatively reconstructing mineral profiles of the compound by comparison with PDF databases from the International Center for Diffraction Data. QPAs were then performed using the Rietveld method. Refinements were accomplished with TOPAS software (version 4.1) by Bruker AXS.

On site, TERRA (Inxitu/Olympus), a portable XRD/XRF system that requires sampling and operates in transmission mode, was used. The system has a 2D Peltier cooled CCD sensor, an XRD range of 5°–55°2Ɵ and XRF energy range of 3–25 KeV. XRD data were processed using the EVA program and the XRF using ARTAX software, both by Bruker.

Gas Chromatography–Mass Spectrometry (GC-MS)[18]

This analysis was used to detect the presence of binding media, namely proteins, lipids, and waxes according to the procedure in Schilling and Khanjian (1996).

Pyrolysis-GC-MS analysis was carried out on a Frontier Lab PY-2020D double-shot pyrolysis system (550°C, 6 sec) attached to an Agilent Technologies 5975C inert MSD/7890A GC-MS. Column: Frontier Ultra ALLOY-5 30 m (0.25 mm × 0.25 μm); helium carrier gas at 1 ml/min flow. Oven program: 40°C for 2 min, ramped 20°C /min to 320°C, then held at 320°C for 9 min; MS ionization: 70eV.

Raman[19]

Measurements to detect the nature of the pigments found in the pink biopatinas and the nature of blue powders of the microbiological growth were conducted using a Horiba Jobin Yvon LabRAM Raman spectrometer, equipped with a He-Ne laser operating at 633 nm. Spectral acquisition times were between 1 and 10 s, with three accumulations in a range of 300–2000 cm^{-1}, and the objective lenses 50× and 100× were used.

μ-Raman[20]

The analyses were performed using a DXR Thermo Scientific Raman microscope equipped with a diode-pumped solid-state 532 nm laser, operating at a power of 8 mW, with a spot size of 1.1 micrometers and using a pinhole of 25 micrometers. The spectra are recorded in the range of 100–3200 cm^{-1}, with a resolution of 2 cm^{-1}, using a 5-second exposure time and generally 32-scan accumulation. Acquired spectra were processed with Ominc software and compared with a reference database published on the RRUFF website (http://rruff.info).

Enzyme-linked Immunosorbent Assay (ELISA)[21]

According to the procedure given in Mazurek et al. (2008), a spectrophotometer or automated plate reader such as Finstruments model #341 96-well microplate spectrophotometer (MTX Lab Systems, Virginia) was used to detect the presence of organic binders.

Ion Chromatography (IC)[22]

Salt species were identified using a Metrohm 940 Professional IC Vario 1 with conductivity detector. A metrostep A Supp 7-250/4 column was used at 0.8 mL/min. The column was heated to 45°C and the eluent was 0.36 M sodium carbonate. The standards were acetic acid 14 ppm to 200 ppm and was a quadratic regression 0.999 correlation.

Results[23]

Results presented here summarize all investigations, carried out both on site and through laboratory-based analysis of samples. In some cases, only one representative sample could be taken from a particular location. Where the stratigraphy was more complex, more than one sample was taken to confirm results. In organizing the results, wall painting technology is discussed first,[24] presented stratigraphically as follows: (1) wall support (primary support), (2) plaster (secondary support), (3) paint layers, and (4) binding media. The results go on to describe non-original materials found: (1) previous intervention materials, (2) surface layer(s), and (3) deterioration agents. To date, no analysis has been undertaken on the mosaic pavement, since it is largely inaccessible, and appears to be in fairly stable condition.

Wall Support

The original architectural support of the wall paintings is tuff block walls constructed in *opus reticulatum* using materials and techniques typical of Roman architecture in this region (Paternoster et al. 2007), with one exception: the two pilasters found on the lower south wall that flank the exterior opening to the peristyle garden are constructed in *opus vittatum*, a composite of tuff and brick alternating between courses.

After the eruption and following excavation, parts of the Roman walls had collapsed and were reconstructed in 1938 by Maiuri's team using tuff blocks in *opus incertum*, in which the blocks are inserted in an irregular way without following a pattern. Portions of the original tuff walls remain in situ.

Preliminary analysis on one sample of original Roman tuff was performed using both polarized light microscopy (PLM) and SEM on thin sections, and XRD analysis was performed on one unmounted sample (BCN_62). Of note, the original Roman tuff does not coincide with the analysis of Casacampora tuff (de Gennaro and Franco 1976; Camardo 2007), which is associated with the construction of Herculaneum (de Gennaro 2016). Due to this discrepancy, further analysis is warranted.

Plaster

Overview of Results[25]

Examination and analysis established that the plaster stratigraphy of the three tablinum walls is not uniform. Roman craftsmen employed six different plastering sequences, using four categories of lime-based plaster, to prepare the wall for painting, make moisture-resistant plasters, and achieve a variety of decorative effects. Consequently, the description of the plasters with regard to number, sequence, and nature of the layers applied over the primary support is location dependent. The following sections provide a summary of all analytical results relating to the characterization of Roman plasters. The specific attributes of each original plaster composition will be described individually, grouped by the locations and/or types of decoration that share the same stratigraphy. The categories are as follows: (1) Base of Wall, (2) Lower East Wall, Lower West Wall, Upper South Wall, Medallions, and Vertical Bands, (3) Upper East and Upper West Walls, (4) Rectangular Scenes, (5) Lower South Wall, and (6) Frieze (fig. 5.1). Where identical plaster layers are present throughout the different categories, the results will not include information already discussed.

A full original stratigraphy of the Roman plasters was difficult to observe. The majority of the wall paintings in the tablinum, particularly those on the east and south walls, were reconstructed from fragments of painted plaster that either detached from their original support due to the eruption or were removed from the wall during excavation in 1938. At that time, plaster fragments were remounted onto a new architectural support constructed of tuff by his team (Maiuri 1958). Visual examination of the remounted fragments suggests that plaster was shaved off the back to leave a fixed thickness of original layers (3–4 cm) to facilitate the remounting process (see Gittins et al., this volume, for more information). A large portion of the lower register in the central part of the west wall appears to have remained intact, evidenced by the plaster found in good condition and less fragmentary than the surrounding areas (fig. 5.2). However, it was prohibitively invasive to sample deeper than 2–4 cm in areas where the full stratigraphy appears to be preserved. Therefore, the full stratigraphy of the paintings cannot be completely described, but it is likely still partially preserved on the west wall and at the base of the east wall. (For a more detailed description, see Piqué, McDonald-Korth, and Rainer 2015; and Rainer and Piqué, this volume.) Generally, the most recurring plaster stratigraphy of the tablinum walls follows

Plaster categories (and their locations):

- Lower east and west: upper south
- Upper east and upper west
- Rectangular scenes
- Frieze
- Lower south
- Base

FIGURE 5.1.
Tablinum basemaps of east, south, and west walls, noting nomenclature for each decorative type and its location.

FIGURE 5.2.
The lower register of the west wall, showing large areas which appear to have remained intact as evidenced by absence of small fragments and cracks unlike the correlating area on the east wall.

Vitruvius's description of plastering walls in *The Ten Books on Architecture*, and is characterized by one or more layers of coarse lime-based gray plaster (with dark volcanic sand aggregate), over which is applied one or more layers of fine white plaster, rich in lime and crushed marble.[26] On the lower east and west walls (including areas of the vertical band and medallions) and upper south wall,[27] a pink-tinted plaster was applied over the fine white plaster. The pink portion of the plaster has the same material characteristics of the white portion below, except that it also contains finely ground red ocher particles, imbuing the layer with a uniformly pink tone.[28] The stratigraphy of the frieze and rectangular scenes is similar, with slight modifications to the sequence of plaster application. Variations on this stratigraphy are seen in the tablinum, namely at the base of the wall and in the lower portion of the south wall.

Following non-invasive and in situ investigations using visual examination, digital microscopy, and endoscopy, twenty-four samples containing at least one layer of plaster were taken from locations throughout the room (see appendix 5.1). Of the samples taken, twelve were selected to undergo full petrographic, mineralogical, chemical, and microstructural material characterization, mainly by means of optical polarizing microscopy, XRD, μ-Raman spectroscopy, and SEM-EDS. The remaining twelve samples were analyzed using optical microscopy and SEM.

Base of Wall

The east wall is the sole area in the tablinum where original painted plaster remains at the base of the wall below the lower register. Determined through in situ and cross-section examination, the stratigraphy here differs from all other areas. The full plaster stratigraphy is composed of at least four coarse and relatively thick gray plaster layers. There is no presence of either the fine white plaster or the pink-tinted plaster layer at the base of the wall.

Using in situ measurements, it is estimated that the entire stratigraphy would have originally been approximately 7 cm from the tuff brickwork to the painted surface. Three samples (BCN_33, BCN_34, and BCN_60) were taken from this area, mounted as cross sections, and subjected to full mineralogical and petrographic analysis. Results of cross-section examination using optical microscopy and SEM correlate with the visual examination and show four plaster layers. Though the layers are similar in composition, analytical results present subtle differences in physical properties that enable the distinction between the layers. The layers are identified as B4 to B1, with B4 representing the layer closest to the tuff wall and B1 found directly below the painted surface.[29]

The four original Roman plaster layers (B4 to B1) are all visually identified as coarse and gray. Their binding matrix is characterized by a yellowish-white color (7.5Y 8/2 Munsell) and a homogeneous carbonate microcrystalline texture. The aggregates are morphologically classified as sub-rounded to rounded and characterized by a medium to low sphericity. Texturally, they are homogeneously distributed in the binder matrix. Petrographically, the aggregate found within all four layers is constituted by a volcanic sand composed of dark to reddish volcanic scoria fragments with abundant phenocrysts of plagioclase, sanidine, clinopyroxene, and leucite and a significant glassy fraction, partially zeolitized, associated with abundant crystals of green and colorless clinopyroxene, rare crystals of feldspar, and flakes of dark mica.[30] In layer B4, a small portion of heterogeneous aggregate composed of limestone and flint fragments is also present. SEM-EDS analyses on the four plaster layers showed limited incidence of pozzolanic reaction despite the reactive nature of several aggregate species.

It is possible to observe a clear difference in cohesive properties between B4 and the uppermost three layers, where the former is more porous than the rest. Consequently, the adhesion between layers B4 and B3 is medium to poor, with the occurrence of extensive interfacial cracking, while conversely, the adhesion between the other layers is substantially better. Particles in B4, B3, and B2 show no distinct orientation, suggesting that they were not polished or compacted upon application, whereas the orientation of the aggregate in layer B1 indicates that the layer could have been partially polished or compacted before setting.

Results of investigations and analysis of the plasters found at the base of the wall are summarized in figure 5.3.

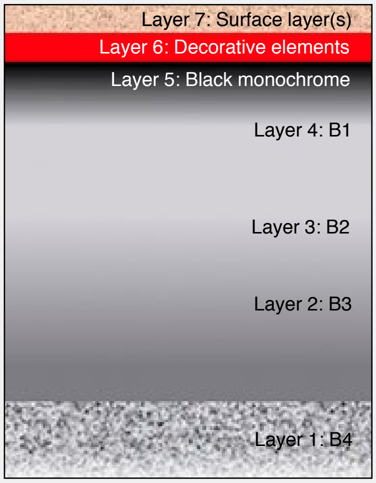
Lower East Wall, Lower West Wall, Upper South Wall, Medallions, and Vertical Bands

The plaster stratigraphies found on the lower east and west walls (including the medallions and vertical bands) and on the upper south wall are identical and thus described together even though they are from different walls and registers. Ten samples were taken from these areas and mounted as cross sections. These areas are compositionally distinct from other areas due to the presence of a pink-tinted plaster layer located between the fine white plaster and the paint layers (figs. 5.4–5.6). In situ digital microscopy confirms that the pink-tinted plaster is consistently visible throughout these areas of the tablinum.

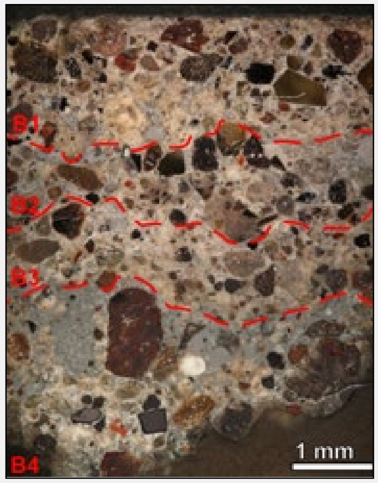
Beginning at a depth of 2–3 cm from the painted surface,[31] the layering sequence of these specific areas begins with a coarse gray plaster (compositionally similar to the B4 plaster discussed previously), thickness unknown, followed by an application of fine white plaster averaging 3.3 mm in thickness, and finally a pink-tinted plaster averaging 0.5 mm in thickness. In all samples examined, there was no evidence of interfacial separation,[32] such as a carbonation layer, between the three layers.

Sample BCN_59, taken from the lower register of the west wall, will be used as the representative sample to illustrate this stratigraphy. Unless indicated, the description of the BCN_59 stratigraphy is identical to that of all ten samples taken from these areas. BCN_59 contains all the layers from the coarse gray plaster up to the surface decoration. All layers are bound with lime, but the coarse gray plaster layer differs from the other two plaster layers in color, type of aggregate, binder-to-aggregate ratio, and presence of fibers, as well as thickness, porosity, and polish. The original Roman gray plaster seen in sample BCN_59 is identical to the B4 plaster described in the “Base of Wall” section above.

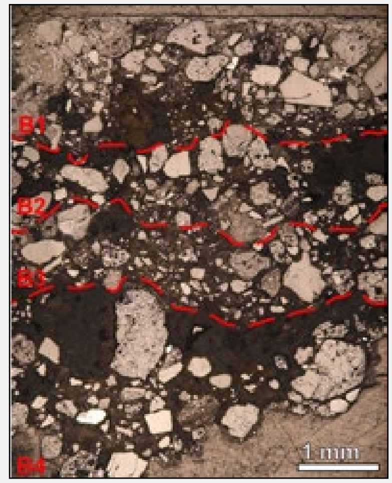
The fine white plaster is characterized by a white color (N9 Munsell), low porosity, and high cohesion. The binder matrix is characterized by a homogeneous carbonate microcrystalline texture. The aggregate is morphologically characterized as sub-angular to angular with medium to low sphericity. Texturally, it is homogeneously distributed in the binder matrix and oriented parallel to the surface, suggesting that it was polished or compacted while the plaster was still fresh. Petrographically, the aggregate is almost entirely composed of large euhedral spathic calcite crystals, indicating that the inert fraction is mainly constituted by crystalline calcite, likely crushed marble.



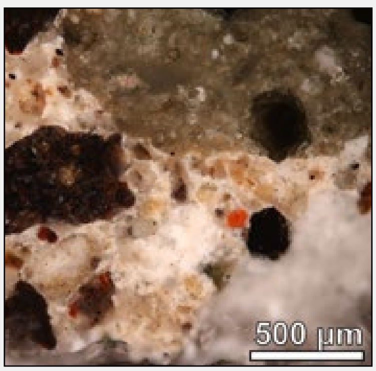
Graphic representation of the stratigraphy of base of wall.



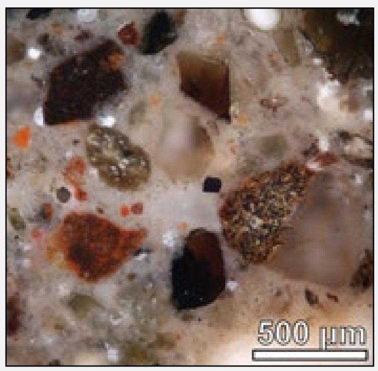
Full stratigraphy of base of wall in cross section, sample BCN_33 taken from base of east wall.



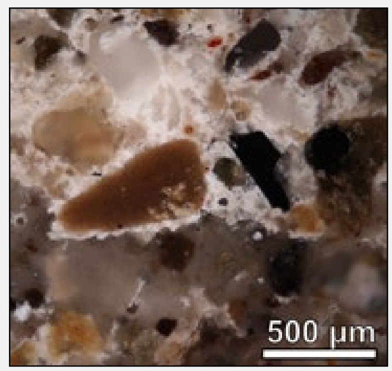
Cross-polar micrograph of BCN_33.



Cross section BCN_60 showing detail of layer 1 (B4).



Cross section BCN_60 showing detail of layer 2 (B3).



Cross section BCN_60 showing interface between layers 3 and 4 (B1 and B2).

Optical and Electron Microscopy (Averages for all samples examined)

Layer	Description	Thickness	Elements Detected	Binder	HI	Aggregate	Binder to Aggregate	Porosity
4-B1	Gray plaster	1.8 mm	Ca, Si	Lime	0.05	Volcanic sand	1 to 2.5 Lean	10–15% High
3-B2	Gray plaster	1 mm	Ca, Si	Lime	0.05	Volcanic sand	1 to 2.5 Lean	7–10% Medium/High
2-B3	Gray plaster	1 mm	Ca, Si	Lime	0.05	Volcanic sand	1 to 2 Lean	7–10% Medium/High
1-B4	Gray plaster	n/a	Ca, Si	Lime	0.05	Volcanic sand	1 to 3 Lean	10–15% High

XRD

Layer	Description	Minerals Identified
1-4 B4-B1	Gray plaster	Calcite is the only phase related to the binder. The remaining crystalline phases are coherent with a natural volcanic sand aggregate fraction constituted by scoria fragments with a ground mass and phenocrysts of sanidine, bytownite, andesine, augite, leucite, biotite, quartz, and hematite and an associated glassy fraction partially zeolitized to analcime. Dolomite is present in two samples.
List of confirming samples: BCN_33, BCN_34, BCN_35, BCN_38, BCN_43B, BCN_44, BCN_60		

FIGURE 5.3.

Summary of results. Plaster: Base of Wall.

FIGURE 5.4.
Basemap of east wall graphically documenting the location of the pink-tinted plaster.

FIGURE 5.5.
Basemap of south wall graphically documenting the location of the pink-tinted plaster.

FIGURE 5.6.
Basemap of west wall graphically documenting the location of the pink-tinted plaster.

The pink-tinted plaster layer can be characterized as a moderate orange pink (5Y 8/4 Munsell). There is very little morphological difference between this layer and the white layer, apart from a slight enrichment in iron, indicating the utilization of finely ground red ocher to impart a delicate pink hue. Such a hypothesis is confirmed by SEM-EDS analyses on the micrometric particles of pigment within the layer. The chemical profile indicates that the pigment is mainly composed of iron, associated with reduced amounts of clay minerals. Furthermore, weak Raman peaks between 100 and 650 cm^{-1} are related to the presence of hematite, and such experimental evidence indicates the utilization of low aliquots of this mineral as pigment in this layer.

In all ten samples, there is an application of a monochrome background color of either yellow, red, or black applied using the fresco technique over the pink-tinted plaster layer. Over the monochrome background, decorative elements or figurative scenes were painted. The materials and techniques employed to decorate the wall surfaces will be discussed in more detail in the “Paint” section.

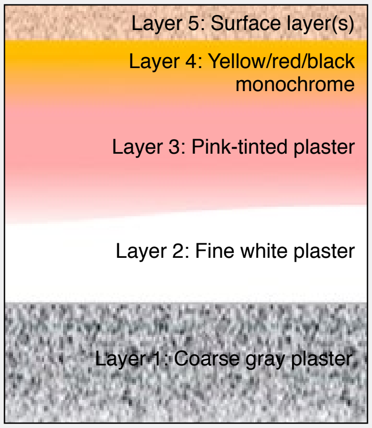
Results of investigations and analysis of the plasters found on the lower east wall, lower west wall, upper south wall, medallions, and vertical bands are summarized in figure 5.7.

Upper East and Upper West Walls

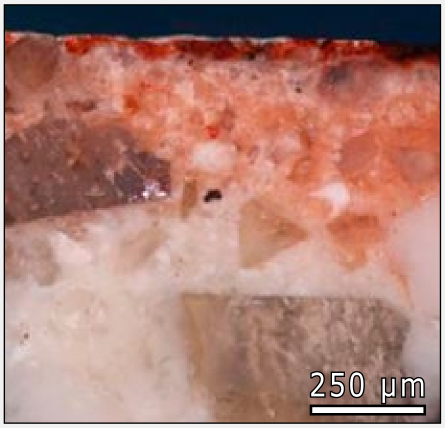
The plaster stratigraphies in the upper register of the east and west walls are similar to those in the lower walls. In general terms, the composition of the coarse gray plaster and the fine white plaster found in other areas is identical to that in the upper east and west walls. However, the layer of pink-tinted plaster is not found in the cross sections or seen by visual examination or in situ digital microscopy.

Three samples were taken from these areas. BCN_51 was taken from the upper east wall; BCN_52 and BCN_58 were taken from the upper west wall. All samples were mounted as cross sections. Sample BCN_58 will be used as the representative sample to illustrate this stratigraphy, as it contains the most stratigraphic information, from the coarse gray plaster with a volcanic sand aggregate to the painted surface. A full mineralogical and petrographic analysis was undertaken on this sample.

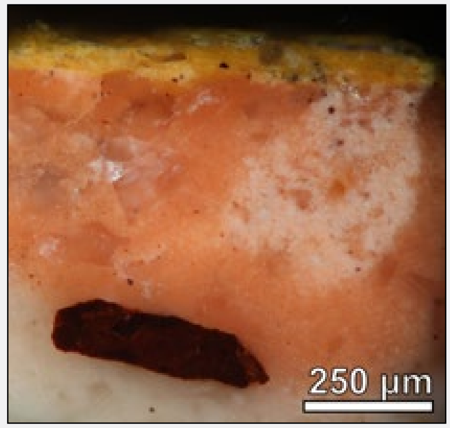
There was no evidence of interfacial separation between the coarse gray and fine white plaster layers. In most categories, both plasters are identical to their counterparts found in other areas of the tablinum. Of note, the fine white plaster is characterized by a medium to



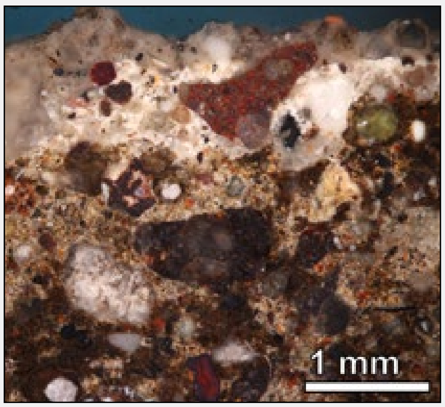
Graphic representation of the stratigraphy of lower east wall, lower west wall, upper south wall, medallions, and vertical bands.



Cross section showing upper stratigraphy (layers 2, 3, 4, and 5) of BCN_59, lower west wall (20×).



Cross section showing upper stratigraphy (layers 2, 3, 4, and 5) of BCN_28, lower east wall (20×).



Cross section of layer 1 of BCN_59 (20×).

Optical and Electron Microscopy (Averages for all samples examined)

Layer	Description	Thickness	Elements Detected	Binder	HI	Aggregate	Binder to Aggregate	Porosity
3	Pink-tinted plaster	0.35–0.6 mm	Ca, Fe, Si, Mg, S	Lime	0.01	Crushed marble	1 to 1 Fat	3–5 % Low
2	White plaster	3.3 mm	Ca, Si, S	Lime	0.01	Crushed marble	1 to 1 Fat	3–5 % Low
1	Gray plaster	n/a	Ca, Si	Lime	0.05	Volcanic sand	1 to 3 Lean	10–15 % High

XRD

Layer	Description	Minerals Identified
1	Gray plaster	Calcite is the only phase related to the binder. The remaining crystalline phases are constituted by scoria fragments and phenocrysts of sanidine, bytownite, andesine, augite, leucite, biotite, quartz, and hematite and an associated glassy fraction partially zeolitized to analcime. Aragonite is found in one sample.

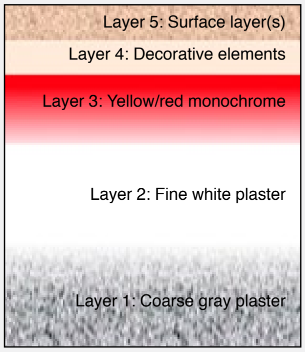
Raman Spectroscopy

Layer	Description	Materials Identified	Additional Comments
3	Pink-tinted plaster	Calcite, hematite, carbon, trace gypsum	
2	White plaster	Calcite, trace gypsum	Gypsum is probably related to a limited occurrence of sulfate attack.
List of confirming samples: E1_11, W1_03, W2_04, BCN_15, BCN_53			

FIGURE 5.7.
Summary of results. Plaster: Lower East Wall, Lower West Wall, Upper South Wall, Medallions, and Vertical Bands.

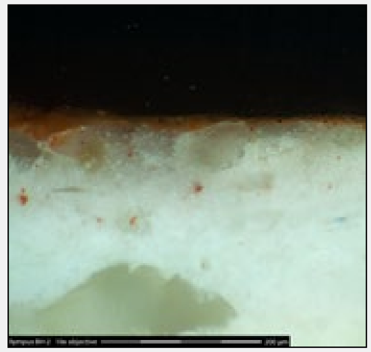
high porosity, which corresponds to the superficial white layer of the rectangular scene. Otherwise, all of the characteristics observed are the same as in those samples of fine white plaster from other locations.

Results of investigations and analysis of the plasters found on the upper east and west walls are summarized in figure 5.8.

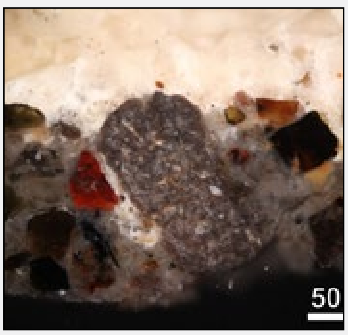


Graphic representation of the stratigraphy of upper east and upper west walls.

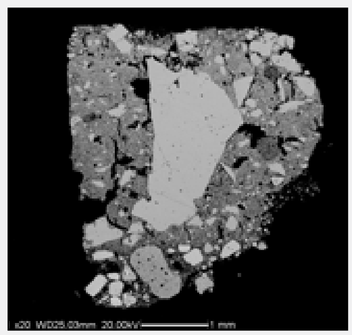
Upper stratigraphy of BCN_58 (upper west wall, south side) showing the clear absence of a pink-tinted plaster layer.



Upper stratigraphy of BCN_52 (upper west wall, north side) showing the clear absence of a pink-tinted plaster layer.



Cross section of lower stratigraphy of BCN_58 (20×).



BSE image of entire stratigraphy of BNC_58.

Optical and Electron Microscopy (Averages for all samples examined)

Layer	Description	Thickness	Elements Detected	Binder	HI	Aggregate	Binder to Aggregate	Porosity
2	White plaster	3.3 mm	Ca, Si	Lime	0.02	Crushed marble	1 to 1 Fat	5–8% Med.
1	Gray plaster	n/a	Ca, Si	Lime	0.05	Volcanic sand	1 to 3 Lean	5–8% Med.

Raman Spectroscopy

Layer	Description	Materials Identified	Additional Comments
2	White plaster	Calcite	

XRD

Layer	Description	
1	Gray plaster	Calcite is the only phase related to the binder. The remaining crystalline phases are coherent with a natural volcanic sand aggregate fraction constituted by scoria fragments with a ground mass and phenocrysts of sanidine, bytownite, andesine, augite, leucite, biotite, quartz, and hematite and an associated glassy fraction partially zeolitized to analcime.
List of confirming samples: BCN_51, BCN_52		

FIGURE 5.8.

Summary of results. Plaster: Upper East and Upper West Walls.

FIGURE 5.9
Example of the plaster join visible around the two rectangular scenes seen in raking light.

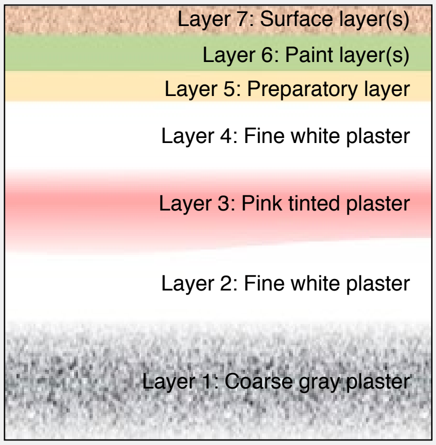
Rectangular Scenes

The two rectangular scenes in the tablinum, located in the center of the east and west walls, have a unique stratigraphy that consists of a gray plaster, a white plaster, a thin pink-tinted plaster, and a final white plaster. Visual examination in raking light shows that the plaster of the rectangular scene is slightly higher than in the surrounding monochrome panel, and there is an overlap of this plaster around all four sides, indicating that the secondary layer of fine white plaster in the rectangular scenes was added over the pink-tinted plaster as a preparation for the figurative painting (fig. 5.9). This stratigraphy suggests that the rectangular scenes in the tablinum are painted in an “inset” technique (Mora, Mora, and Philippot 1984), a technique seen in Roman wall painting in which a rectangular recess was left unpainted during the original execution of the monochrome background layer, to be finished by specialized artists on a freshly applied final plaster layer.

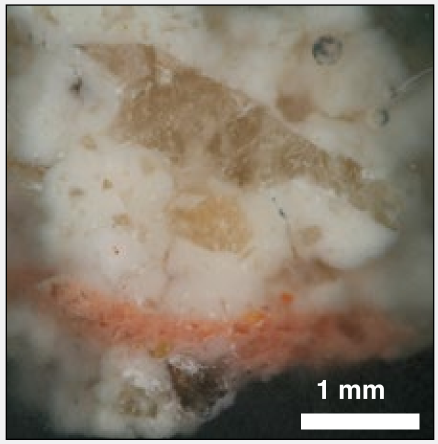
Only one sample of plaster was taken from the rectangular scenes due to the significance and fragility of these areas.[33] The cross section BCN_29, taken from the east wall, shows the stratigraphy described above. The two layers of fine white plaster in BCN_29 are similar to each other and comparable to the white plasters found in different stratigraphies throughout the room. The pink-tinted plaster, sandwiched between these two white layers, has the same characteristics in terms of composition, porosity, and thickness as the pink-tinted plasters found elsewhere. The coarse gray plaster described in previous sections is visible and appears to be identical to other areas, but could not be sampled without causing undue damage.

There is no evidence of interfacial separation between the first white layer, the pink layer, and the uppermost white layer.[34] The white and pink-tinted plasters are identical to their correlating plasters except that their cohesion is slightly less (only medium high as opposed to high), and porosity is slightly greater. The higher porosity is attributed to the final white layer, and the occurrence of large irregular vughs is probably due to physical alteration phenomena of the plaster. Conversely, porosity in the internal layers is mainly constituted by dendritic microchannels.

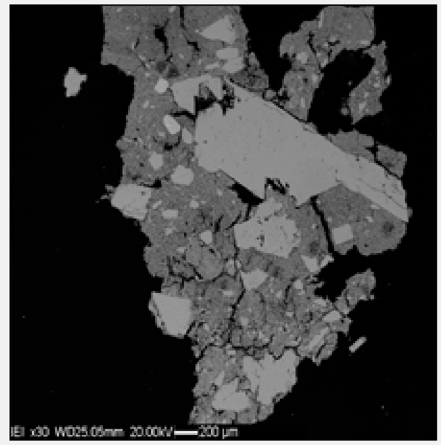
Results of investigations and analysis of the rectangular scene plasters are summarized in figure 5.10.



Graphic representation of the stratigraphy of the rectangular scenes.



Cross section showing two white plasters with the pink-tinted plaster between them (east wall, rectangular scene).



Backscattered electron image of BCN_29 showing absence of interfacial separation between the lower white, pink, and upper white plaster layers.

Optical and Electron Microscopy (Averages for all samples examined)

Layer	Description	Thickness	Elements Detected	Binder	HI	Aggregate	Binder to Aggregate	Porosity
4	White plaster	n/a	Ca, Si	Lime	0.02	Crushed marble	1 to 1 Fat	5–10% Med.
3	Pink-tinted plaster	0.35–0.6 mm	Ca, Fe, Si, Mg	Lime	n/a	Crushed marble	1 to 1 Fat	5–10% Med.
2	White plaster	n/a	Ca, S, Si	Lime	0.02	Crushed marble	1 to 1 Fat	5–10% Med.
1	Gray plaster	Unable to be sampled						

Raman Spectroscopy

Layer	Description	Materials Identified	Additional Comments
4	White plaster	Calcite	
3	Pink-tinted plaster	Calcite, hematite, carbon	
2	White plaster	Calcite, trace gypsum (in only a few samples)	Gypsum probably related to a limited occurrence of sulfate attack
List of confirming samples: n/a			

FIGURE 5.10.
Summary of results. Plaster: Rectangular Scene.

Lower South Wall

The plaster stratigraphy of the pilasters flanking the opening to the peristyle garden is unique in the tablinum, as it is the only area where the plaster contains crushed brick as an aggregate. No plaster material with corresponding composition is found elsewhere. This is of interest, as it could indicate that the Roman craftsmen formulated their plaster for areas of exposure, or that later renovations were undertaken using a different plaster composition. In *The Ten Books on Architecture*, Vitruvius writes that crushed brick should be used for “damp places,” which could apply to this situation as the pilasters of the lower south wall face the peristyle garden. Examples of plasters from other Roman buildings exhibit similar composition, but those described in published reports were found with a finishing plaster layer over the top (Mariani et al. 2005; Bugini and Folli 2013; Bugini et al. 2017) and do not have pigment applied directly over the plaster layer in a fresco technique, as seen in the tablinum.

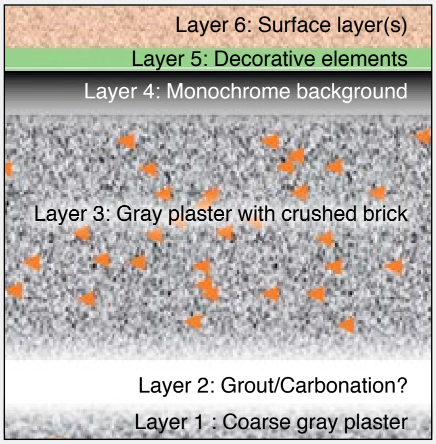
One sample, BCN_42b, from the lower south wall, was taken, mounted in cross section, and subjected to a full mineralogical and petrographic analysis. The stratigraphy begins with a microscopic amount of coarse gray plaster that appears similar to the B4 found elsewhere in the room when examined by SEM. Over this, a lime-rich layer that has the characteristics of either a thick carbonation layer or modern grout is found. The next layer is a gray plaster that is compositionally different from the others in the tablinum. This uppermost gray plaster is composed of lime, volcanic sand, and crushed brick and is found only on the pilasters of the lower south wall. Neither fine white nor pink-tinted plasters are present.

The binder matrix of the uppermost gray plaster layer is characterized as a pale grayish-orange color (10YR 8/6 Munsell) with moderate to high cohesion and a homogeneous microcrystalline texture. Present within the matrix are abundant brick fragments showing clear reaction rims at the interface with the surrounding binder, suggesting the presence of both carbonated lime portions and areas rich in hydrated calcium aluminosilicates due to pozzolanic reaction. The aggregate grains are morphologically characterized as subrounded to rounded and with medium to low sphericity. Texturally, they are homogeneously distributed in the binder matrix, and their orientation suggests that the surface was not polished or compacted in any way, unlike any other plaster directly under painted areas, except for the plaster at the base of the wall, which is similarly treated. Petrographically, the brick fragments have an abundant glassy fraction and quartz, plagioclases, and k-feldspars. Furthermore, a subordinated volcanic sand fraction is present, characteristically similar to aggregate seen in the coarse gray plasters found elsewhere in the room.

Results of investigations and analysis of the plasters found on the lower south wall are summarized in figure 5.11.

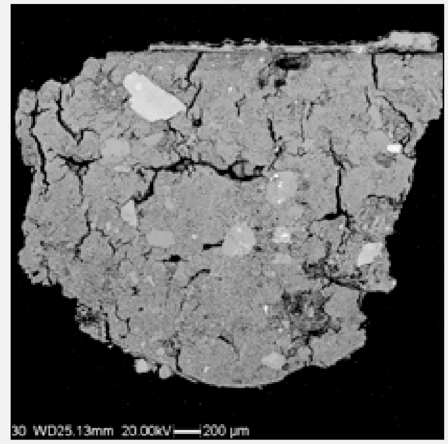
Frieze

The area of the frieze has a stratigraphy composed of the layers described in the upper walls, with an additional layer of painted plaster applied over the original monochrome

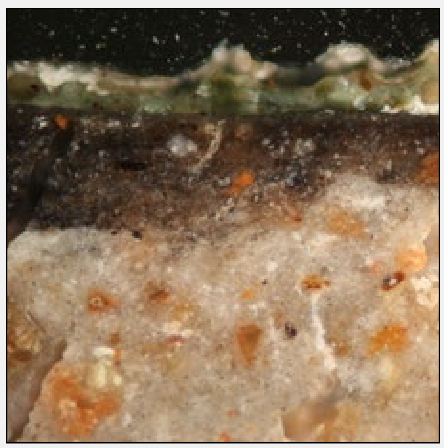


Graphic representation of the stratigraphy of the lower south wall.

