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Melanie Jonasch, Linda Adorno, Pablo Aparicio-Resco

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Deutsches Archäologisches Institut, Zentrale, Podbielskiallee 69–71, 14195 Berlin, Tel: +49 30 187711-0
Email: info@dainst.de | Web: https://www.dainst.org

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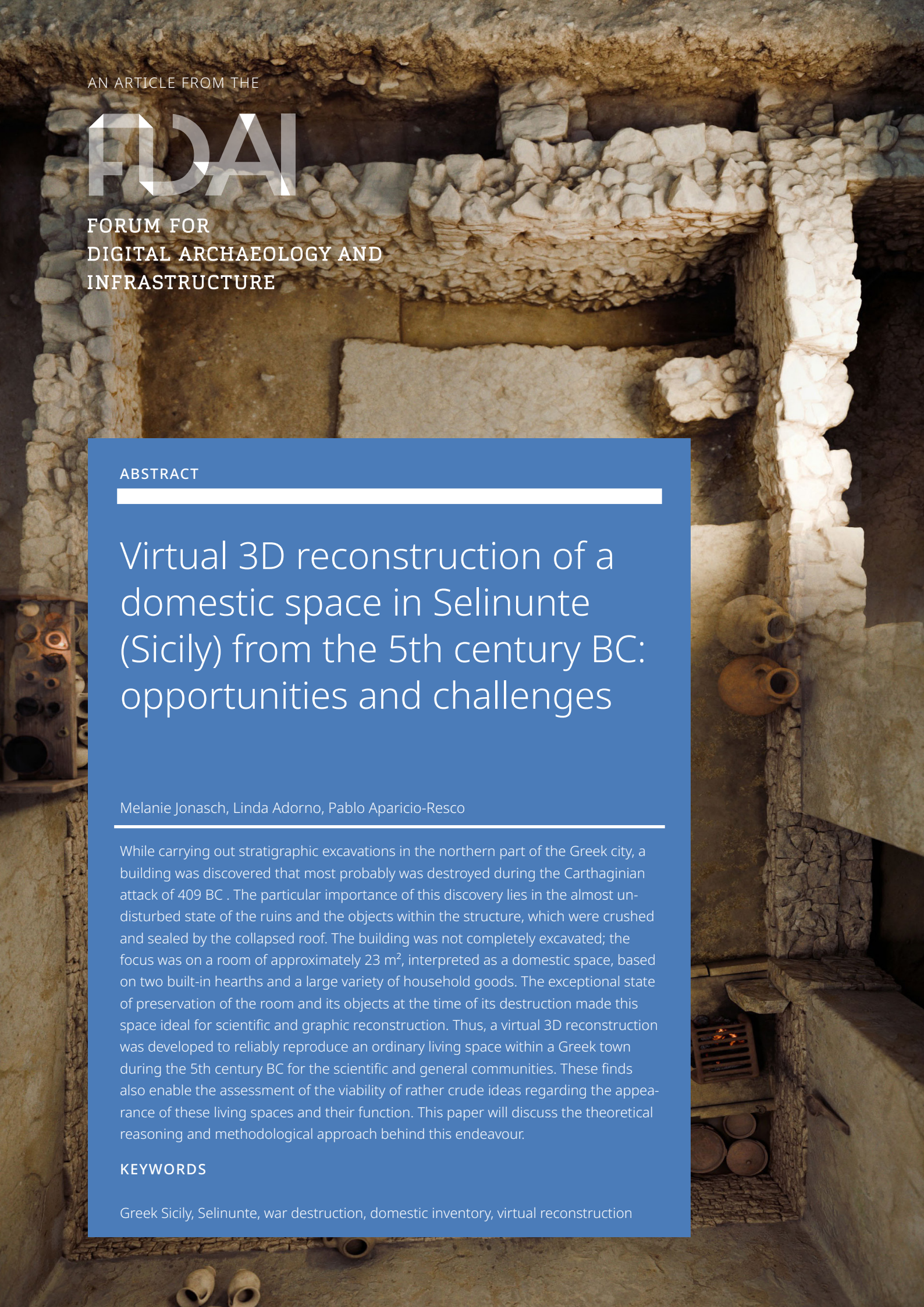

ABSTRACT

# Virtual 3D reconstruction of a domestic space in Selinunte (Sicily) from the 5th century BC: opportunities and challenges

Melanie Jonasch, Linda Adorno, Pablo Aparicio-Resco

While carrying out stratigraphic excavations in the northern part of the Greek city, a building was discovered that most probably was destroyed during the Carthaginian attack of 409 BC . The particular importance of this discovery lies in the almost undisturbed state of the ruins and the objects within the structure, which were crushed and sealed by the collapsed roof. The building was not completely excavated; the focus was on a room of approximately 23 $m^2$, interpreted as a domestic space, based on two built-in hearths and a large variety of household goods. The exceptional state of preservation of the room and its objects at the time of its destruction made this space ideal for scientific and graphic reconstruction. Thus, a virtual 3D reconstruction was developed to reliably reproduce an ordinary living space within a Greek town during the 5th century BC for the scientific and general communities. These finds also enable the assessment of the viability of rather crude ideas regarding the appearance of these living spaces and their function. This paper will discuss the theoretical reasoning and methodological approach behind this endeavour.

KEYWORDS

Greek Sicily, Selinunte, war destruction, domestic inventory, virtual reconstruction

MELANIE JONASCH, LINDA ADORNO, PABLO APARICIO-RESCO

# Virtual 3D reconstruction of a domestic space in Selinunte (Sicily) from the 5th century BC: opportunities and challenges

## Archaeological evidence and historical background

1 Selinunte is the westernmost Greek colony on the southern coast of Sicily. It was founded at the end of the 7 century BC by settlers from Megara Hyblaea and quickly became an important economic centre in the region; its inhabitants intensively cooperated and competed with the other groups in the area, including the Elymians and Phoenicians. In 409 BC, an army sent by Carthage responded to a call for help by Segesta, a neighbouring town of Selinunte, and took the opportunity to widely destroy the Greek city and to slaughter most of its inhabitants. Although resettled in the second half of the 4 century BC by a community of unknown origin, Selinunte never regained its former glory and was again depopulated during the First Punic War[1].

