SCIRES it
SCIentific RESearch and Information Technology
Ricerca Scientifica e Tecnologie dell'Informazione
Vol 14, Issue 2 (2024), 125-140
e-ISSN 2239-4303, DOI 10.2423/i22394303v14n2p125

CASPUR-CIBER Publishing, http://www.sciresit.it

SURVEY AND 3D RECONSTRUCTION OF THE TEMPLE II IN FRANCAVILLA MARITTIMA (CS)

Paolo Brocato, Antonio Agostino Zappani***

*Department of Humanities, University of Calabria – Rende (CS), Italy.
**Department of Civil Engineering, University of Calabria – Rende (CS), Italy.

Abstract

The study presents the results of an interdisciplinary research project focusing on the survey and 3D reconstruction of Temple II of the sacred area of Timpone della Motta near Francavilla Marittima (CS, IT). Beginning with the photogrammetric survey, the re-reading of archaeological data and previous graphic renderings, the analysis of construction techniques, the critical study of bibliographical sources, and also proceeding with reasoning by analogy, a series of conjectures were formulated, which made it possible to obtain a technically and architecturally plausible reconstruction. The temple, divided into a *pronaos distilo in antis*, *naos* and *adyton* (depth ratios of 2:4: 1), was covered by a pitched roof. In an early phase, a pole placed almost in the centre of the *naos*, collaborated in supporting the roof; later, this scheme evolved into a more complex system with two poles, connected by a horizontal frame, supporting all the purlins.

Keywords

Timpone della Motta, Temple II, digital photogrammetry, survey, 3D reconstruction.

1. *Foreword*

The archaeological excavations conducted in the sacred area of Timpone della Motta in Francavilla Marittima (CS), on several occasions between the 1960s and 2000s, have brought to light the remains of five buildings (I, II, III, IV and V) and a enclosure base[1] (Fig. 1). The structures, the post holes, the foundation channels and the finds testify to an occupation of the site from the Middle Bronze Age to the end of the 4th century B.C., with Buildings I, III and V characterised by a wooden phase, preceding the masonry phase, and Buildings II and IV by the masonry phase alone. For some of them, archaeologists do not agree on the function and dating, but Building II, the subject of this memoir, has been rightly classified as a temple structure since its discovery; hence in the remainder of this essay we will refer to the structure as Temple II.

The proposed path of knowledge winds between the survey, the analysis of the surviving wall structures and the reinterpretation of previous research, with the aim of arriving at a 3D reconstruction of the temple[2]. The preliminary phase of critical study of bibliographic sources and previous traditional surveys was followed by the analysis of construction techniques and the identification of similar situations, taking advantage of the analogy with contemporary architectures, without neglecting historical buildings chronologically closer to us in terms of construction techniques. In identifying possible similarities and correspondences, useful for

[1] The bibliography on the sacred area of the Timpone della Motta is extensive, but as initial references to untangle the complex events that have affected the site and to get a synoptic picture of studies and research, see: De Lachenal (2007); Kleibrink and Pace (2018). For a reinterpretation of the wooden phase, see Brocato (2022a). To indicate the sacred area, scholars also use the term acropolis.

[2] The present research is part of the pilot project "Enabling accessibility and sustainability in minor destinations" (Spoke 4 - Goal 4.5 PP1; scientific resp.: prof. F. Bruno), which is part of the Research Programme "Tech4You" (PNRR, Mission 4, Component 2, Investment 1.5), funded by the European Union-NextGenerationEU. It is also part of the three-year research and excavation concession of the Ministry of Culture (prot. no. 629 of 23/05/2022; scientific resp.: prof. P. Brocato; survey resp.: prof. A.A. Zappani and ing. A. Lio).
The authors would like to thank the Soprintendenza Archeologia Belle Arti e Paesaggio for the province of Cosenza, in the person of the Superintendent Dr. P. Aurino and the area official Dr. M. Barbato, as well as Dr. Archaeologists F. Galluccio and L. Altomare for their constant discussion on the subject.