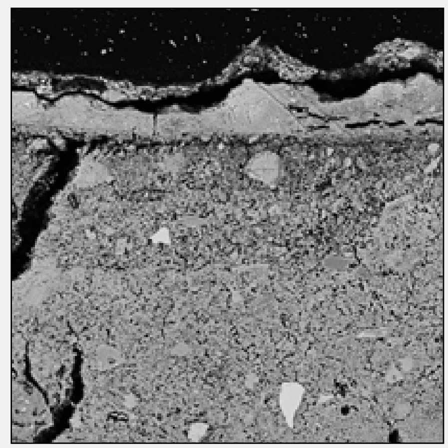
Cross section of BCN_42 (lower south wall, west side) showing the unique plaster found with the brick dust as aggregate. Layer 2 is indicated by the white arrow.



Backscattered electron image of BCN_42.



Cross-section detail of BCN_42 at 20× magnification.



Backscattered electron image of detail of BCN_42.

Optical and Electron Microscopy (Averages for all samples examined)

Layer	Description	Thickness	Elements Detected	Binder	HI	Aggregate	Binder to Aggregate	Porosity
3	Gray plaster with brick dust	2.4 mm	Ca, Si, Al	Lime	0.1	Crushed brick/ volcanic sand	1 to 1 Fat	5% Low
2	Carbonation layer? Grout?	20 μm	Ca, Si	Lime	n/a	n/a	n/a	n/a
1	Coarse gray plaster	n/a	Ca, Si	Lime	n/a	Volcanic sand	n/a	n/a

XRD

Layer	Description	Materials Identified	Additional Comments
2	Carbonation layer? Grout?	Calcite, dolo-mite, silicate	The nature of the layer is confirmed by the determined mineralogical profile, where calcite is the highly dominant phase. The reduced presence of dolomite and silicate phases is related to contaminations with surrounding plaster layers during sampling.
List of confirming samples: n/a			

FIGURE 5.11.
Summary of results. Plaster: Lower South Wall.

backgrounds of the upper and lower registers, presumably to mask the plaster join of the *pontata*. This can be seen visually and in the stratigraphy of four samples.

Sample BCN_54, taken from the frieze of the east wall, shows the gray plaster, white plaster, and yellow monochrome background layer (corresponding to the stratigraphy of the upper east wall directly above where the sample was taken), followed by the painted plaster of the frieze, which is described below. BCN_31, taken from the opposite end of the east frieze, and BCN_55, taken from the west frieze, show the white plaster and red monochrome background layer (corresponding to the stratigraphy of the upper east and west walls, respectively, directly above where the samples were taken), followed by the frieze plaster. BCN_56, taken from the south frieze, exhibits the white plaster, pink-tinted plaster, and red monochrome background layer (corresponding to the stratigraphy of the upper south wall), followed by the painted plaster of the frieze. The discussion below is limited to the frieze plaster. All of the underlying layers correspond to plaster stratigraphies from the upper register described in previous sections, followed by a yellow monochrome background or red monochrome background—either originally red or converted to red, depending on location.

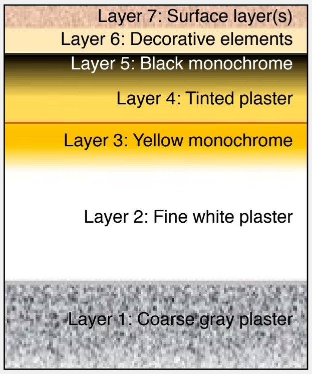
In all four samples (BCN_31, BCN_54, BCN_55, and BCN_56), the frieze plaster is a tinted plaster directly under the black monochrome paint layer. However, each of the four samples presents a different color and slightly different elemental composition when mapped with SEM. The frieze plaster seen in sample BCN_54 (east wall) is tinted a creamy yellow color and has a relatively high content of calcium and silicon, a medium amount of aluminum and sulfur, and a low amount of magnesium and iron.[35] BCN_31 (east wall) is tinted orange-red and has a relatively high content of calcium, a medium amount of aluminum, and a low amount of silicon and iron. BCN_55 (west wall) is tinted dark red and has a relatively high content of calcium, sulfur, and magnesium and a low amount of iron, silicon, aluminum, potassium, and chlorine.[36] Comparatively, BCN_56 (south wall) is tinted brownish red and has a relatively high amount of calcium, a medium amount of silicon and sulfur, and a low amount of aluminum and iron (table 5.2). The visual and compositional differences are more likely due to effects of heat from the eruption rather than an intentional use of different pigments to tint the plaster. In all four samples, the plaster is lime based with crushed marble as the main aggregate. The thickness of each is consistent and measures approximately 250 µm. In all cases, there is an interfacial separation between the monochrome background layer and the layer of the tinted frieze plaster, but no separation between the frieze plaster and the uppermost black monochrome background is observed in the SEM-EDS backscattered images. The aggregates in the frieze plaster are generally oriented parallel to the external surface, indicating that the plaster was polished or compacted on application.

Results of investigations and analysis of the plasters found on the frieze are summarized in figure 5.12.

TABLE 5.2. Frieze plaster examined by optical and electron microscopy.

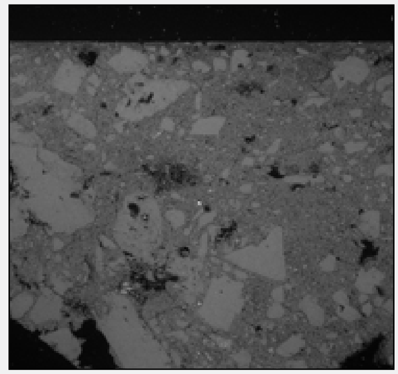
Sample	Location	Description	Thickness	Elements Detected
BCN_31	EW	Orange-red	0.6 mm	**Ca,** Al, *Si, Fe*
BCN_54	EW	Creamy yellow	0.5 mm	**Ca, Si,** Al, S, *Mg, Fe*
BCN_55	WW	Dark red	0.7 mm	**Ca, S, Mg,** *Fe, Al, K, Cl*
BCN_56	SW	Brown red	0.6 mm	**Ca,** Si, S, *Al, Fe*

Ca (strong presence), Ca (present), *Ca (minor presence)*

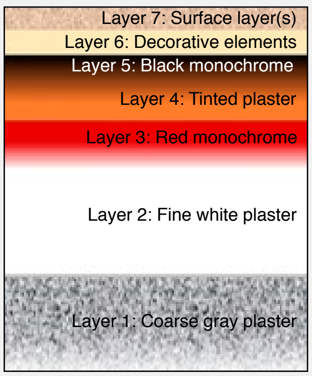


Graphic representation of the stratratigraphy of the frieze from the east wall showing yellow-tinted plaster

Cross section of the frieze plaster sampled from the atrium-end of the east wall, BCN_54, showing layers 4, 5, and 7.

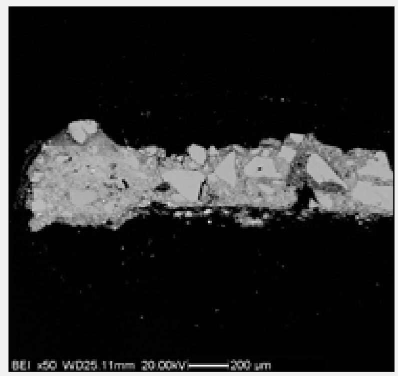


Backscattered electron image of BCN_54 showing the lack of interfacial separation.



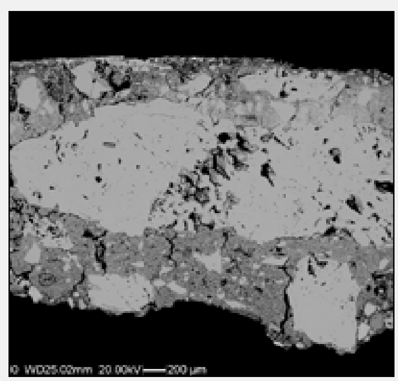
Graphic representation of the stratratigraphy of the frieze from the east wall showing orange-tinted plaster.

Cross section of the frieze plaster sampled from the peristyle garden-end of the east wall, BCN_31f, showing layers 3, 4, 5, and 7.



Backscattered electron image of detail of BCN_31f.

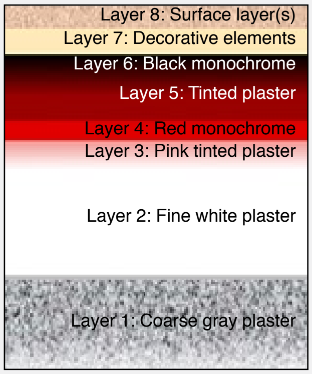
Cross section of the monochrome background and white plaster, found directly underneath the frieze plaster (pictured above), BCN_31R, showing layers 2 and 3.



Backscattered electron image of detail of BCN_31R.

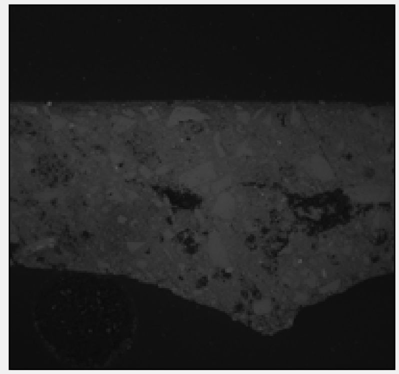
FIGURE 5.12

Summary of results. Plaster: Frieze.

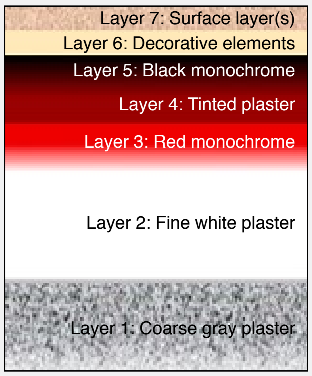


Graphic representation of the stratigraphy of the frieze from the south wall showing reddish brown-tinted plaster.

Cross section of the frieze plaster sampled from the south wall, BCN_56, showing layers 5 and 6.

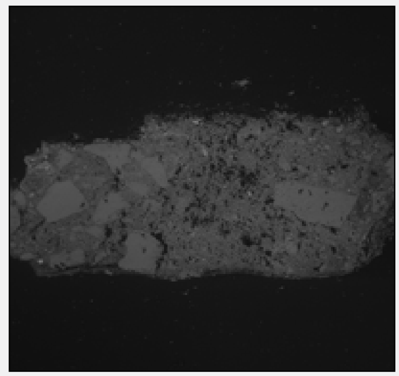


Backscattered electron image of detail of BCN_56.



Graphic representation of the stratigraphy of the frieze from the west wall showing red-tinted plaster.

Cross section of the frieze plaster sampled from the west wall, BCN_55, showing layers 4 and 5.



Backscattered electron image of detail of BCN_55.

Optical and Electron Microscopy (Averages for all samples examined)

Layer	Description	Thickness	Elements Detected	Binder	HI	Aggregate	Binder to Aggregate	Porosity
4	Tinted frieze plaster	n/a	(See table 5.2)	Lime	0.02	Crushed marble	1 to 1 Fat	3–5 % Low
3	Monochrome background	0.2 mm	Ca, Fe	Lime	n/a	n/a	n/a	n/a
2	White plaster	n/a	Ca, Si	Lime	0.01	Crushed marble	1 to 1 Fat	3–5 % Low
1	Gray plaster	unable to be sampled						

Raman Spectroscopy

Layer	Description	Materials Identified	Additional Comments
4	Tinted frieze plaster	Hematite	
3	Monochrome background	See Paint section	
2	White plaster	Calcite	
List of confirming samples: n/a			

Paint

Overview of Results[37]

Consistent with Roman wall painting technology of this period and region, the monochrome background of the walls of the tablinum were painted using the fresco technique, in which the pigments are dispersed in water and applied to the lime-based plaster before it has fully set.[38] The monochrome background colors of yellow, red, and black were applied onto the fresh plaster as fields of color the height of each *pontata* and correspond to the overall decorative scheme. The background would have been painted and then polished or compacted prior to the complete setting of the plaster to obtain a smooth surface. In most areas throughout the tablinum, decoration was added in a thickly applied paint directly over the monochrome backgrounds, whereas the rectangular scenes were painted directly over a layer of bare white plaster. The investigations provided a profile for each of the decoration types, defined by an individual paint stratigraphy. The results are organized as follows: (1) monochrome background, (2) decorative elements (including frieze and vertical bands), (3) medallions, and (4) rectangular scenes. (For full descriptions, see Rainer and Piqué, this volume.)

By combining a number of non-invasive methods, including visual examination, digital microscopy, technical imaging, portable XRF, and FTIR, pigments were characterized and their distribution was mapped. To undertake the laboratory-based analysis, fifty-eight microsamples were taken, thirty-one were mounted as cross sections, and twenty-seven were scrapings (see appendix 5.1). Elemental analysis using ESEM-EDX mapping detected the main chemical elements present, and the subsequent hypothesis of the nature of each pigment was possible in a number of cases. Molecular analysis on representative samples using XRD, FTIR, μ-Raman, and GC-MS was used to confirm the above analyses and answer other specific questions. To date, no original organic colorants have been positively identified in any of the paint layer samples from the tablinum.

Reds, yellows, and some greens were identified as iron oxide–based pigments. The reds and yellows used for the monochrome background colors were mixed with small amounts of carbon black. Blacks were identified as carbon black using μ-Raman. Cinnabar was also identified in areas that are currently a bright fuchsia or areas that have altered to a hazy gray or black. Cinnabar was also found in areas of flesh tone mixed with yellow ocher and lime white. Blue pigment was clearly identified as Egyptian blue using microscopy, VIL, SEM, and FTIR. Analysis also found Egyptian blue as a component of purple,[39] light blue, green,[40] and creamy white, all made as paint mixtures.

Analysis confirmed that the pure white paint used in the lines of the borders and architectural elements that decorate the monochrome background was composed of calcite indicating lime white. XRD, FTIR, and ESEM found that the white paint used in the light-blue preparation layer of the medallions was composed of Egyptian blue, dolomitic lime, and calcite. Aragonite and dolomite were found, along with calcite, in association with the preparation layer on the rectangular scenes using portable FTIR, XRD, and ESEM. Though the intentional use of aragonite is unconfirmed, physical evidence of shell white has been found with PLM and SEM in two samples (BCN_20 and BCN_29).[41]

Gypsum is distributed within the paint layers, but its presence in some instances—whether an intentional Roman addition or a formation as part of a deterioration process—has yet to be determined with certainty. In most cases, it is clearly formed as part of a deterioration product; in others it is possibly related to an intentional use as a binder or an extender in combination with lime. The latter is found only in the uppermost paint layers applied over the monochrome background layers, most often seen in the red or green paint layers, and in samples from the light-blue background layers of the medallions. Evidence of this technique of mixing gypsum with lime to form a binder material in Roman times is limited to the archaeological discovery of gypsum and lime pots found together at Pompeii (Cottica and Mazzochin 2009). However, Maguregui et al. (2014) has shown that calcite will transform into gypsum upon exposure to SO_2 atmosphere and high relative humidity. XRD analysis showed that several samples of the light-blue background layer painted directly above the red background as a base layer for the medallions contained pure calcite, magnesium calcite, gypsum, and aragonite, used in a mixture with Egyptian blue. Attempts to ascertain the origin of gypsum were made by checking the interdependence of the various minerals, since alteration gypsum should be inversely proportional to calcite from which it originated.

A number of the pigments present underwent physical and chemical alterations, thus their environmental exposure and long physical history had to be carefully considered during the identification process, particularly red pigments. Evidence shows that some areas were originally red and other areas, now red, converted from yellow due to the heat of the eruption and high temperatures of the volcanic materials deposited. Cinnabar altered to black in some places and gray in others.

Results of investigations and analysis of the pigments found in the tablinum are summarized in table 5.3.

TABLE 5.3. Pigments found in the tablinum.

Type of Decoration	Sample in Cross Section	Scraping	Colors Identified	Pigments Identified
Yellow monochrome	BCN_28, BCN_51, BCN_54	BCN_51, SS17	Yellow	Yellow ocher (Goethite)
Red monochrome	W1_03, E1_11	BCN_69, BCN_70	Red	Red ocher (Hematite)
Yellow converted to red monochrome	BCN_23	BCN_31, BCN_67, SS30	Red	Red ocher (Hematite)
Black monochrome	W2_04, BCN_31, BCN_42, BCN_54, BCN_55, BCN_56, BCN_59	E2_13, E2_16, W2_05, BCN_18, BCN_26, BCN_27	Black	Carbon black
Vertical band	W2_04, BCN_59	E2_13, E2_16, W2_05, BCN_18, BCN_26, BCN_27	Black, red, white, green, yellow	Carbon black Yellow ocher Red ocher (Hematite) Cinnabar Green earth Egyptian blue
Decorative elements	BCN_23, BCN_42, W2_04	n/a	Red, white	Red ocher Lime white Green earth
Medallions	E1_12, E1_14, W1_01, BCN_02, BCN_06, BCN_15, BCN_21	E1_01, W1_02, BCN_01, BCN_05, BCN_08, BCN_19, BCN_20	Red, white, blue, green, flesh tone	Yellow ocher Red ocher Aragonite (?) Egyptian blue
Rectangular scenes	W3_06, W3_08, W3_10, BCN_03, BCN_07, BCN_09, BCN_10, BCN_17, BCN_22	W3_09, BCN_04, BCN_30, BCN_32	White, blue, green, pink, red	Yellow ocher Red ocher Vermillion Aragonite (Shell white) Green earth Egyptian blue
Frieze	BCN_31, BCN_54, BCN_55, BCN_56	n/a	Black, red, white	Carbon black Yellow ocher Red ocher (Hematite)
Egg & dart	BCN_57	n/a	Red, cream	Red ocher Lime white

Monochrome Background: Overview

Monochrome background paint layers of yellow, red, or black cover all of the plastered surfaces of the tablinum except in areas of the rectangular scenes (figs. 5.13–5.15). Depending on the area and decorative scheme, the pigment or pigments employed were either yellow ocher (μ-Raman identified goethite), red ocher (μ-Raman identified hematite), or carbon black applied in the fresco technique over the plaster layer. Within areas of both red and yellow monochrome backgrounds, black flecks, identified with μ-Raman as carbon black, are visible using digital microscopy in a fairly even distribution across the entire surface (figs. 5.16 and 5.17).

In some areas, the original monochrome yellow ocher (goethite) converted to hematite when the paintings were exposed to high heat during the eruption of Mount Vesuvius. The east wall shows visible evidence of this phenomenon: some fragments retain their original yellow color, while other portions show a graduation from yellow to red, and some are entirely red. It is theorized that the monochrome background color of both the central panels found in the lower register and the entirety of the upper register were originally

FIGURE 5.13
Basemap of east wall showing the location of monochrome background colors.

FIGURE 5.14
Basemap of south wall showing the location of monochrome background colors.

FIGURE 5.15
Basemap of west wall showing the location of monochrome background colors.

FIGURE 5.16
Micrograph showing flecks of carbon black present throughout the yellow monochrome background paint mixture.

FIGURE 5.17
Micrograph showing flecks of carbon black present throughout the red monochrome background paint mixture.

FIGURE 5.18
Basemap of east wall showing presumed location of original background colors.

FIGURE 5.19
Basemap of south wall showing presumed location of original background colors.

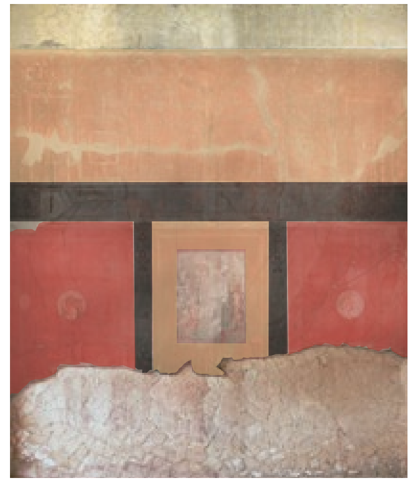


FIGURE 5.20
Basemap of west wall showing presumed location of original background colors.

yellow (figs. 5.18–5.20). Due to the differences in painting technology (such as difference in color and composition of paint and plaster) and in conditions found in the areas of the monochrome background, fifteen representative samples taken in a grid-like pattern distributed throughout the room were mounted as cross sections and analyzed. Eight microscrapings of pure pigment were taken from the same areas as the cross-section samples and analyzed using SEM, XRD, and μ-Raman. Each of the samples contributed greatly to the understanding of the painting technology and condition issues affecting the areas of monochrome background, the results of which will be discussed in the following sections: (1) Monochrome Background: Yellow, (2) Monochrome Background: Red, (3) Monochrome Background: Red converted from Yellow, and (4) Monochrome Background: Black.

Results of investigations and analysis of the pigments found in monochrome backgrounds are summarized in table 5.4.

Monochrome Background: Yellow

Today, the yellow monochrome background is visible only on the east wall, and it was sampled in three areas. Though there are similarities between the samples, each has a different plaster stratigraphy and some variation in characteristics. The samples are

TABLE 5.4. Elements found in yellow, yellow converted to red, red, and black monochrome backgrounds.

Monochrome Background Paint Layers Examined by XRF, Optical and Electron Microscopy		
Description	**Location**	**Elements Detected**
Yellow monochrome	Upper East wall	**Ca**, Al, *Si, Fe, Pb*
	Lower East wall	**Ca**, Al, *Si, Fe*
Yellow converted to red monochrome	Upper South	**Ca**, Al, S, *Si, Cl, K, Fe, Pb*
	Upper West	**Ca**, Al, Si, S, *Mg, Fe, Pb*
	Lower West wall	**Ca**, Al, *Si, S, Fe*
Red monochrome	Lower East and West walls	**Ca**, *Al, Si, S, Fe, Zn, As, Pb*
Black monochrome	Lower South wall	**Ca,** Si, S, *Al, Fe*

Ca (strong presence), Ca (present), *Ca (minor presence)*

BCN_28, from the central panel of the lower register; BCN_51, from the upper register; and BCN_54, from an area where the yellow monochrome background is underneath the frieze plaster. As stated in the overview of the monochrome background section above, two yellow ochers with a slight difference in composition were found; the yellow used in the upper register contains lead (BCN_51 and BCN_54), whereas the yellow used in the central panels of the lower register does not (BCN_28).[42]

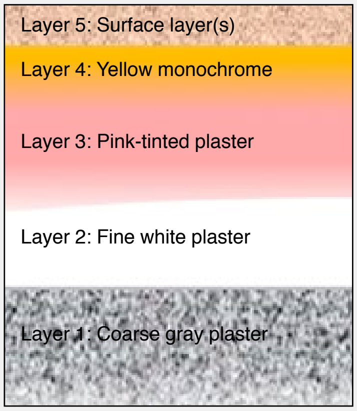
Beginning with BCN_28, taken from the central panel of the lower register of the east wall, the yellow is visually characterized by 10YR 8/8 Munsell. In this cross section, there is no clear interfacial separation between the yellow monochrome background and the pink-tinted plaster layer underneath. It is also observed that the orientation of the aggregate is parallel to the surface. This is clearly indicated by SEM-EDS images and indicates that the yellow pigment was polished or compacted after application to achieve a smooth, uniform surface.

The yellow layer is mainly composed of calcium carbonate with relatively high amounts of iron, confirming the presence of yellow ocher pigment in a calcium carbonate matrix. Furthermore, considerable amounts of silicon and aluminum are present, suggesting the abundant occurrence of clay minerals in the yellow ocher. SEM-EDS analyses on pigment particles showed rounded particles characterized by high BSE signal and mainly composed of iron, typical for iron hydroxides like goethite, which are associated with larger particles characterized by low BSE signal and mainly composed of equal amounts of silicon and aluminum, indicating a clay. ESEM-EDX mapping shows a high quantity and even distribution of aluminum. Confirmation of these analyses was made with μ-Raman, in which the spectra of the yellow layer show the typical sharp peaks of calcite, associated with a series of broader peaks between 100 and 700 cm^{-1} attributable to the mineral goethite. Furthermore, two strong, broad peaks centered at 1300 and 1600 cm^{-1} are present, typical for charcoal. Such evidence indicates a mixture of yellow ocher and carbon black pigments. This mixture is confirmed by in situ digital microscopy, which shows black inclusions found evenly distributed throughout all areas of yellow monochrome background.

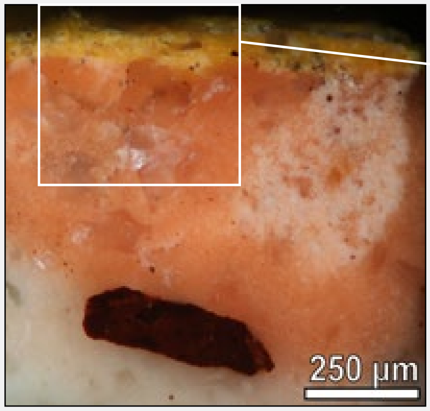
BCN_51, taken from the upper register of the east wall, and BCN_54, taken from below the frieze plaster, vary slightly from BCN_28. As discussed, the plaster stratigraphy here does not include the pink-tinted plaster layer, and the yellow ocher pigment is applied directly to the fine white plaster layer with no evidence of interfacial separations. Visual examination and microscopy (both PLM and SEM) show that the composition of the yellow pigment employed in the upper register is similar to that of BCN_28 and consists mainly of an iron-based pigment with a significant presence of silicon and aluminum. Unusually, XRF measurements show the presence of lead associated with the iron-based yellow paint layer. Analysis of scrapings with XRD was undertaken to aid in the understanding of this anomaly; however, results show that no crystalline lead present in the sample could be detected. Additionally, μ-Raman investigations showed no presence of specific peaks related to lead-based material. SEM analysis does confirm the presence of lead, both in the iron hydroxide particles of the pigments and in the matrix, with no apparent connection to specific lead oxide particles.

Due to the presence of lead found only in the original yellow in the upper register, it can be hypothesized that two different yellow ochers, one in the lower register and one in the upper register, were used, with one containing lead in the mineral composition. Further study of the lead isotope signal will be attempted and could provide information with regard to the geological source of the ocher pigments.

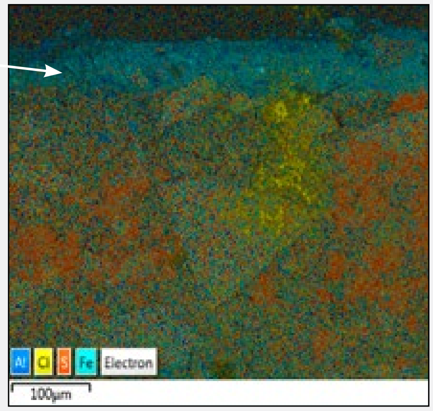
Results of investigations and analysis of the yellow monochrome backgrounds found in the tablinum are summarized in figure 5.21.



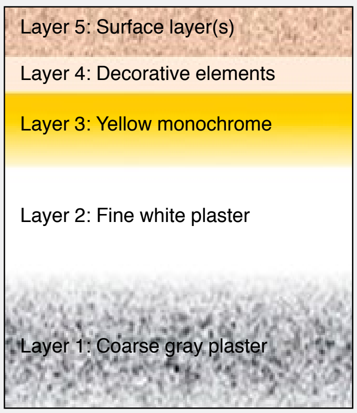
Graphic representation of the stratigraphy of yellow monochrome background painted over a pink-tinted plaster.



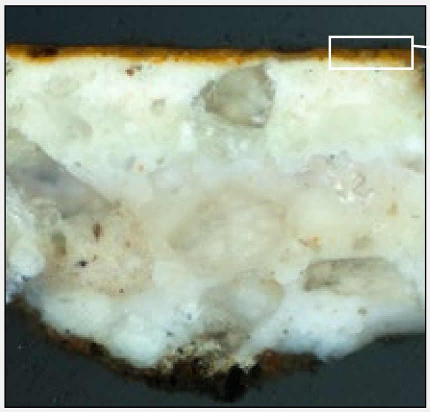
Cross section of BCN_28 from the central panel of the lower register of the east wall showing yellow monochrome background over the pink-tinted plaster.



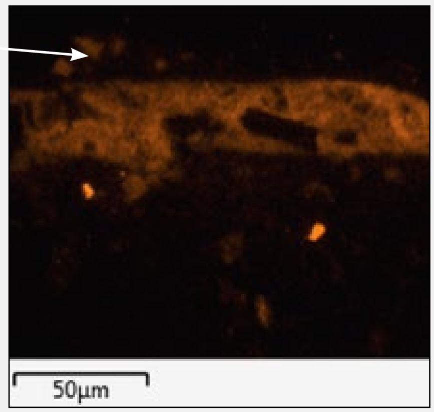
Elemental map of BCN_28 showing high content and even distribution of Al⁻.



Graphic representation of the stratigraphy of yellow monochrome background painted directly over the fine white plaster.



Cross section of BCN_51 from the upper register of the east wall showing the yellow monochrome painted directly over the fine white plaster.



Elemental map of BCN_51 showing high content and even distribution of Al⁻.

Optical and Electron Microscopy

Layer	Description	Thickness	Elements Detected	Additional Comments
5	Surface layer(s)	5–10 µm	S	Deposition of dirt/volcanic dust within surface accumulation and conservation materials.
3/4	Yellow monochrome	80 µm	Ca, Fe, Al, Si	Yellow ochre/goethite applied in the fresco technique

XRF

Layer	Description	Elements Identified	Additional Comments
3/4	Yellow monochrome	Ca, Fe, (Pb)	Pb was only identified in the upper register (layer 3).

XRD

Layer	Description	Minerals Identified	Additional Comments
3/4	Yellow monochrome	Goethite	

Raman

Layer	Description	Materials Identified	Additional Comments
3/4	Yellow monochrome	Yellow ocher/goethite	PbO in BCN_51 from the upper register (layer 3), final confirmation is forthcoming.
List of confirming samples: n/a			

FIGURE 5.21
Summary of results. Paint: Monochrome Background: Yellow.

Monochrome Background: Red

Areas of red monochrome background can be found on the four panels flanking the central section of the lower register of the east and west walls (figs. 5.22 and 5.23). Visual examination and analytical results indicate that these were originally red and not the result of a yellow to red alteration from the heat of the eruption. See Rainer and Piqué in this volume for visual observations of the decorative scheme that support this theory. This composition shows the presence of lead, arsenic,[43] and zinc[44] and low concentrations of aluminum. In areas of red monochrome, which are thought to have originally been yellow, no lead, arsenic, or zinc is found and aluminum is present in higher concentrations and evenly distributed. Two representative samples were taken and mounted as cross sections, one from the east wall (BCN_E1_11) and one from the west wall (BCN_W1_03). The results from W1_03 are shown, as it is the most representative sample.

From visual assessment, optical microscopy, and elemental analysis, the plaster stratigraphy of these areas begins with the coarse gray plaster, to the fine white plaster, into the pink-tinted plaster (as described in the previous section). Over the pink-tinted plaster there is a highly pigmented layer primarily colored with red iron oxide and carbon black within a calcium carbonate matrix. Analysis shows that in contrast to the areas of yellow, the red monochrome background has reduced amounts of clay minerals, as indicated by the lower amount of silicon, aluminum, and alkalis (see table 5.4). Another difference is the content of small amounts of lead, arsenic, and zinc. SEM-EDS shows that the lead and zinc are associated with the upper pigmented layer, though no crystalline pigments containing these elements was found through XRD and μ-Raman analyses. In situ XRF measurements of the lower register show that lead and arsenic are present only in areas thought to have been originally red, namely the monochrome backgrounds of the lower side panels on the east and west walls and not the background of the central panels. When a horizontal profile of the lead and arsenic found in the lower register of the east and west walls was mapped using XRF, a clear pattern indicating the difference between the originally red (lead and arsenic detected) and originally yellow (where no lead or arsenic can be detected)

FIGURE 5.22
Basemap of east wall, lower register, showing the area that would have originally been red. Note this area on the right extends slightly into the vertical band. The areas at the base are not represented. Due to the deterioration along the base of the wall, it is difficult to determine the exact location and extent of the original red background in this area.

FIGURE 5.23
Basemap of west wall, lower register, showing the area of original red monochrome background.

areas of monochrome background could be seen (see appendix 5.2). Research by Marcaida et al. (2017), using XRF to determine a measureable difference between original red and red transformed from yellow in two houses at Pompeii, found that arsenic was present only in areas of original red. The μ-Raman spectra generated from the red layer are associated with strong, broad bands centered at 1300 and 1650 cm^{-1}, typical for charcoal and indicating the presence of carbon black. Furthermore, a series of μ-Raman peaks between 100 and 650 cm^{-1} can be related to the presence of hematite. This evidence indicates the utilization of red iron oxide pigment with the addition of carbon black.

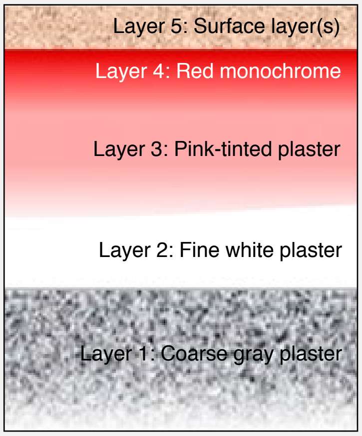
In the red paint layer from sample BCN_34, taken from the base of the east wall, the presence of red iron oxide is confirmed by SEM-EDS analyses on pigment particles, which show iron with minor amounts of silicon, aluminum, and alkalis. This chemical profile indicates that the pigment is mainly composed of iron oxides, associated with reduced amounts of clay minerals. No lead is found in this sample. (For a description of the colors visible at the base of the wall, see Rainer and Piqué, this volume.)

Results of investigations and analysis of the red monochrome backgrounds found in the tablinum are summarized in figure 5.24.

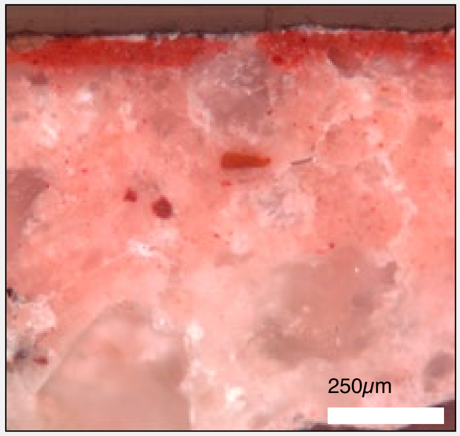
Monochrome Background: Red Converted from Yellow

This section addresses areas of monochrome background that now appear red but, through visual examination and scientific analysis, are thought to have been originally yellow. Heat causing the conversion of yellow to red ocher is a well-known and studied phenomenon (Brindley and Brown 1980; Goss 1987;[45] Rickerby 1991; Baraldi and Bensi 2006).

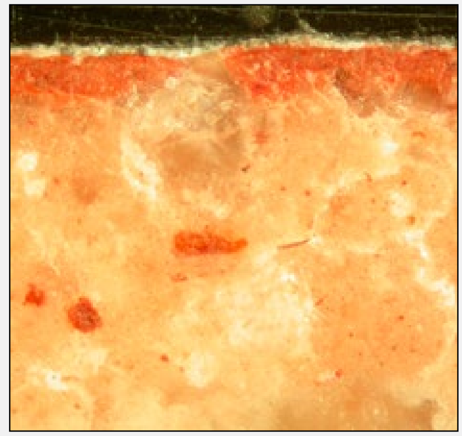
In the tablinum, there appear to be two types of yellow converted to red; these follow the pattern of the two types of yellow monochrome background found. One type, seen in the central panels of the lower register, is yellow converted to red with no associated lead.



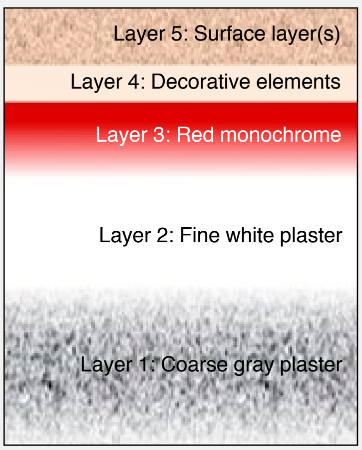
Graphic representation of the stratigraphy of the red monochrome background painted over a pink-tinted plaster.



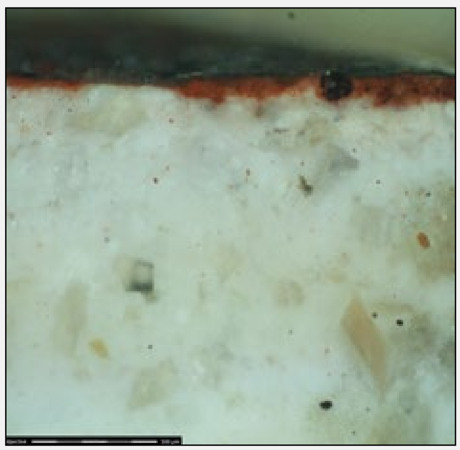
Upper stratigraphy of W1_03, lower west wall, showing layers 2, 3, 4, and 5.



Detail of red monochrome paint layer, W1_03.



Graphic representation of the stratigraphy of the red monochrome background painted directly over fine white plaster.



Upper stratigraphy of BCN_52, upper west wall, showing layers 2, 3, and 5. Note the absence of a pink-tinted plaster layer.