2 Previous archaeological investigations occasionally uncovered traces of wartime destruction, but more found remnants of systematic pillaging. Most buildings did in fact not fall during the Carthaginian attack, but were mainly demolished in the aftermath of the assault to provide building material for the new fortification on the southern hill. As these buildings were previously

1 For a more detailed presentation of the historic profile of the city, see Cusumano-2009.

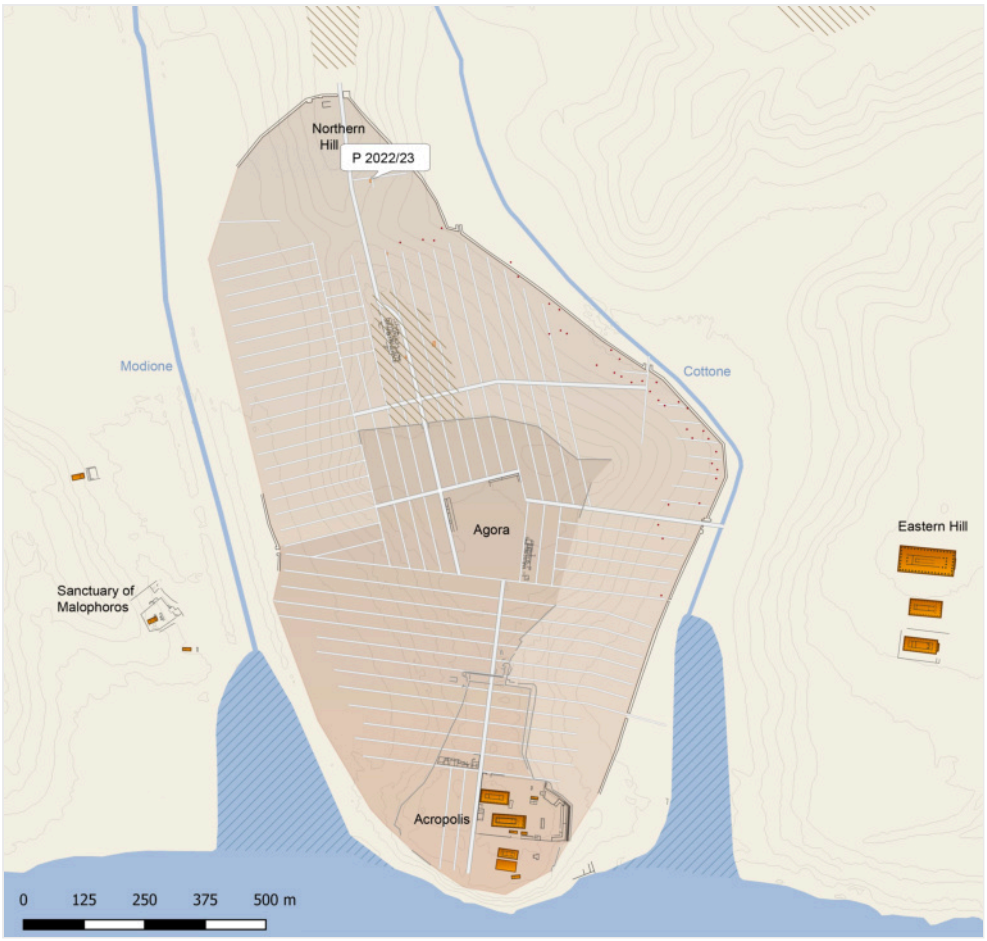


Fig. 1: Map of ancient Selinunte with the position of the trench in its northern part.

1

deprived of all reusable objects, the discovery of a war-damaged house with a nearly undisturbed domestic inventory is unparalleled in Selinunte to this point[2].

## Architecture and interior design

3 This building is located on the outskirts of the city, slightly more than 100 m away from the northern gate (Fig. 1) [3]. The construction date of the latest building phase is unclear; several of the most recent walls were built on top of older structures, while others were constructed directly on seemingly sterile soil. While the pottery found beneath the final level of use can be generally dated only to the Archaic Period, the moment of destruction and abandonment can be determined with precision due to a large number of objects dating from the second half of the 5 century BC, including several coins minted no earlier than 415 BC[4]. Thus, a causal link between the abandonment of the buildings

2 Similar examples appear at Himera, destroyed by the Carthaginians in 409/408 BC (see Belvedere-2023), and at Akragas, victim to a Carthaginian attack in 406 BC (see Parello-2021, 124-128).

3 This small-scale excavation was part of the multidisciplinary project "A new model for the city of Selinunte", a collaboration between the German Archaeological Institute in Rome, the Christian-Albrechts University of Kiel, the University of Palermo and the Archaeological Park of Selinunte, Pantelleria and Cave di Cusa. The project, carried out between 2021 and 2024, was funded by the German Research Foundation. For the latest preliminary reports, see Jonasch et al.-2024 and Jonasch et al.-2021. The trench in question has been named P 2022/23.

4 For a hemilitron (SL 49661) and tetras (SL 49693) from Akragas, minted between 415 and 406 BC, see Frey-Kupper in print.


Fig. 2: Ortho-image of trench P 2023 in its final state

2

and the Carthaginian attack on the city in 409 BC is quite plausible. While the destruction of the roof was caused by fire, a significant amount of river pebbles, found between the collapsed roof tiles, may be evidence of a battle at the site[5]. Following the collapse of the building, the ruins appear not to have been looted or cleaned up but remained largely undisturbed until rediscovery in 2023.

4 The building in question is situated on a gentle slope with a north-south orientation. The excavated room, 3.70 m wide and 6.20 m long and flanked by streets to the north and east (Fig. 2), has three doorways (A, B and C) leading to adjacent rooms (2, 3 and 5) with widths between 1.00 and 1.15 m. None of the doors open directly onto the streets, but all lead to the interior of the building, the layout of which remains largely unknown. The floor plan and character of the rooms leading off from room 1 are equally unknown, but relevant for the reconstruction, since they directly influence aspects such as roof pitch, light incidence and door design. Based on the collapsed roof tiles and objects found in the small, excavated areas of rooms 2 and 5, these likely were originally covered spaces. No roof tiles and only a few objects were found in the excavated section of room no. 3, which suggests its identification as an open courtyard. Therefore, the reconstruction assumes that the corner room was accessible from an open space through doorway B, while the others led to covered rooms (Fig. 3).

5 Diod. Sic. 13.56.6-7 recounts that the inhabitants of Selinunte attempted to barricade the streets and stopped the attackers by throwing stones and tiles from the rooftops. For a short discussion of the archaeological record, see Jonasch et al.-2024, 131-133.

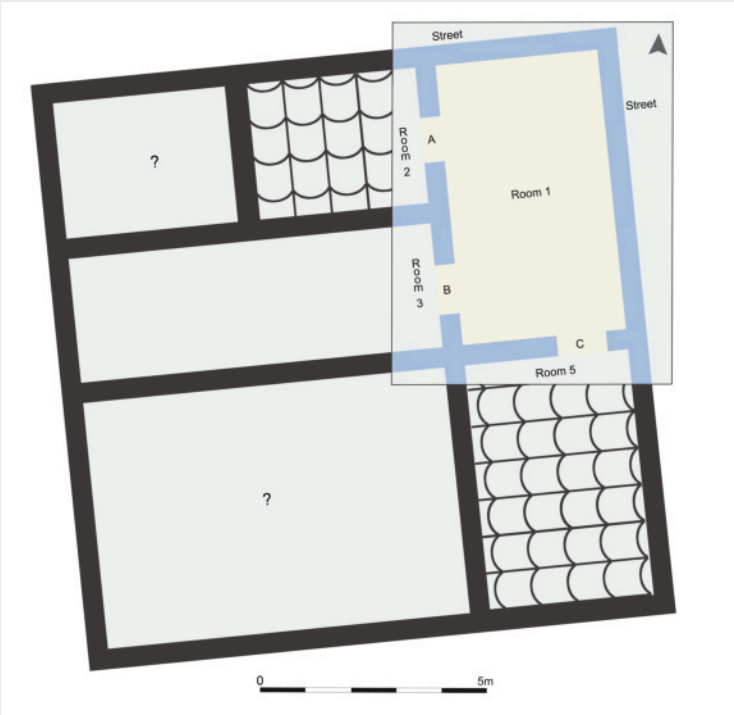


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Fig. 3: Hypothetical reconstruction of the house's layout.