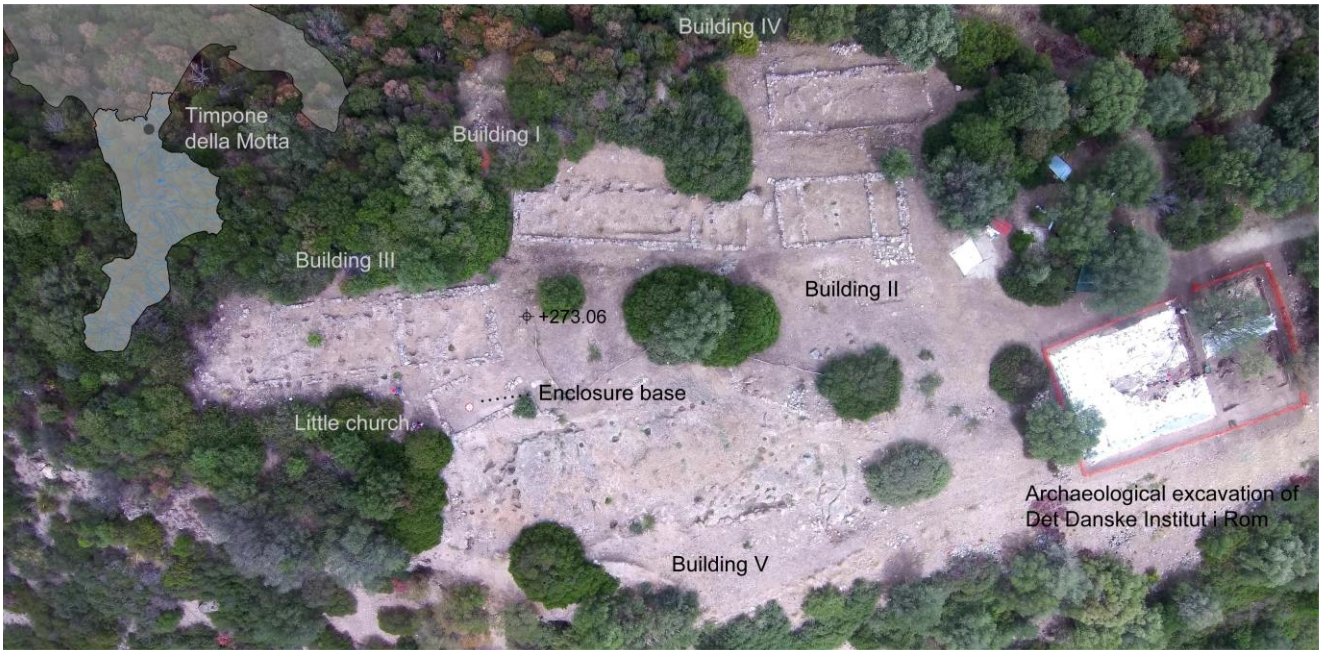

Fig. 1: Aerial photo of the sacred area of the Timpone della Motta

reconfiguring the elevated, painted or relief decorations of Etruscan tombs provided useful insights into the structure of the roof[3].

The scarcity of the remains, the perishability of the construction materials used, the excavation method and its documentation, and the restoration of the structure are the factors that have further complicated the process of interpretation and reconstruction. The metric data, direct observations, construction clues and comparisons allowed for a series of conjectures to be formulated that directed the reconstruction towards technologically and architecturally plausible solutions. Where the clues proved to be more tenuous, for example in the colouring of the surfaces, the decoration and architectural plastic (capitals, crowning, decorative elements of the roof) and the dimensions of the openings, a measured distance was deliberately maintained in representing the hypothesised situation. Further insights, in the future, may perhaps also come from the few fragments of architectural decoration.

2. *The sacred area of Francavilla Marittima and Temple II*

The history of the research and preservation of the site has been, in both respects, very troubled and it is not easy, from what is available in scientific literature, to reconstruct the scientific methods and data, especially when entering into specifics and detailed analysis. The Stoop excavations in relation to Temple II have been dealt with in Brocato (2024) as well as some of the problems related to this building.

The structure under examination appears to be successive in time in relation to Buildings I, III and V for reasons of topography and building technique. Building IV, for reasons of orientation and because of its position right below Temple II, could indicate a connection between them, perhaps even a chronological one. However, the question remains unresolved due to the total absence of published excavation data. A chronology of Temple II attributable to the mid-third quarter of the 6th century B.C. seems plausible, even if based solely on building technique.