Detail of red monochrome paint layer, BCN_52.

Optical and Electron Microscopy (Averages for all samples examined)

Layer	Description	Thickness	Elements Detected	Additional Comments
5	Surface layer(s)	5–10 μm	S	Deposition of dirt/volcanic dust within surface accumulation and conservation materials.
3/4	Red monochrome	50–80 μm	Ca, Fe, (Pb, Zn)	Red ocher, with associated lead present in the mixture in small quantities. Pb, Zn only found in lower register.

XRF

Layer	Description	Materials Identified	Additional Comments
3/4	Red monochrome	Ca, Fe, (Pb, As)	Pb, As only found in lower register.

XRD

Layer	Description	Materials Identified	Additional Comments
3/4	Red monochrome	Hematite	The lead found with other techniques has been determined by XRD to be non-crystalline in nature.
List of confirming samples: E1_11, BCN_69, BCN_70			

FIGURE 5.24
Summary of results. Paint: Monochrome Background: Red.

The other, found in the upper register, is yellow converted to red with an associated presence of lead.

In the first instance, it can be said that the original color was yellow but, due to the heat from the eruption, the yellow ocher converted to a red ocher. The hypothesis of conversion has been confirmed by visual evidence (figs. 5.25 and 5.26), compositional symmetry, and multiple analyses. Sample BCN_23, a monochrome background presently seen as red, was taken from the central panel of the lower register of the west wall, which mirrors the area of yellow on the east wall in the same location (figs. 5.27 and 5.28). Though now seen as red, analysis suggests that the monochrome background of BCN_23 was originally yellow. Several analytical results contributed to this assessment: FTIR analysis shows the presence of kaolin/kaolinite; SEM analysis indicates relatively high and evenly distributed amounts of silicon and aluminum that can be attributed to clays; the hematite peaks generated by XRD analysis are broader, with respect to the peaks of the original red pigments, indicating a less crystalline particle structure than is typical for hematite; and there is no indication of lead, arsenic, or zinc found in the sample using SEM or in XRF measurements taken across the surface of this area (WL2). (Heginbotham 2017) This supports the theory


FIGURE 5.25 (LEFT)
Fragment showing conversion from yellow to red, lower east wall.

FIGURE 5.26 (RIGHT)
Fragment showing conversion from yellow to red, upper east wall.

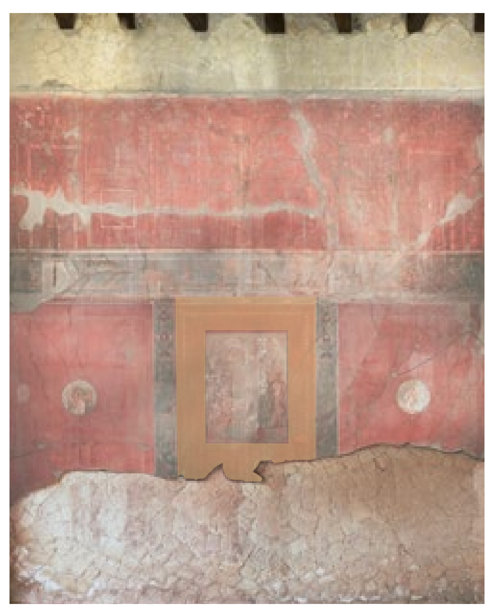



FIGURE 5.27 (LEFT)
Basemap of the east wall, lower register, showing the areas that would have been originally yellow but are partially converted to red. The areas at the base of the wall are not represented. Due to the deterioration of this area, it is difficult to determine the exact location of the original yellow background at the base of the wall.

FIGURE 5.28 (RIGHT)
Basemap of west wall, lower register, showing the area that would have originally been yellow.

that yellow ocher, rich in clay, was used for the original execution of some areas now seen as red, converted by the heat from the eruption.

The second circumstance is on the upper walls, where visual evidence indicates they would have originally been yellow but are now red. However, due to the presence of lead seen with XRF, this supposition is more difficult to confirm by analysis. These areas are represented by cross sections from the red monochrome background of the upper walls (BCN_52, BCN_53, and BCN_58) and from the red monochrome background found underneath the frieze plaster (BCN_31, BCN_55, and BCN_56). In these samples, SEM maps do not show a high and even distribution of aluminum. However, results of XRD analysis obtained from scrapings taken from associated locations (numbered BCN_31, BCN_63, BCN_64, and BCN_65) indicate that hematite peaks have a similar shape to those seen in the samples from the central panel of the lower register. XRD analysis from areas of original red shows the typical sharp and narrow peaks of hematite, indicating an iron oxide formed either by natural diagenesis or through intentional heating at much higher temperatures, thus increasing the crystallinity of the hematite. Without visual evidence of color transformation occurring on the wall, the analysis is not able to differentiate between pigment heated intentionally by a Roman artist and pigment heated by the eruption. However, as noted in Kakoulli (2009), due to the lower concentration of ferric oxide, artificially produced red ochers do not provide the desired intensity of color or covering power.

The final indication regarding all areas of the upper register, where the monochrome background was originally yellow, is that neither arsenic nor zinc was found with analysis.

In one sample, BCN_58, taken from the upper register, pumice shards were found within the monochrome background layer.[46]

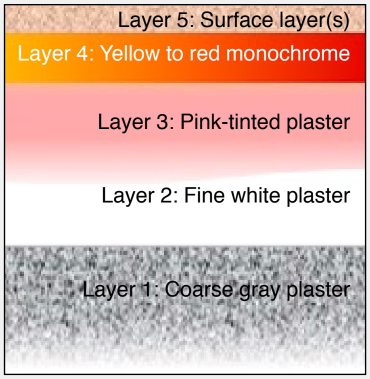
Results of investigations and analysis in areas of monochrome background where the yellow has converted to red are summarized in figure 5.29.

Monochrome Background: Black

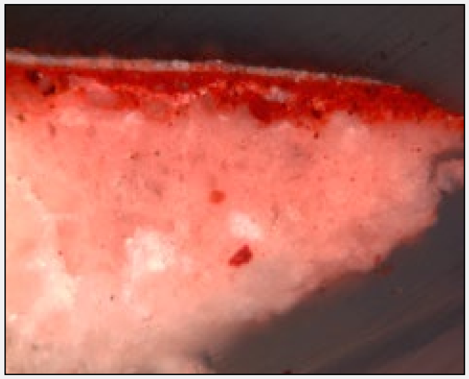
A monochrome black background is found in the vertical bands of the east and west walls, the frieze that runs the length of all three walls, the base of the east wall, and the lower pilasters of the south wall (figs. 5.30–5.32). The black pigment, identified by μ-Raman in all cases as carbon black, was applied while the various underlying plasters were still fresh in the fresco technique. In most cases, the black is applied over a tinted or gray plaster: pink-tinted plaster for the vertical bands; yellow-, orange-, red-, or brown-tinted plaster in the frieze; gray (lime and volcanic sand) plaster at the base of the east wall; and orange-gray (lime, crushed brick, and volcanic sand) plaster for the lower pilasters of the south wall.

In portions of the vertical bands, this stratigraphy varies slightly. Two vertical bands, each on the east and west walls and decorated with fantastical and floral motifs over a black monochrome background, serve as decorative borders between the central and side panels of the lower register. They also cover the seam between the yellow and red monochrome blocks of color. On some edges of the vertical bands, particularly visible in EV2, the red or yellow monochrome background extends under the black monochrome background (fig. 5.33), though this is likely not the case on the opposite band, as seen with XRF results. The presence of lead stops at the exact border of the vertical band on the west wall. At the edges of the bands, in an unknown width, black paint is applied over the adjacent red or yellow monochrome backgrounds. In these cases, the black of the vertical band was painted over an initial layer of red or yellow monochrome background, essentially creating two layers of monochrome background.

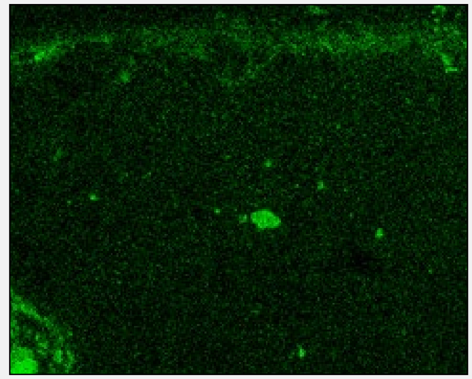
In all samples (W2_04, BCN_42b, BCN_54, BCN_55, BCN_56, and BCN_59), black pigment penetrates between 100 and 250 micrometers into the calcium carbonate matrix.



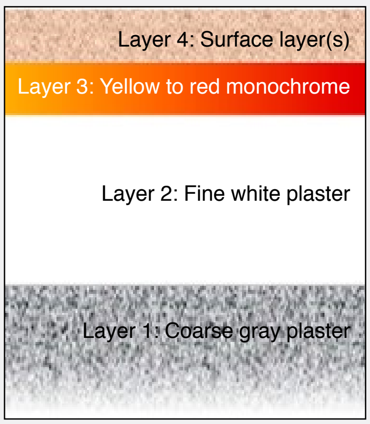
Graphic representation of the stratigraphy of the yellow converted to red monochrome background painted over a pink-tinted plaster.



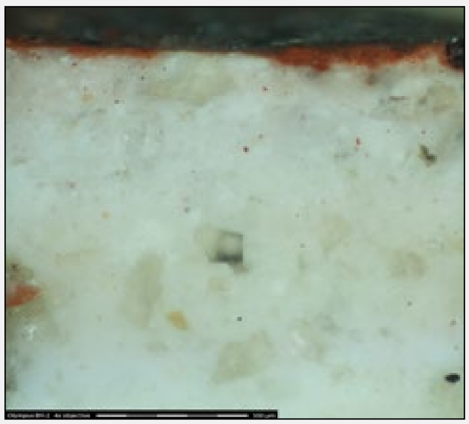
Cross section of BCN_23, lower west wall (20×), showing layers 2, 3, 4, and 5.



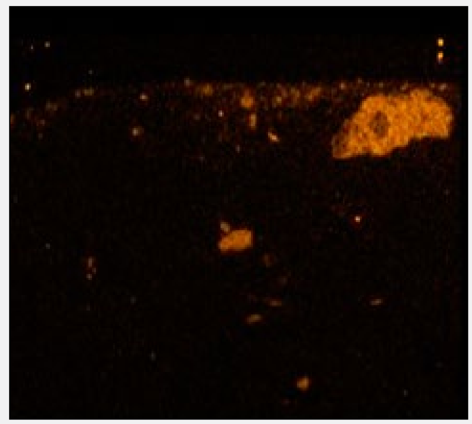
Elemental map of the distribution of aluminum found in BCN_23.



Graphic representation of the stratigraphy of the red monochrome background painted directly over fine white plaster.



Upper stratigraphy of BCN_52, upper west wall, showing layers 2, 3, and 4. Note the absence of a pink-tinted plaster layer.



Elemental map of the distribution of aluminum found in BCN_52.

Optical and Electron Microscopy (Averages for all samples examined)

Layer	Description	Thickness	Elements Detected	Additional Comments
5	Surface layer(s)	5–10 µm	S	Deposition of dirt/volcanic dust within surface accumulation and conservation materials.
3/4	Yellow transformed to red monochrome	50–80 µm	Ca, Fe, (Pb)	Red ocher, with associated lead present in the mixture in small quantities. Pb was only identified in the upper register.

XRF

Layer	Description	Materials Identified	Additional Comments
3/4	Yellow transformed to red monochrome	Ca, Fe, (Pb)	Pb was only identified in the upper register.

XRD

Layer	Description	Materials Identified	Additional Comments
3/4	Yellow transformed to red monochrome	Hematite	The lead found with other techniques was determined by XRD to be non-crystalline in nature. The hematite peaks were more broad than is typical, suggesting hematite in transformation.
List of confirming samples: BCN_31, BCN_53, BCN_55, BCN_56, BCN_63, BCN_64, BCN_65			

FIGURE 5.29

Summary of results. Paint: Monochrome Background: Red Converted from Yellow.

FIGURE 5.30
Basemap of east wall, lower register, showing the areas with a black monochrome background. The areas at the base of the wall are not represented. Due to the deterioration of this area, it is difficult to determine the exact location of the original black background at the base of the wall.

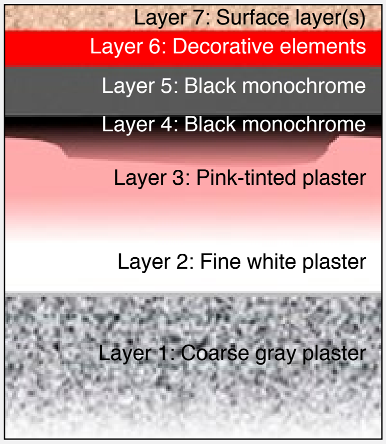
FIGURE 5.31
Basemap of south wall, lower register, showing the areas with a black monochrome background.

FIGURE 5.32
Basemap of west wall, showing the areas with a black monochrome background.

FIGURE 5.33
Image showing the pink-tinted plaster layer showing through the abraded black monochrome paint layer of the vertical bands found on the lower register of the east wall.

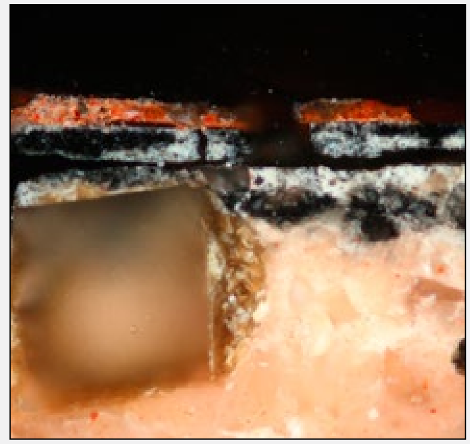
In the frieze, only one layer of black is observed. Samples from the vertical band and south wall (W2_04, BCN_42b, and BCN_59) have multiple applications of black paint. In these areas, layers are applied above the initial layer of black monochrome background; these upper layers have a higher concentration of underbound black pigment, and interfacial separations are marked by a carbonation layer. This is of interest, as both Vitruvius and Pliny refer to the use of an organic binder needed to fix the black pigments to a wall. Using SEM to examine the cross sections shows interfacial separations between layers, indicating that subsequent applications occurred after a pause that was long enough for a carbonation layer to form. The average thickness of these additional layers is 80 micrometers.

Results of investigations and analysis of the black monochrome backgrounds found in the tablinum are summarized in figure 5.34.

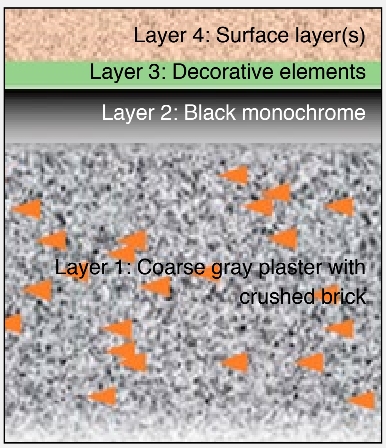


Graphic representation of the stratigraphy of the vertical bands where multiple layers of black monochrome were applied over a pink-tinted plaster.

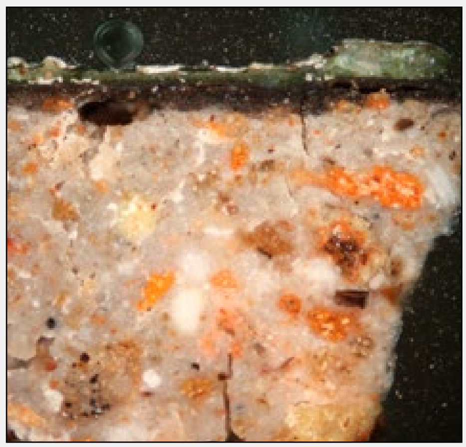
Cross section of W2_04, black monochrome background painted over a pink-tinted plaster, from a vertical band on the west wall (10×), showing layers 3, 4, 5, 6, and 7.



Detail of cross section of W2_04 (20×). Note the absence of interfacial separation between layers 3 and 4 and the interface between layers 4 and 5.



Graphic representation of the stratigraphy of the lower south wall where a black monochrome background was painted over a gray-orange plaster.



Cross section of BCN_42b, black monochrome background painted over a gray-orange plaster, lower south wall, west side (10×).

Detail of cross section of BCN_42b, black monochrome background painted over a gray-orange plaster, lower south wall (20×).

Optical and Electron Microscopy (Averages for all samples examined)

Layer	Description	Thickness	Elements Detected	Additional Comments
4/7	Surface layer(s)	5–10 µm	S	Deposition of dirt/volcanic dust within surface accumulation and conservation materials.
2/4/5	Black monochrome	80–120 µm	Ca, Si	

Raman

Layer	Description	Materials Identified	Additional Comments
2/4/5	Black monochrome	Carbon black	
List of confirming samples: BCN_54, BCN_55, BCN_56, BCN_59			

FIGURE 5.34

Summary of results. Paint: Monochrome Background: Black.

Decorative Elements

Decorative elements are defined as the painted decoration applied in one or more layers over monochrome backgrounds. They consist of simple, elegant borders with repetitive geometric motifs found around the central and side panels in the lower register, the figures and architectural elements in the upper register, the frieze with its egg-and-dart motif, the vertical bands, and the pilasters of the south wall. These layers can be described as full-bodied thick impasto, with a relatively diverse palette.

Pigments employed in the execution of the decorative elements include lime[47] for all sampled areas of white, yellow ocher (goethite), red ocher (hematite), cinnabar, green earth, and Egyptian blue, as well as mixtures of these pigments to obtain a more varied palette. The pigments found were identified using visual examination, optical microscopy, technical imaging, SEM, XRF, FTIR, and μ-Raman.

Ten samples were taken that include paint from this uppermost stratigraphy in the frieze, vertical bands, and lower south wall. Five were mounted as cross sections (BCN_23, BCN_42b, BCN_57, BCN_59, and W2_04) and show a full stratigraphy, including the design layer. All decorative elements appear to have been painted in the *secco* technique over the smoothed or polished monochrome background layer once it had set. The paint was sometimes applied in multiple layers; the elevated content of lime suggests they were applied over the monochrome background and bound with lime, and possibly additional organic binders, though none were identified in the samples from the tablinum. Using ESEM mapping, the even distribution of sulfur found within one of the discrete red layers in sample W2_04 and a green layer in BCN_42b gives rise to the possibility that gypsum was intentionally added, possibly as a binder, extender, or filler or to accelerate the curing. The average thickness of these layers is 40 micrometers.

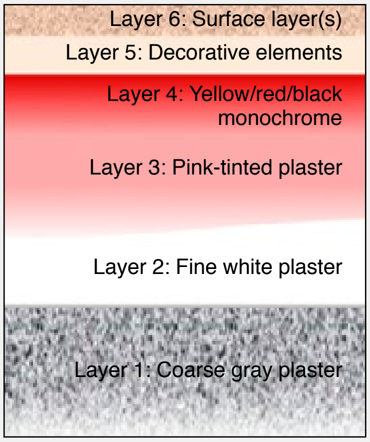
A decorative border in the egg-and-dart motif was painted along the bottom of the frieze on the east and west walls. It is visually different from the other areas of decoration. It has only two colors in the scheme and is not as refined as the rest of the exquisite technique seen in the tablinum. The brushstrokes are loosely painted, and the impasto is much thicker than in any other area. One sample, BCN_57, was taken from this area but does not contain the full stratigraphy down to the plaster. The cross section was examined using optical microscopy and SEM to identify lime and red ocher. It appears from this analysis that a lime binder was employed.

Results of investigations and analysis of the decorative elements found in the tablinum are summarized in figure 5.35; two representative cross sections can also be found in figure 5.35.

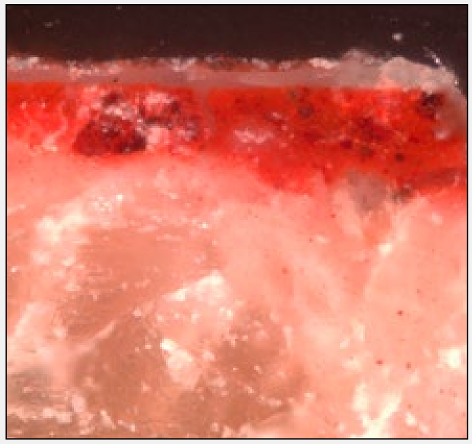
Medallions

Four medallions, containing high-quality figurative paintings, adorn the lower register and are painted in the center of each of the side panels. The paintings are applied over a light-blue background applied directly on the red monochrome background.[48]

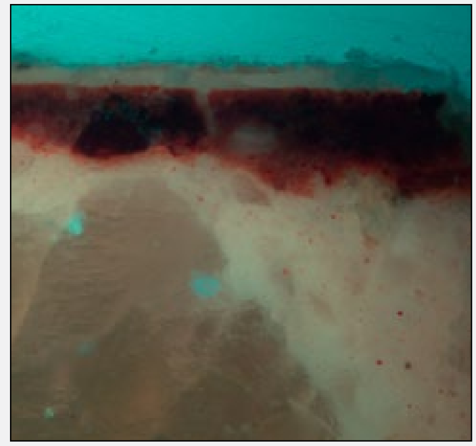
The medallions differ from the decorative elements because of the presence of the light-blue preparation layer, a more complex and layered painting technique, and severe conservation problems. Fifteen samples were taken to study these areas: seven were scrapings analyzed using XRD, and eight were mounted as cross sections and analyzed with multiple techniques. Using VIL, XRD, FTIR, and ESEM, the light-blue paint layer was determined to contain primarily calcium carbonate, dolomite, and Egyptian blue pigment (figs. 5.36 and 5.37). This layer functioned as a background for the figurative paintings.



Graphic representation of the stratigraphy under decorative elements in the lower register and upper south wall.



Cross section of BCN_23, decorative elements applied over a red monochrome background (20×), showing layers 3, 4, 5, and 6.



Cross section of BCN_23, seen under UV light, showing the decorative elements applied over a red monochrome background (20×).

Optical and Electron Microscopy

Layer	Description	Thickness	Elements Detected	Additional Comments
6	Surface layer(s)	5–10 µm	S	Deposition of dirt/volcanic dust within surface accumulation and conservation materials.
5	Decorative elements	20–40 µm	Ca, Si, Ca, Fe, Cu, Hg	Various elements detected depending on color
List of confirming samples: W2_04, BCN_42				

FIGURE 5.35
Summary of results. Paint: Decorative Elements.

FIGURE 5.36
Medallion imaged with visible capture.

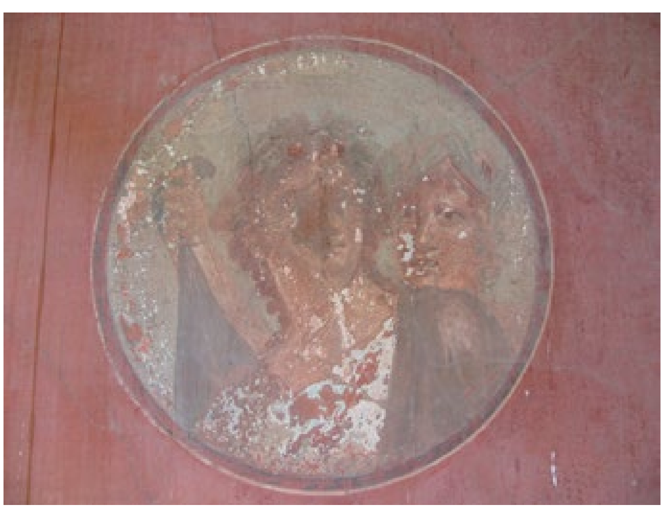


FIGURE 5.37
Medallion imaged with visible induced luminescence capture showing the presence of Egyptian blue.

E1_11 and E1_12 were chosen as representative samples due to the fact that, combined, they represent the entire paint stratigraphy found in the medallions.

In a number of samples from the light-blue background, gypsum and the aragonite form of calcium carbonate are found, along with the more common calcite. Although the calcium carbonate likely comes from the addition of a lime binder, the presence of gypsum and aragonite is puzzling, and it is difficult to determine if it is intentional. The calcium sulfate seen in the medallion samples was mapped using ESEM following the element sulfur (S), and confirmed by XRD as gypsum. The gypsum could have been intentionally added in its hemi-hydrate form and the aragonite could have been added as shell white, or the gypsum could be present as a deterioration product (Bersani, Lottici, and Casoli 2005). In some places where sulfur was found, the sulfur was evenly distributed only throughout the light-blue background layer (E1_12 and BCN_15, east wall; BCN_06, W1_01, west wall). In other places, calcium sulfate appeared alongside fractures, losses, or other disruptions (BCN_02 and BCN_21, west wall). It is possible that calcium sulfate may be present as both an original and an alteration material. In the majority of the cross sections, a thin layer of sulfur was found on the surface. Portable FTIR found gypsum on all points measured on the medallions, though it was impossible to ascertain with this technique whether the gypsum is present on the surface or in depth.

Using XRF, SEM, FTIR, and XRD, cinnabar was identified in the flesh tones, hair, and lips of some of the figures; lime white, yellow ocher, red ocher, and green earth were also identified.[49]

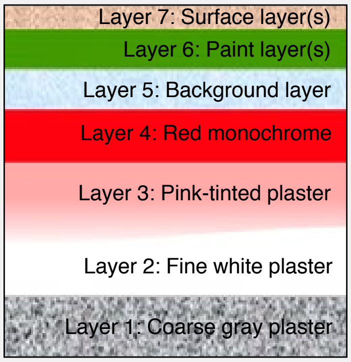
Results of investigations and analysis of the medallions found in the tablinum are summarized in figure 5.38.

Rectangular Scenes

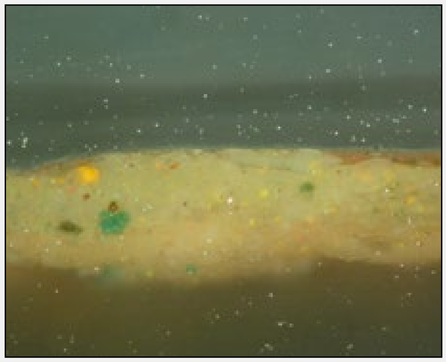
As mentioned in the section above describing the plaster stratigraphy of the rectangular scenes, these figurative paintings are executed over a rectangular “inset” of plaster applied over the surrounding pink-tinted plaster. They further differ in their paint stratigraphy from other decorative types, as visual and analytical evidence suggest that a preparatory layer was applied in the *secco* technique directly to the fine white plaster. This layer is beige and clay-like and acts as a preparatory layer for the painting. However, no sample containing both the paint layers and the plaster could be taken because of the inherent weakness of the adhesion between the paint and the plaster. This lack of interlayer adhesion is further evidence that the paint was not applied in the fresco technique in the rectangular scenes.

Employing a technique similar to that used on the medallions, the paintings of the rectangular scenes were built up over a white preparation layer using thick impasto layering to create finely executed figures and landscapes. The complexity of the technique and severity of the deterioration observed in these areas warranted the taking of thirteen samples from the scenes on the east and west walls. Four were scrapings and analyzed using XRD, whereas nine were mounted as cross sections and analyzed using a number of different analytical techniques.

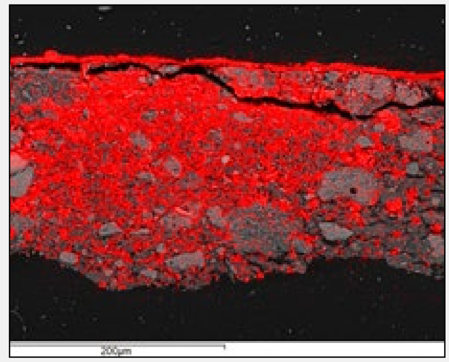
XRD, FTIR, and SEM were used to understand the white preparation layer. FTIR found magnesium and calcium carbonate, which can identify a component of the layer as magnesium calcite, possibly dolomite. Eight samples analyzed with XRD confirmed these results and also identified aragonite and gypsum. Using the Rietveld method to understand proportionality of the components, it was shown that calcium carbonate and aragonite were often found in consistent proportions. From the high content of calcium carbonate, a lime



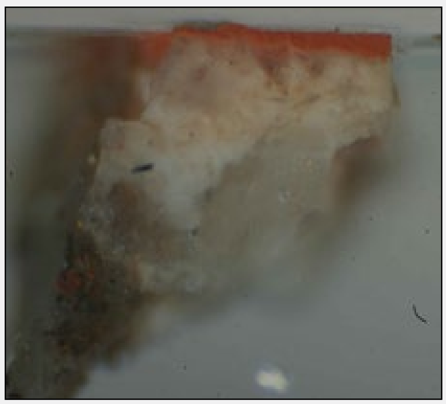
Graphic representation of the stratigraphy of the medallions.



Cross section of E1_12, east wall, lower register, Egyptian blue of medallion (20×), showing layers 5, 6, and 7.



Elemental map of the distribution of sulfur found in E1_12.



Cross section of E1_11, east wall, lower register (10×), showing layers 1, 2, 3, and 4.

Optical and Electron Microscopy (Averages for all samples examined)

Layer	Description	Thickness	Elements Detected	Additional Comments
7	Surface layer(s)	5–10 µm	S	Deposition of dirt/volcanic dust within surface accumulation and conservation materials
6	Paint layer(s)	40–60 µm	Ca, Fe, Si, Cu, Hg, S	
5	Light-blue background layer	80 µm	Ca, S, Si, Cu	

XRF

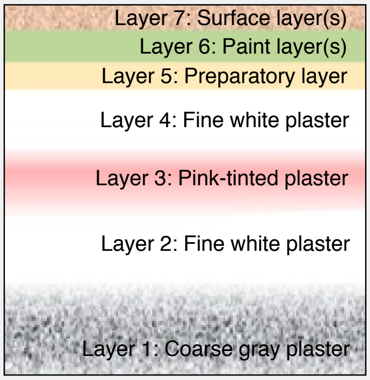
Layer	Description	Elements Identified	Additional Comments
6	Paint layer(s)	Ca, Fe, Si, Cu, Hg, S	Different elements were found in different colors
5	Light-blue background layer	Cu, (Fe?)	Fe was present but attributed to the underlying layer

XRD

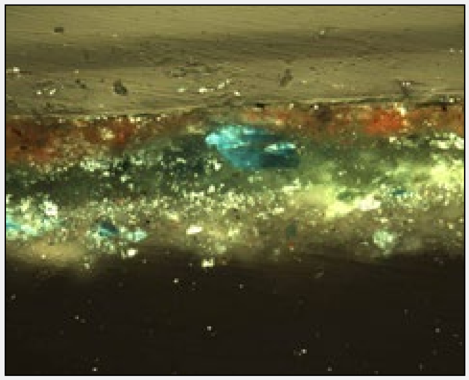
Layer	Description	Minerals Identified	Additional Comments
5	Light-blue background layer	Aragonite, dolomite, calcite, gypsum, cuprite	
List of confirming samples: BCN_01, BCN_02, BCN_05, BCN_06, BCN_19, BCN_20, BCN_21, W1_01			

FIGURE 5.38

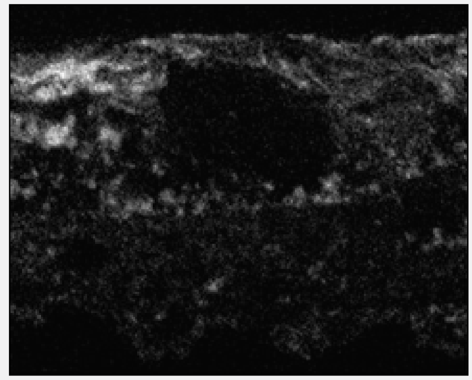
Summary of results. Paint: Medallions.



Graphic representation of the stratigraphy of the rectagular scenes.



Cross section of BCN_17, from the rectangular scene on the east wall, showing layers 6 and 7.



Elemental map of the distribution of sulfur found in BCN_17.

Optical and Electron Microscopy (Averages for all samples examined)

Layer	Description	Thickness	Elements Detected	Additional Comments
7	Surface coating	5–10 µm	S	Deposition of dirt/volcanic dust within surface accumulation and conservation materials.
6	Paint layer(s)	40–60 µm	Ca, Fe, Si, Cu, Hg, S, Mg, Al	
5	Preparatory layer	80 µm	Ca, S, Mg	In multiple samples a discrete Mg-rich layer was found.

XRF

Layer	Description	Elements Identified	Additional Comments
6	Paint layer(s)	Ca, Fe, Si, Cu, Hg	S was measured but could be attributed to either the paint layer(s) or the surface coating.
5	Preparatory layer	Ca, S, Mg	

XRD

Layer	Description	Minerals Identified	Additional Comments
6	Paint layer(s)	Goethite, kaolinite, gypsum	
5	Preparatory layer	Aragonite, dolomite, calcite, gypsum	Aragonite could be attributed to shell white.
List of confirming samples: BCN_03, BCN_22, BCN_30, W3_06, W3_08, W3_10			

FIGURE 5.39
Summary of results. Paint: Rectangular Scenes.

binder was likely used. The presence of aragonite could be due to the intentional addition of shell white. As discussed above, the gypsum could have been intentionally added as a binder, extender, or filler. Again, the Rietveld method was used to determine the ratio of aragonite to gypsum, which remained fairly constant throughout the samples (Piqué et al. 2010). For the same reasons seen in the samples from the medallions, the presence of gypsum and aragonite cannot be definitively confirmed as intentional additions.

Technical imaging identified some of the pigments used in the upper design layers; VIL identified Egyptian blue, and IR false color identified cinnabar. Samples analyzed with SEM, FTIR, and XRD confirmed the presence of these pigments and also identified yellow ocher, red ocher, and green earth.

Results of investigations and analysis of the two rectangular scenes found in the tablinum are summarized in figure 5.39.

Binding Media

Excepting those of monochrome backgrounds, all analyzed samples from the tablinum show the presence of calcium carbonate in relatively high proportions, indicating a lime binder. No organic materials were identified that would have been originally used as binding media.[50] However, given the physical history of the paintings, it is highly improbable that any organic material would have survived, and it is possible that organic binders may have been used, for example, in the black monochrome background.

Analysis with ESEM and XRD show possible evidence of gypsum, which may have been intentionally added as a binder, extender, or filler in four samples (BCN_42, W2_04, E1_12, and BCN_15), but it is not easy to determine this. In these cases, gypsum was identified with XRD and the distribution of calcium and sulfate was mapped with ESEM, showing an even distribution of particles throughout a discrete layer in all four samples. This is complicated by the fact that there is also the presence of gypsum (identified by FTIR and mapped by ESEM) in the materials present on the surface of the wall paintings. In one case, sample BCN_56, the presence of sulfur was seen only within one discrete layer but exhibited characteristics of both intentional additions (even distribution) and deterioration (distribution that correlates to pores) (figs. 5.40–5.42). Aliatis et al. (2010) find gypsum in similar conditions and conclude that it cannot be definitively attributed to an intentional addition or deterioration.

Four samples (BCN_1, BCN _4, BCN_5, and BCN_7) were tested by ELISA to identify amino acids (protein), fatty acids, and oil/wax/resin as indicators of possible organic binding media, and one sample (BCN_10) was tested by ELISA to look for plant gum. All returned negative results. In all the samples, beeswax was found, which contains, among hundreds of other components, the free fatty acids palmitic and stearic acids. These fatty acids are also a major component of drying oils and egg lipids, but, due to the absence of azelaic acid and glycerol (two other major components of these media), egg lipids and drying oils were not considered a source of the fatty acids in these samples. Some of the samples contained 0.1%–0.2% amino acids but did not match any of the GCI reference proteins (Mazurek 2008).[51]

GC-MS was used to identify organic material on six samples taken from different decorative areas: egg-and-dart, rectangular scenes, black monochrome background, and medallions. The results are inconclusive, as the only material present that could be attributable to an original binding medium was beeswax, which, due to the high amount present, is more likely from application during the restoration process (Mazurek 2016). It not unusual to be unable to identify organic binding media in wall paintings of this age and physical history,

FIGURE 5.40
Cross section of BCN_56.

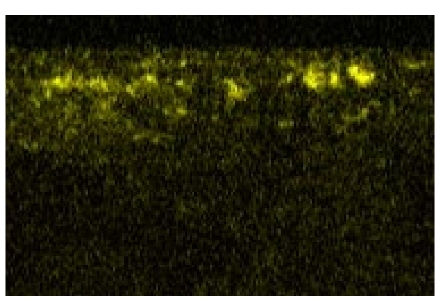


FIGURE 5.41
ESEM map of BCN_56 detail showing sulfur distributed evenly throughout the sample.