## Walls, doors and windows

5 The walls of the single-story building, made from rough stone and mud brick, were very simply constructed compared to other buildings in more central locations, without sophisticated building materials or any identifying characteristic[6]. Not even traces of plaster indicate the visual enhancements of the rough wall base[7]. The rising part was made originally from mud brick that had dissolved over time[8], although partially preserved in a massive clay layer that covered the wall base and the collapsed roof (Fig. 4). No information remains on the size of the bricks, the technique used in construction or the finishing of the rising walls[9]. Thus, the reconstruction depicts a roughly plastered finish of the mud brick wall that conceals any detail, including brick size or possible additional load-bearing elements made from wood. Similar constructions in Sicily, however, demonstrate that these types of walls perfectly functioned without a wooden reinforcement[10]. A good example appears in the *emporion* of Bosco Littorio at Gela, where a series of well-preserved rooms made from rough stone and mud brick was discovered in the 1980s (Fig. 5)[11]. On short stone foundations of only 20-30 cm, the rising walls, solely made from mudbrick, to this day still reach heights of up to 3 m, testifying to the remarkable structural safety of this simple construction technique. The openings for the roof beams are still present in some of the walls, as are windows and doorways.

6 At Selinunte, the wall base, preserved to a height of around 50 cm, likely was not significantly higher in its original state. For the reconstruction, the maximum wall height was estimated at 2.80 m following the example at Bosco

6 For comparison with buildings from the Acropolis and the Agora, see Mertens-2003, 248-249.
7 Plaster of different quality was found in other trenches; see Jonasch et. al. 2024, 11 Fig. 16.
8 The upper part of the walls may have been made from rammed clay, not mud brick. The use of mud brick in Selinunte and other colonial contexts is much more common; see Germanà-2011 and Spatafora et al.-2011.
9 In another trench on the Manuzza Plateau, mud bricks were found with a side length of 45 cm, in accordance with the width of the average archaic wall, and a height of 10 cm; see Jonasch et al.-2021, 12.
10 E.g., Germanà-2011. For different techniques in the construction of mud brick walls, see Höpfner-1999, 529-531.
11 Panvini-1999, Germanà-2011, 171 and Panvini-2024 with further bibliography. The buildings at Gela are dated to the Archaic period and were abandoned in the first decades of the 5th century. While no precise information is available on the width of the walls, it seems to vary between 40 and 80 cm, depending on the static function of the respective wall. Inconsistent information states the size of the bricks to be 40x40x10, 15x15x10 or 60x60x10 cm; half formats are possible.

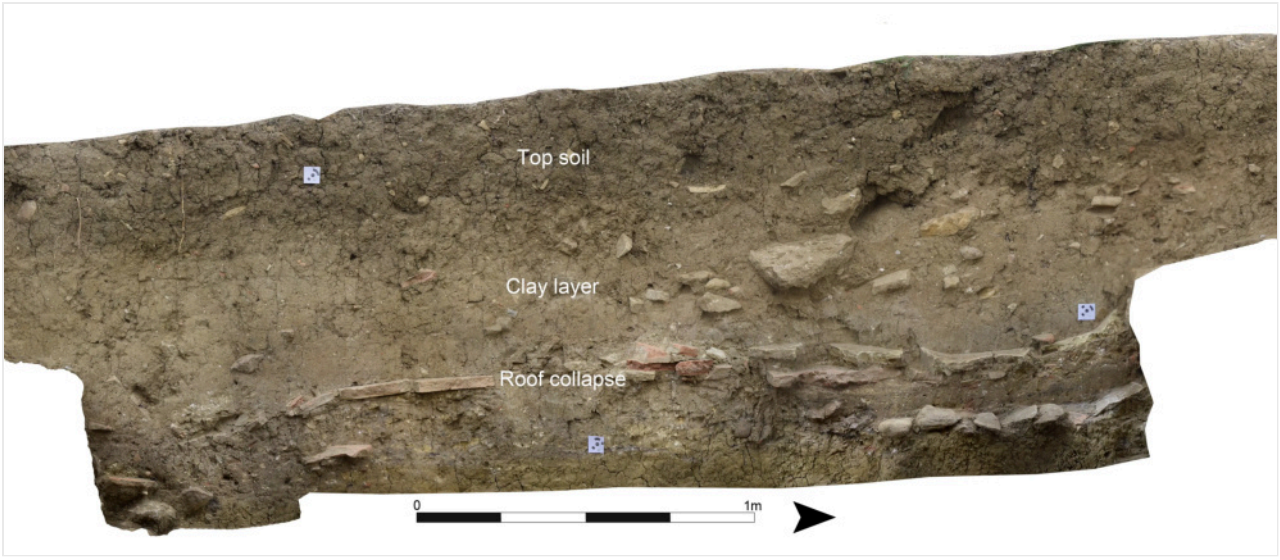


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Fig. 4: Western profile of the trench, northern section.

5

Fig. 5: Buildings made from mud brick at Bosco Littorio, Gela.

Littorio and structural calculations made with BIM (Building Information Modelling) methods[12].

7 To secure the doorways, wooden lintels likely were inserted into the brickwork, a technique also used at Bosco Littorio, where the supports of the wooden beams are still visible in some doorways[13]. Whether the small window, with a size of only 28 x 16 cm, had a wooden frame remains unclear. While no evidence for windows exists in the rising walls of the Selinuntine building, nevertheless, two simple slit windows were inserted into the eastern wall to allow an enhanced light penetration and air circulation; examples for this basic form can be found on vase paintings and in stone architecture[14]. This design has the advantage of not requiring protection devices, such as window bars or shutters. Although the amount of incoming light is low, such a design also acts as an effective barrier against cold and wet weather. In winter, inserting textiles into the openings would be sufficient. The size of the two windows is similar to that

12 Gruška et. al. 2017, 167: "The maximum height of drywalls made with these techniques without other substructures, and avoiding static problems of any kind, has been estimated to be around 2.8 m."
13 Panvini-2024, fig. 2.
14 Höpfner-1999, 532-533.

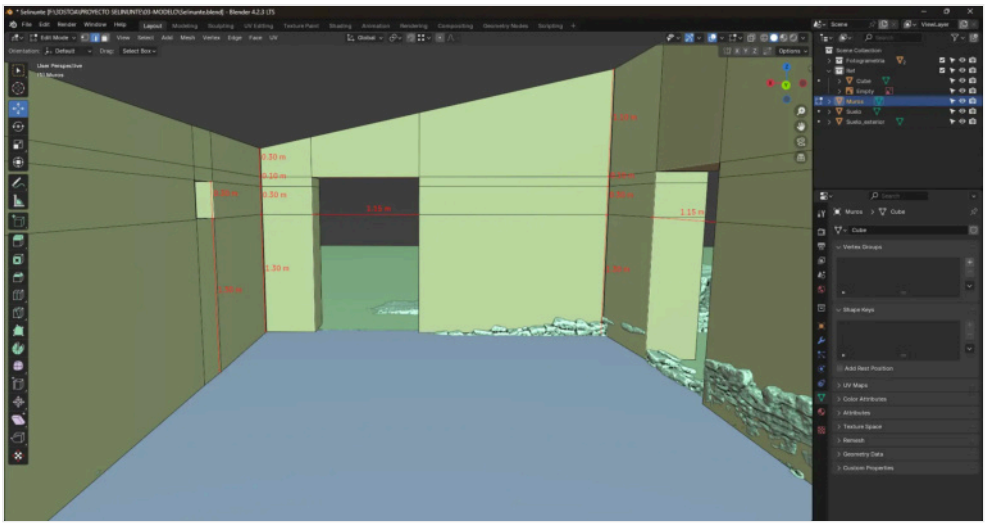


Fig. 6: Screenshot illustrating the development of the architecture model.