The stratigraphic analysis conducted retrospectively, based on publications, allows some important, albeit partial, considerations to be made. What was recorded at the time of the excavations seems to be related to the obliteration phase of the building, which took place with diversified forms of ritual, including levels of obliteration (roof tiles), placement of votive

[3] This memorandum is the result of the joint studies of the authors. Paragraph 2 are attributed to Paolo Brocato, paragraphs 3, 4, 5, 6 and 7 to Antonio Agostino Zappani.

offerings and vase offerings. It is problematic to define the chronology and the phases of obliterations, but everything seems to be definitively sealed towards the end of the 4th century B.C., a period after which evidence of the life in the settlement disappears.

It appears problematic to define the divinity worshipped within the temple, even though, precisely from here, excavations recovered the famous bronze plate with the dedication to Athena of Cleombroto. Maria W. Stoop had rejected the inscription's relevance to the temple because of a chronological discrepancy, the building for the scholar dated to 510 B.C., whereas the inscription dated to a much earlier period. Therefore, as there were no other older phases for her, the inscription was not in its original context (Stoop, 1979, p. 84). Marianne Kleibrink, rejecting the too early chronology attributed to the temple by Stoop, argued instead for a later chronology, around 560-540 B.C., presumably in line, according to the scholar, with the dating of the inscription (Maaskant-Kleibrink, 1993, p. 42). The chronology of the inscription, however, is around 600-575 B.C. (finally on the inscription, see Paoletti, 2018), a period certainly earlier than that proposed by Kleibrink, but also earlier than the new chronologies based on recent considerations of construction technique (mid-third quarter of the 6th century B.C.). Thus, the inscription is not pertinent, at least in its original phase, to Temple II. Rather, it should be referred to the building made of squared limestone blocks, of which only a few scattered blocks remain, and which represents the true architectural innovation of the acropolis and of the Francavilla architecture at the beginning of the 6th century B.C. (Brocato, 2022b). It is easy to assume that the important inscription was moved from its original location in Temple II, perhaps as a result of destruction and theft in circumstances that we can only speculate about. What is certain is that, at the end of the story, the inscription was hidden within a pit in Temple II, concealing it and, probably, consecrating it at the same time. From around the temple, specifically at Building IV, downstream from Temple II, come terracottas depicting Athena *Promachos*. This could be a clue to the identification of the temple proposed by Kleibrink, but the lack of finds in the primary deposit does not allow to obtain certainty. Other terracottas related to Pan and the Nymphs, between Temple II and Building I, are a clue to the presence of later cults that complemented the earlier ones over time. But even here, the data hardly indicate a generic topographical position. The presence of attestations linked to the dimension related to Demetra also underlines the complexity of the cult system of the Timpone, where other cults may have been consolidated and connected around Athena.

One perspective that may be considered, but which certainly needs to be deepened with further research on the site, could be to take into account the fact that the settlement was involved in the Crotonian conquest of the area of Sibari. and was partly abandoned and destroyed. Perhaps then at this time (ca. 510 B.C.) one can conjecture the destruction of the limestone-block temple (Building V, Archaic phase) and the transfer to the nearby Temple II of the dedication to Athena, where it was either ritually buried directly or preserved until the final burial. Other alternatives, although possible, are part of dynamics that are impossible to reconstruct at the moment and therefore unknown to us.

3. 3D polygonal acquisition and modelling

Digital photogrammetry, based on Structure from Motion (SfM) techniques, was used for the survey of Temple II, with the aim of generating a polygonal model with a high-resolution photographic texture; in this way, it was possible to faithfully 'record' the wall structures, the course of the conglomerate bank and the post holes (Fig. 2). The images were captured with the Nikon D800 camera equipped with the Nikkor AF-S 16-35 mm lens, while a series of targets, evenly distributed and beaten with the Leica TCR 407p total station, were used to scale the model, as well as to check the metric quality of this operation.

Fig. 2: Orthoimage deduced from the mesh

The mesh, obtained using Agisoft Metashape Pro 1.7.0, was subsequently modified and optimised using the software Geomagic Wrap 2021, to improve its quality with automatic and manual actions (correction of topological errors; filling gaps; noise reduction). The result is a polygonal model of approx. 30 million triangles with a geometric resolution of 5 mm (average value).

From the polygonal model, detailed scale line drawings (planimetry and profiles) were deduced, as well as contour lines (equidistance of 5 cm) and high-resolution orthoimagery, which are typical of the photogrammetric technique used.