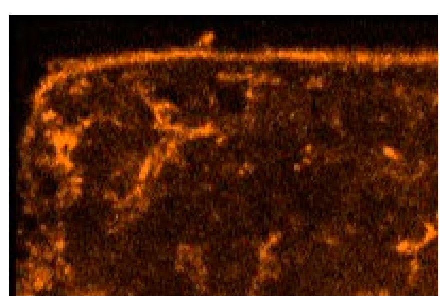


FIGURE 5.42
ESEM map of BCN_56 detail showing sulfur in distribution pattern indicating deterioration.

where an organic binder would have been used in relatively small amounts in relation to the pigment content, if it was used at all. Organic materials would have deteriorated over time and with exposure to the high temperatures associated with the volcanic eruption. Although GC-MS analysis did not detect the presence of an organic material that could have been an original binding medium, this does not necessarily preclude the use of one during execution. GC-MS analysis of an untreated fragment, BSN_01,[52] from the recently excavated basilica, suggested the presence of beeswax and animal glue within the paint layers (Mazurek 2012). This is the only positive result so far for the presence of binding media. Although no binding medium was detected in the black monochrome of the tablinum, there is evidence it may have had a binder, given the pattern of deterioration and the multiple layers with interlayer separations seen in cross section along with the information given in Vitruvius and Pliny. However, the age and physical history of the paintings are limiting factors and could produce false-negative results.

In the tablinum, beeswax was detected in almost all samples analyzed with laboratory-based FTIR (nineteen of twenty-six samples) or GC-MS (six samples); however, its presence in significant proportions in samples of every type, including those that sampled only non-original surface accumulation, is indicative of the application of a modern intervention material rather than use as an original binding medium. It is possible that beeswax could have also been used in the original execution of the wall paintings (Khanjian and Graves 2016; and Mazurek 2016).

Results of investigations and analysis of the binding media are summarized in table 5.5.

Previous Interventions

Described more thoroughly in preceding reports (Rainer and Piqué, this volume; Rainer, this volume; Gittins et al., this volume), the architectural surfaces of the tablinum were subjected to a number of campaigns of previous interventions, beginning with the excavation and remounting in 1938 by Maiuri. A majority of the wall paintings remounted by Maiuri's

TABLE 5.5. Analytical results for binding media.

Original Organic Binding Media Analyzed by GC-MS					
Sample	**Location**	**Description**	**Thickness of Layers**	**Weight of Sample**	**Media Detected**
BCN_57	WW: Egg and dart	Three layers of red and creamy yellow	0.4 mm	~ 8 mg	None
Binding Media Analyzed by ELISA					
Sample	**Location**	**Amino Acids (Protein)**	**Fatty Acids/ Oil/Wax/Resin**	**Sugars (Plant Gum)**	**Media Detected**
BCN_1	WM3	0.1% amino acids, does not match reference protein	Beeswax detected No oil or resin	n/a	None
BCN_4	WS2	n/a	Beeswax detected No oil or resin	n/a	None
BCN_5	WM1	0.2% amino acids, does not match reference protein	Beeswax detected No oil or resin	n/a	None
BCN_7	ES2	0.1% amino acids, does not match reference protein	Beeswax detected No oil or resin	n/a	None
BCN_10	ES2	> 0.1% amino acids, does not match reference protein	Beeswax detected No oil or resin	> 0.1% sugars	None

FIGURE 5.43
Image of east wall showing Maiuri restoration plaster.

team resulted in a stratigraphy in most areas that is a mix of original Roman and restoration plasters (fig. 5.43). There is very limited literature and documentation detailing the interventions. Oral histories by site custodians report the application of various materials to restore the wall paintings; custodians provided a sample block of paraffin previously applied to them in maintenance interventions. Research by Casoli et al. (2006) confirms by analysis that similar materials were used at Pompeii. Both in situ and laboratory analyses detected the widespread presence of organic materials over the surface of the walls, probably applied during modern interventions. These non-original repair plasters, grouts, and coatings were analyzed to understand if these materials are compatible and/or are causing damage to the Roman wall paintings. Paints and lime washes applied over the repair plasters are also present but were not analyzed at this time.

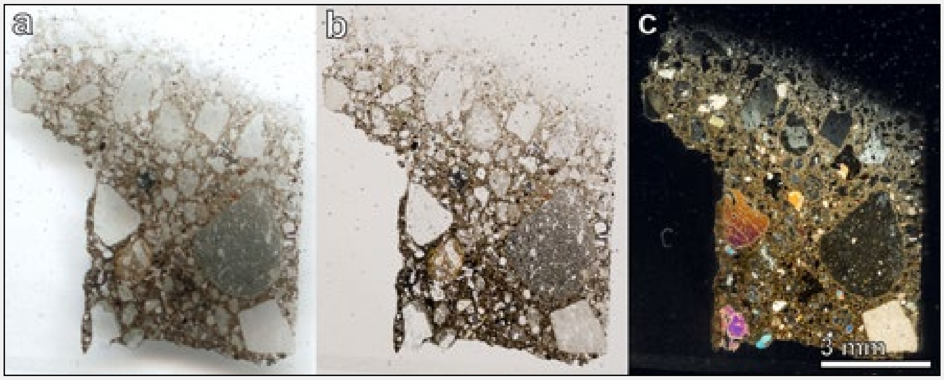
Results of investigations and analysis of the materials used in previous interventions found in the tablinum are summarized in figure 5.44.

1938 Excavation and Reconstruction Materials: Support

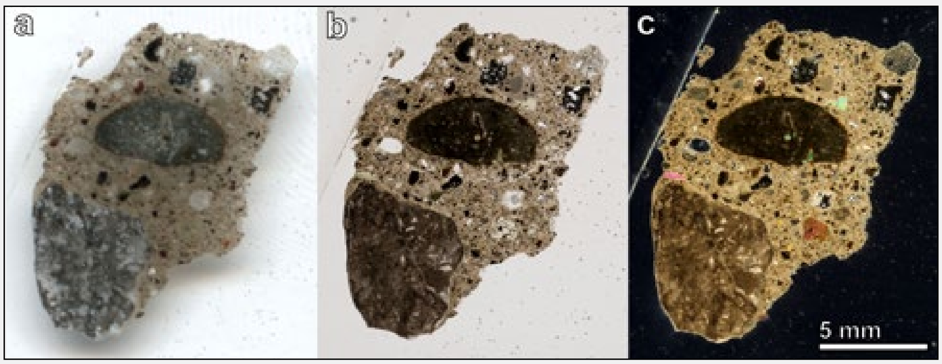
Preliminary analysis on one non-original tuff sample (BCN_64), taken from Maiuri tuff reconstruction material, was performed using PLM and SEM on thin sections, and XRD analysis was performed on powder. Results point to the sample of 1938 reconstruction tuff being chemically and petrographically similar to tuffs of the Neapolitan Yellow Tuff formation product of the Campi Flegrei. The formation of the tuff from this quarry is known to be dated from approximately fifteen thousand years ago (de Gennaro 2016).

1938 Excavation and Reconstruction Materials: Plasters

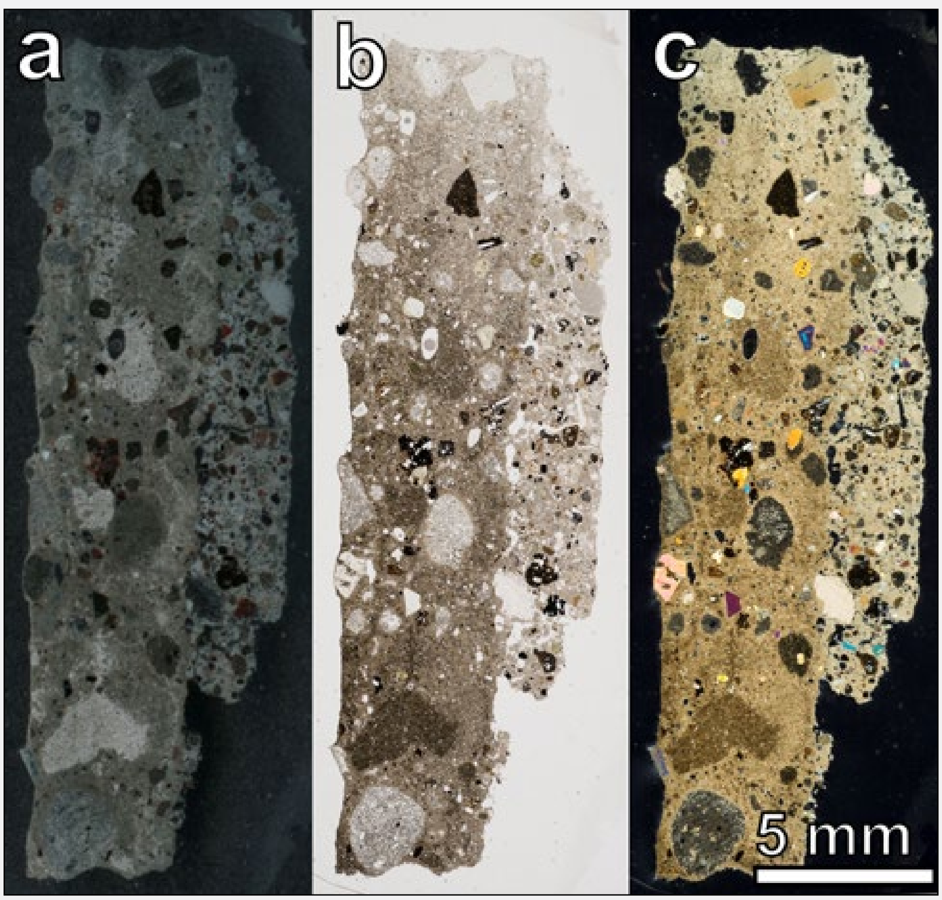
Using non-invasive methods, five types of materials thought to be employed to complete the 1938 reconstruction were determined. Following non-invasive and in situ investigations using visual examination, digital microscopy, and endoscopy, eight samples containing at least one layer of 1938 restoration materials were taken. All eight underwent a full petrographic, mineralogical, chemical, and microstructural characterization, mainly by means of PLM, XRD, μ-Raman spectroscopy, and SEM-EDS. While the techniques used by Maiuri



Thin section of BCN_50b representing the 1938 excavation and reconstruction backing plaster seen in (a) reflected light, (b) transmitted light, plane polars, and (c) transmitted light, crossed polars.



Thin section of BCN_39b representing the 1938 excavation and reconstruction grouting mortar seen in (a) reflected light, (b) transmitted light, plane polars, and (c) transmitted light, crossed polars.



Thin section of BCN_43b representing the post-1938 repair plasters seen in (a) reflected light, (b) transmitted light, plane polars, and (c) transmitted light, crossed polars.

FIGURE 5.44
Summary of results. Previous Interventions.

Optical and Electron Microscopy/XRD analysis (Averages of all samples examined)

Samples	Description	Binder	Aggregate	Binder to Aggregate	Notes
BCN_38b BCN_50b	BACKING PLASTER 1938 excavation and reconstruction material	Calcium aluminate cement (CAC):Lime 4:6	Volcanic sand/ pumice	1:1	Denser and more binder than the anchoring mortar
BCN_40b	ANCHORING MORTAR 1938 excavation and reconstruction material	Lime/CAC 1:1	Volcanic sand/ crushed pumice	1:2	
BCN_39b	GROUTING MORTAR 1938 excavation and reconstruction material	CAC/Lime 1:9	Volcanic sand/ crushed pumice	n/a	Pozzolanic reaction
BCN_45b	LOWER PLASTER 1938 excavation and reconstruction material	Lime	Volcanic sand/ crushed pumice	1:3	Pozzolanic reaction Reconstruction plaster layer Internal plaster fill material
BCN_46b	UPPER PLASTER 1938 excavation and reconstruction material	Lime	Volcanic sand/ crushed pumice	1:1.5	Reconstruction plaster layer
	PLASTER SKIM/WASH 1938 excavation and reconstruction material	Lime	n/a	n/a	Tint added
	PLASTER SKIM/WASH Post-1938 Restoration	n/a	n/a	n/a	
BCN_43b BCN_44b	FILL/PATCHING PLASTER Post-1938 Restoration	Lime/Cement slag	Volcanic sand	n/a	

and his team to remount the fallen Roman wall painting fragments are discussed in detail in Gittins et al. in this volume, analysis identified the materials used, and basic construction methods can be inferred. The results show compatibility between the plaster materials selected by Maiuri and the original Roman materials. The use of lime with very limited cement contributed greatly to the success of the 1938 remounting and ensured the long-term stability of this intervention.

1938 Excavation and Reconstruction Materials: Backing Plaster

Backing plaster is the material used in the 1938 intervention to adhere a group of detached and fallen fragments into clusters before they were remounted on the walls.

Two samples (BCN_38b and BCN_50b) were taken and underwent a full mineralogical and petrographic analysis. The binding matrix is characterized by a pale reddish-brown color (10R 4/6 Munsell), a heterogeneous microcrystalline texture, and extremely high cohesion typical for hydraulic cementitious binders, with an approximate binder-to-aggregate ratio of 1:1. SEM-EDS confirms that the binder mixture is constituted by aerial lime and calcium aluminate cement (CAC). SEM-EDS was also used to determine that the aggregate is composed mainly of volcanic sand and pumice fragments of two main grain sizes, coarse and fine sands (maximum dimension 350 micrometers, mean dimensions 700 and 200 micrometers). Morphologically, the aggregate is generally sub-rounded to sub-angular and characterized by a medium to low sphericity. Petrographically, it is predominantly a volcanic sand composed of dark to reddish and green volcanic tuff and scoria fragments, with abundant phenocrysts of plagioclase, sanidine, clinopyroxene, and leucite and a significant glassy fraction, partially zeolitized, associated with pumice fragments rich in leucite phenocrysts, abundant crystals of green and colorless clinopyroxene, rare crystals of feldspar, and flakes of dark mica. A small portion of heterogeneous aggregate composed of limestone and flint fragments is also present. The sample is characterized by a reduced porosity (3%–5% of the total volume).

1938 Excavation and Reconstruction Materials: Anchoring Mortar

Anchoring mortar is the material used in the reconstruction to adhere the assembled fragments to the wall once the backing plaster had set.

One sample (BCN_40b) was taken and underwent a full mineralogical and petrographic analysis. The binding matrix is a light-brown color (5YR 6/4 Munsell), with a heterogeneous microcrystalline texture and moderate cohesion. The approximate binder-to-aggregate ratio is 1:1.5. Abundant micrometric-size pumice fragments are uniformly dispersed throughout the carbonate binder and show a pozzolanic reaction at the interface. Observations under magnification show binder relicts, reddish to opaque in color, around 50 micrometers in size, suggesting the utilization of CAC. XRD and SEM-EDS analyses show the presence of carbonate phases (calcite, aragonite, and vaterite) in the analyzed material, associated with several polymorphs of aluminum hydroxide (gibbsite and bayerite), and iron oxides (wuestite and hematite), indicating the utilization of a binder mixture of predominantly aerial lime and CAC.

The aggregate size is mainly classed as coarse sand (maximum dimension 300 micrometers, mean dimension 600 micrometers) and an abundant silt fraction mainly constituted by pumice fragments. Morphologically, the grains are generally sub-rounded to sub-angular and characterized by a medium to low sphericity. Texturally, they are homogeneously distributed in the binder matrix. Petrographically, the aggregate is a mixture of crushed volcanic sand and crushed pumice. The sample is characterized by a medium porosity (5%–10% of the total volume).

1938 Excavation and Reconstruction Materials: Metal Pins

Islands of fragments assembled on backing plaster were placed on the wall and held by metal pins inserted into the wall along the edge of the fragments until the anchoring plaster had set. Some of the pins were then removed or cut where possible.

GPR was used to confirm the presence of subsurface metal pins. The data generated were processed using a microwave tomographic approach based on a linear model of the scattering phenomenon (Soldovieri et al. 2007). One metal pin was visible and used to confirm the data of unseen anomalies. Directly above the visible nail, GPR detected another area with similar electric contrast, but seen at a lower level within the plaster. Unfortunately, because a qualitative imaging was performed, it was not possible to discriminate between a pin covered by a thin layer of plaster or a hole made by a pin, as they are similar in shape and give rise to a strong electric contrast. Mock-ups of the walls with voids and metal inclusions were made to test the techniques using known parameters. The results of these investigations confirmed the ability of the GPR survey to detect anomalies at different depths but not always to distinguish between different materials and/or voids.

1938 Excavation and Reconstruction Materials: Grouting Mortar

Once the assembled fragments were secured to the wall using the anchoring mortar, grout was used to fill any remaining voids.

The material used for grouting was sampled (BCN_39b) and underwent full mineralogical and petrographic analysis. The binding matrix is characterized by a light-brown color

(5YR 6/4 Munsell), a homogeneous microcrystalline texture, low cohesion and abundant micrometric pumice fragments uniformly dispersed, and clear reaction rims at the interface with the surrounding binder. This suggests the presence of both carbonated lime portions and areas rich in hydrated calcium aluminosilicates due to pozzolanic reaction. The binder-to-aggregate ratio is approximately 1:2. Petrographically, the aggregates are mainly composed of natural volcanic sand and pumice, both materials being crushed into particles classed as very fine sand (maximum dimension 700 micrometers, mean dimension 100 micrometers), with an abundant silt fraction constituted by pumice fragments. Morphologically, the grains are generally sub-angular to angular and characterized by a medium to low sphericity. Texturally, they are homogeneously distributed in the binder matrix. The sample was characterized by a significant porosity (15%–20% of the total volume). Such characteristics indicate the adoption of high water-to-solid ratios in order to improve the rheological properties of the grouting mortar. Analysis with SEM-EDS and XRD was used to confirm these results.

Post-1938 Repair Materials: Plasters

In contrast, post-1938 cement patches were used in later repairs. This is seen predominantly along the base of the east wall. Analysis identified this as a cementitious material containing autochthonous sodium sulfate salts. These cement patches are harmful not only because of their salt content but also because of their different mechanical properties as compared to the Roman plasters, causing preferential loss of the more fragile original material below.

Two samples of the post-1938 repair material (BCN_43b and BCN_44b) were taken and underwent a full mineralogical and petrographic analysis. The plaster is macroscopically characterized by a gray color (5YR 6/4 Munsell), extremely high cohesion, and heterogeneous microcrystalline texture typical for mixtures of aerial lime-hydraulic cementitious binders. It has an approximate binder-to-aggregate ratio of 1:1. The aggregate is classified as medium sand (maximum dimension 2 mm, mean dimension 400 micrometers), with a reduced silt fraction. Morphologically, the particles are generally sub-rounded to sub-angular and characterized by a medium to low sphericity. Texturally, they are homogeneously distributed in the binder matrix. Petrographically, the aggregate is predominantly constituted by a volcanic sand composed of dark to reddish and green volcanic tuff and scoria fragments. Despite the predominantly pozzolanic nature of the aggregate, no clear reaction rims are recognizable at the binder-aggregate interface. The sample is characterized by a reduced porosity (3%–5% of the total volume).

The presence of carbonate phases (calcite and aragonite) in the analyzed material, associated with a predominant amorphous fraction plus relict phases of the ordinary Portland cement (calcium aluminate and ferrite), indicates the utilization of a binder mixture constituted by both aerial lime and cement.

Surface

Visual examination and analytical results indicate that the painted surface is covered with materials both intentionally applied and naturally accumulated. Through visual examination and analysis, it appears that different coatings have been applied to different parts of the wall paintings. It is fairly typical practice to coat selective areas of wall paintings most in need, and these were typically the decorated areas. As described above, the decorated areas and figurative scenes were executed with a more complex technique and have a multilayer stratigraphy, thus, tend to suffer more severe deterioration. At the time of excavation, all areas required stabilization and restoration. The application of a coating by saturating the surface had the effect of dramatically improving the legibility of the paintings.

It is reported from oral histories that beeswax, paraffin wax, and some form(s) of acrylic resins (likely applied locally) were applied to the paintings of the tablinum since excavation as restorative and protective layers.[53]

Examination with UV light shows the presence of surface fluorescing materials with a strong emission in the vertical bands, medallions, and rectangular scenes. The lack of fluorescence in the surrounding red and yellow monochrome background is probably due to false-negative results (due to auto-absorption by the pigments in the paint layer), as material is visible on the surface and in cross section. While this imaging technique cannot identify the material that is fluorescing, it is likely related to the presence of restoration materials applied repeatedly and preferentially on the figurative scenes, vertical bands, and frieze (fig. 5.45). Almost all of the thirty-one cross sections taken before consolidation treatment show evidence of an amorphous material present on the surface. It is evident that some of the material is dirt and particulate deposits embedded in surface coatings (fig. 5.46).

FIGURE 5.45
Medallion imaged with UV fluorescence capture, showing widespread organic material(s) on the surface.

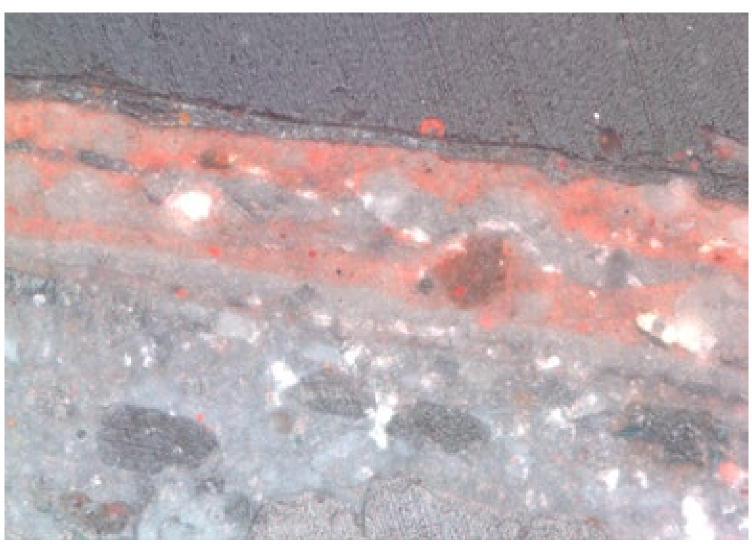


FIGURE 5.46
Cross section of BCN_22 showing a layer of surface accumulation.

Portable FTIR measurements revealed the widespread presence of organic material (wax or other organic material) on the paintings (Piqué et al. 2007). Laboratory-based FTIR confirmed the presence of beeswax in nineteen of twenty-six samples analyzed. Beeswax was found in analysis performed on the surface accumulation and upper paint layers. The limitations of the FTIR molecular data do not preclude the co-presence of paraffin wax (Khanjian and Graves 2015).

Ten surface scrapings were taken and analyzed using laboratory-based GC-MS. Paraffin and beeswax were identified in all samples on the surface. However, the surface scraping from the rectangular scene on the east wall also contains a compound that most closely matches Irganox, a phenolic antioxidant. Irganox was found in two surface scrapings from the vertical bands together with acetyl tributyl citrate (possibly Citroflex[54]). This antioxidant was also found in one sample taken from the medallion and in one taken from the frieze. Irganox has been used in conservation to protect substrates against thermo-oxidative degradation. Experiments showed that it can yellow with UV exposure (Lafontaine 1979). This analysis is of interest, as the yellowed appearance and other physical characteristics of the surface coating on the rectangular scenes is different from other areas on the wall paintings in the tablinum (Mazurek 2016).

Analysis by μ-Raman spectroscopy showed the presence of another organic material found in the cracks of sample BCN_29, taken from the rectangular scene on the east wall. Several superficial cracks appeared to be sealed by a transparent organic compound, as demonstrated by the presence of typical C-H stretching peaks between 2800 and 3000 cm^{-1}.

Results of investigations and analysis of the surface coatings found in the tablinum are summarized in table 5.6.

TABLE 5.6. Analytical results for surface layer(s).

Surface Layer(s) Analyzed by GC-MS and Laboratory FTIR				
Sample	**Location**	**Description**	**GC-MS**	**FTIR**
SS33	WV1	White coating	Beeswax, Paraffin, Irganox, acetyl tributyl citrate	Gypsum?
SS34	WS2	Yellowed brown (glassy) coating	Beeswax, Paraffin, Irganox	Aragonite?
SS35	EM3	Brownish-gray coating	Beeswax, Paraffin, Irganox	Gypsum?
SS36	WF2	Peach haze	Beeswax, Paraffin, Irganox	Gypsum?

Deterioration Agents

Deterioration phenomena affecting the wall paintings include thin plaster delaminations and deep voids occurring in the plaster layers, whereas powdering, micro-flaking, and flaking occur in the paint layers. In particular, the figurative scenes exhibit severe powdering and flaking, and significant loss of the design layer since excavation can be observed. Archival information and oral histories have shown that the majority of loss occurred between 1938, when the paintings were excavated and restored by Maiuri, and 1970. However, extensive loss has also occurred since the 1970s and appears to be ongoing regardless of previous interventions employed to stabilize the paintings.

Three analytical methods were trialed at the tablinum to detect detachment: IRT, GPR, and laser speckle interferometry. Of these, laser speckle interferometry was most efficiently able to detect areas of detachment with the least amount of access and without contact with the surface. The system used acoustic excitation of the plaster to incite minor vibrations in the areas of detached plaster, detected by video capture of reflected laser in order to visualize vibration and displacement. Any variation, even minimal, of the surface created a difference in the speckle pattern. While it was possible to reproduce results with laser speckle interferometry, it required an identical installation of equipment for each comparative recording. The technique was used to map detachment in the tablinum and assess the efficacy of grouting treatments (Graves et al. 2017).

Cycling of relative humidity on samples was trialed. When the humidity reached a level above dew point, the moisture that formed on the surface was absorbed into the substrate, but neither deformation nor change in dimension was measured during either the wetting or drying phase. (Chiari, personal communication, 2016).

Another issue affecting the paintings, particularly at the base of the east wall, is salt activity (figs. 5.47 and 5.48). Eight areas of visually different salt efflorescence were found along the base of the east and west walls in the tablinum. All were analyzed using XRD and IC. The major salt species identified was sodium sulfate, or thenardite, in all six samples (Mazurek 2015). However, also present in smaller quantities in two samples was aphthitalite, a sodium-potassium salt.

FIGURE 5.47
East wall, showing the visible line of salt efflorescence reaching approximately 100 cm from floor along the base of the wall.

FIGURE 5.48
Detail of salt efflorescence.

Portable FTIR measurements revealed the widespread presence of gypsum and calcium oxalates, very likely on the surface (Piqué et al. 2007). Laboratory-based FTIR confirmed the presence of these materials and found the distribution of oxalates to be concentrated on the surface. Oxalates are common non-original materials found on the surface of wall paintings and are suggested to have originated from microorganisms or from the oxidation product of a degraded organic material used in previous restorations (Cariati et al. 2000).

Biodeterioration present in the tablinum was also sampled and studied. Biological degradation was limited to localized areas, though there is a prevalent presence of a pink biopatina along the base of the east and west walls. Four samples were taken of the various colors of biomaterial visible. Through optical microscopy, SEM, and μ-Raman spectroscopy, the species identified for the green, black, and blue biofilms was a cyanobacteria (Caneva 2014). The same analytical methods applied to the pink biopatina identified the organism as from the genus *Rubrobacter* (Tescari 2015). Further analysis, including DNA testing, is being carried out and results are forthcoming. An association between pink patinas and salt efflorescence (in this case sodium sulfate) is observed. The halophilic nature of bacteria-producing pink patinas is observed, and this phenomenon is recorded in other studies on European pink patinas (Imperi et al. 2007; Ettenauer et al. 2014).

Discussion

A great deal of knowledge was gained through the analytical study to inform the conservation plan and develop appropriate treatment methodologies; however, a few outstanding archaeometric questions remain. In terms of plaster analysis, it is still unknown why the pilasters of the lower south wall have such a distinct plaster composition. One theory may be the fact that the two pilasters of the lower south wall flank the opening to the peristyle garden and are less protected from the elements than all other tablinum wall surfaces. The addition of the crushed brick may have served to protect against the effect of water and moisture on the plaster. Another theory is that these slender load-bearing pilasters suffered damage in the earthquake of 62 CE, thus requiring renovation. Further investigation in collaboration with archaeologists at the site could help provide an answer.

The question remains as to whether aragonite was used as an intentional addition to the preparatory layers of the figurative scenes. Though research from a fairly equal number of sources supports both sides of the issue, in the specific case of the tablinum, the strongest evidence to suggest that shell white was used is the morphology of particles found in two samples from this layer, suggesting cleavage of shells.

Visual and compositional differences found in the four samples taken to characterize the frieze plaster layer may be due to differential exposure to heat during the eruption, rather than an intentional painting technique choice, but the question remains outstanding.

An issue relating to the composition of the paint materials is the presence of lead found in the areas of yellow and red monochrome backgrounds (thought to be converted from yellow) in the upper register. Mazzocchin et al. (2006) conducted a non-invasive and invasive analysis of ten houses at Herculaneum, and while there are many similarities between their results and the results presented here, they did not find the presence of lead associated with any pigments found. However, other studies in the relevant literature found the presence of lead to be related to an ocher and attributed to a pigment. Davy (1815) analyzed a pigment pot from Pompeii that contained yellow ocher mixed with red lead. In Cottica and Mazzochin (2009), SEM-EDS analysis of fragments taken from Pompeii found the presence of lead in conjunction with an area identified as goethite. Though it is stated within Cottica and Mazzochin's study that the small amount of lead may be attributable to lead white or yellow lead oxide, its intentional addition to the paint layer was unable to be confirmed. Paternoster et al. (2005) also identified lead in areas of yellow paint and red paint using XRF, even though only minium was identified in association with areas of red ocher. Furthermore, Sciuti et al. (2001) identified lead in two out of four XRF measurements taken in areas of yellow monochrome background, but as the study did not undertake laboratory-based analysis, the nature of the lead was unconfirmed. Both Pliny (1960) and Dioscorides (trans. 2000) mention a pigment called false sandarac, and Pliny goes on to describe it as a pale yellow that is different from a pure minium. However, interpretation of Dioscorides's false sandarac in Eastaugh et al. (2004a, 2004b) associates it with a true red lead or realgar and mentions it as a red-colored pigment.

The hypothesis of whether a binder other than lime was employed in the tablinum wall paintings cannot be proven. Again, there are examples in the physical evidence and the literature that could argue the case for both sides. For example, the condition of the black monochrome background is significantly different from that of the red or yellow background. These condition issues are seen in other rooms, such as in the House of the Black Room, and throughout the site where black, and the multiple black paint layers applied, was used as a monochrome background color. This could be due to the fact that the black pigment was applied to the walls with a binding medium, as suggested by Vitruvius and Pliny as the appropriate technique to apply carbon black to frescoes. Based on the historical records, as well as the distinct condition issues of the black, and the multiple-black paint layers applied, it is hypothesized that the carbon black of the monochrome background of the vertical bands was applied with some type of binder and not in the true fresco technique. GC-MS analysis of an untreated fragment, BSN_01, from the recently excavated basilica suggested the presence of beeswax and animal glue within the paint layers. Analysis has not confirmed this in the tablinum; however, given the physical history of the tablinum, the possibility cannot be ruled out. As mentioned repeatedly, the idea that gypsum was added as a binder to the upper design layers to increase the setting time and working properties of the impasto paint layer has merit but has not been determined with certainty.

Conclusions

The wall paintings in the tablinum of the House of the Bicentenary are some of the most highly valued at Herculaneum, and unfortunately they exhibit severe flaking and significant loss of the design layers. Through scientific study of selected samples, GCI scientists and conservators have collaborated with external specialists to expand the understanding of plaster and paint stratigraphies, original pigments, plaster materials, and previous intervention materials. The results of this study have informed the planning for preventive and passive interventions and the conservation treatment for plaster stabilization, paint flake readhesion, surface cleaning, and development of climate improvement strategies for the wall paintings.

A tangential result was the ability to test a wide variety of portable analytical techniques in the field, aiding the understanding of their capabilities and limitations when applied to site-based research. This is particularly the case with respect to laser speckle interferometry, which is not yet widely used but an extremely useful diagnostic tool for site-based conservators.

There were certain limitations to this research. First was the limited sample size that could be taken, given the significance of the paintings. Other limitations included the heat from the eruption of Mount Vesuvius, which altered original materials; burial and excavation, which may have led to severe deterioration; and past restoration materials, which, applied in quantity, may have masked the presence of original organic binding media.

The full study of plasters provided valuable information on original and 1938 reconstruction materials. The original Roman plasters can be categorized into four main types:

1. Gray: lime-based with volcanic sand as the main aggregate; fibers present in some samples
2. Gray-orange: lime-based with crushed brick and volcanic sand as the main aggregates
3. White: lime-based with crushed crystalline marble as the main aggregate
4. Tinted: lime-based plaster with crushed crystalline marble as the main aggregate and tinted either pink or yellow with an iron oxide pigment

These plasters are applied in the tablinum at various locations and sequences with six variations of stratigraphy. The plasters found are typical for Roman wall painting technique and generally follow the procedure for constructing wall paintings as outlined by Vitruvius. Particularly interesting is the use of crushed brick as an aggregate on the pilasters that flank the entrance to the peristyle garden, which could have been a calculated choice with respect to their location. The presence of the pink-tinted plaster specifically chosen for the presentation areas merits consideration, as this plaster is not often cited in the literature. There is anecdotal evidence that this type of plaster is found at other Roman archaeological sites, but there is a scarcity of publications to confirm its existence. The plasters found in the tablinum elucidate the Roman methods of choosing plasters not only to create well-constructed and long-lasting walls but also to improve the visual aesthetic.

Identification of the 1938 restoration materials was of great importance, as it showed that Maiuri was careful to select materials that he believed to be compatible with the original Roman plaster. It gives insight into his philosophies and proves that there is no reason to remove most of these materials. In contrast are the post-1938 cementitious plaster repairs, which are causing active deterioration to the original plasters and should to be removed.

The palette of the tablinum consists of two types of yellow ocher, red ocher, cinnabar, green earth, Egyptian blue, carbon black, lime white, and possibly shell white. One type of yellow ocher, from the upper register, shows the presence of lead, while the other type, from the lower register, does not. This result suggests that either the pigments were from a different origin or only one was used in a mixture with a lead-based pigment. Egyptian blue was used in many paint mixtures to make a number of other colors such as purple, green, light blue, and white. Yellow ocher, cinnabar, and calcite were combined for the flesh tones.

The only confirmed binding medium present is calcium carbonate, and organic materials are confirmed only as restoration materials, including beeswax, paraffin wax, acetyl tributyl citrate, and Irganox.

Deterioration agents present are two types of microbiological growth, cyanobacteria and a pink biopatina, from the genus *Rubrobacter*; sodium sulfate salt efflorescence; calcium oxalates (mainly in the form of weddellite); and gypsum. Characterization of the pink biopatina and dissemination of its prevalence can help other practitioners to distinguish between its presence as biological growth as opposed to original plaster tinting. Research into the activation mechanisms and parameters of the pink biopatina is an important step toward preventing further growth across both the site and the region. Identification of all the deteriogens enabled their effective removal as well as the installation of preventive measures to mitigate further deterioration.

The analytical research undertaken in the tablinum of the House of the Bicentenary to identify original and non-original materials, as well as an understanding of the environmental conditions, optimized the development of appropriate conservation measures to prevent or at least slow further deterioration. The results of this study have contributed to a deeper understanding of deterioration agents and mechanisms causing harm to these Roman wall paintings and others in the Vesuvian region.

Acknowledgments

This report on the scientific investigations carried out on the wall paintings of the tablinum of the House of the Bicentenary is the culmination of the work of numerous scientists from the GCI and external institutions from 2006 to 2016. The authors would like to acknowledge the following colleagues who have contributed to this project since its inception.

Professor Giorgio Torraca was the driving force behind this project. He not only initiated the research on the materials and deterioration of figurative scenes in the tablinum but also contributed tirelessly to the study and preservation of the cultural heritage of Herculaneum. Giacomo Chiari was responsible for the GCI's involvement in this scientific study from the beginning in collaboration with Professor Torraca. He undertook a significant portion of the analysis, working closely with scientists and conservators on various aspects of the research.

At the GCI, we wish to thank our colleagues: Beril Biçer-Simsir, associate scientist, was responsible for moisture studies carried out on samples of original Roman plaster, helping to characterize them. David Carson, laboratory manager, was a valuable asset both on site, carrying out laser speckle interferometry, and in the laboratory, using ESEM and XRD; he also provided conservator training on XRF. Furthermore, he was extremely helpful in interpretation of data generated by the study. Art Kaplan, research lab associate, provided assistance with ESEM mapping of samples. Lionel Keene, former assistant scientist, developed the equipment and software for the laser speckle interferometer and was present during the initial testing and implementation of the technique on site. Herant Khanjian, assistant scientist, ran numerous samples and was an excellent resource on FTIR in the laboratory. Emily MacDonald-Korth, former associate project specialist, assisted with many types of analysis as well as data processing from 2011 to 2013. She also mounted a number of cross sections and performed investigatory microscopy both in the laboratory and on site. Shin Maekawa, senior scientist, was responsible for the environmental monitoring and development of climate control strategies. Joy Mazurek, assistant scientist, contributed her expertise on a number of analytical techniques such as GC-MS, IC, and ELISA. Alan Phenix, scientist, optimized cross-section preparation and contributed to the microscopy. Michael Schilling, senior scientist, gave generously of his time with GC-MS.