6

of Bosco Littorio but follows more precisely an example from Orraon in Epirus, measuring 30 cm in height, with an interior width of 35 cm and an exterior width of merely 10 cm[15] ( Fig. 6).

8 The height of the doorway, reconstructed as 1.70 m, allows for the same door height in all three entrances. Considering that, due to the roof inclination, the wall height falls to 2 m in the eastern wall, the doorway in the southeast corner cannot be much higher. The maximum headroom would have been around 1.55 m after subtracting an average of 15 cm for the thresholds. These thresholds have been retrofitted into the western wall in the course of the last construction phase, while in the south an older wall was used as a threshold (Fig. 7). Unfortunately, no information remains concerning the size of the doorways at Bosco Littorio, although the one passage still intact seems to have a similar ratio[16].

9 An interesting feature preserved in all three doorways is an oblong stone in an upright position that protects the base of the wall on the right side of the passage against damage from wear (Fig. 7) [17]. Thus, a possible door hinge was probably attached to the left side (seen from within the room). For attaching a proper door, a wooden frame would have been necessary. In the model, only a wooden board on top of the threshold was added in doorway B, which allows for the mechanical fastening of a door hinge top and bottom.

10 In the ancient Greek house, doors were part of the mobile furniture, not of the building[18]. Thus, not every doorway was equipped with a proper door. In the model, a single door was inserted in doorway B, as several iron nails and iron sheets were found nearby, together with traces of ashes and burnt soil (Fig. 8) [19]. Although the exact construction and mechanism of the door

15 Haus 1 in Höpfner-1999, 533; Tsakirgis-2010.
16 Information on dimensions is available only for one doorway, walled up in a later moment, which seems to have been quite low (108 x 128 cm), although whether the floor level is known remains unclear.
17 The stone in doorway A was no longer in situ and needed to be removed during the excavation.
18 Tsakirgis-2010, 571; Höpfner-1999, 531-532.
19 SL 49735 (six nails, one clamp, three iron sheets) and SL 49734 (four fragments of iron metal sheets).

7

Fig. 7: View of the wall bases in the south and west of room 1.


8

Fig. 8: Position of the metal door fittings in front of doorway B.

remain unclear, enough evidence remains to suggest that the passage to the possible courtyard had a weatherproof option for closure. No other metal fittings have been found to allow the reconstruction of additional wooden doors anywhere else in the room. For this reason, a hypothetical curtain has been chosen for doorway C to separate the adjacent room 5 to the south[20]. No curtain was hung to close off doorway A, as it was next to the open fire on the western hearth. In the absence of evidence regarding a fireproof room divider, the passage was left open[21].

## Roof construction

11 The room in question undoubtedly was covered by a tiled roof, as many of the roof tiles were found where they had collapsed at the end of the 5 century BC (Fig. 9). They clearly belonged to a single-pitch roof, as there are no ridge tiles among them[22]. The beams supporting them obviously were aligned along the short side of the room, and the water drainage from the roof most probably was directed eastwards, towards the road. For the model, the pitch of

20 For the use of curtains, see Tsakirgis-2010, 571.
21 The idea of the open doorway is supported by the discovery of fragments of the same vessel, a miniature lekythos (SL 49755), in room 1 and 5.
22 For flat tiles and circular cover tiles of standard sizes (57 x 80 cm resp. 20 x 80 cm), see Conti-2018, 31, 35. A variety of rim contours were mixed and prove the reuse of roof tiles from different manufacturers or production batches.


Fig. 9: Assembled ortho-image of the collapsed roof in room 1.

9

the roof was estimated to be 12° (Fig. 10), resulting in a loss of about 80 cm of headroom from the west wall to the east wall (see Fig. 6). As the flat tiles were not fixed to the beams but remained in place due to their own weight of c. 24 kg each, a low pitch was recommendable; to ensure water drainage, however, a pitch of at least 10° needed to be maintained[23].

12 The spacing between the beams was determined by the size of the flat tiles; each longitudinal joint between the rows of flat tiles was positioned exactly above a beam. The beams were modelled with a cross-section of 12 cm, enough to support the weight of the roof, estimated at approximately 110 kg per square meter[24]. The type of wood used is unclear, but holm oak seemingly was one of the most common trees at the time in the area[25]. The beams likely caught fire during the attack and caused the collapse of the roof. All that remains of them in the archaeological record were a few ashes and small pieces of charcoal.

13 Two special tiles were found in the collapse of the roof: a complete *opaion* tile, with a circular opening of about 28 cm in diameter, and a fragmented *opaion* tile, with a rectangular opening of 50 x 16 cm (Fig. 11). In the model, both have been placed according to their place of discovery, although whether their position in the roof was originally linked to the two permanent hearths in the northern part of the room is unclear.

23 According to modern guidelines for ensuring the waterproofing of tiled roofs.
24 72 flat tiles of 24 kg each (= 1728 kg) and at least 66 cover tiles of c. 10 kg each (= 660 kg) on a roof of approximately 23.5 m² produce a roof load of at least 101 kg per square meter. Online calculators for building materials recommend a cross section of the beams of 14 cm and a minimum requirement of 10 cm.
25 Pollen profile shows woodlands dominated by holm oak and olive trees, as noted in Stika et al.-2008.

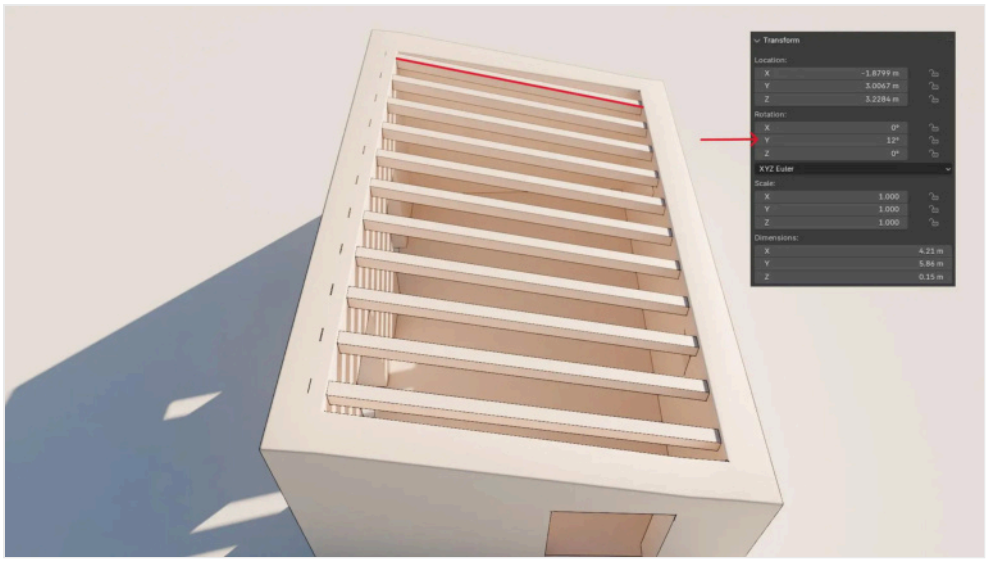



Fig. 10: Screenshot illustrating the first attempt at modelling the roof with 15 cm beams.