The following external scientists contributed to the research presented in this report: Ivana Angelini, assistant professor, University of Padua, performed μ-Raman spectroscopy on a number of the original Roman and restoration material samples. Gilberto Artioli, director, and Michele Secco, assistant professor, of the CIRCe Center for the Study of Cement Materials, University of Padua, were invaluable to the analysis using SEM and XRD on a great number of samples, and contributed substantially to an improved understanding of the yellows and reds present in the tablinum. Giulia Caneva, professor, and Marco Tescari, research fellow, at Roma Tre University, identified the types of microbiological growth present in the tablinum. Arlen Heginbotham, conservator, J. Paul Getty Museum, optimized processing of XRF data and assisted with laboratory experiments of reverse-engineering yellow and red pigment compositions for identification. Ippolito Massari and Alessandro Massari, engineers at Studio Massari, completed a moisture survey in the house. Lorenzo Crocco, Francesco Soldovieri, Ilaria Catapano, and Gianluca Gennarelli of the Institute for Electromagnetic Sensing of the Environment (IREA)–National Research Council of Italy (CNR) were responsible for the research undertaken using GPR. Nicola Masini and Maria Sileo of the Istituto per i Beni Archeologici e Monumentali (IBAM–CNR) were responsible for the research undertaken using IRT. Professor Maurizio de Gennaro of the University of Federico II, Naples, performed analysis on the tuff samples.

The authors are grateful for all of the expertise, time, and effort given by these many scientists and conservators on the scientific study of materials and techniques used in the execution of the wall paintings in the tablinum of the House of the Bicentenary. Gratitude is also due to HCP and PA-ERCO and its previous iterations for granting permissions and facilitating sample collection.

Notes

1 The HCP is an initiative of the Packard Humanities Institute through its Italian arm, the Istituto Packard per i Beni Culturali, in collaboration with the Parco Archeologico di Ercolano (PA-ERCO) and its previous iterations. The HCP team has been working on conservation of the house in parallel to the GCI research on the wall paintings.

2 In 2016, Herculaneum became an autonomous site, PA-ERCO.

3 In addition to Professor Torraca, Francesca Piqué of the University of Applied Sciences and Arts of Southern Switzerland (SUPSI) provided assistance and analytical support to the scientific study. The initial analytical research was conducted within the framework of the HCP in collaboration with the SMAArt Centre of CNR-ISTM (Department of Chemistry, University of Perugia), which provided access to non-invasive FTIR and XRF, and with the Department of Chemistry of the University of Pisa, which undertook the organic material analysis. The contributing scientists were Maria Perla Colombini (professor, University of Pisa); Antonio Sgamellotti, Costanza Miliani, Francesca Rosi, and Lara Cartechini of the SMAArt Centre; Giovanni Verri (lecturer, Courtauld Institute of Art); Corrado Graziu (geologist, private practice, Pisa); and Marcello Spampinato (chemist, private practice, Lucca).

4 The preliminary results of the initial non-invasive studies of the tablinum were published in Piqué et al. 2010.

5 Performed by Giovanni Verri (Courtauld Institute of Art), Giacomo Chiari (GCI), Kiernan Graves (GCI), and Francesca Piqué (SUPSI).

6 The UV lamps are Mercury vapor lamps with a maximum emission at 365 nm and are equipped with a Schott DUG11 filter to cut off the visible light portion. The lamps were developed by the Istituto di Fisica Applicata Nello Carrara (IFAC) del Consiglio Nazionale delle Ricerche (CNR) di Firenze.

7 Performed by Giacomo Chiari (GCI) with assistance from David Carson (GCI).

8 Performed by Francesca Piqué (SUPSI), Emily MacDonald-Korth (GCI), Anna Arcudi (Conservazione Beni Culturali, CBC), and Kiernan Graves (GCI).

9 Performed by Francesca Piqué (SUPSI), Leslie Rainer (GCI), and Shin Maekawa (GCI).

10 Performed in 2015 by Francesca Piqué (SUPSI) and Kiernan Graves (GCI), with training, data processing, and assistance with analysis from David Carson (GCI) and Arlen Heginbotham (J. Paul Getty Museum).

11 Research by Nicola Masini and Maria Sileo (IBAM–CNR).

12 Research by Lorenzo Crocco, Francesco Soldovieri, Ilaria Catapano, and Gianluca Gennarelli (IREA–CNR).

13 Developed by Lionel Keene (GCI). Performed on-site and optimized by Lionel Keene and David Carson (GCI).

14 Performed by Emily MacDonald-Korth (GCI), Kiernan Graves (GCI), Alan Phenix (GCI), Michele Secco (CIRCe), and Marco Tescari (Roma Tre University).

15 Performed by David Carson (GCI), Art Kaplan (GCI), Emily MacDonald-Korth (GCI), Kiernan Graves (GCI), Arlen Heginbotham (J. Paul Getty Museum), Gilberto Artioli (CIRCe), Michele Secco (CIRCe), and Marco Tescari (Roma Tre University).

16 Performed by Herant Khanjian (GCI).

17 Performed by Giacomo Chiari (GCI), David Carson (GCI), Gilberto Artioli (CIRCe), and Michele Secco (CIRCe).

18 Performed by Joy Mazurek (GCI) and Michael Schilling (GCI).

19 Performed by Marco Tescari (Roma Tre University).

20 Performed by Ivana Angelini (CIRCe).

21 Performed by Joy Mazurek (GCI).

22 Performed by Joy Mazurek (GCI).

23 Although the information collection can be considered representative, this is not meant to be an exhaustive technical study.

24 For a description of the paintings and their iconography, see Rainer and Piqué, this volume.

25 The majority of the technical results reported in the plasters section are from four reports generated by the CIRCe laboratory (Secco and Artoli 2015a, 2015b, 2016, 2017).

26 Coarse-grained, euhedral, and almost perfectly rhombohedral calcite crystals, sometimes referred to as spathic calcite, were found in a number of thin-sections from the fine white plaster layer. This was interpreted by Secco and Artioli (2015a, 2015b and 2016) as indicative of crushed marble fragments. Some have suggested that the large and transparent calcite crystals may be from another source (personal communication, Giacomo Chiari 2015). The origin of the aggregate merits further investigation.

27 The upper south wall may have been considered a presentation area as seen from the atrium (see Rainer and Piqué this volume).

28 The pink-tinted plaster is infrequently referred to in the literature, though it is seen in three fragments of Roman wall painting from Greece (Meggiolaro et al. 1997) and has been anecdotally described at other Roman sites.

29 B4 is the layer most similar in thickness, texture, and composition to the coarse gray plasters found elsewhere in the tablinum, directly underneath the fine white plaster layer.

30 Similar composition of aggregate was found in the analysis of Rione Terra mortars, in samples dated to after the Augustan age (Paternoster et al. 2007).

31 The depth to which it was possible to visually examine the sample, and often the point where the 1938 remounting materials begin.

32 Lack of interfacial separation is defined by the absence of a physical barrier, such as a carbonation layer, between two stratigraphic layers. The presence of a carbonation layer signifies that there was a pause between plaster applications. Cornale et al. (2005) suggest from experimental evidence that the pause would need to be longer than 8 hours, allowing the carbonation process to begin. Current thinking is that the thickness of the carbonation layer is a relatively qualitative indication of time passing; however, a precise quantifiable conclusion is difficult to draw. Also, the lack of interfacial separation, or absence of carbonation layer, could indicate that the plasters were applied wet on wet or that the plaster was scraped back, that is, made rough, thereby physically removing any carbonation layer, before the application of the next sequential plaster.

33 This sample was taken from a previous sample location (2004), which revealed the lower plaster layers.

34 As the coarse gray plaster could not be sampled from this area below the rectangular scene, its relationship to the first white plaster layer, particularly in terms of interfacial separation, could not be examined.

35 Data compiled from ESEM maps, one taken as an overall map and two maps looking in more detail at the plaster layer.

36 See note 35.

37 The identification of pigments was not comprehensive or exhaustive, as this research was not intended as a technical study.

38 The depth of penetration of the pigment particles into the plaster substrate, evidence of polishing or compacting the surface, and presence of *pontate* are indicators of the fresco technique.

39 This mixture has also been identified in Pompeian wall paintings by Davy (1815), Varone and Béarat (1997), Aliatis et al. (2010), Mazzocchin et al. (2010), and Amadori et al. (2015).

40 Duran, et al. (2010) found the same mixture of yellow ocher and Egyptian blue to make green in the House of the Golden Bracelet in Pompeii, executed in the Third Style.

41 A number of references have found the presence of aragonite in Roman wall paintings (three articles in Béarat et al. 1997; Amadori et al. 2015) but cannot confirm that it is an intentional addition. Augusti (1967); Paolini and Faldi (2000); Mazzocchin et al. (2006); Baraldi et al. (2007); Duran, Castaing et al. (2010); and Duran, Jimenez de Haro et al. (2010) either hypothesize or confirm the addition as intentional. Vitruvius and Pliny mention grinding shells for adding luminescence to paintings.

42 The mixture of red ocher and red lead is documented by Davy (1815) and Augusti (1967) by the analysis of pots of raw pigment from Pompeii. However, relatively few recent analytical studies of wall paintings identify this mixture. Only Paradisi et al. (2012) and Sciuti et al. (2001) were able to identify pigment particles of red lead in a mixture with red ocher, while Amadori et al. (2015) found lead in two red samples but could not link this presence to the intentional use of a red pigment. In GCI research thus far, no particles were identified as a lead-based pigment. However, the lead was found to be associated with the paint layer.

43 No arsenic was found in any areas of yellow monochrome background, or red monochrome background which were originally yellow. In areas of red monochrome background, thought to have been originally red, where red iron oxide is present in higher proportion, small amounts of lead and trace amounts of arsenic were found using XRF. Paternoster et al. (2005) and Aliatis at al. (2010) also found the presence of arsenic in red areas of Roman wall painting using SEM-EDX but are unable to explain its origin. Analytical results from tablinum samples show the ratio of iron and lead to be approximately 20:1 by weight, whereas iron and arsenic to be in the range of 500:1 or even higher. The trace amount of arsenic present suggests that realgar, or another arsenic-based pigment, would not have been an intentional addition.

44 Using SEM, zinc was found to be associated with the areas of original red iron oxide in W1_03, the one cross section from these areas analyzed for the presence of zinc.

45 Many other studies citing corresponding data are found in professional journals of crystallography, mineralogy, and thermal analysis.

46 This is notable, as a corresponding reference was not found in the literature review, and pumice was not found in any other original Roman plaster sample. Thus the presence of the pumice is likely a contamination from non-original materials.

47 In some samples, only calcite was found. In others, high concentrations of magnesium were found using SEM, suggesting the presence of dolomite as well. No evidence of aragonite or gypsum was seen in the decorative elements, but evidence of these minerals was seen in the figurative scenes, suggesting that the decorative elements and scenes were painted using different paint mixtures and possibly by different artists.

48 A similar layer composed of a mixture of Egyptian blue and calcite is seen by Duran. (2010) in the House of the Golden Bracelet in Pompeii.

49 Other pigments may be present but were not identified in this study.

50 Casoli et al. (2006) found, based on analysis with FTIR and GC-MS undertaken on forty-three samples from the Insula del Centenario at Pompei, from two campaigns of research, that no organic binders were present as original materials; however, beeswax, animal glue, and egg were used as restoration materials. These samples included a number taken from areas of black monochrome backgrounds; four were taken from recently excavated areas. Also, the presence of a proteinaceous binder was found in samples from the Villa of the Papyri in Herculaneum (Amadori et al. 2015).

51 Typically, to report the presence of a protein in a paint sample, at least a 0.2% amino acid concentration is needed, as well as a good match (0.93 absorbance value and above) to a reference protein.

52 It is known that the fragment was never treated, unlike the samples from the tablinum.

53 Custodians of the site have indicated that paraffin was used in previous treatments. Giuseppe Zolfo (Soprintendenza Pompei) commented that an acrylic coating was employed in the past. Guards and custodians at Pompeii report the use of beeswax as a protective restoration material (Casoli et al. 2006).

54 Citroflex is a plasticizer used in several synthetic polymers (such as acrylic, methacrylic, ethylcellulose, hydroxymethyl cellulose, nitrocellulose, vinyl acetate, vinyl chloride, vinyl pyrrolidone, vinylidene chloride, and urethane coatings).

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APPENDIX 5.1

All Sample Locations

Casa del Bicentenario, Tablinum, East Wall - Overall

SAMPLE LOCATIONS

- Plaster sample
- Paint sample
- Plaster and paint sample
- Paint sample, mounted as cross section
- Plaster and paint sample, mounted as cross section
- Tuff sample

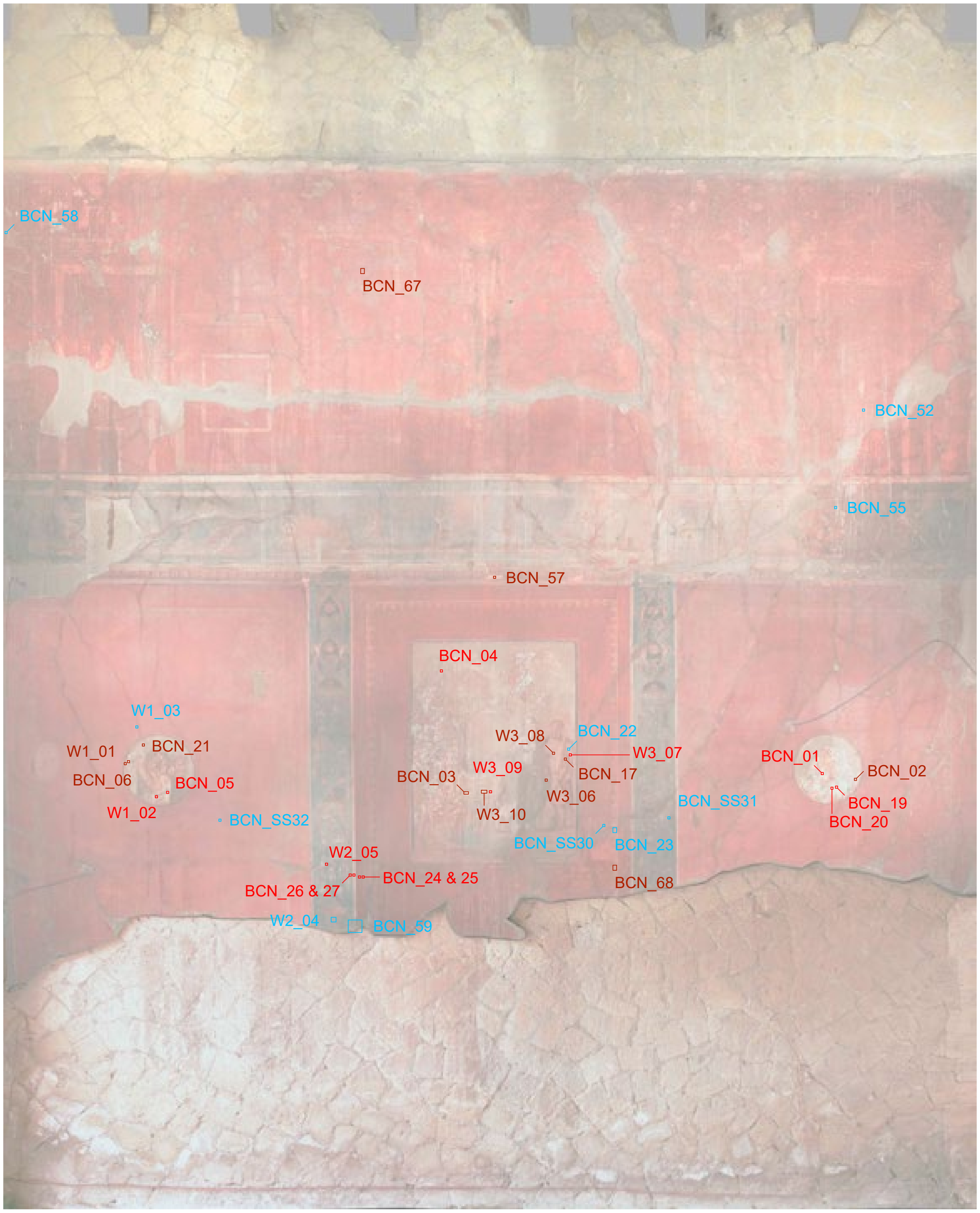
Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY -----	DATE RECORDED 2008-2016 LAST REVISED 2017/05	**EW** SCALE 1:25

Casa del Bicentenario, Tablinum, South Wall - Overall

SAMPLE LOCATIONS

- Plaster sample
- Paint sample
- Plaster and paint sample
- Paint sample, mounted as cross section
- Plaster and paint sample, mounted as cross section
- Tuff sample

Casa del Bicentenario, Tablinum	PROJECT	PARTNERS	PROJECT MANAGER	DATE RECORDED	SW
The Getty Conservation Institute	Herculaneum Project	SP, HCP	Leslie Rainer	2008-2016	
	LOCATION	COPYRIGHT	RECORDED BY	LAST REVISED	SCALE
	Herculaneum, Italy	GCI	-----	2017/05	1:25



Casa del Bicentenario, Tablinum, West Wall - Overall

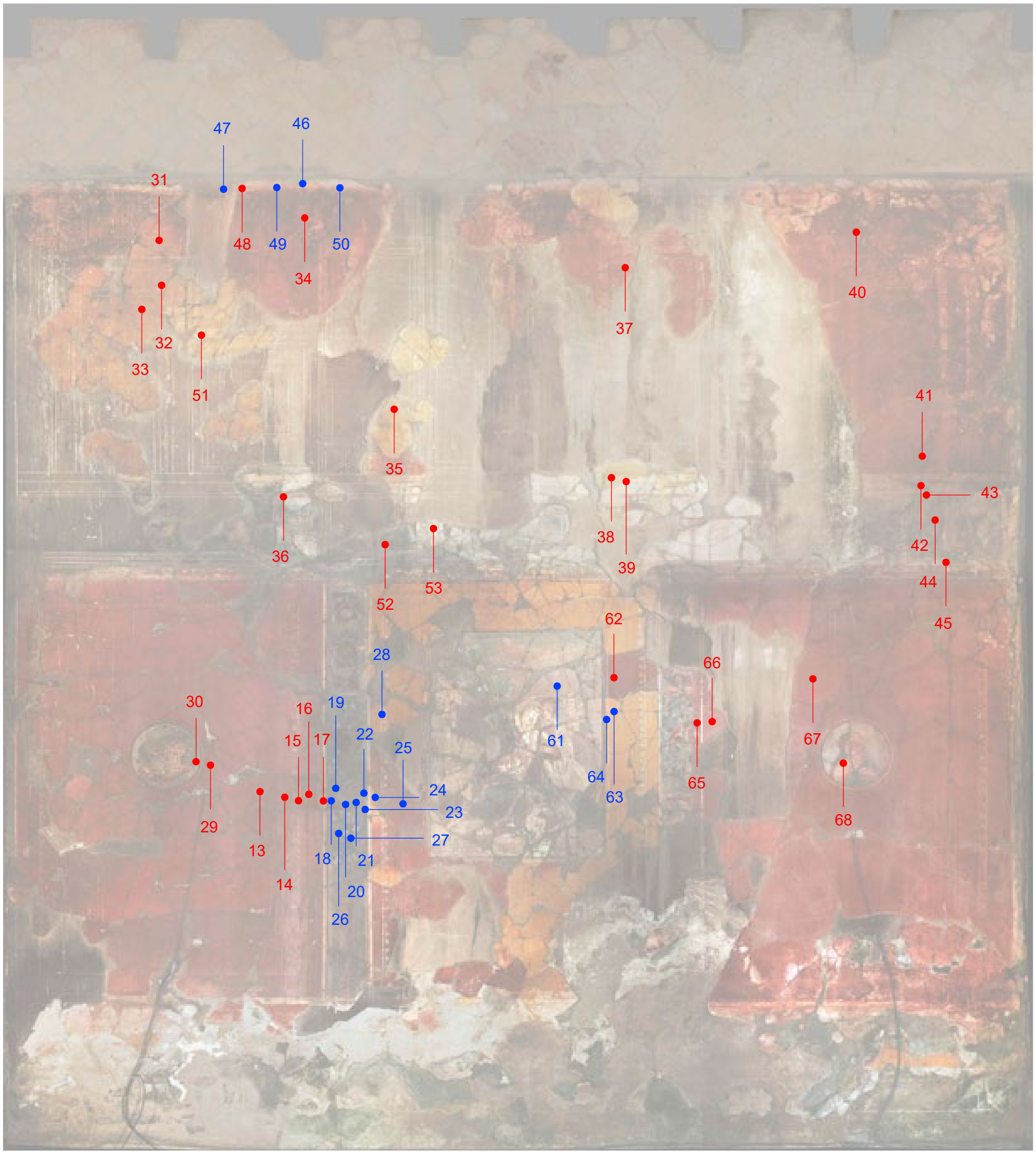
SAMPLE LOCATIONS

- Plaster sample
- Paint sample
- Plaster and paint sample
- Paint sample, mounted as cross section
- Plaster and paint sample, mounted as cross section
- Tuff sample

Casa del Bicentenario, Tablinum	PROJECT: Herculaneum Project	PARTNERS: SP, HCP	PROJECT MANAGER: Leslie Rainer	DATE RECORDED: 2008-2016	WW
The Getty Conservation Institute	LOCATION: Herculaneum, Italy	COPYRIGHT: GCI	RECORDED BY: -----	LAST REVISED: 2017/05	SCALE: 1:25

APPENDIX 5.2

XRF Point Locations

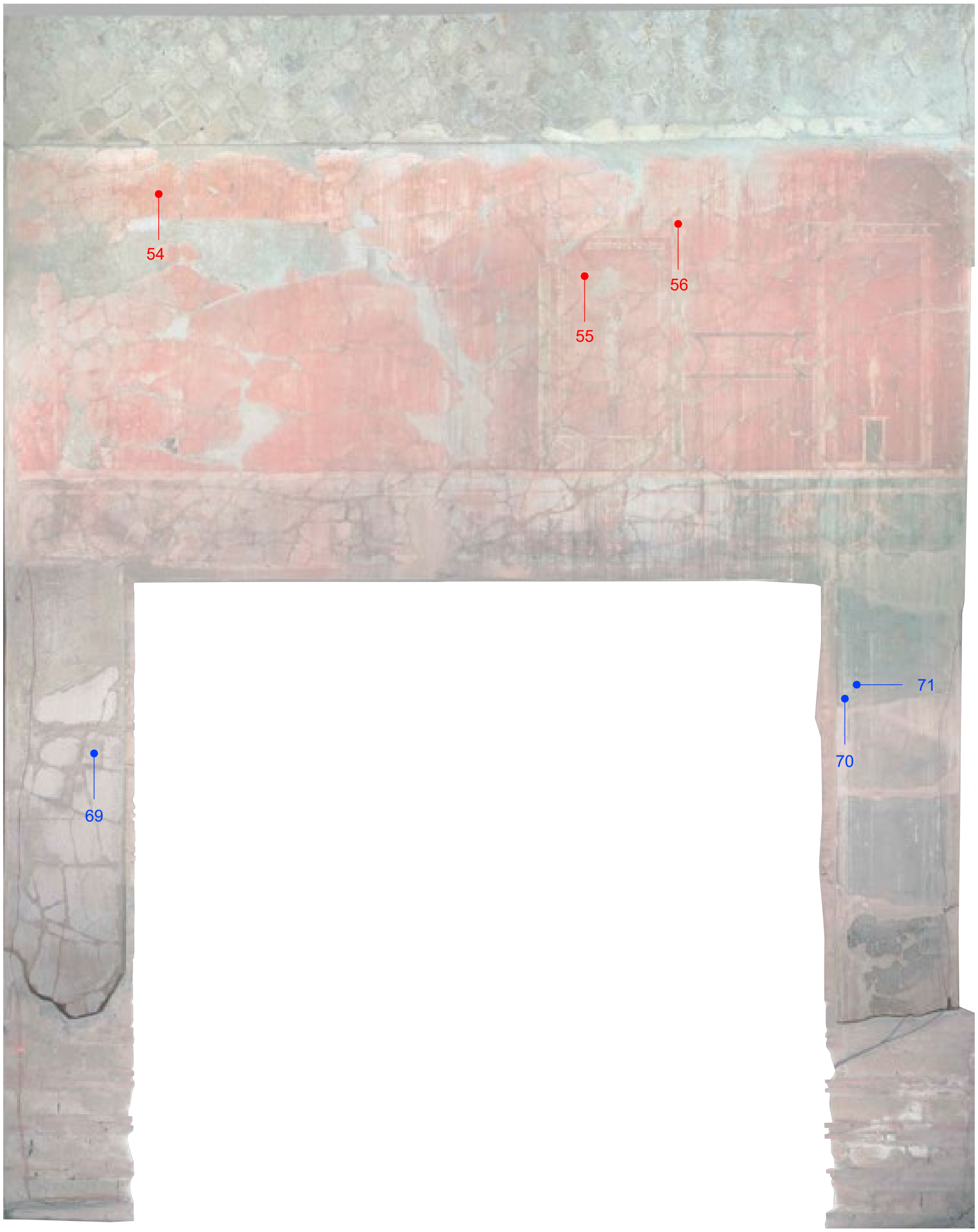


Casa del Bicentenario, Tablinum, East Wall - Overall

X-RAY FLUORESCENCE SPECTROSCOPY

- Point with Pb
- Point without Pb

Casa del Bicentenario, Tablinum	PROJECT	PARTNERS	PROJECT MANAGER	DATE RECORDED	EW
The Getty Conservation Institute	**Herculaneum Project**	SP, HCP	Leslie Rainer	2015/05	
	LOCATION	COPYRIGHT	RECORDED BY	LAST REVISED	SCALE
	Herculaneum, Italy	GCI	FP, KG	2017/05	1:25



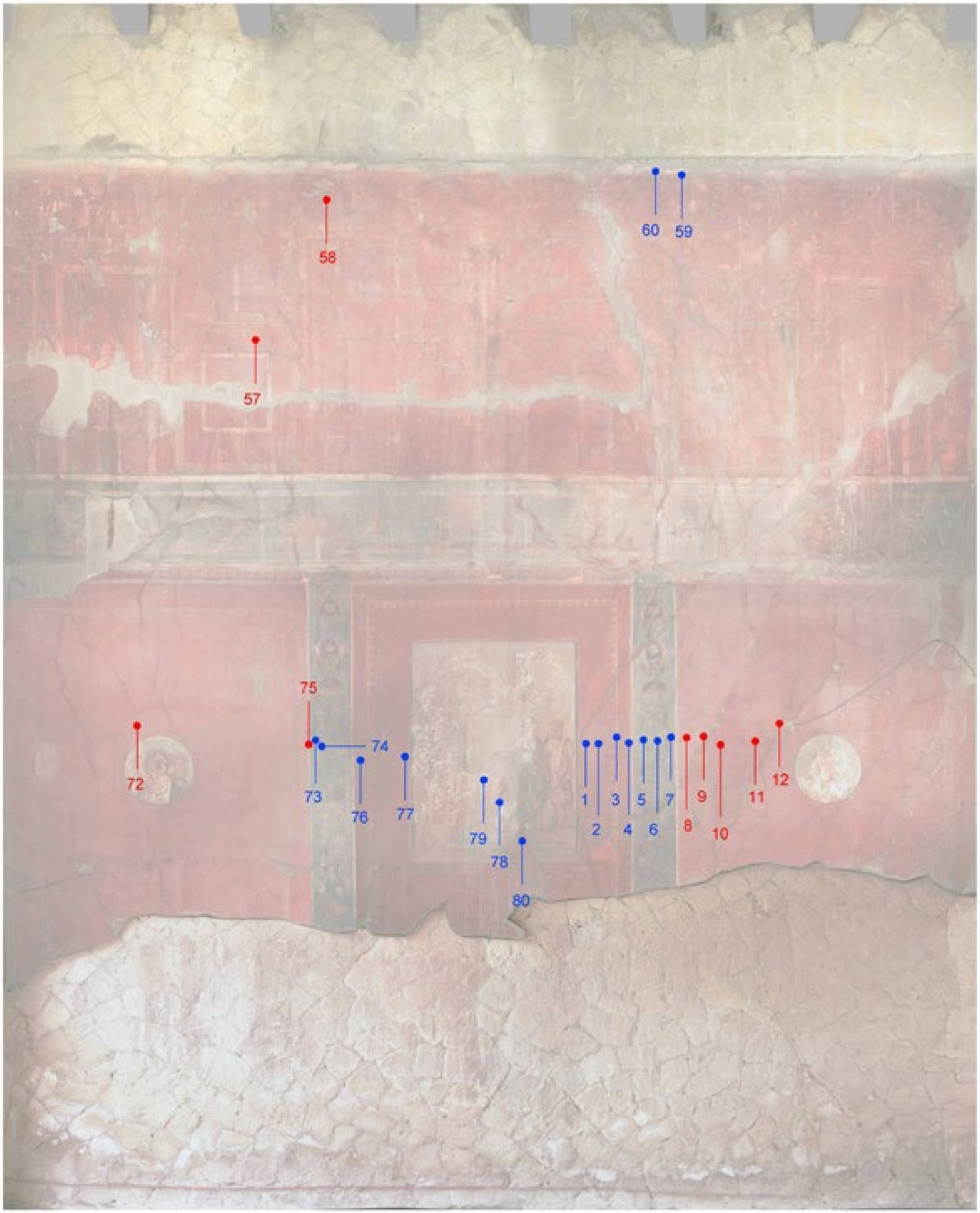
Casa del Bicentenario, Tablinum, South Wall - Overall

X-RAY FLUORESCENCE SPECTROSCOPY

● Point with Pb

● Point without Pb

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY FP, KG	DATE RECORDED 2015/05 LAST REVISED 2017/05	**SW** SCALE 1:25



Casa del Bicentenario, Tablinum, West Wall - Overall

X-RAY FLUORESCENCE SPECTROSCOPY

- Point with Pb
- Point without Pb

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY FP, KG	DATE RECORDED 2015/05 LAST REVISED 2017/05	**WW** SCALE 1:25

CHAPTER 6

Conditions of the Wall Paintings in the Tablinum of the House of the Bicentenary

Leslie Rainer

Introduction

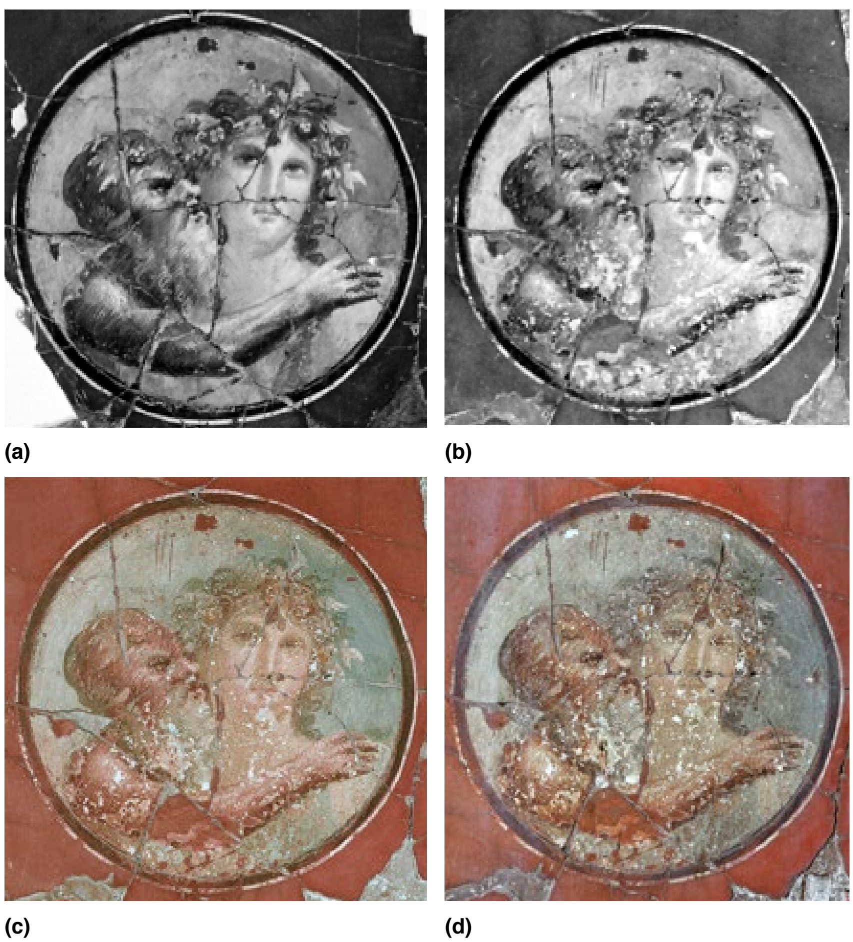
This report describes the conditions of the architectural surfaces in the tablinum of the House of the Bicentenary (Casa del Bicentenario). It synthesizes information on archaeological context, iconographic description, and technique of execution of the wall paintings, found in "Description of Architectural Surfaces in the Tablinum of the House of the Bicentenary," by Leslie Rainer and Francesca Piqué; the remounting technique used post-excavation, described in "Reconstruction and Remounting Materials and Techniques of the Wall Paintings in the Tablinum of the House of the Bicentenary," by Mark Gittins, Maria Luigia Bonaschi, Francesca Piqué, and Leslie Rainer; and interventions after 1938, detailed in "Previous Interventions (1939–2011) to the Tablinum of the House of the Bicentenary," by Leslie Rainer and Kiernan Graves. These reports, combined with "Environmental Assessment of the Tablinum of the House of the Bicentenary," by Shin Maekawa, and "Scientific Report on the Wall Paintings in the Tablinum of the House of the Bicentenary," by Kiernan Graves, Francesca Piqué, and Leslie Rainer, all in this volume, are the basis for the condition assessment of the architectural surfaces in the tablinum of the House of the Bicentenary. The condition assessment provides a studied overview of the state of conservation of the tablinum and an understanding of factors of deterioration, which provides critical information for the development of the conservation treatment.

The conditions of the tablinum are the result of a complex physical and conservation history of the room, from occupation in ancient Roman times, the eruption of Mount Vesuvius in 79 CE and subsequent burial, to the excavation, reconstruction, and restoration in 1938 by Amedeo Maiuri and his team, followed by environmental exposure, maintenance interventions, and eventual deferred maintenance over the next decades. The House of the Bicentenary, including the tablinum, has been closed to the public since the 1990s due to structural problems, water infiltration, and other conservation issues (fig. 6.1).

Severe deterioration of the wall paintings and the figurative scenes in particular, which at the time of excavation were in good condition, was the impetus for the study and conservation of the architectural surfaces in this room. The changes over time are evident in the comparison of historical photographs from the Maiuri archives with recent photographs (figs. 6.2a–6.2d).

The combination of environmental conditions and the different events and interventions over time have affected the structural elements, plasters, paint layers, and surface of the wall paintings and mosaic pavement of the tablinum, which will be addressed in this order. Environmental conditions have been a significant factor in the deterioration of the wall paintings. Additionally, different painting techniques exhibit different conditions; these conditions will be addressed by technique. The excavation, remounting of fragments, and

FIGURE 6.1.
View from the atrium into the tablinum, showing the condition of the interior of the House of the Bicentenary in 2009, noting water infiltration and structural issues. A comprehensive project is under way to address conservation issues of the house. The focus of the GCI project is the conservation of the architectural surfaces of the tablinum.



FIGURES 6.2A–6.2D.
Changes over time in condition of the figurative scenes, as shown in this medallion in photographs dating from 1938 (a) to 2011 (d). Progressive flaking and loss of paint can be seen, occurring preferentially in different colors and areas of the painting. (6.2a. 1938 Archivio Maiuri, AZS89 SP, 6.2b. 1978 Archivio Maiuri, D14406 SP, 6.2c. 1992 Archivio Foglia, 150636 SP, 6.2d. 2011)

restoration of the wall paintings and mosaic pavement have contributed to the current state of conservation of the architectural surfaces, and previous maintenance interventions have also contributed to deterioration of the wall paintings in the brief period from excavation and reconstruction in 1938 to the present.

Methods

Condition assessment was based on research of historical sources, visual examination, and photographic and graphic condition recording, combined with an environmental assessment and materials analysis. Evidence of original technique, previous interventions, and conditions were recorded by the Getty Conservation Institute (GCI) project team in phases beginning in 2011, in written, photographic, and graphic form, including digital photography,[1] in situ microscopy, and graphic mapping of the wall paintings and mosaic pavement.[2] An illustrated glossary at the back of this volume, defining technique of execution, previous interventions, and conditions, was developed by the project team. Using AutoCAD, a set of layers and symbols was created to graphically map execution and remounting, previous interventions, conditions, and sample and sensor locations. A complete body of documentation was compiled, entered directly into tablets or drawn by hand, and transferred to digital format (see appendix 6.1 for overall maps of each wall and individual figurative scenes).

Environmental Conditions

Environmental conditions are described in detail in Maekawa, this volume. In summary, the tablinum, a semi-confined space, experiences significant diurnal and seasonal fluctuations of ambient temperature and relative humidity, which closely follow those in the adjacent peristyle garden. Until 2013, the opening in the south wall leading to the peristyle garden was secured only with bird netting (fig. 6.3).[3] Direct sunlight irradiates portions of the walls at certain times of the year, causing additional spikes in surface temperature and fluctuation of relative humidity (fig. 6.4). Wind passes through the House of the Bicentenary and exac-

FIGURE 6.3.
View of the tablinum and peristyle garden from the atrium of the House of the Bicentenary in 2012, showing the large opening to the garden covered only with bird netting. A screen door has since been installed to reduce temperature fluctuations, airflow, and solar irradiation.

FIGURE 6.4.
Until 2013, bird netting over the large opening to the peristyle garden allowed the walls of the tablinum to be exposed to direct sunlight at different times of the day depending on the season.

FIGURE 6.5.
High moisture content in the lower walls has activated salts and led to degradation of original and restoration plaster at the base of the east wall.

erbates fluctuations in the environment of the tablinum. The lower walls have high moisture content (90%–100%) up to 100 cm on the east, south, and west walls. This is particularly critical on the east wall, which retains original plaster and paint along the base. Areas on the east wall with high moisture content correspond to areas of salt efflorescence, visible erosion, and deterioration of plaster and paint (fig. 6.5). These conditions are also degrading the exposed tuff along the base of the south and west walls (fig. 6.6).

Structural Conditions

Roof

The current roof, replaced by the Herculaneum Conservation Project (HCP) and the Soprintendenza Archeologica di Napoli e Pompeii (SANP) in 2011, is in good condition. Prior to this, the previous roof leaked; most noticeably, a large hole in the southeast corner

FIGURE 6.6.
Deterioration of the exposed tuff related to salt activity can be observed along the base of the west wall.

allowed the infiltration of rainwater (fig. 6.7). Water streamed down the wall, advancing deterioration of the tuff, erosion of the plaster and paint layers, deposition of salts, and growth of microbiological organisms (fig. 6.8). Other evidence of previous water infiltration is visible as drips in many places on the walls and wall paintings. This condition is most noticeable along the upper walls, particularly in the southeast corner.

FIGURE 6.7.
A large hole in the roof over the tablinum led to water infiltration in the past, particularly in the southeast corner of the room. In 2011, a new slab roof was installed.

FIGURE 6.8.
Damage along the south end of the upper east wall includes powdering and spalling tuff, drips down the wall, and biogrowth, the result of the roof leak and water infiltration.

FIGURE 6.9.
Open vertical cracks are observed in all four corners of the tablinum.

FIGURE 6.10.
Tuff blocks on the upper east wall are spalling and powdering in areas of previous water infiltration.

Wall Support

Significant portions of the walls were reconstructed at the time of excavation using modern tuff blocks in an irregular pattern (*opus incertum*) to join with original portions of the wall, which were constructed in Roman times using a different pattern (*opus reticulatum*). In some places, original and reconstruction blocks have separated where the two types of blocks join. Open vertical cracks up to 15 mm wide can be seen in each corner (fig. 6.9). In the northeast and southwest corners of the tablinum, these cracks appear to be through-wall cracks. Crack monitors in the northwest corner of the adjacent triclinium (Ambiente 9), which correspond to the vertical crack in the northeast corner of the tablinum, have shown no movement since 2013.[4]

In areas at the top of the east wall, along the south wall, and along the base of the west wall, some tuff blocks exhibit spalling and powdering. These conditions appear to be related to previous water infiltration and salt activity (fig. 6.10).

Plaster

At the time of excavation, large portions of the wall paintings were found as fragments in the volcanic fill or found in situ but fragmentary, and subsequently remounted on the walls. The stratigraphy of the plasters is therefore a combination of original and reconstruction layers (see Gittins et al., this volume).

Original Roman Plaster

Generally, the original Roman plasters in areas that have not been exposed to water infiltration from above or to capillary rise from the ground are in good condition.

Diagonal and vertical cracks through plaster layers are visible in both original wall paintings and reconstruction plaster. There are significant vertical and diagonal cracks in the center of the east wall (approx. 330 and 380 cm from the north end), likely corresponding to the join of the original tuff and reconstruction tuff blocks on the wall. The south wall has a crack in the plaster approximately 80 cm from the east end. On the west wall, there are significant vertical and diagonal cracks approximately 375 and 425 cm from the north end (fig. 6.11).

Voids and delaminations were detected using laser speckle interferometry, carried out by GCI scientists, and acoustic tapping, carried out by the conservation team.[5] Plaster is delaminated between various layers in localized areas of the wall paintings. Voids in the lower plaster layers are often associated with cracks. Extensive plaster delamination is found in the central part of the west wall, associated with a large, open diagonal crack (see fig. 6.11). On the upper south wall, plaster fragments are delaminated in areas of previous water infiltration. These delaminations are typically very thin and stratigraphically located just below the final finish plaster layer. In these areas, some plaster fragments have lost their upper plaster and paint layers, exposing lower plaster layers.

Plaster is powdering in localized areas, particularly on the upper south and upper east walls, where previous roof leaks led to water infiltration, eroding plaster and paint layers and leaving a decohesive plaster layer and traces of powdering paint (fig. 6.12).

The base of the east wall (the lower 160 cm) retains original Roman plaster fragments, partially covered by a combination of lime-based 1938 reconstruction plasters and later cementitious repair plasters. This area is severely deteriorated; conditions include detachment, losses, decohesion, and salt efflorescence, which is principally located on the original plaster. The area has been subject to ground moisture and capillary rise due to water from the peristyle garden and previous roof leaks that pooled at the base of the wall. Additionally, as the adjacent triclinium (Ambiente 9) was exposed to the elements until 2013, when it was reroofed by HCP and SANP, water also pooled at the base of the east wall on the triclinium side. Salt efflorescence can be seen in some areas up to 160 cm, the height of the capillary rise. Clearly, the entire zone has undergone treatments in the past, as evidenced by the presence of cementitious fills applied in post-1938 interventions (fig. 6.13).

The lower east wall exhibits loss of the uppermost layer of plaster associated with thin delaminations of plaster and paint in areas of salt activity (fig. 6.14).

FIGURE 6.11.
Significant vertical and diagonal cracks are visible on the east and west walls of the tablinum.

FIGURE 6.12.
Detail of the south wall, showing decohesive plaster and powdering paint layers.

FIGURE 6.13.
Detail of the base of the east wall, showing cementitious fills partially covering original Roman plaster fragments and resulting in deterioration from salt activity.

FIGURE 6.14.
Thin delaminations of the uppermost plaster occur along the lower east wall in areas of water infiltration and ongoing salt activity.

1938 Reconstruction Plaster

The 1938 reconstruction plaster is spalling and friable on the upper east wall in the area of previous water infiltration from roof leaks at the south end (fig. 6.15) and along the lower 1 m of the east wall. Reconstruction plasters exhibit cracking, which, in some places, can be correlated with joins between the original and reconstruction tuff blocks of the wall. On the upper east wall, vertical cracks in the reconstruction plaster have been successively repaired by applying cementitious fills and washes tinted different colors over them. Drips can be seen in the reconstruction plaster on the upper east wall, and the lime wash over the reconstruction plaster in this area has washed away in places, leaving the white plaster layer exposed and in some places discolored. Generally, smaller 1938 Maiuri-era fills have a thick, opaque tinted layer that corresponds to the color of the surrounding fragments (fig. 6.16). In some areas, 1938 plasters and original Roman plasters and paint layers are covered by later cementitious repair plasters. These are typically very thin (1 to 3 mm) and are most extensive along the base of the east wall (see fig. 6.13).

Paint Layers

Condition of the paint layers varies by area and in many cases by painting technique. Prevalent conditions include powdering, flaking, and loss.

The painted surface of the wall paintings exhibits extensive powdering. Due to the presence of wax and other surface coatings previously applied as maintenance and restoration treatments, and the subsequent breakdown of the wax in places, the type and extent of powdering differs from area to area. In areas of previous water infiltration, and in recent losses in the figurative scenes where lower paint layers are exposed, there is severe powdering. In other places on the walls, the wax coating is not continuous, and powdering is visible both underneath the wax and where the wax has already been lost. Other areas show powdering paint beneath a continuous and stable layer of wax.

Flaking occurs at different scales and in different patterns depending on the painting technique and conservation history. In many areas, mainly on the monochrome

FIGURE 6.15.
Upper east wall at the south end, showing 1938 reconstruction plaster that is spalling and friable in the area of previous water infiltration from roof leaks. Cracks in this area have been repaired in the past with different colored materials.

FIGURE 6.16.
Smaller Maiuri-era fills exhibit a thick, tinted layer in some areas.

background, the paint and wax layers are lifting together in flakes less than 2 mm, defined as micro-flakes. Small flakes, approximately 2 to 4 mm, can be seen in many places on the wall. This type of flaking is particularly widespread in areas where multiple paint layers are applied over the monochrome background, such as on figurative scenes and architectural decoration. Large flakes greater than 5 mm occur mainly in the decorative egg-and-dart motif along the lower edge of the frieze where there is substantial paint buildup, at the plaster join of two *pontate*.

Paint loss is the result of mechanical damage, abrasion, erosion, and complete loss of flaking paint. Loss by mechanical damage since excavation is seen on both the monochrome background and the figurative scenes. Severely abraded or eroded paint layers are present in the upper sections of the wall paintings, where the figures are barely visible, with only traces of the paint layer remaining on the surface. This may be a result of powdering and micro-flaking paint, the remounting technique, water infiltration, effects of the eruption, wear over time, or a combination of these. Losses are also associated with flaking paint depending on the area and painting technique; large, small, and micro-flakes are seen on the wall paintings, and losses follow the same pattern as flakes not yet lost (i.e., in areas of large flakes, large paint losses can be seen; in areas of micro-flaking, small losses are present). The egg-and-dart motif along the frieze, for example, painted directly over a plaster layer in the area of a *pontata* exhibits large flakes and losses, while figurative scenes show a pattern of flaking and loss with small lifted flakes over a powdering underlayer, and areas of monochrome background show micro-flaking and powdering of the paint layer.

Specific conditions can also be correlated to original painting technique. The following sections further describe the different conditions of the paint layers by technique, as set out in Rainer and Piqué in this volume.

Monochrome Background

The monochrome background is in varying conditions across the three walls and the most widespread conditions exhibited are powdering, micro-flaking, and mechanical damage.

FIGURE 6.17.
Detail of east wall, showing micro-flaking on a red monochrome background.

On the monochrome background, the paint layer is powdering as described above. In some places, paint is powdering underneath either a disrupted or a continuous wax layer. In other places, exposed pigment is powdering where the coating is lost.

On the three walls, the red and yellow monochrome backgrounds exhibit micro-flaking in many areas (fig. 6.17). Micro-flaking is associated with deterioration of the wax coating, which lifts and pulls up loose pigment where the pigment is more adhered to the wax coating than to the plaster below. This is particularly evident on the west wall around the central rectangular scene, where there is a band of micro-flaking approximately 6 cm wide across the top and along the two sides of the scene.

On the lower south wall pilaster to the east of the opening to the peristyle garden, the black monochrome background has washed away, leaving the underlying plaster exposed. To the west of the opening, the black monochrome background of the pilaster on the lower south wall is fairly stable with little powdering, although the density of the black color varies across this area (fig. 6.18).

Losses in the monochrome background are the result of erosion of the paint layer due to water infiltration or past mechanical damage. Unintentional mechanical damage can be seen on the wall paintings as nicks, scrapes, or gouges, which extend into the plaster layer, most notably in the south corner of the east and west walls, and extending from the edge of the north medallion on the west wall. Intentional scratched graffiti also mars the surface of the east wall at the south end (fig. 6.19). Less than 5% of the wall paintings show mechanical damage, and it is generally limited to the monochrome background.

FIGURE 6.18.
On the lower section of the south wall, the black paint layer on the east side (left) has been washed away; on the west side (right), the layer is more coherent, although the condition varies across the surface.

FIGURE 6.19.
Graffiti scratched into the east wall at the south end.

Tape marks are visible in the monochrome background around three sides of the medallion on the south end of the west wall and on the center panel of the west wall, surrounding the central rectangular scene, suggesting that paper was taped to the wall in order to trace the medallion and scene.

On the east wall, areas of transformation from yellow to red can be seen in the monochrome background. Areas of yellow background are present mainly around the central rectangular scene (fig. 6.20a) and in the upper register at the north end of the wall. Several fragments exhibit both yellow and red on the same piece (fig. 6.20b), indicating that the red is a result of alteration and that these areas were originally yellow transformed to red as a consequence of the heat of the eruption (see Rainer and Piqué, this volume; Graves, Piqué, and Rainer, this volume). Neither the south wall nor the west wall exhibits areas of yellow monochrome background or any other evidence of this phenomenon, although the yellow portions of the wall paintings on the east wall suggest that the background around the central scene on the west wall also would have been yellow, as

(a)

(b)

FIGURE 6.20A–6.20B.
(a) View of the east wall, showing areas of yellow monochrome background, notably in the lower register in the central panel surrounding the rectangular scene. (b) Fragments exhibiting yellow and red are also present.

would the upper sections of all three walls (see Graves, Piqué, and Rainer this volume, for further discussion).

Decorative Elements

Decorative elements are painted directly over the monochrome backgrounds and include decorative borders on the lower walls and architectural decoration and figures on the upper walls. This type of painting, typically applied in one or more layers, with thick impasto in places, exhibits flaking, losses, and abraded paint layers.

Flaking and paint loss are observed in the decorative borders surrounding the rectangular scenes (fig. 6.21). The decorative borders appear white on the east wall and discolored to off-white on the west wall.

Much of the architectural decoration on the upper south and west walls, and in places where decoration remains on the upper east wall, has a distinctly eroded or abraded appearance. Only traces of figures and decoration can be seen (fig. 6.22). Traces of green and purple can be seen in the decoration on the upper east wall but are mostly lost on the upper south and west walls. Where green remains on the upper west wall, it is slightly darkened.

In many places on the decorative borders, losses are concentrated in areas where paint was applied most thickly and in specific colors, particularly green and red, which are almost completely lost (fig. 6.23).

FIGURE 6.21.
Paint flaking and loss can be seen in the decorative linework and borders.

FIGURE 6.22.
On the upper walls, architectural decoration and figures applied directly over the monochrome background on the upper walls are abraded and eroded.

FIGURE 6.23.
Decorative borders are composed of different designs executed with thickly applied paint, which exhibits widespread flaking and loss, particularly in specific colors such as green and red.

Vertical Bands

Powdering, flaking paint, and paint loss affect the painted decoration within the vertical bands. This appears to be frequently associated with paint thickness and with specific colors, especially details executed in green earth. Painted details on all four vertical bands are lifting and show micro-flaking, flaking, and paint loss (fig. 6.24).

On the east wall, significant portions of the south vertical band are lost. The edges of the black background of both vertical bands on the east wall have been partially washed away in areas of previous water infiltration, exposing the red or yellow monochrome background underneath (fig. 6.25a), and on the north vertical band, the original pink-tinted plaster is exposed in places (fig. 6.25b). Alteration of cinnabar from a bright red to a dull brown-black can be seen in some of the decorative elements on the vertical bands (see fig. 6.25b).

FIGURE 6.24.
Painted detail on a vertical band, applied over a black background, exhibits micro-flaking, flaking, and paint loss.

FIGURE 6.25A–6.25B.
The vertical bands show flaking, cupping and loss. On the vertical bands of the east wall, the black has washed away in areas, revealing the original pink-tinted plaster on the north end and red or yellow underneath. Note also the alteration of cinnabar from bright red to brown-black in the floral decoration of the south vertical band.

FIGURE 6.26.
Detail of medallion, showing lifting, cupping, flaking, and losses. In some places, the loss is down to the monochrome background; in other areas, only the upper design layer is lost, exposing the light-blue background layer.

Medallions

The four medallion paintings show varying degrees of deterioration. All medallions exhibit decohesion/powdering of the light-blue background layer, incipient flaking, flaking paint, and paint loss, particularly where the paint is built up in multiple layers, including in the flesh tones of the figures and areas of drapery (fig. 6.26). Old and new losses are found on all medallions, indicating that deterioration is active. The medallion at the south end of the east wall is in the best condition. The two medallions on the west wall are in the worst condition.

The medallion at the north end of the east wall shows extensive flaking, cupping, and lifting over the majority of the surface, particularly in the design layers (fig. 6.27). Across the surface of the medallion, 30%–35% of the painted decoration is lost, and the remaining paint is in precarious condition. The underlayer is decohesive/powdering, which leads to lifting and flaking of the painted design layers above, caused by a lack of adhesion between the powdery underlayer and the more stable paint layer above. There is both loss of the design layers down to the monochrome background and flaking with paint loss of the upper design layers.

The medallion at the south end of the east wall is in more stable condition. There is localized lifting, cupping, and flaking, and some paint loss (approximately 10%–15%) but much less of the design layer is affected (fig. 6.28). The preparation layer is decohesive where it is exposed and may be powdering under the upper design layers.

The medallion at the north end of the west wall shows severe flaking, cupping, and lifting over the majority of the surface, concentrated on the robe and in places on the figure's neck and face. There is some loss down to the monochrome background layer. Most of the loss is down to the exposed underlayer, which is decohesive/powdering, leading to lifting and flaking of the design layers. There is approximately 25%–30% paint loss on this medallion, and the remaining paint is in precarious condition. A deep scrape along the lower right half of the medallion measures approximately 10 cm (fig. 6.29).

The medallion at the south end of the west wall is lifting, cupping, and flaking with approximately 15%–20% loss. The face of the figure in the foreground is nearly lost, with a large lacuna exposing the red monochrome layer. Additionally, there is extensive loss in the figure's tunic and along the left edge of the blue background. The majority of loss on this medallion is down to the light-blue background. The exposed underlayer is decohesive/powdering, leading to lifting of the design layers and areas of paint loss, exposing the monochrome background and upper design layers (fig. 6.30).

Rectangular Scenes

The central rectangular scenes on the east and west walls show severe lifting, flaking, and paint loss. The underlayer on both rectangular scenes is decohesive/powdering, leading to lifting of the design layers. Paint loss is mostly seen in areas of thick paint or impasto, mainly on the figures, where paint was applied more thickly than on the background.

Upon excavation, both scenes were in fairly good condition. Many details clearly visible at the time of excavation and restoration by the Maiuri team are now entirely lost or barely visible.

In the rectangular scene on the east wall, the majority of loss is concentrated on the figures (fig. 6.31). The features on the face, chest, and upper arms of Venus and the face of Mars are mostly lost, leaving the powdery white preparation exposed (fig. 6.32). Details found in historical photographs, such as the cupids and the symbolic weapons of Mars, are barely visible. Loss occurs mostly down to the powdery/decohesive white preparation layer

FIGURE 6.27.
Medallion at the north end of the east wall, exhibiting severe cupping, flaking, and loss of paint in the design layer, exposing the monochrome red background in several places.

FIGURE 6.28.
Medallion at the south end of the east wall, showing a loss in the face exposing the monochrome background, and localized flaking and cupping on the figure and background.

FIGURE 6.29.
Medallion at the north end of the west wall, presenting severe deterioration of the figure's robe, neck, and face, with most of the loss down to the exposed underlayer. A deep scrape is seen on the lower right.

FIGURE 6.30.
Medallion at the south end of the west wall, exhibiting severe damage exposing the monochrome background in the face and robe of the figure in the foreground. The majority of the design layer is severely cupping, lifting, and flaking. The decohesive preparation layer is exposed in these losses.

FIGURE 6.31.
The central rectangular scene on the east wall exhibits severe deterioration concentrated mainly on the figures. Many details, including Mars's weapons, are barely visible.

FIGURE 6.32.
Detail of rectangular scene on the east wall, showing severe loss of paint in the faces of Venus and Mars and the chest and arms of Venus, exposing the decohesive white preparation layer.

FIGURE 6.33.
The rectangular scene on the west wall exhibits flaking, lifting, and loss of paint concentrated in the skin tones of the figures and in details of the painted decoration. Paint loss is also visible in areas of paint buildup, particularly Pasiphaë's face and upper body, the animals at left and center, and the figure at the top of the painting.

and in places down to the smooth white plaster. Approximately 10%–15% of the paint layer is lost on this scene.

Pigment alteration can be seen in the robe of Venus, which is a reddish tone in one fragment and brown in an adjoining fragment, suggesting that fragments were differentially heated and altered as a result of the eruption prior to remounting on the wall (see Gittins et al., this volume).

The central rectangular scene on the west wall shows lifting, flaking, and paint loss concentrated in the skin tone of the figures and in the thickly painted details. The underlayer is decohesive/powdering, leading to lifting of the design layers. Discrete areas of paint have been lost where paint is built up, including the face, arm, and upper robe of Pasiphaë, areas on the animals, the head and robe of the upper figure, and along the left edge of the scene, leaving the white preparation layer exposed. Approximately 5%–10% of paint is lost on this scene (fig. 6.33).

Frieze

The paint layer of the frieze exhibits powdering, flaking, and loss. In the painted figures and decoration, paint is also abraded and decohesive/powdering. Primarily on the center section of the west wall, the design and black background of the frieze are abraded and worn, exposing the lower tinted plaster layer (fig. 6.34). The frieze on the east wall is fragmentary, with less than 50% remaining.

Where paint was most thickly applied, there are some occurrences of loss of the entire painted decoration, exposing the red background (fig. 6.35). Along the egg-and-dart motif, which extends along the lower edge of the frieze, there are areas where the paint is poorly adhered to the underlying plaster, and large flakes and losses are visible (fig. 6.36).

FIGURE 6.34.
Detail of figurative painting on the frieze, showing powdering, flaking and exposure of the lower tinted plaster layer, all of which is obscured by the white drips due to water infiltration and excess wax.

FIGURE 6.35.
In some areas of the frieze where paint was most thickly applied, the entire painted decoration has been lost, leaving the red background below exposed.

FIGURE 6.36.
Along the lower edge of the frieze on the west wall, the egg-and-dart design exhibits large flakes with associated losses. The paint in this area is poorly adhered to the plaster substrate. This decoration appears to be covering the overlap of the frieze plaster and the plaster of the lower wall.

Base of Wall

Along the base of the wall, original painted plaster is extant only in the southeast corner on the east wall (fig. 6.37) with some traces of painted plaster along the base of this wall, which is severely deteriorated, and numerous fills that cover the original plasters in many places. For the most part, the paint and plaster layers exhibit efflorescence, powdering, pitting, and loss caused by chronic cycling of salt deliquescence and crystallization, due to capillary rise of both groundwater and standing water following rain events. Moreover, the severe degradation of this area has led to the subsequent and repeated application of fills in maintenance interventions post-excavation and reconstruction. A series of hard gray cementitious fills covers original Roman plaster, with traces of color in some places. The combination of capillary rise and the cementitious nature of these repair fills has led to salt activity in this area, and salts have crystallized and accumulated on and in the original Roman plaster around the repair fills, leading to further deterioration and necessitating their removal (fig. 6.38). The base of both the south and west walls is exposed tuff and brick in *opus vittatum*, and tuff blocks in *opus incertum*, respectively, and the entire Roman stratigraphy is lost.

Surface

The surface of the wall paintings has a variable appearance and sheen across the three walls, depending on location. Conditions include an opaque white haze, drips, discolored coatings, and microbiological growth in various places.

White Haze

The surface of the wall paintings is heterogeneous, and there is a white haze over large areas of all walls. This haze has a variable appearance depending on the area, background

FIGURE 6.37.
Remnants of original painted decoration along the base of the wall are extant only in the southeast corner on the east wall with traces of paint on original plaster in some places along the base of this wall.

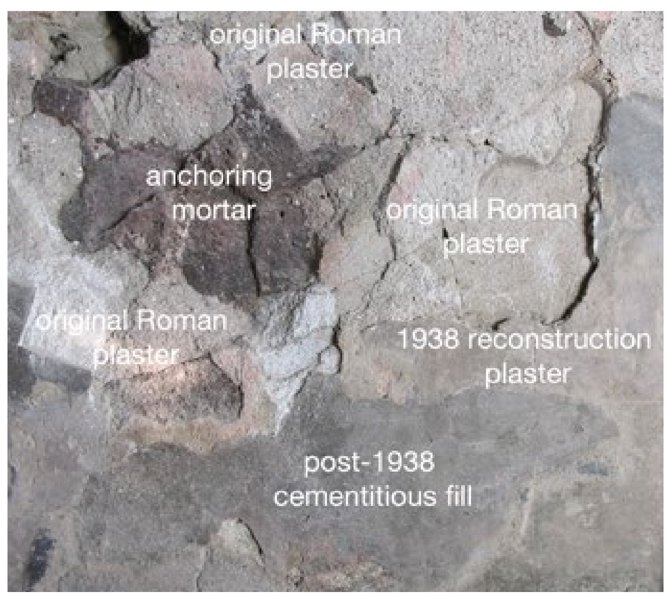


FIGURE 6.38.
Detail of base of the east wall, showing plaster stratigraphy with fragments of original plaster remaining under modern fills. Salt efflorescence surrounds the fills.

color, and decorative scheme. It is particularly obscuring in the southwest corner and in places where water has dripped down from past roof damage.

An accumulation of wax on the surface, which was applied in previous interventions as a maintenance measure since excavation, can be seen on all walls (Piqué et al. 2010) with a variable opaque white haze and variations in sheen (see fig. 6.11). This wax layer has trapped and embedded particulates and is heavily applied showing clear brushstrokes in many areas (fig. 6.39). A waxy buildup can be seen on the monochrome background, and built up on the figurative scenes as a dull sheen, often associated with micro-flaking of the paint layer (see fig. 6.17). It can also be seen on 1938 reconstruction plaster (fig. 6.40), especially on the upper east wall, The surface accumulation is composed of a combination of materials, including oxalates, beeswax, paraffin wax, other unidentified coatings, sulfur, and other particulate matter (see Graves, Piqué, and Rainer this volume).

FIGURE 6.39.
Detail of the upper west wall, showing clear brushstrokes and wax accumulated on the surface of the wall paintings that creates a variable and dull sheen.

FIGURE 6.40.
Detail of the upper east wall, where wax can be seen overlapping the 1938 reconstruction plaster surrounding original Roman plaster fragments.

FIGURE 6.41.
Detail of vertical band on the west wall, showing a disfiguring white haze over the black monochrome background and decoration, giving the band a blue-gray cast. In this case the white veil is a crust attached to the underlying paint.

FIGURE 6.42.
Distinct, oval-shaped white spot next to the medallion at the south end of the west wall, most likely caused by light from a lamp placed close to the wall. Tape marks from the tracing can also be seen around the medallion.

On areas with a black background, including the vertical bands, frieze, and lower south wall, the haze gives the background a blue-gray cast, which, on the frieze, obscures the figurative painting. On the vertical bands, the white haze is a crust that is firmly attached to the paint beneath and appears to be composed of multiple layers (fig. 6.41). It is most evident on the two vertical bands on the west wall.

A distinct, oval-shaped white spot measuring approximately 4 × 8 cm is observed next to a medallion at the south end of the west wall (fig. 6.42). This likely corresponds to the previous placement of a lamp close to the wall for tracing of the medallion; the illumination from the lamp appears to have heated the surface and re-formed the wax in this location. Tape marks are also visible around the medallion.

Drips

The wall paintings exhibit a variety of types and colors of drips in different parts of the three walls. White drips extend down the surface in many areas. These drips are in part an accumulation of wax applied to the surface, which has been degraded by water infiltration from above, creating an opaque white veil obscuring the wall paintings, and in part a washing

FIGURE 6.43. (LEFT) Detail of upper south wall and frieze. White drips are caused by a buildup of wax on the degraded surface, and also a washing away of the paint layer that exposes the underlying white plaster.

FIGURE 6.44. (RIGHT) Red drips on the upper east wall are likely powdering pigment from the original painting, washed down the wall by previous water infiltration.

away of the paint layer, exposing the underlying plaster (fig. 6.43). White drips extend down the upper south wall on the west side and are particularly noticeable on the frieze. There are white drips down the west wall, especially at the south end, at the south end of the east wall, and in other locations across all three walls.

On the north and center sections of the upper east wall, drips of red pigment are visible and are likely original powdering pigment from original Roman plaster that has been washed down the surface of the reconstruction plaster by water infiltration (fig. 6.44). A dark brown drip at the south end of the upper west wall is possibly a stained coating used on the beams above (fig. 6.45).

Drips of bird excrement can be seen on both the east and west walls at the north end of the room, and on the south and west walls in the southwest corner of the room, suggesting that the upper edges of the wall paintings have served as suitable perching locations (fig. 6.46).

Other Coatings

In addition to the wax, which was applied over the surface of the wall paintings, the rectangular scenes and medallions exhibit a glossy surface and appear to have a discolored coating (see Rainer and Graves, this volume). Both the scenes and medallions have a yellowed appearance (fig. 6.47). A coating on the rectangular scenes, particularly, is hard and well adhered to the paint layer below, unlike the surrounding areas of monochrome background. Some figures in the frieze also appear to have a coating, which can be seen by the difference in sheen and by the evidence of brushstrokes.

FIGURE 6.45.
Detail of the south end of the upper west wall, showing a brown drip that most likely is from a stain used on the beams above.

FIGURE 6.46.
Drips of bird excrement on the east wall. The upper edges of the wall paintings serve as ideal locations for birds to perch.

FIGURE 6.47.
The medallions and rectangular scenes have an uneven and discolored appearance with traces of a yellowed coating.

Microbiological Growth

Traces of microbiological growth are present in a number of forms: as dark-green marks on the reconstruction plaster at the south end of the east wall (fig. 6.48); much more extensively, as green deposits in the southeast corner of the room extending almost down to ground level (fig. 6.49); as a dark-green patina in patches on the exposed tuff of the upper south wall, and more sporadically, on the tuff of the upper west wall. A pink biopatina, a form of bacteria, is also visible over the original and restoration plaster along the base of the east and west walls (figs. 6.50 and 6.51). First observed in 2014, this biopatina showed a vari-

FIGURE 6.48.
Detail of the south end of the east wall, showing biogrowth appearing as dark-green marks and black-green deposits.

FIGURE 6.49.
The southeast corner of the tablinum shows a green microbiological growth that follows drips in areas of previous water infiltration and covers post-1938 fills.

FIGURE 6.50.
A pink biopatina along the base of the east wall covers original and reconstruction plaster. This form of bacteria appears to be sensitive to both light and salts, and fluctuates according to environmental conditions.

FIGURE 6.51.
The same biopatina, visible on the exposed tuff along the base of the west wall. This biopatina is also present along the base of the walls in other parts of the house.

able presence over the following two years and seems to be correlated with light and with humidity in the walls (see Graves, Piqué, and Rainer this volume).

Salts

Salt efflorescence can be seen mostly along the base of the walls up to approximately 1 m high on all three walls: on exposed tuff on both the west wall (fig. 6.52) and the south wall (fig. 6.53), and on original and restoration plaster on the east wall (fig. 6.54), and has caused spalling, pitting, and erosion (fig. 6.55). Reconstruction tuff blocks on upper walls

FIGURE 6.52.
Base of the west wall, showing a tideline of salt efflorescence on the exposed tuff.

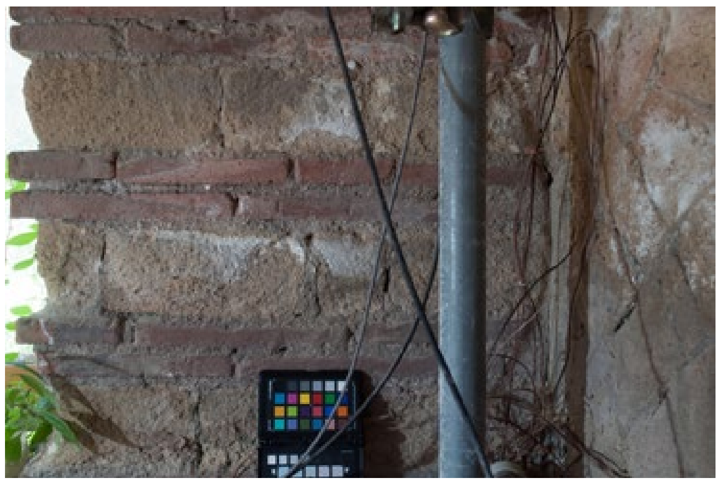


FIGURE 6.53.
Base of the west pilaster on the south wall, showing salt efflorescence concentrated on the exposed tuff in this area.

FIGURE 6.54.
Salt efflorescence has caused extensive deterioration along the base of the east wall in the original and restoration plasters, leading to erosion and loss of plaster.

show the same conditions in areas that likely correspond to water infiltration. Salt activity is variable depending on fluctuations of temperature, relative humidity, and air exchange. Tidelines of salt crystallization can be seen up to 1 m from the floor but may be lower at different times of the year.

Efflorescence is also present in areas of original plaster on the east wall around post-1938 repairs and later cementitious fills, and has caused damage to the original and 1938

FIGURE 6.55.
Detail of damage caused by salt activity in the lower east wall, where the original painted plaster is spalling due to subfluorescence of salts.

FIGURE 6.56.
Subsequent repairs using cementitious plasters have led to salt activity, resulting in further damage to the surrounding original and 1938 reconstruction plasters.

reconstruction plasters in these areas (fig. 6.56). The majority of salts found on the walls of the tablinum are made up of sulfates (Graves, Piqué, and Rainer this volume).

Conclusions

In conclusion, the conditions of the architectural surfaces in the tablinum are related to a number of factors that, when combined, lead to deterioration of the architectural surfaces. Beginning with the eruption of Mount Vesuvius in 79 CE, the wall paintings were heavily damaged with the collapse of walls and the force and heat of the pyroclastic surge. From that time, while they lay buried in a stable environment for nearly two thousand years, degradation of organic materials would have occurred. Excavation and exposure of the vulnerable painted surfaces in 1938 radically changed the environment of the architectural surfaces and likely led to further degradation. Environmental conditions with fluctuations of temperature, humidity, and air exchange, as well as driving rain and standing water, have since contributed to salt activity at the base of the walls. Solar radiation, spikes in temperature, and fluctuations of humidity, combined with painting technique and previous intervention materials applied as surface coatings (e.g., beeswax and paraffin), are likely in part responsible for the severe flaking of the paint on the figurative scenes, which are especially vulnerable given the thick buildup of paint over a powdering preparatory layer. Additionally, deferred maintenance of the roof and water infiltration from the top of the walls led to the powdering and spalling of tuff, thin delaminations of plaster, and drips of powdering pigment down the surface of the walls, damaging both original Roman paintings and 1938 reconstruction plasters.

These various factors are often interrelated and, combined, lead to further damage and the ongoing deterioration of the wall paintings. The development of an integrated approach to conservation is necessary to address this complex set of factors and slow the ongoing deterioration, stabilize the painted surfaces, and ensure the preservation of the tablinum of the House of the Bicentenary over the long term.

Acknowledgments

The author would like to acknowledge colleagues from HCP and PA-ERCO (formerly SP) for their support of the project and their sharing of information regarding conditions at the site. Project team members from the GCI and external consultants also contributed to the condition recording over the course of the project, and scientists from the GCI and external institutions provided valuable data that informed the condition assessment.

Notes

1 Detailed digital photography of the walls in sections (approx. 1 m × 1 m with overlap) was carried out by the GCI team to be used for baseline documentation of the condition of the wall paintings prior to conservation intervention. Massimo Brizzi, consultant to the Herculaneum Conservation Project (HCP), provided overall rectified photographs to use as base images for the subsequent condition mapping of the wall paintings. Maps were hand drawn, then transferred to AutoCAD.

2 Due to the protection covering the mosaic pavement at the time of inspection by Thomas Roby in 2011, the full mosaic could not be examined. However, representative areas were mapped over a scale drawing. A full examination will be carried out when the floor protection is removed.

3 In August 2013, a screen door was installed to filter light and reduce airflow.

4 These monitors were not installed by the GCI project team; it is not known when they were installed.

5 Acoustic tapping, which involves tapping or knocking by hand on the plaster, is a technique used by conservators to assess the condition of the plaster and determine if there are delaminated plaster layers or voids behind the surface.