10

Fig. 11: Two opaia from the collapsed roof.

11

## Floor, hearths and domestic inventory

14 The two hearths were found in situ on opposite sides of the room (see Fig. 2). While the western hearth was made of reused roof tiles and was found completely intact, the eastern hearth was made of a mixture of stones and fragments of roof tiles and had suffered some damage during or after the collapse of the roof. It was only partially covered by roof tiles, as the first row of tiles appears to have largely fallen onto the adjacent road, in line with the pitch of the roof. As a result, the area immediately inside the wall, exposed to various external influences over time, was less well preserved.

15 The floor was originally made from simple beaten clay; clearly distinguishing the floor finish from its preparation level or the soil deposited on it was not possible. The identification of the floor level was made even more difficult by the subsequent sinking of the ground and the structures above, which resulted in surface differences of up to 45 cm between the northwestern and southeastern corners of the room. The most important indicators for the final level of use were the objects crushed on top of it, the built-in hearths and the wall foundations.

16 Not all objects found under the collapsed roof were originally located on the ground. Those that probably were standing on the floor have been placed in the model according to their findspot. This was an easy task for the heavy *louterion*, which was simply lying upside down in the centre of the room (Fig. 12). Positioning the grill on the western hearth, where its four feet were found, was also fairly straightforward. The concentration of cooking pots and other kitchen equipment on the perimeter of the hearth in the northwestern corner is also consistent with the circumstances of their discovery, including the bull horns. More complicated was the arrangement of the amphorae, which required something to lean against, which were found scattered across the entire length of the room. Ultimately, they were arranged rather arbitrarily alongside the walls, especially on the short sides of the room, where most of the necks were found[26].

17 In the southern part of the room, roughly in line with doorway B, a number of broken vessels were discovered, including several black-glazed vases. On the same line, three miniature altars had apparently fallen from an elevated position and were lying upside down next to the eastern wall (Fig. 13). To accommodate the altars and the other objects found in the same spatial context, an open cupboard with three shelves was modelled. The objects inside were positioned according to their findspot, assuming that the cupboard had fallen to the floor and taken everything inside with it. For example, the altars were placed on the bottom shelf, as they were found closest to the wall.

18 Standing shelves or open cupboards are not very common in visual art, yet some examples on Greek vases and on wall paintings from Pompeii prove the existence of such simple pieces of furniture[27]. The table reconstructed in the southwestern corner, however, has many examples in vase painting. In the archaeological record, a rectangular piece of burnt earth with a side length of about 80 cm, found in this corner, suggests that a piece of wooden furniture may have been located there (Fig. 14). The objects depicted on top were all found in this corner, including a miniature altar that left a clear imprint still visible after its removal[28].

26 The three local amphorae in the southeastern corner are not supported by the archaeological record but were added for aesthetic reasons.
27 Richter-1966, 78-79, fig. 413, 417-18.
28 Andrianou-2009, 51 notes that tables in vase paintings usually are not depicted as storage areas but mainly for the preparation and consumption of food or for work. See also Richter-1966, 63-72.


Fig. 12: The basin of the louterion in upside-down position among the tiles of the collapsed roof.

12

Fig. 13: Three miniature altars in fallen position.

13

19 Finally, a small hanging shelf, quite popular in vase painting[29], was added to the northern part of the eastern wall. The side elements practically allow the attachment of the shelf to the beams of the roof, as the mud brick wall would not have been sufficiently strong to carry much weight. This shelf was added since some smaller vessels, including the black-glazed jug with a trefoil mouth, were found in the northeastern corner of the room. The wooden furniture in the reconstruction is largely joined together with mortise and tenon joints to avoid the use of nails, of which only a few were found during the excavation[30].

20 In vase painting, strong evidence remains for the hanging of individual objects on the wall. although no archaeological proof for this type of storage exists in the room in question, as the upper parts of the mud-brick walls are missing. A single bronze nail of almost 13 cm in length, unbent and with only small signs of wear[31], may indicate use, not as a door nail, but to pierce a low-resistance material, such as mud brick. This is merely a hypothesis, as is the positioning of the vessels hanging on the north wall in the model.

29 Richter-1966, fig. 411; Andrianou-2009, 83-84.
30 Two additional nails (SL 49688) were found in the collapse and used for attaching the small shelf to the beams of the roof.
31 SL 49726. For a common type of nail usually referred to as a doornail, see Baitinger-2016, 146.

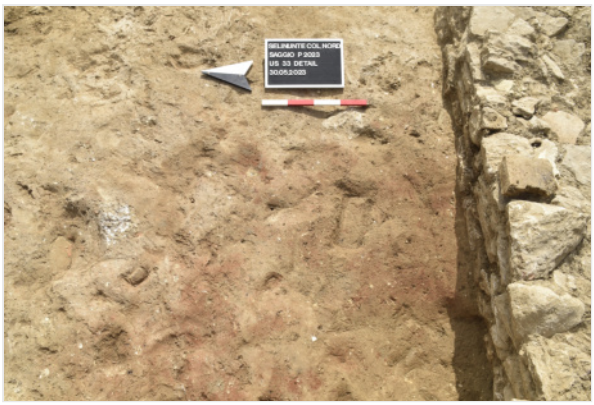


Fig. 14: Floor level in the south-western corner of room 1 with red discolouration.

14

Fig. 15: Black-glazed skyphoi: original (right) and models.

15

Fig. 16: Black-glazed guttus: original (right) and model in working state.

16

## Objects

21 A significant quantity of ceramic material was recovered from the excavated area, although much of it was severely damaged as a result of the roof collapse. The degree of fragmentation and dispersion of the finds presented three main challenges:

1. the identification of pottery types
2. the quantification of the vessels
3. the reconstruction of the original forms

22 To meet these challenges and to provide the most accurate information possible for the 3D reconstruction, thorough documentation of the finds on- and


Fig. 17: Mould with running Gorgo: original (right) and model.

17

off-site was required; many finds were also professionally restored (cleaned and, if fragmented, reassembled).

## Identification

23 Several objects survived the collapse fairly well and could easily be identified among the piles of fragments. These included the basin of the *louterion* in the centre of the room, which was entirely preserved and easy to reassemble (see Fig. 12) [32], as were the mortar, three miniature altars (see Fig. 13), the cooking plate and several smaller vessels, including the black-glazed *oinochoe* with trefoil mouth and a few small bowls. Very few objects remained completely intact during the collapse, including an *unguentarium*, a small bowl, a miniature *olpe*, three miniature lamps and another miniature altar. Three black-glazed *skyphoi* ( Fig. 15), two ribbed mugs and a *guttus* with a lion-head spout were also easily identified, although not all of their pieces were recovered (Fig. 16). The terracotta objects, in addition to the miniature altars, deserving a mention include the mould for the relief plate of the running Gorgo, which has been almost completely reassembled (Fig. 17).

24 The amphorae shown in the reconstruction could be identified by their necks, form of body and the composition and colour of the clay. The most striking specimens were the three Punic amphorae, large parts of which were preserved under the collapsed roof (Fig. 18, Fig. 19, Fig. 20) [33], although shattered into too many pieces to be completely reassembled. Of two Western Greek amphorae, only the necks and several random handles have been preserved[34]. As no evidence of feet or large parts of the body remains, it is not clear whether they were complete or used as storage vessels in a fragmented state. Furthermore, locally produced amphorae of different sizes, as well as a table amphora, could be identified[35].

32 SL 49781. The flat basin, characteristic of the fifth century BC, was unsuitable as a container for liquids; see Iozzo-1981, 147. Terracotta figurines depicting women bending over similar vessels while preparing food suggest that it was used as a work surface; see Pisani-2003, 10-13.
33 SL 49681, 50101, 50102.
34 SL 49679, 49744.
35 SL 49678, 49680, 49682: three necks of locally produced amphorae; SL 49742: neck of a table amphora.


Fig. 18: Punic amphora: original (left) and model.

18

Fig. 19: Punic amphora: original (left) and model.

19

25 The most difficult challenge was to identify the significant amount of undecorated, locally produced vessels. It was, however, possible to determine some of the original forms, including *hydriai*, various jugs, *olpai*, *lekythoi* and bowls, based on diagnostic elements, including rim and neck fragments or handles (Fig. 21, Fig. 22). Through comparison with similar objects already known and classified, reconstruction of complete profiles of several vessels was possible. The original pieces could not be reassembled due to the large number of undecorated fragments of the same size, clay and colour, which could not be assigned to individual objects.

Fig. 20: Punic amphora: original (left) and model.

20

## Quantification

26 The problem of quantification also mainly impacted the locally produced undecorated vessels and other pottery of daily use, while the black-glazed forms, for example, were all single pieces. As stated previously, also the amphorae could not be counted as easily as expected, especially if they were only preserved in a small part[36].

27 Reassembling the fragments of cooking pots, such as *chytrai* and *lopadia*, was utterly impossible because the clay is generally very friable. Good evidence from handles and rim fragments nevertheless suggests that up to twelve *chytrai* of different forms and at least three *lopadia* were stored in the northern part of the room (Fig. 23, Fig. 30) [37].

28 The largest source of uncertainty in terms of numbers was undoubtedly the large number of undecorated vessels of local production. These could only be estimated based on the preserved diagnostic elements, such as rims, feet and handles From the characteristics of the clay and the dimensions, an approximate number of pieces was established. The majority of these were small bowls and two-handled cups, with at least a dozen of each form (see Fig. 22). Similarly, a minimum number of six jugs was identified, four of which are represented in the reconstruction, as well as three *olpai* and three *lekythoi*. Although only two complete necks of local *hydriai* could be reconstructed, the preserved fragments suggest that as many as six copies were in the room (Fig. 21). Four of these are presented in the reconstruction based on suitable comparisons from other contexts. Of course, the estimated number of pieces of each form only provides an approximate indication of the original quantity.

36 Single fragments of Eastern Greek, Corinthian and Punic amphorae were excluded from the reconstruction, as they were considered to be residual material.

37 In the reconstruction, the number of chytrai was reduced to a minimum of two for reasons of space and visibility.

Fig. 21: Above: diagnostic elements of undecorated hydriai, table-amphorae, lekythoi and various jugs. Below: modelled selection.

21

Fig. 22: Above: Diagnostic elements of undecorated bowls and cups. Below: modelled selection.

22

## Reconstruction

29 The inability to reassemble many undecorated fragments was not the only reason why comparisons from other contexts were needed to reconstruct the objects in the room. Several fragments were also lost during the excavation, as the earth was not sieved on site due to time and weather conditions. While not affecting identification or quantification, this loss required a search for suitable comparisons to reconstruct the complete forms of some vessels. For example, the black-glazed *guttus* with a lion-head spout, which is missing the connecting pieces between the body and the spout (see Fig. 16, Fig. 32), was reliably rendered, as this fairly common form preserved all necessary information

Fig. 23: Above: diagnostic elements of cooking pots. Below: modelled selection.

23

about the shape and decoration[38]. On the other hand, the large jar with vertically protruding handles, arranged as part of the table accessories in the southwestern corner of the room, has no known equivalent (see Fig. 31); the body thus was recreated based on the proportions of the preserved parts, as the identification and reassembly of its fragments was impossible.

30 In some cases, object parts were missing prior to the excavation, as with the base and column of the *louterion*, which were not entirely covered by roof tiles and were unprotected against theft and landslides. While the missing parts of the base were filled in according to the preserved part's decoration, the column was entirely reconstructed. With a height of 75 cm, it follows examples from complete *louteria* found at other sites, including Himera or Locri[39].

31 The feet of the terracotta grill, which were still standing on the western hearth when discovered, provide a second example (Fig. 24). The cooking grid was lost, as it was too fragile to survive the collapse of the roof. The reconstruction drew upon an example from the Athenian Agora, while the rectangular form was chosen at random (Fig. 24, Fig. 30) [40].

32 In the case of local production forms, such as amphorae and cooking pots, hypothetical reconstructions were made in the absence of any documented comparisons. For example, as the complete form of locally produced amphorae, so far found only in fragmentary state, is unknown, the proposed reconstruction of the complete form was based on the found elements. The

38 Comparable examples from regional private collections exist in the Museum of Trapani; see Famà-2009, 186-187.

39 The terracotta louteria of the Classical period found at Himera reach heights between 70 and 80 cm; see Allegro-1982, 121. A second louterion (SL 49777), found in the adjacent room no. 2, has a complete column of 40 cm. Combined with a base of approximately 15 cm and a basin of 10 cm, its total height is estimated at only 65 cm.

40 Both forms are known from the Athenian Agora; see Sparkes – Talcott-1970, pl. 70, 2024 and Manakidou-2022, 437 for a terracotta miniature of a man in front of a grill.

Fig. 24: Above: Original fragments of the four feet of the grill. Below left: Grill from the Athenian Agora. Below right: Reconstructed grill.

24


Fig. 25: Head of terracotta figurine: original (left) and model.

25

missing parts were supplemented by forms supported by morphological analysis and comparisons with similar finds[41].

33 Although there are comparisons of entire forms, some objects are presented in the fragmented state in which they were found. For instance, the head of the terracotta figurine, which was discovered next to the eastern hearth and placed on the lower shelf in the reconstruction, is a case in point (Fig. 25, Fig. 33). As the loss of all the body fragments during the excavation was unlikely, the head possibly was displayed alone originally in a domestic context[42]. Whether it was a defective piece from the production process or the remains of a complete figurine remains to be determined. Furthermore, the five omega-shaped bronze clamps, which may have been part of a wooden container, were placed as scrap

41 As no single foot of a local amphora could be clearly identified, it is unclear whether they stood on a pedestal or a rim or whether they had a slightly rounded bottom edge like the Punic specimens.