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APPENDIX 6.1

Graphic Documentation: Conditions

Casa del Bicentenario, Tablinum, East Wall - Overall

CONDITIONS: STRUCTURAL AND TUFF

Hole
Structural crack
Spalling
Powdering
Drip
Abrasion/erosion

Pages regarding structural and tuff conditions of EF, EL1, EL2, EL3, EV, EB, EM1, ES2, EM3 are not present since tuff is not visible in these sections of the wall

Casa del Bicentenario, Tablinum	PROJECT Herculaneum Project	PARTNERS SP, HCP	PROJECT MANAGER Leslie Rainer	DATE RECORDED 2011-2016	EW
The Getty Conservation Institute	LOCATION Herculaneum, Italy	COPYRIGHT GCI	RECORDED BY -----	LAST REVISED 2017/05	SCALE 1:25

Casa del Bicentenario, Tablinum, South Wall - Overall

CONDITIONS: STRUCTURAL AND TUFF

- Hole
- Structural crack
- Spalling
- Powdering
- Drip
- Abrasion/erosion

Pages regarding structural and tuff conditions of SF, SL1, SL2 are not present since tuff is not visible in these sections of the wall

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY -----	DATE RECORDED 2011-2016 LAST REVISED 2017/05	**SW** SCALE 1:25

Casa del Bicentenario, Tablinum, West Wall - Overall

CONDITIONS: STRUCTURAL AND TUFF

- Hole
- Structural crack
- Spalling
- Powdering
- Drip
- Abrasion/erosion

Pages regarding structural and tuff conditions of WF, WM1, WS2, WM3 are not present since tuff is not visible in these sections of the wall

Casa del Bicentenario, Tablinum	PROJECT	PARTNERS	PROJECT MANAGER	DATE RECORDED	WW
The Getty Conservation Institute	Herculaneum Project	SP, HCP	Leslie Rainer	2011-2016	
	LOCATION	COPYRIGHT	RECORDED BY	LAST REVISED	SCALE
	Herculaneum, Italy	GCI	-----	2017/05	1:25

Casa del Bicentenario, Tablinum, East Wall - Overall

CONDITIONS: PLASTER

Loss
Loss lime/cement wash
Delamination
Crack greater than 1 mm
Crack less than 1 mm
Powdering
Abrasion/erosion
Remounted fragment (1938 reconstruction and remounting)

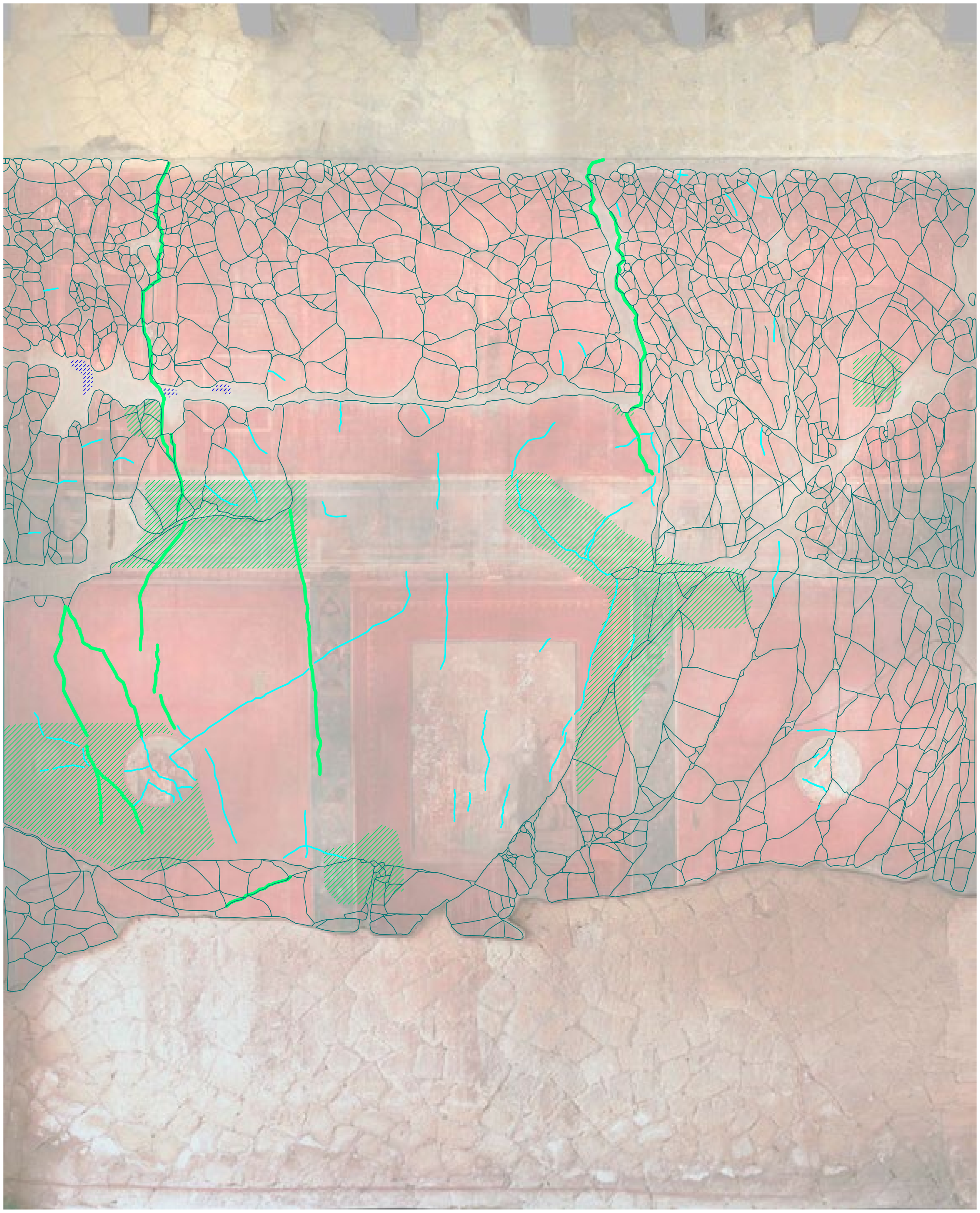
Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY ------	DATE RECORDED 2011-2016 LAST REVISED 2017/05	**EW** SCALE 1:25

Casa del Bicentenario, Tablinum, South Wall - Overall

CONDITIONS: PLASTER

Loss	Delamination	Crack less than 1 mm	Abrasion/erosion
Loss lime/cement wash	Crack greater than 1 mm	Powdering	Remounted fragment (1938 reconstruction and remounting)

Casa del Bicentenario, Tablinum	PROJECT **Herculaneum Project**	PARTNERS SP, HCP	PROJECT MANAGER Leslie Rainer	DATE RECORDED 2011-2016	**SW**
The Getty Conservation Institute	LOCATION Herculaneum, Italy	COPYRIGHT GCI	RECORDED BY -----	LAST REVISED 2017/05	SCALE 1:25



Casa del Bicentenario, Tablinum, West Wall - Overall

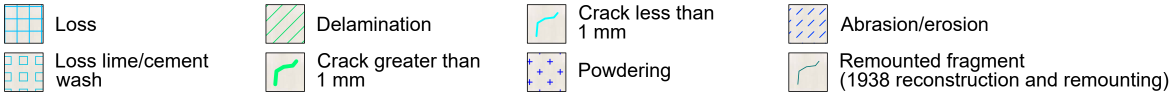
CONDITIONS: PLASTER

Loss	Delamination	Crack less than 1 mm	Abrasion/erosion
Loss lime/cement wash	Crack greater than 1 mm	Powdering	Remounted fragment (1938 reconstruction and remounting)

Casa del Bicentenario, Tablinum	PROJECT	PARTNERS	PROJECT MANAGER	DATE RECORDED	WW
The Getty Conservation Institute	**Herculaneum Project**	SP, HCP	Leslie Rainer	2011-2016	
	LOCATION	COPYRIGHT	RECORDED BY	LAST REVISED	SCALE
	Herculaneum, Italy	GCI	-----	2017/05	1:25

Casa del Bicentenario, Tablinum, East Wall - East Medallion 1 (North) [EM1]

CONDITIONS: PLASTER



Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY AA, MLB	DATE RECORDED 2011-2016 LAST REVISED 2017/05	**EM1** SCALE 1:2

Casa del Bicentenario, Tablinum, East Wall - East Scene 2 (Center) [ES2]

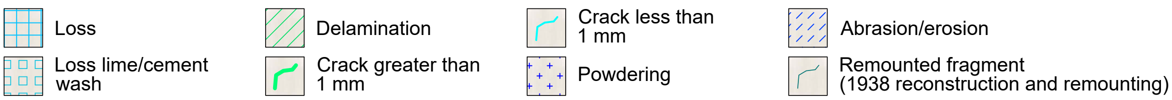
CONDITIONS: PLASTER

Loss	Delamination	Crack less than 1 mm	Abrasion/erosion
Loss lime/cement wash	Crack greater than 1 mm	Powdering	Remounted fragment (1938 reconstruction and remounting)

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY AA, MG, MLB	DATE RECORDED 2011-2016 LAST REVISED 2017/05	**ES2** SCALE 1:5

Casa del Bicentenario, Tablinum, East Wall - East Medallion 3 (South) [EM3]

CONDITIONS: PLASTER



Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY MLB	DATE RECORDED 2011-2016 LAST REVISED 2017/05	**EM3** SCALE 1:2

Casa del Bicentenario, Tablinum, West Wall - West Medallion 1 (South) [WM1]

CONDITIONS: PLASTER

Loss	Delamination	Crack less than 1 mm	Abrasion/erosion
Loss lime/cement wash	Crack greater than 1 mm	Powdering	Remounted fragment (1938 reconstruction and remounting)

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY MLB	DATE RECORDED 2011-2016 LAST REVISED 2017/05	**WM1** SCALE 1:2

Casa del Bicentenario, Tablinum, West Wall - West Scene 2 (center) [WS2]

CONDITIONS: PLASTER

- Loss
- Loss lime/cement wash
- Delamination
- Crack greater than 1 mm
- Crack less than 1 mm
- Powdering
- Abrasion/erosion
- Remounted fragment (1938 reconstruction and remounting)

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY JD, MLB	DATE RECORDED 2011-2016 LAST REVISED 2017/05	**WS2** SCALE 1:5

Casa del Bicentenario, Tablinum, West Wall - West Medallion 3 (North) [WM3]

CONDITIONS: PLASTER

Loss	Delamination	Crack less than 1 mm	Abrasion/erosion
Loss lime/cement wash	Crack greater than 1 mm	Powdering	Remounted fragment (1938 reconstruction and remounting)

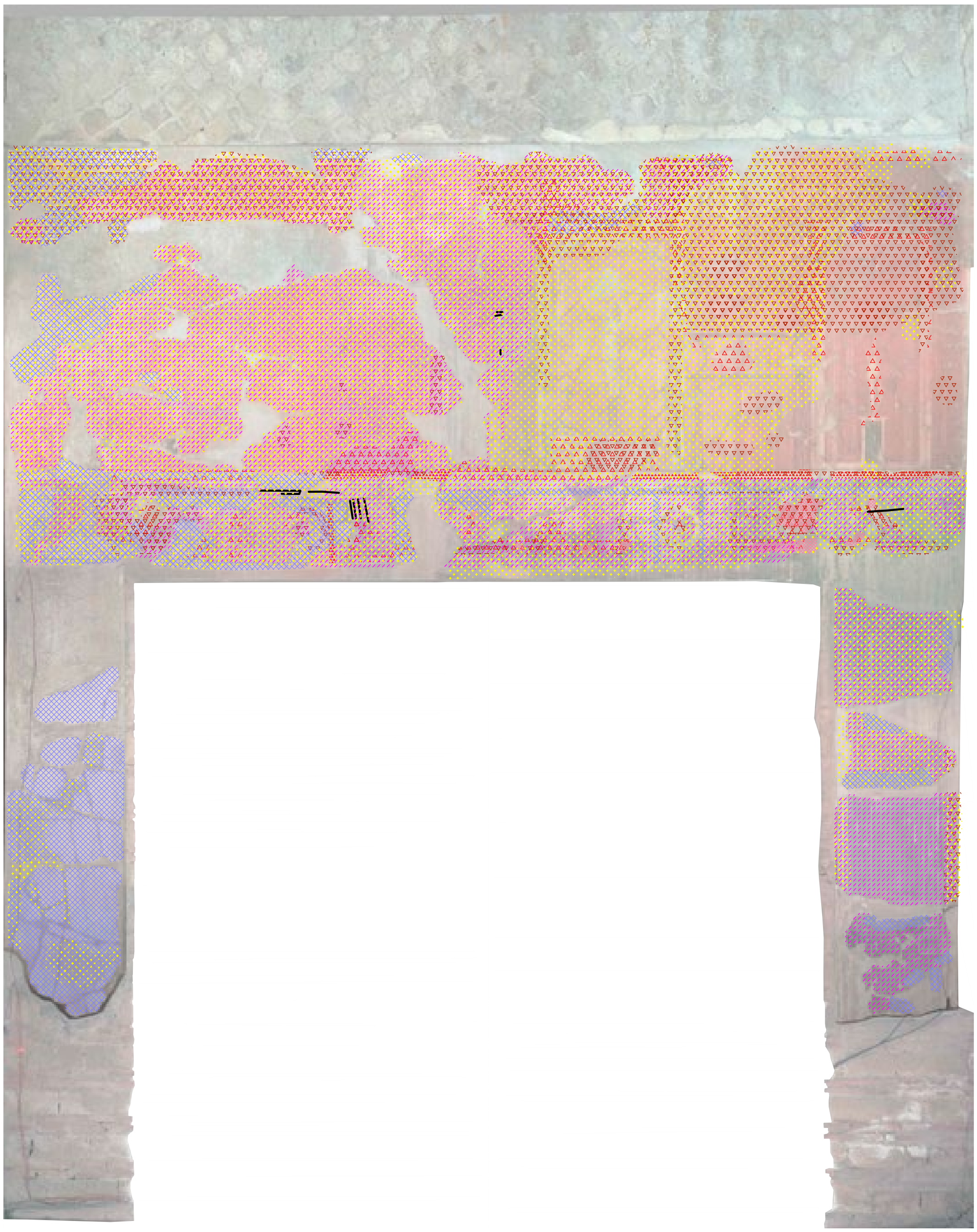
Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY MLB	DATE RECORDED 2011-2016 LAST REVISED 2017/05	**WM3** SCALE 1:2

Casa del Bicentenario, Tablinum, East Wall - Overall

CONDITIONS: PAINT

Loss: monochrome
Loss: design layer(s)
Loss: ground and paint figurative scenes
Loss: undetermined depth figurative scenes
Abrasion/erosion: monochrome
Abrasion/erosion: design layer(s)
Incipient flaking
Microflaking
Flaking
Powdering
Mechanical damage
Graffiti

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT Herculaneum Project LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY -----	DATE RECORDED 2011-2016 LAST REVISED 2017/05	EW SCALE 1:25



Casa del Bicentenario, Tablinum, South Wall - Overall

CONDITIONS: PAINT

Loss: monochrome	Loss: undetermined depth figurative scenes	Incipient flaking	Powdering
Loss: design layer(s)	Abrasion/erosion: monochrome	Microflaking	Mechanical damage
Loss: ground and paint figurative scenes	Abrasion/erosion: design layer(s)	Flaking	Graffiti

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY -----	DATE RECORDED 2011-2016 LAST REVISED 2017/05	**SW** SCALE 1:25

Casa del Bicentenario, Tablinum, West Wall - Overall

CONDITIONS: PAINT

- Loss: monochrome
- Loss: design layer(s)
- Loss: ground and paint figurative scenes
- Loss: undetermined depth figurative scenes
- Abrasion/erosion: monochrome
- Abrasion/erosion: design layer(s)
- Incipient flaking
- Microflaking
- Flaking
- Powdering
- Mechanical damage
- Graffiti

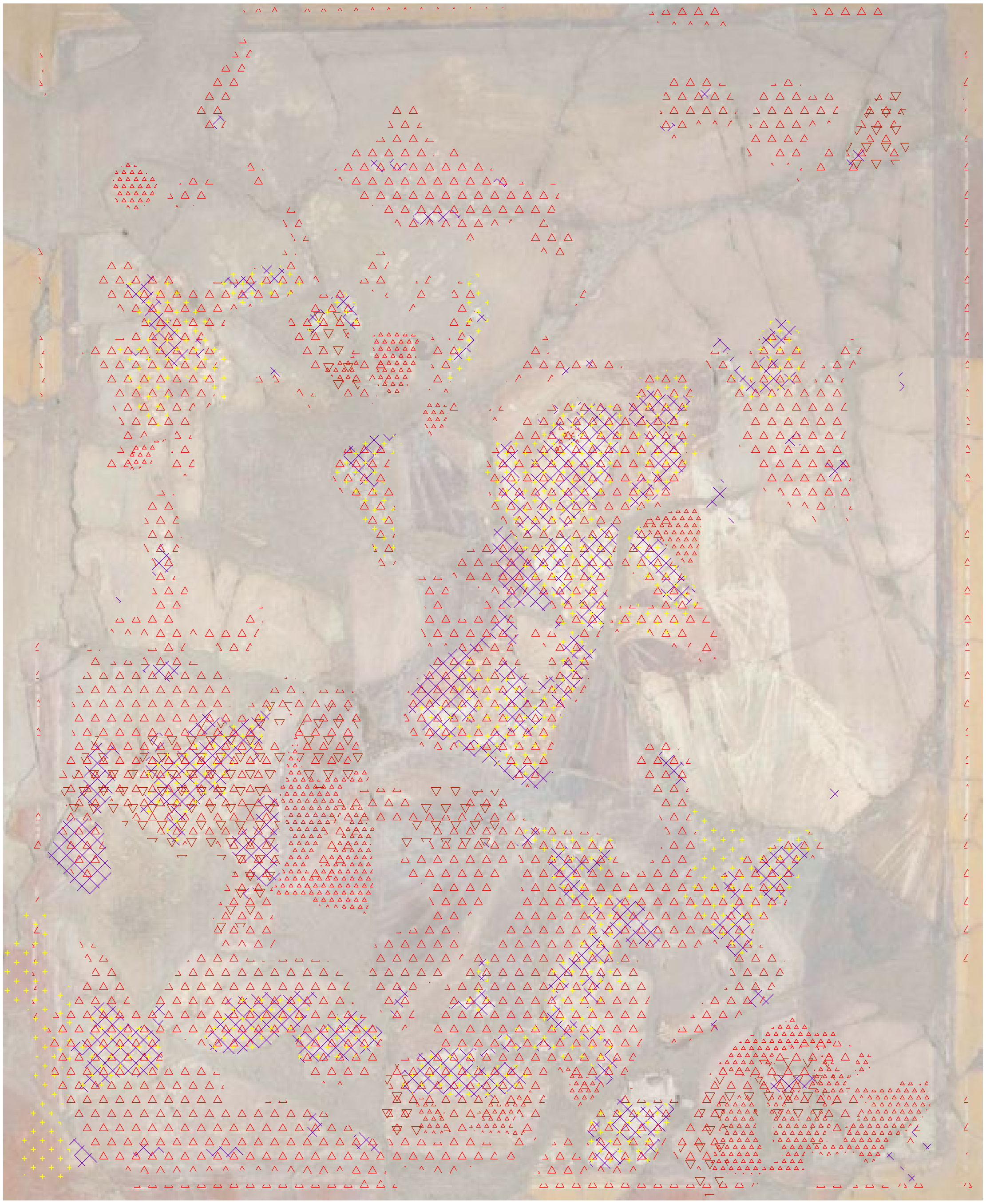
Casa del Bicentenario, Tablinum	PROJECT	PARTNERS	PROJECT MANAGER	DATE RECORDED	WW
The Getty Conservation Institute	Herculaneum Project	SP, HCP	Leslie Rainer	2011-2016	
	LOCATION	COPYRIGHT	RECORDED BY	LAST REVISED	SCALE
	Herculaneum, Italy	GCI	------	2017/05	1:25

Casa del Bicentenario, Tablinum, East Wall - East Medallion 1 (North) [EM1]

CONDITIONS: PAINT

Loss: monochrome
Loss: design layer(s)
Loss: ground and paint figurative scenes
Loss: undetermined depth figurative scenes
Abrasion/erosion: monochrome
Abrasion/erosion: design layer(s)
Incipient flaking
Microflaking
Flaking
Powdering
Mechanical damage
Graffiti

Casa del Bicentenario, Tablinum	PROJECT	PARTNERS	PROJECT MANAGER	DATE RECORDED	EM1
The Getty Conservation Institute	Herculaneum Project	SP, HCP	Leslie Rainer	2011-2016	SCALE
	LOCATION	COPYRIGHT	RECORDED BY	LAST REVISED	1:2
	Herculaneum, Italy	GCI	AA	2017/05	



Casa del Bicentenario, Tablinum, East Wall - East Scene 2 (Center) [ES2]

CONDITIONS: PAINT

- Loss: monochrome
- Loss: design layer(s)
- Loss: ground and paint figurative scenes
- Loss: undetermined depth figurative scenes
- Abrasion/erosion: monochrome
- Abrasion/erosion: design layer(s)
- Incipient flaking
- Microflaking
- Flaking
- Powdering
- Mechanical damage
- Graffiti

Casa del Bicentenario, Tablinum	PROJECT	PARTNERS	PROJECT MANAGER	DATE RECORDED	ES2
The Getty Conservation Institute	Herculaneum Project	SP, HCP	Leslie Rainer	2011-2016	SCALE
	LOCATION	COPYRIGHT	RECORDED BY	LAST REVISED	1:5
	Herculaneum, Italy	GCI	AA	2017/05	

Casa del Bicentenario, Tablinum, East Wall - East Medallion 3 (South) [EM3]

CONDITIONS: PAINT

Loss: monochrome
Loss: design layer(s)
Loss: ground and paint figurative scenes
Loss: undetermined depth figurative scenes
Abrasion/erosion: monochrome
Abrasion/erosion: design layer(s)
Incipient flaking
Microflaking
Flaking
Powdering
Mechanical damage
Graffiti

Casa del Bicentenario, Tablinum	PROJECT	PARTNERS	PROJECT MANAGER	DATE RECORDED	EM3
The Getty Conservation Institute	Herculaneum Project	SP, HCP	Leslie Rainer	2011-2016	SCALE
	LOCATION	COPYRIGHT	RECORDED BY	LAST REVISED	1:2
	Herculaneum, Italy	GCI	MG	2017/05	

Casa del Bicentenario, Tablinum, West Wall - West Medallion 1 (South) [WM1]

CONDITIONS: PAINT

- Loss: monochrome
- Loss: design layer(s)
- Loss: ground and paint figurative scenes
- Loss: undetermined depth figurative scenes
- Abrasion/erosion: monochrome
- Abrasion/erosion: design layer(s)
- Incipient flaking
- Microflaking
- Flaking
- Powdering
- Mechanical damage
- Graffiti

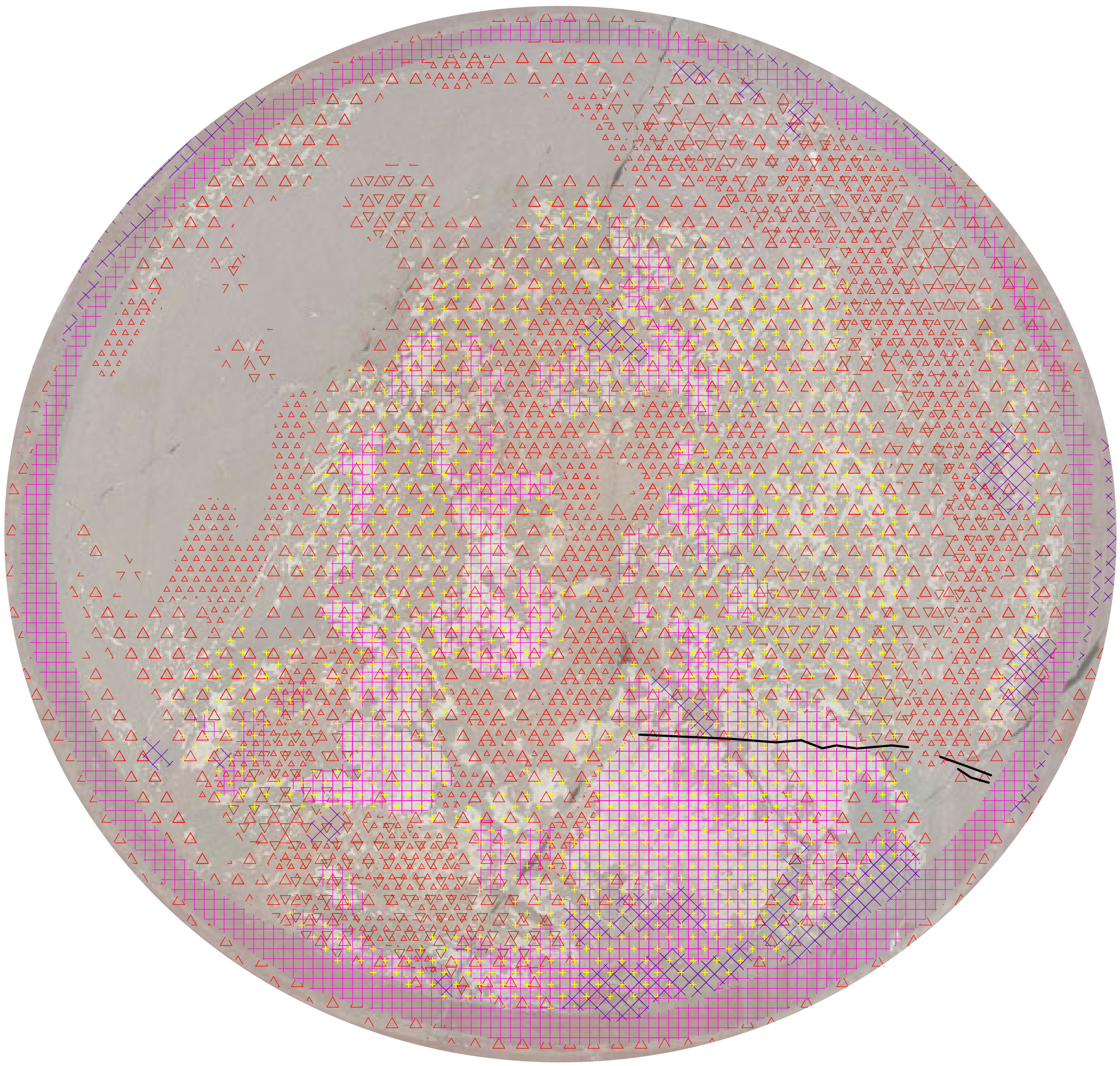
Casa del Bicentenario, Tablinum	PROJECT Herculaneum Project	PARTNERS SP, HCP	PROJECT MANAGER Leslie Rainer	DATE RECORDED 2011-2016	WM1
The Getty Conservation Institute	LOCATION Herculaneum, Italy	COPYRIGHT GCI	RECORDED BY MLB	LAST REVISED 2017/05	SCALE 1:2

Casa del Bicentenario, Tablinum, West Wall - West Scene 2 (center) [WS2]

CONDITIONS: PAINT

- Loss: monochrome
- Loss: design layer(s)
- Loss: ground and paint figurative scenes
- Loss: undetermined depth figurative scenes
- Abrasion/erosion: monochrome
- Abrasion/erosion: design layer(s)
- Incipient flaking
- Microflaking
- Flaking
- Powdering
- Mechanical damage
- Graffiti

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY JD	DATE RECORDED 2011-2016 LAST REVISED 2017/05	**WS2** SCALE 1:5



Casa del Bicentenario, Tablinum, West Wall - West Medallion 3 (North) [WM3]

CONDITIONS: PAINT

Loss: monochrome	Loss: undetermined depth figurative scenes	Incipient flaking	Powdering
Loss: design layer(s)	Abrasion/erosion: monochrome	Microflaking	Mechanical damage
Loss: ground and paint figurative scenes	Abrasion/erosion: design layer(s)	Flaking	Graffiti

Casa del Bicentenario, Tablinum	PROJECT Herculaneum Project	PARTNERS SP, HCP	PROJECT MANAGER Leslie Rainer	DATE RECORDED 2011-2016	WM3
The Getty Conservation Institute	LOCATION Herculaneum, Italy	COPYRIGHT GCI	RECORDED BY MLB	LAST REVISED 2017/05	SCALE 1:2

Casa del Bicentenario, Tablinum, East Wall - Overall

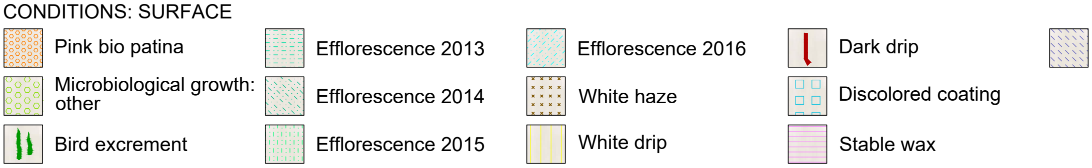
CONDITIONS: SURFACE

- Pink bio patina
- Microbiological growth: other
- Bird excrement
- Efflorescence 2013
- Efflorescence 2014
- Efflorescence 2015
- Efflorescence 2016
- White haze
- White drip
- Dark drip
- Discolored coating
- Stable wax
- Discontinuous/ broken wax

Casa del Bicentenario, Tablinum	PROJECT	PARTNERS	PROJECT MANAGER	DATE RECORDED	EW
The Getty Conservation Institute	Herculaneum Project	SP, HCP	Leslie Rainer	2011-2016	
	LOCATION	COPYRIGHT	RECORDED BY	LAST REVISED	SCALE
	Herculaneum, Italy	GCI	-----	2017/05	1:25

Casa del Bicentenario, Tablinum, South Wall - Overall

CONDITIONS: SURFACE



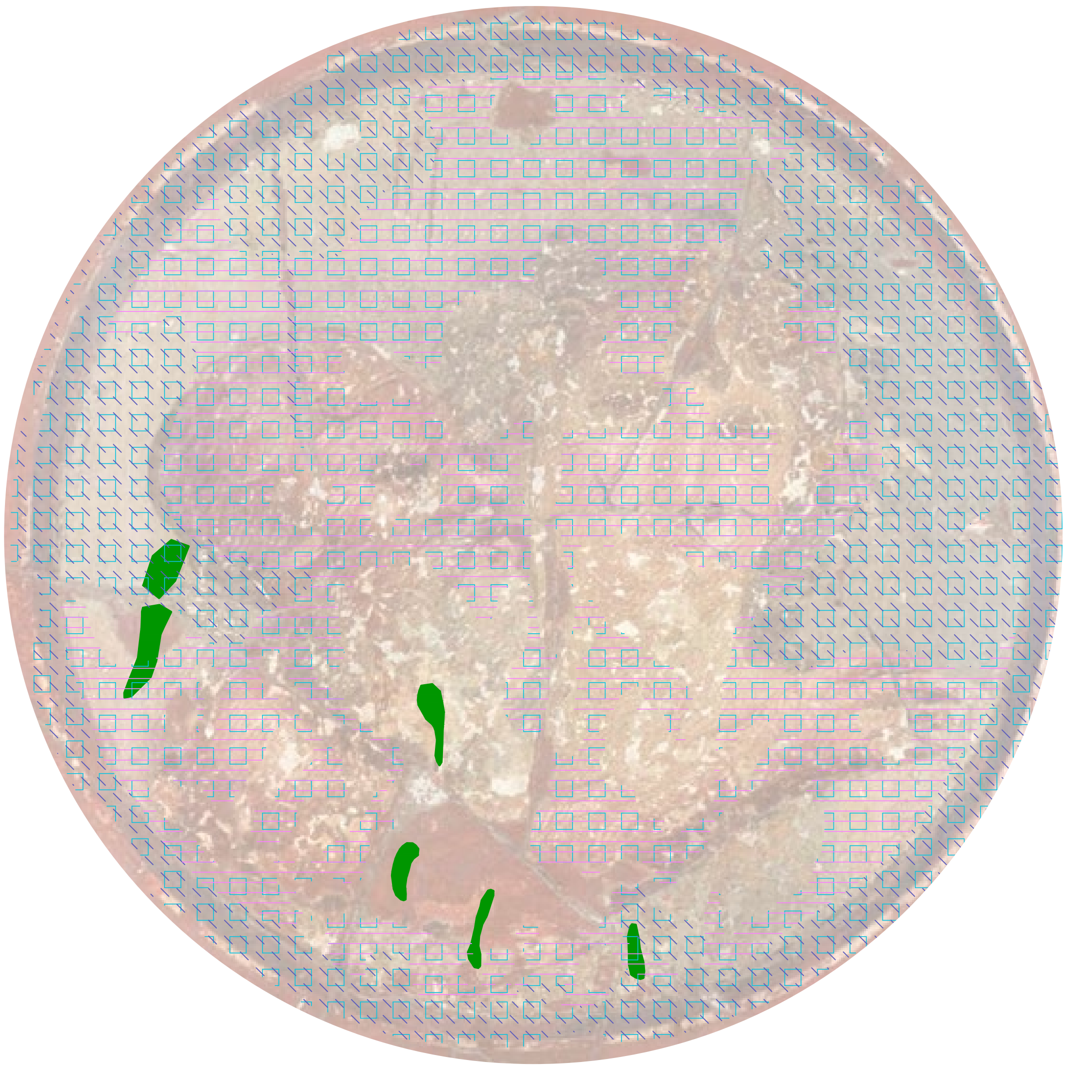
Casa del Bicentenario, Tablinum	PROJECT	PARTNERS	PROJECT MANAGER	DATE RECORDED	SW
The Getty Conservation Institute	Herculaneum Project	SP, HCP	Leslie Rainer	2011-2016	SCALE
	LOCATION	COPYRIGHT	RECORDED BY	LAST REVISED	1:25
	Herculaneum, Italy	GCI	-----	2017/05	

Casa del Bicentenario, Tablinum, West Wall - Overall

CONDITIONS: SURFACE

Pink bio patina	Efflorescence 2013	Efflorescence 2016	Dark drip	Discontinuous/ broken wax
Microbiological growth: other	Efflorescence 2014	White haze	Discolored coating	
Bird excrement	Efflorescence 2015	White drip	Stable wax	

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY ------	DATE RECORDED 2011-2016 LAST REVISED 2017/05	**WW** SCALE 1:25



Casa del Bicentenario, Tablinum, East Wall - East Medallion 1 (North) [EM1]

CONDITIONS: SURFACE

- Pink bio patina
- Microbiological growth: other
- Bird excrement
- Efflorescence 2013
- Efflorescence 2014
- Efflorescence 2015
- Efflorescence 2016
- White haze
- White drip
- Dark drip
- Discolored coating
- Stable wax
- Discontinuous/ broken wax

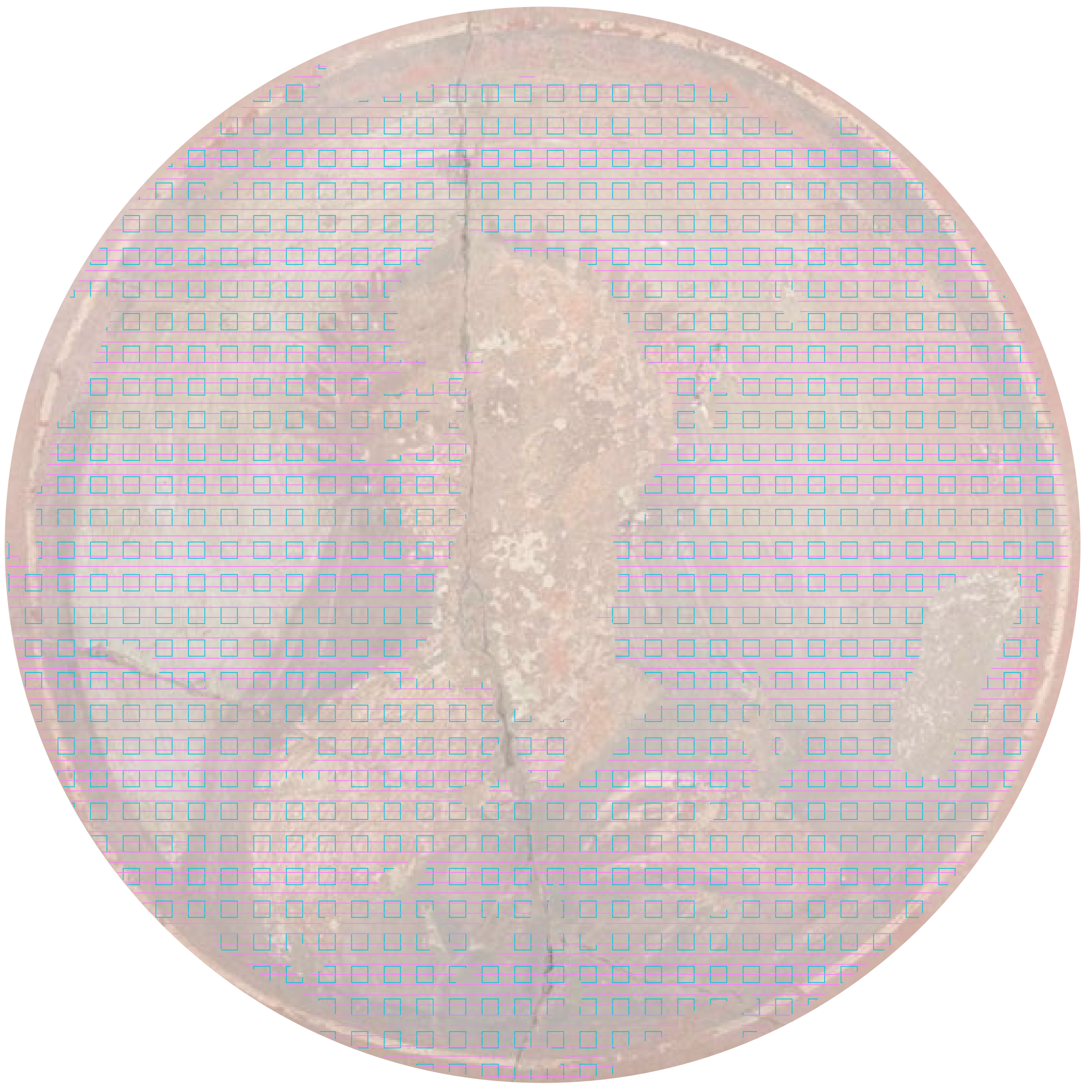
Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT Herculaneum Project LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY AA	DATE RECORDED 2011-2016 LAST REVISED 2017/05	EM1 SCALE 1:2