42 In a domestic context, terracotta figurines could be displayed as votive offerings or could have magical or purely decorative functions; see Albertocchi – Parisi-2019, 497. For the possibility of a home-based production of figurines and other terracotta objects, see Spagnolo-2000, 181 with an example from Gela.

Fig. 26: Development of the architectural reconstruction on the basis of a photogrammetric 3D model.

26

metal on one of the altars, as no matching counterparts were found holding them in place[43].

34 Finally, not all objects present in the room at the time of the collapse were virtually reconstructed, since some smaller items that were not immediately visible were purposely omitted for practical reasons (e.g., metal objects, coins, fragments of figural terracotta and objects made from bone). On the other hand, some items made from organic materials were added to make the overall appearance of the domestic space more realistic. For example, the baskets under the large shelf were modelled on an example from the National Archaeological Museum in Athens[44].

35 The space most likely was filled with many more objects made from perishable materials, including straw mats, wooden containers and tableware[45]. The first step of the reconstruction, however, stayed as close as possible to the archaeological record. For further didactic purposes, the model can be enriched in the future with other possible equipment.

## The technical realization and scientific methodology of 3D models

36 As demonstrated throughout this study, the value of virtual reconstruction extends beyond its capacity to visually communicate archaeological and historical research findings with greater impact; it also serves as a crucial investigative tool that deepens understanding of the remains and facilitates the formulation of more precise hypotheses[46]. Virtual reconstruction, acting as both a scientific and educational medium, enables researchers to pose questions both

43 Baitinger-2016, 140: the needle-like end pieces were typically inserted into metal fittings that were attached to the wood.

44 A plain form without handles that could have been used for storing or transporting various goods has been depicted. This type of basket, both simple and timeless, is known from imprints left in the soil during different periods of antiquity, rather than from iconographic sources. Greek vase paintings typically depict more sophisticated baskets with specific functions, such as the kalathos for wool working, the shallow basket containing oils and fashion accessories, or the food baskets, that were hung on the wall in scenes from symposia; see Pettitt-2016.

45 Andrianou-2009.

46 Medri-2003, 186; Rodríguez-Hernández et al.-2021, 16-17.

Fig. 27: Birds-eye perspective of the excavated room and the reconstruction.

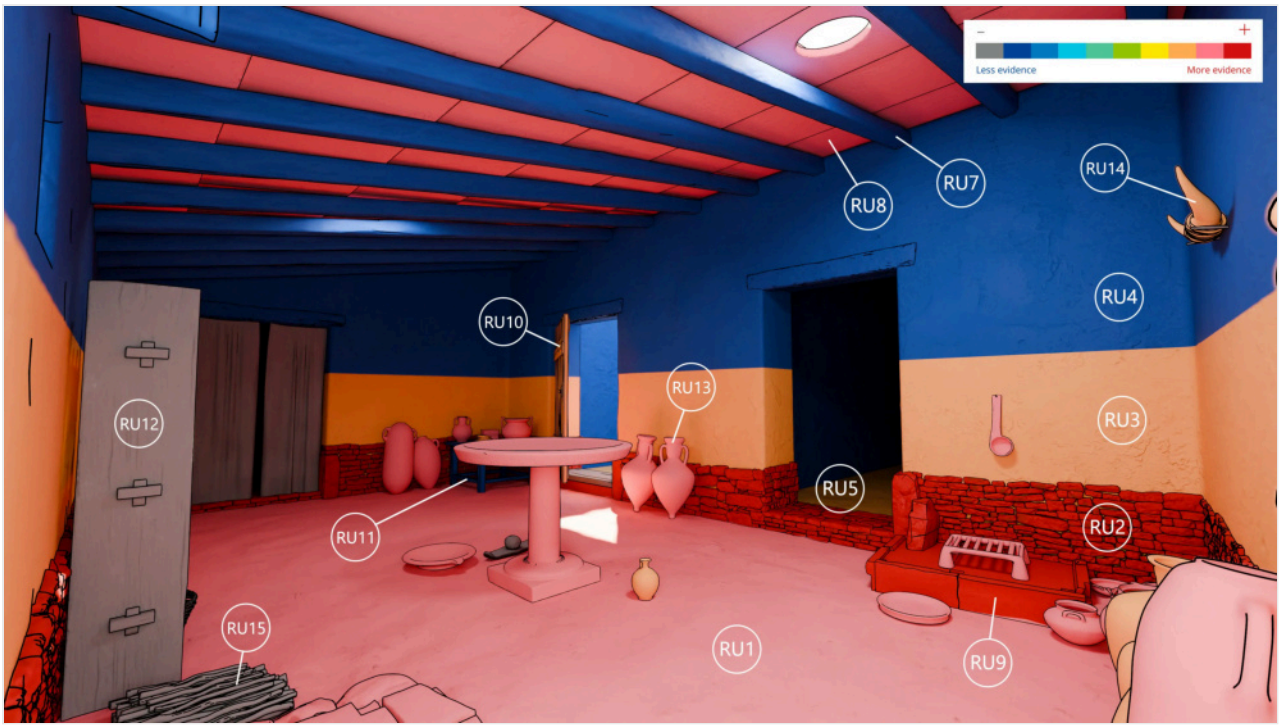
27

rarely considered explicitly during excavation work and focused primarily at the foundation level, including investigations about door types, the presence of windows, or the arrangement of objects on shelves, addressed through comparative parallels earlier in this article. Conducting a virtual reconstruction requires a careful balance between strict adherence to archaeological evidence and creative interpretation to fill the inevitable gaps in the historical record[47].

37 Technically, this project employed the open-source software Blender for 3D modelling, texturing, image rendering and utilising detailed architectural plans and photogrammetric 3D models. Additionally, commercial software was used: Adobe Substance 3D Painter for detailed texturing of specific objects, ZBrush for digital sculpting of select pieces and Adobe Photoshop for post-processing and infographic design.

38 To achieve the most accurate virtual reconstruction, the process began by establishing the volumetric framework of the architectural space over the

47 Carandini-2010, 153.




28

Fig. 28: Example of the implementation of the historical-archaeological evidence scale for virtual reconstructions.

photogrammetric 3D model of the room (Fig. 26). This step is fundamental: starting from a digital twin enables precision in dimensions, proportions, scale and measurements and thus ensures that the virtual reconstruction fully respects the preserved remains. From here, a dynamic iterative workflow ensued, which involved close and ongoing collaboration between the design and excavation teams. This dialogue allowed for proposing alternatives, implementing adjustments and exchanging solutions, which culminated in the finalised graphic hypothesis. Subsequently, materials and textures were carefully designed to provide a photorealistic finish to the scene, always grounded on the in situ remains and the historical-archaeological parallels discussed earlier in the article.

39 A comparable approach was applied to the virtual reconstruction of the various artefacts found within the room. Whenever possible, the photogrammetric models of these objects served as the basis; when unavailable, detailed plans drawn from the original pieces guided their modelling. Advanced digital sculpting techniques, occasionally employed to create precise replicas, thus recovered the original volumetric detail. Following their design, the models were textured and integrated into the complete spatial reconstruction of the room, with placement informed by excavation data (Fig. 27).

40 Importantly, virtual reconstruction is a scientific methodology that must maintain transparency in its processes and allow traceability of the decisions behind each reconstructed element. Thus, two complementary tools were employed: the Historical-Archaeological Evidence Scale for Virtual Reconstructions and the Reconstructive Units (RUs)[48]. The former provides a ten-level graphical scale representing the degree of evidential support for each

48 Aparicio-Figueiredo-2017; Rodríguez-Moreno-2024; Rodríguez-Hernández et al.-2021, 13-14.


29

Fig. 29: Screenshot of the prototype of a virtual tour through the reconstructed space.

part of the reconstruction, arranged from cooler tones (indicating lower certainty) to warmer tones (indicating higher certainty). Each level correlates with specific types of evidence and associated reliability (Fig. 28). The latter tool, the Reconstructive Units, catalogues and describes individual reconstructed elements, their sources and their assigned evidence levels. Together, these tools aid both specialists and the general public in comprehending the knowledge base underlying the virtual reconstruction and how this knowledge is visually encoded.

41 The resulting models and infographics allow viewers to explore the reconstructive hypothesis of the room prior to its destruction from multiple perspectives by providing a comprehensive understanding of the space and its contents. Several views are accompanied by corresponding images of the evidence scale, linked to RU tables for readers wishing to investigate the hypothesis formation in greater detail. Additionally, several renderings of the reconstructed objects in 3D and a prototype immersive virtual tour, developed using the Panoee tool[49], enable interactive 360 exploration of the scene (Fig. 29, Fig. 30, Fig. 31, Fig. 32, Fig. 33).

49 The tour is accessible at: https://tour.panoee.net/67a3642039b9554c3361c48b/67a3643739b95523e861c495.

Fig. 30: Screenshot of a detail of the model: the western hearth with cooking pots and storage vessels.

30

Fig. 31: Screenshot of a detail of the model: view from the centre of the room towards the door and the table in the corner.

31

## Conclusions

42 The 3D model of a domestic space in 5-century Selinunte presented here was created through a thorough analysis of the preserved archaeological remains, a careful consideration of the appearance of missing parts and an intelligent use of advanced modelling techniques. Its main tasks are twofold. The first carefully shapes and confirms the perception of an ancient reality that fortuitously has been preserved in such an undisturbed state. The second task presents and publicises this archaeological find, which is difficult to grasp in its original state, to a wider audience, all while maintaining scientific reliability. Reconstructions of complex contexts, such as this ancient living space, are always hypothetical and fragmentary. The precise design of the rising walls and structural components remains unconfirmed, as do the visual characteristics,

Fig. 32: Screenshot of a detail of the model: detail of the uppermost board of the large shelf.

32

Fig. 33: Screenshot of a detail of the model: detail of the undermost board of the large shelf.

33

the incidence of light and the form and position of the objects. The furnishings, made from perishable materials, are only conjectural, while the particular textiles, food supplies and combustibles that rendered the space habitable in the first place are unknowable. In this initial version of the reconstruction, the atmospheric details were kept to a minimum and thereby facilitated the traceability of the archaeological record. In the future, the model will be further developed, in line with new research findings and future requirements.

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## SOURCE OF ILLUSTRATIONS

Fig. 1: DAI-M. Jonasch
Fig. 2: DAI-M. Jonasch
Fig. 3: DAI-M. Jonasch
Fig. 4: DAI-M. Jonasch
Fig. 5: Regione Sicilia: https://parchiarcheologici.regione.sicilia.it/gela/siti-archeologici/bosco-littorio-gela/
Fig. 6: 3DStoa
Fig. 7: DAI-M. Jonasch
Fig. 8: DAI-M. Jonasch
Fig. 9: DAI-M. Jonasch
Fig. 10: 3DStoa
Fig. 11: DAI-M. Jonasch
Fig. 12: DAI-M. Jonasch
Fig. 13: DAI-M. Jonasch
Fig. 14: DAI-M. Jonasch
Fig. 15: 3DStoa / DAI-D. Gauss
Fig. 16: 3DStoa / DAI-D. Gauss
Fig. 17: 3DStoa / DAI-D. Gauss
Fig. 18: 3DStoa / DAI-D. Gauss
Fig. 19: 3DStoa / DAI-D. Gauss
Fig. 20: 3DStoa / DAI-D. Gauss
Fig. 21: 3DStoa / DAI-D. Gauss
Fig. 22: 3DStoa / DAI-D. Gauss
Fig. 23: 3DStoa / DAI-D. Gauss
Fig. 24: Above: DAI-F. Palumbo: Below left: https://www.antike-tischkultur.de/griechkochgitter.html (04.07.2025); Below right: 3DStoa
Fig. 25: 3DStoa / DAI-D. Gauss
Fig. 26: 3DStoa
Fig. 27: DAI-M. Jonasch / 3DStoa
Fig. 28: 3DStoa
Fig. 29: 3DStoa
Fig. 30: 3DStoa
Fig. 31: 3DStoa
Fig. 32: 3DStoa
Fig. 33: 3DStoa

## ZUSAMMENFASSUNG

### Virtual 3D reconstruction of a domestic space in Selinunte (Sicily) from the 5th century BC: opportunities and challenge

Melanie Jonasch, Linda Adorno, Pablo Aparicio-Resco

Bei Ausgrabungen im Norden der griechischen Stadt Selinunt wurde im Jahr 2023 ein Gebäude entdeckt, das vermutlich während des Angriffs der Karthager im Jahr 409 v. Chr. zerstört wurde. Die besondere Bedeutung dieser Entdeckung liegt in dem nahezu ungestörten Zustand der darin enthaltenen Gegenstände, die unter dem eingestürzten Dach versiegelt wurden. Das Gebäude wurde nicht vollständig ausgegraben; der Fokus lag stattdessen auf einem etwa 23 m² großen Raum, der aufgrund zweier eingebauter Herde und einer Vielzahl von Haushaltsgegenständen als privater Koch- und Wohnraum interpretiert wird. Da das Gebäude nach der Einnahme der Stadt weder geplündert noch wiederverwendet wurde, ist der ausgegrabenen Raum ideal für eine systematische Rekonstruktion der Bausubstanz und des Inventars geeignet. Auf der Grundlage der Funde und Befunde wurde daher eine virtuelle 3D-Rekonstruktion entwickelt, die einen multifunktionalen Wohnraum des 5. Jh. v. Chr. auch einer breiteren Öffentlichkeit zugänglich machen kann. Der Befund ermöglicht zudem die Überprüfung bisheriger Vorstellungen vom Aussehen und Funktionieren derartiger privater Bereiche. In diesem Beitrag werden die sachlichen Grundlagen und der methodische Ansatz der virtuellen Rekonstruktion diskutiert.

### SCHLAGWORTE

Sizilien, Selinunt, Kriegszerstörung, Hausinventar, 3D-Rekonstruktion

## AUTHORS

Melanie Jonasch
Freie Universität Berlin

Linda Adorno
Freie Universität Berlin

Pablo Aparicio-Resco

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