Casa del Bicentenario, Tablinum, East Wall - East Scene 2 (Center) [ES2]

CONDITIONS: SURFACE

Pink bio patina	Efflorescence 2013	Efflorescence 2016	Dark drip	Discontinuous/ broken wax
Microbiological growth: other	Efflorescence 2014	White haze	Discolored coating	
Bird excrement	Efflorescence 2015	White drip	Stable wax	

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT Herculaneum Project LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY ------	DATE RECORDED 2011-2016 LAST REVISED 2017/05	ES2 SCALE 1:5

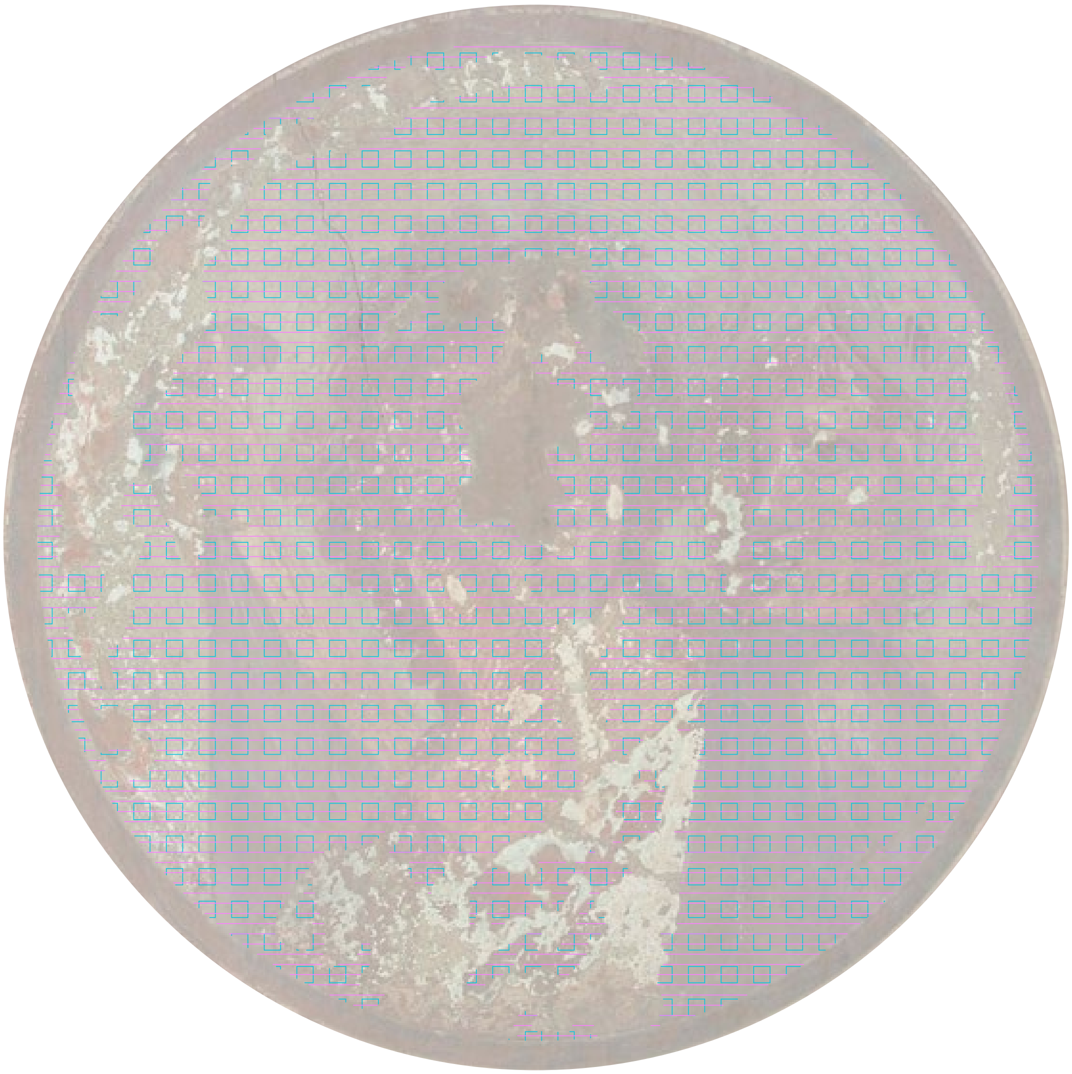


Casa del Bicentenario, Tablinum, East Wall - East Medallion 3 (South) [EM3]

CONDITIONS: SURFACE

Pink bio patina	Efflorescence 2013	Efflorescence 2016	Dark drip	Discontinuous/ broken wax
Microbiological growth: other	Efflorescence 2014	White haze	Discolored coating	
Bird excrement	Efflorescence 2015	White drip	Stable wax	

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT Herculaneum Project LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY ------	DATE RECORDED 2011-2016 LAST REVISED 2017/05	EM3 SCALE 1:2



Casa del Bicentenario, Tablinum, West Wall - West Medallion 1 (South) [WM1]

CONDITIONS: SURFACE

Pink bio patina	Efflorescence 2013	Efflorescence 2016	Dark drip	Discontinuous/ broken wax
Microbiological growth: other	Efflorescence 2014	White haze	Discolored coating	
Bird excrement	Efflorescence 2015	White drip	Stable wax	

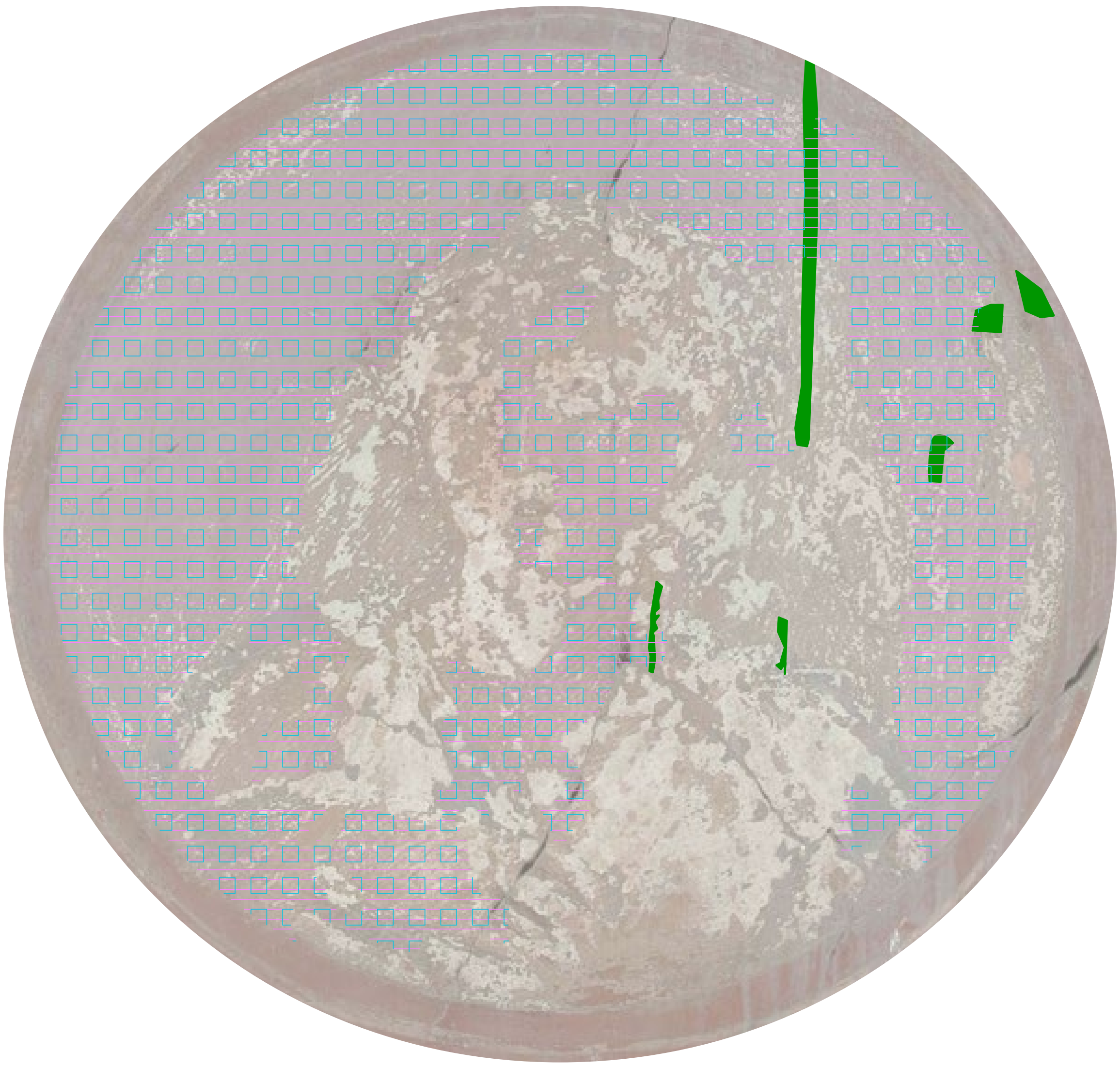
Casa del Bicentenario, Tablinum	PROJECT Herculaneum Project	PARTNERS SP, HCP	PROJECT MANAGER Leslie Rainer	DATE RECORDED 2011-2016	WM1
The Getty Conservation Institute	LOCATION Herculaneum, Italy	COPYRIGHT GCI	RECORDED BY ------	LAST REVISED 2017/05	SCALE 1:2

Casa del Bicentenario, Tablinum, West Wall - West Scene 2 (center) [WS2]

CONDITIONS: SURFACE

Pink bio patina	Efflorescence 2013	Efflorescence 2016	Dark drip	Discontinuous/ broken wax
Microbiological growth: other	Efflorescence 2014	White haze	Discolored coating	
Bird excrement	Efflorescence 2015	White drip	Stable wax	

Casa del Bicentenario, Tablinum The Getty Conservation Institute	PROJECT **Herculaneum Project** LOCATION Herculaneum, Italy	PARTNERS SP, HCP COPYRIGHT GCI	PROJECT MANAGER Leslie Rainer RECORDED BY JD	DATE RECORDED 2011-2016 LAST REVISED 2017/05	**WS2** SCALE 1:5



Casa del Bicentenario, Tablinum, West Wall - West Medallion 3 (North) [WM3]

CONDITIONS: SURFACE

Pink bio patina	Efflorescence 2013	Efflorescence 2016	Dark drip	Discontinuous/ broken wax
Microbiological growth: other	Efflorescence 2014	White haze	Discolored coating	
Bird excrement	Efflorescence 2015	White drip	Stable wax	

Casa del Bicentenario, Tablinum	PROJECT	PARTNERS	PROJECT MANAGER	DATE RECORDED	WM3
The Getty Conservation Institute	Herculaneum Project	SP, HCP	Leslie Rainer	2011-2016	
	LOCATION	COPYRIGHT	RECORDED BY	LAST REVISED	SCALE
	Herculaneum, Italy	GCI	MLB	2017/05	1:2

ILLUSTRATED GLOSSARY

Architectural Surfaces in the Tablinum of the House of the Bicentenary

Introduction

This illustrated glossary of documentation terms establishes the vocabulary used to graphically record physical evidence of original technique, previous interventions, and conditions, observed or undertaken during the study of the wall paintings in the tablinum of the House of the Bicentenary at the archaeological site of Herculaneum from 2012 to the present.

For each term, the glossary provides a definition, the symbol used in the graphic documentation, and a representative image. Condition definitions are based on visible examination and scientific research.

This glossary is a working document. It is intended to be updated as necessary.

List of Terms

1. Original Technique

- *Opus reticulatum* tuff
- *Opus vittatum* tuff and brick
- Plaster join
- Incised line
- Compass point
- Tinted plaster
- Monochrome background
- Decorative elements
- Figurative scenes

2. 1938 Reconstruction and Remounting Techniques

- *Opus incertum* tuff
- *Opus vittatum* tuff and brick
- Anchoring mortar
- Grouting mortar
- Backing plaster
- Rough fill
- Reconstruction plaster
- Incision
- Metal element
- Remounted fragment
- Tool and pencil marks
- Edging
- Unfilled area

3. Post-1938 Interventions

- Post-1938 tuff
- Fill
- Injection hole
- Lime/cement wash
- Traces of 1938 edging
- Post-1938 edging
- 2004 sample location (pre-GCI)

4. Interventions, Date Unknown

- Reintegration
- Coating: wax
- Coating: other

5. Conditions

Structural and Tuff

- Hole
- Structural crack
- Spalling
- Powdering
- Drip
- Abrasion/erosion

Plaster

- Loss
- Loss of lime/cement wash
- Delamination
- Crack
- Powdering
- Abrasion/erosion

Paint

- Loss: monochrome
- Loss: design layer(s)
- Abrasion/erosion: monochrome
- Abrasion/erosion: design layer(s)
- Incipient flaking
- Micro-flaking
- Flaking
- Powdering
- Mechanical damage
- Graffiti

Surface

- Pink biopatina
- Microbiological growth: other
- Bird excrement
- Efflorescence
- White haze
- White drip
- Dark drip
- Discolored coating
- Stable wax
- Discontinuous/broken wax

Graphic Documentation Legend

ORIGINAL TECHNIQUE

- *Opus reticulatum* tuff
- *Opus vittatum* tuff and bricks
- Plaster join
- Incised line
- Compass point
- Tinted plaster
- Rectangular scene
- Medallion
- Monochrome background
- Decorative elements
- Roman plaster

RECONSTRUCTION AND REMOUNTING MATERIALS AND TECHNIQUES (1938)

- *Opus incertum* tuff
- *Opus vittatum* tuff and bricks
- Anchoring mortar
- Grouting mortar
- Backing plaster
- Rough fill
- Reconstruction plaster
- Limewash
- Incisions
- Tool and pencil marks
- Remounted fragment
- 1938 edging
- Metal element
- Unfilled area

PREVIOUS INTERVENTIONS (1939-2011)

- Post-1938 tuff
- Fill
- White grouting mortar
- Injection hole
- Lime/cement wash
- Traces of 1938 edging
- Post-1938 edging
- 2004 Sample location (pre-GCI)

INTERVENTIONS (DATE UNKNOWN)

- Reintegration
- Coating: wax
- Coating: other

Graphic Documentation Legend

CONDITIONS: STRUCTURAL AND TUFF

- Hole
- Structural crack
- Spalling
- Powdering
- Drip
- Abrasion/erosion

CONDITIONS: PLASTER

- Loss
- Loss lime/cement wash
- Delamination
- Crack greater than 1 mm
- Crack less than 1 mm
- Powdering
- Abrasion/erosion
- Remounted fragment (1938 reconstruction and remounting)

CONDITIONS: PAINT

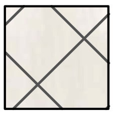
- Loss: monochrome
- Loss: design layer(s)
- Loss: ground and paint figurative scenes
- Loss: undetermined depth figurative scenes
- Abrasion/erosion: monochrome
- Abrasion/erosion: design layer(s)
- Incipient flaking
- Microflaking
- Flaking
- Powdering
- Mechanical damage
- Graffiti

CONDITIONS: SURFACE

- Pink biopatina
- Microbiological growth: other
- Bird excrement
- Efflorescence 2013
- Efflorescence 2014
- Efflorescence 2015
- Efflorescence 2016
- White haze
- White drip
- Dark drip
- Discolored coating
- Stable wax
- Discontinuous/ broken wax

Original Technique

***Opus reticulatum* tuff**
A form of brickwork used in ancient Roman architecture, consisting of diamond-shaped tuff bricks, set into a mortar core in regular diagonal courses.



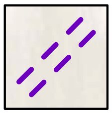
***Opus vittatum* tuff and brick**
A Roman construction technique using alternating tuff and brick courses applied horizontally and parallel to each other, also referred to as *opus mixtum.*

Original Technique

Plaster join
Area where the plaster applied during different sessions of work abuts or overlaps. Two types are present:

Type 1: *Pontata*, rectangular sections of painted plaster applied and painted in the fresco technique in a single day, corresponding to the height of the scaffolding used.

Type 2: The addition of plaster applied to a surrounding or adjacent painted plaster (e.g., rectangular scenes/inset plaster and frieze), creating an overlap of plaster layers.



Original Technique

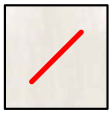
Incised line

An incision made in the fresh plaster to lay out the design. Two types are observed; differentiated by the technique used.

Type 1: An incision made with a straight edge for a precise line, used primarily for laying out decorative borders.

Type 1.

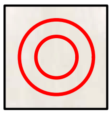
Type 2: An incision made by freehand drawing, seen in the figures on the upper wall.



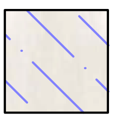
Type 2.

Original Technique

Compass point
Evidence of the preparatory technique using a compass as an instrument to lay out decorative elements, such as arcs and circles, applied over the monochrome background, in which the sharp point of the compass left a mark in the plaster at the center of the arc (see arrow).

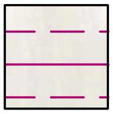


Tinted plaster
A Roman lime-based finishing plaster tinted with a small amount of pigment.

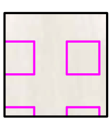


Original Technique

Monochrome background
A solid panel of color—yellow, red, or black in the case of the tablinum—painted in the fresco technique, over which the decoration is applied.



Decorative elements
Painted decoration applied over the monochrome background in one or more layers to create architectural, floral, or figurative designs. The paint layers were built up using pigment in binder to form impasto layers of decoration.



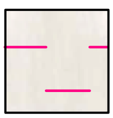
Original Technique

Figurative scenes

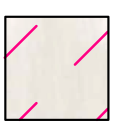
The scenes are executed in a *secco* technique with pigments in binder applied over a uniform preparation layer; over this, the paintings are finely executed with multiple layers of paint.

Two types are present:

Type 1: *Medallions*, round paintings of bacchantes, maenads, and Silenus figures. The preparation layer, which also serves as the background of the painting, is composed of Egyptian blue and lime white, applied over the monochrome background.

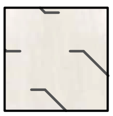


Type 2: *Rectangular scenes*, large paintings of mythological scenes in the center of the walls. These paintings are executed over a fine white plaster composed of lime and crushed marble inset into the wall paintings applied directly over the pink-tinted plaster, with no presence of the monochrome background. The preparation layer is composed of lime white, with the possible additions of shell white and gypsum.

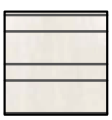


1938 Reconstruction and Remounting Techniques

***Opus incertum* tuff**
Tuff blocks used in the 1938 reconstruction of architectural features of the buildings destroyed by the eruption of Mount Vesuvius. Walls were partially or completely reconstructed in *opus incertum* in order to visually distinguish them from original Roman walls (e.g., *opus reticulatum, opus vittatum*).

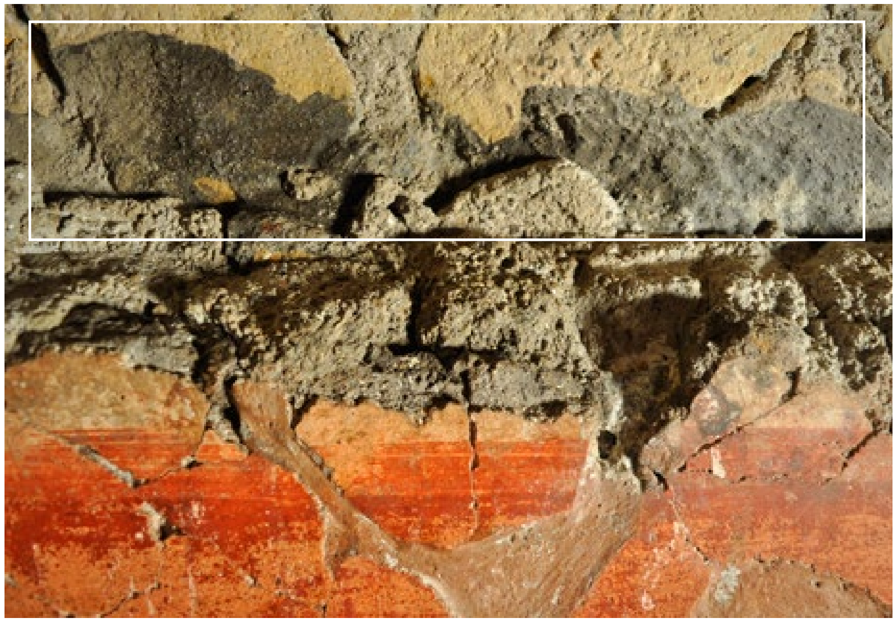


***Opus vittatum* tuff and brick**
A Roman construction technique using alternating tuff and brick courses applied horizontally and parallel to each other that was emulated in the 1938 reconstruction of architectural elements, also referred to as *opus mixtum* by Maiuri's team.

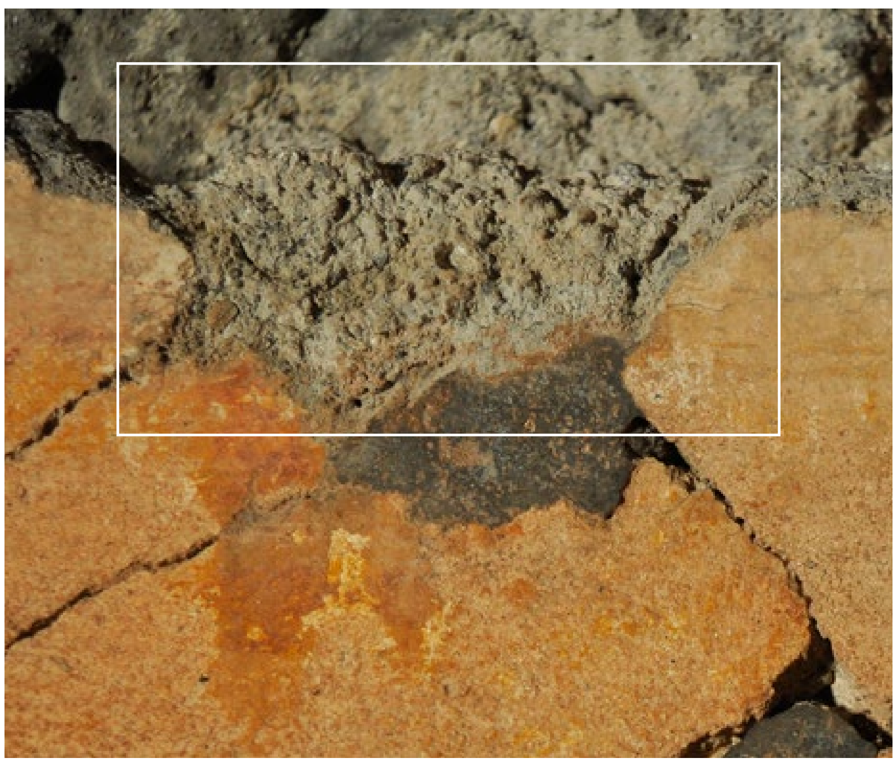


1938 Reconstruction and Remounting Techniques

Anchoring mortar
Dark-gray cementitious mortar applied during the remounting process of the 1938 reconstruction,visible at the top of the walls.



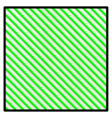
Grouting mortar
Light-gray friable mortar used during the remounting process of the 1938 reconstruction to fill areas of void between plaster layers.



1938 Reconstruction and Remounting Techniques

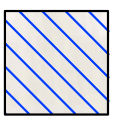
Backing plaster

Dark-gray plaster repair material, composed of lime and calcium aluminate cement (CAC) and used to reassemble fragments during the 1938 remounting and reconstruction of the wall paintings. In places, this material is visible between wall painting fragments where it has seeped through cracks and gaps, and is flush with the original Roman painted surface.



Rough fill

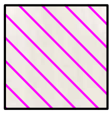
Gray lime-based repair plaster with occasional incised lines. It is applied to be slightly below surface level of the remounted fragments.



1938 Reconstruction and Remounting Techniques

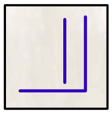
Reconstruction plaster

Gray fill plaster covered by a thin white fine plaster with a gray lime wash over it, used to fill large lacunae, and incised with lines to reconstruct the missing design (see below).



Incision

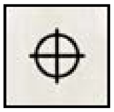
Thin outlines cut into the 1938 reconstruction plaster to imitate and complete the Roman decorative scenes in large areas of loss.



1938 Reconstruction and Remounting Techniques

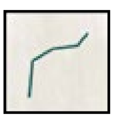
Metal element

A metal component that was inserted into the tuff during the 1938 reconstruction as an anchor or pin to hold wall paintings in place.



Remounted fragment

Pieces of original Roman painted plaster, often with worn edges, remounted during the 1938 reconstruction.



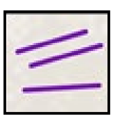
1938 Reconstruction and Remounting Techniques

Tool and pencil marks
Marks made on the painted surface thought to be associated with the 1938 excavation reconstruction and remounting process. These include impressions from tools and pencil marks.

Type 1: A variety of scratched or imprinted marks, likely made from tools during the excavation and reconstruction process.

Type 1.

Type 2: Marks on the surface made with pencil, likely used to align fragments during the remounting process.

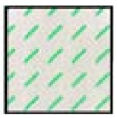


Type 2.

1938 Reconstruction and Remounting Techniques

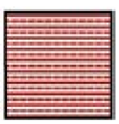
Edging

Mortar fill applied to both the upper and lower borders of the original and reconstructed plasters, applied as a wide and sloped edging during the 1938 reconstruction. The edging material appears to be similar to the gray fill plaster.



Unfilled area

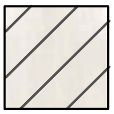
Small gaps between remounted fragments that were left unfilled during the 1938 reconstruction process.



Post-1938 Interventions

Post-1938 tuff

Tuff blocks used in post-1938 interventions to make necessary repairs laid in *opus incertum* with a different mortar used in the joins from the 1938 reconstruction mortar.

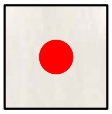


Fill

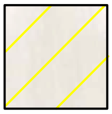
A range of materials used to fill losses occurring since 1938, for example very hard, dark gray, cementitious repairs (pictured); predominantly present along the lower east wall.

Post-1938 Interventions

Injection hole
A puncture made through the Roman or modern plaster to inject grout during a previous intervention.

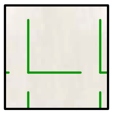


Lime/cement wash
Thin (1–2 mm) cement- and/or lime-based layer(s) of repair materials applied over the 1938 reconstruction lime wash. The dark-gray cementitious wash can be seen on the right-hand side of the image.

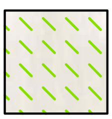


Post-1938 Interventions

Traces of 1938 edging
Traces of the 1938 edging applied during the reconstruction and remounting process (highlighted with yellow line), which was later removed and replaced with less visible repairs (see below).

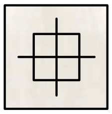


Edging
Fill mortar applied to the lower edge of the wall paintings (e.g., lower west wall); this edging was applied to be perpendicular to and flush with the original Roman plaster, in order to be less visible.



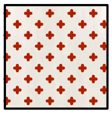
Post-1938 Interventions

2004 sample location
Sample taken in 2004 prior to the current project.

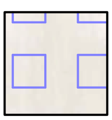


Interventions, Date Unknown

Reintegration
Application of color to reintegrate areas of loss into the original design layer during a previous intervention.

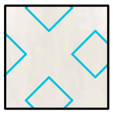


Coating: wax
One or more applications of beeswax and/or paraffin wax applied on the surface of the paintings during the 1938 remounting and reconstruction and in maintenance campaigns since 1939.



Interventions, Date Unknown

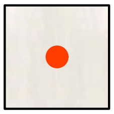
Coating: other
One or more applications of unidentified coating(s) applied to the wall paintings, particularly noticeable in the rectangular scenes and vertical bands.



Conditions: Structural and Tuff

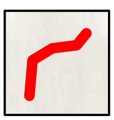
Hole

Visible hole in the tuff wall likely where a pin or anchor has been removed.



Structural crack

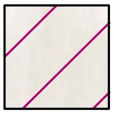
A fissure that traverses the plaster and wall support.



Conditions: Structural and Tuff

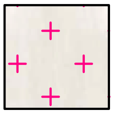
Spalling

Fragments of tuff that are detaching from the block.

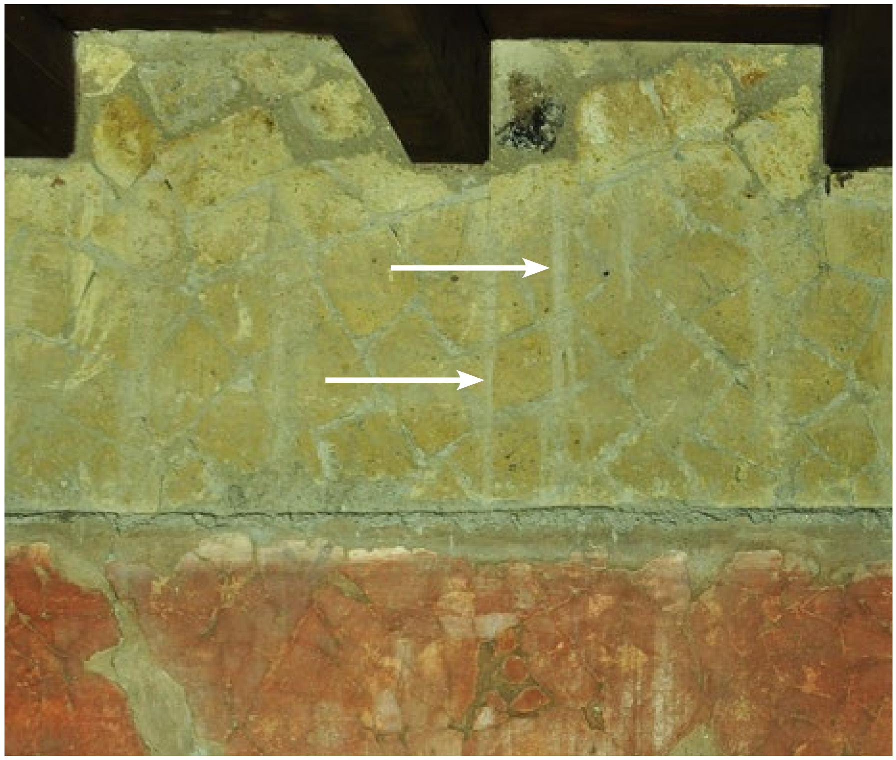


Powdering

Decohesion of the tuff.

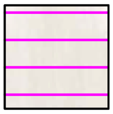


Conditions: Structural and Tuff



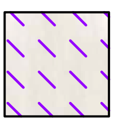
Drip

Drips of tuff powder found in streaks on the surface of the tuff blocks, which vary in thickness from 1 to 2 mm.



Abrasion/Erosion

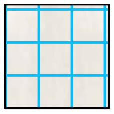
Areas of tuff with an uneven surface caused by the partial loss of the upper layers.



Conditions: Plaster

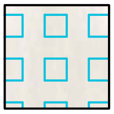
Loss

Loss of original and/or 1938 reconstruction plaster to a variable or undetermined depth. This differs from gaps between plaster fragments in which plaster fragments were not remounted.



Loss of lime/cement wash

Areas where lime or cement wash applied as finishing restoration layer is missing, exposing the underlying 1938 reconstruction plaster



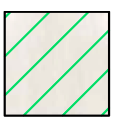
Conditions: Plaster

Delamination
Lack of adhesion between plaster layers, resulting in detachment of varying thickness and depth, including thin delamination and deep voids. This condition affects the original and restoration materials and can be present as visible detachment or blind voids between the plaster layers or plaster and wall support.

Two different types of detachment are present:

Type 1: Thin delamination, which occurs within upper plaster layers and leads to loss of the upper plaster layer(s).

Type 2: Deep voids behind the surface, which may be related to cracks and/or to areas where 1938 grouting mortar has eroded or never penetrated.



Type 1.

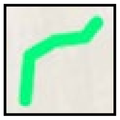
Type 2.

Conditions: Plaster

Crack
A fissure that traverses the plaster layer(s).

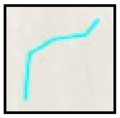
Two types of plaster cracks are present:

Type 1: Open cracks greater than 1 mm, which have occurred since the 1938 remounting and reconstruction.



Type 1.

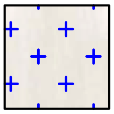
Type 2: Small, tight fissures less than 1 mm that are not active, located within plaster fragments.



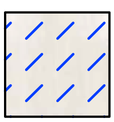
Type 2.

Conditions: Plaster

Powdering
Decohesion that occurs within the plaster, found predominantly along the lower east wall.

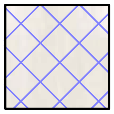


Abrasion/erosion
Partial loss of a smooth plaster, causing an uneven surface and exposed aggregate.

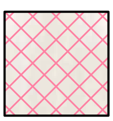


Conditions: Paint

Loss: monochrome
Complete loss of the monochrome background layer, exposing the underlying plaster.

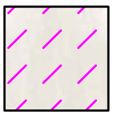


Loss: design layer(s):
Partial or complete loss of the upper paint layer(s), exposing the underlying paint layer or the monochrome background, or, in the case of rectangular scenes, the complete loss of paint exposing bare plaster.

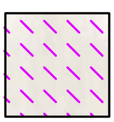


Conditions: Paint

Abrasion/erosion: monochrome
Partial loss of the monochrome background, resulting in a reduced thickness of the paint layer and/or small areas of monochrome paint interspersed with small areas of partially or fully exposed plaster.

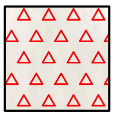


Abrasion/erosion: design layer(s)
Partial loss of painted decoration that results in a reduced thickness of the paint layer and/or small areas of painted decoration interspersed with small areas of partially or fully exposed monochrome background.

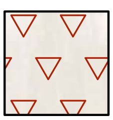


Conditions: Paint

Incipient flaking
Initial stage of delamination between the design layer(s) and the monochrome background layer, where paint may be lifting but not yet actively flaking and edges are not exposed; often associated with micro-flaking.



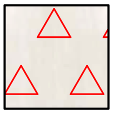
Micro-flaking
Lifting and/or cupping of the paint layer(s) on a micro scale <1 mm.



Conditions: Paint

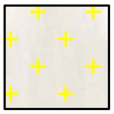
Flaking

Lifting and/or cupping of paint layer(s) greater than 1 mm.



Powdering

Lack of cohesion within individual paint layer(s) (indicated by white circle). This condition may also occur under a layer of stable wax.

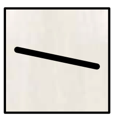


Conditions: Paint

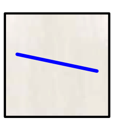
Mechanical damage
This includes two types:

Type 1: Unintentional nick, scrape, scratch, gouge, or abrasion on the surface.

Type 2: Tape marks visible on the surface of the monochrome background layer.

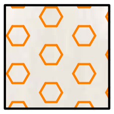


Graffiti
Intentional marks scratched into the surface of the painting.

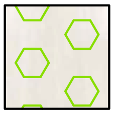


Conditions: Surface

Pink biopatina
Pink microbiological growth occurring along the base of walls in the House of the Bicentenary; variable in height and extent depending on environmental conditions.



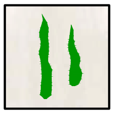
Microbiological growth: other
Microbiological matter of various origin on surface.



Conditions: Surface

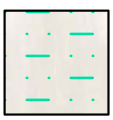
Bird excrement

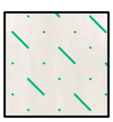
Deposits of bird excrement on the surface of the walls.

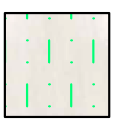


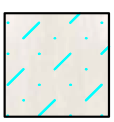
Efflorescence

Deposits of crystallized salts, appearing as a white veil, powder, or crust on the surface or within the paint and/or plaster layer(s).

 **Efflorescence 2013**

 **Efflorescence 2014**

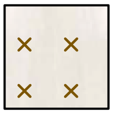
 **Efflorescence 2015**

 **Efflorescence 2016**

Conditions: Surface

White haze

An opaque film or veil obscuring the painted surface.

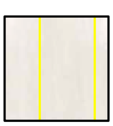


White drip

Two different types of white drips are present:

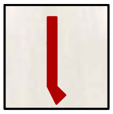
Type 1: Thickly applied restoration coating materials (primarily wax, but also carbonation layer or other surface accumulations) that have become opaque over time and obscure the original paint layer(s) (pictured at right).

Type 2: Areas where the paint layer is abraded/eroded, exposing the white plaster below in the shape of a drip, with loss of paint (not pictured).

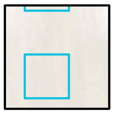


Conditions: Surface

Dark drip
Discolored materials that have run down the surface of the wall.

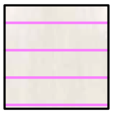


Discolored coating
Previous restoration materials applied on the surface of the wall paintings that have yellowed or discolored over time.

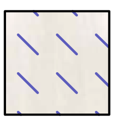


Conditions: Surface

Stable wax
Coherent, compact layer of wax that covers the painted plaster in areas. In some cases it has become opaque (see white haze) and in others it remains a fairly transparent layer.



Discontinuous/ broken wax
A disrupted wax layer present in areas on the surface of the wall paintings, frequently associated with micro-flaking.



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