4. Surveys and graphic renderings

4.1 Previous surveys

The previous surveys were conducted with traditional methods and instruments and the plan published by Stoop (1983, p. 20) is a schematic graphic representation of the temple; it shows the type of materials, the approximate position of the roof tile collapses and the dark stain, which the author assumes to be an *eschara*. The rock and post holes are not reported[4], while no indication alludes to the extent of the excavation area. A comparative reading of the period photographs and the drawing leads one to think that the plan, at least in some parts, is not an accurate transcription of the state at the time of the discovery; in particular, the dividing wall between the *naos* and the *adyton* is traced intact even though it was partly affected by a collapse.

Between 1968 and 1970, Dieter Mertens and Helmut Schläger surveyed[5] and studied *in situ* the Buildings I, II and III unearthed by Stoop and the fragments of their decorative *apparatus* (Mertens & Schläger 1983). The plan, the elevation of the NO perimeter wall and the detailed cross-section, as well as the overall plan of the sacred area, constitute the body of the graphic documentation of Temple II. In depicting the plan, Mertens makes use of graphic mediation techniques that maintain both a strong figurative relationship with the represented and symbolic codifications to: emphasise the masonry and post holes in relation to the rest, acting on the graphic tone; distinguish the conglomerate blocks from the other lithic materials; clearly identify the rock and the ground that partially covers it; and so on. Overall, the author acts in the direction of focusing perception by degrees, making the masonry-pole system 'emerge', so as to create a situation of figurative homogeneity between them, then the ground and finally the bench. The post holes deserve a separate discourse, rendered with simplified forms and whose position diverges from that of the actual survey, with the central hole shifted and placed along the longitudinal axis of the *naos*; perhaps an unconscious figurative adaptation consequent to the author's interpretation of the archaeological remains as a post hole scheme for the support post of the ridge purlin. In addition, unlike in the plans of the other buildings, not all the holes are sampled in the same way, but some are filled in with hatching similar to that used for the ground, perhaps to denote the presence of the latter in the hole at the time of the survey or to visually imply a shallower depth.

The two plans are not perfectly superimposable with the current one deduced from the photogrammetric model, partly because of the techniques adopted, which make it difficult to restore similar situations with traditional tools, and partly because they refer to different situations, in terms of excavation and conservation of the walls, which have undergone restoration in the meantime[6]. These interventions modified certain sections of the walls with additions and repairs.

In addition to the drawings by Stoop and the surveys by Mertens, the graphic production concerning the sacred area includes a further plan of Temple II, published by Kleibrink (Maaskant-Kleibrink, 1993, p. 35). This is not a further survey, but a redrawing of the Stoop plan with some modifications and the addition of the post holes: the overall graphic result is similar and, like this

[4] In the 1983 publication, the author refers to only one post hole, which is to be related to Building I (p. 38).

[5] Paola Zancani Montuoro initially commissioned Helmut Schläger, from the Germanic Archaeological Institute in Rome, to survey and study the structures of the buildings discovered on the acropolis, also assisted by Mertens. The latter, after Schläger's sudden death (1969), replaced him and continued the work undertaken (for more details see: Zancani Montuoro (1977, p. 7); Zancani Montuoro (1983, p. 142); Stoop (1983, p. 16). The site plan and drawings of the buildings are by R. Sponer Za, while those of the decoration fragments are by U. Sternberg.

[6] In the case of the plan edited by Stoop, the particular events that followed the abrupt interruption of the excavations must be taken into account, so much so that her student M. Kleibrink (2011) recalls that the scholar was "not even allowed to study the material she excavated; and therefore her publications remained incomplete" (p. 3).

Fig. 3: View from the S of Temple II. You can see, in the foreground, the podium made of fragments of limestone blocks

one, is not entirely superimposable to the one presented in this memoir.

4.2 The new graphic restitutions

The methods and tools of traditional surveying tend to simplify and rationalise the forms of the represented, reducing their geometric complexity and causing – in some cases – the loss of information, precisely because of the insufficient fidelity to the actual situation (Fig. 3). The 3D polygonal model obtained by means of digital photogrammetry, on the other hand, faithfully replicates the real situation from both the metric and colorimetric points of view, so much so as to act as a cognitive intermediary, flanking the real artefact in the knowledge process set in motion with the survey; through it it is possible to explore, interrogate and manipulate the surviving masonry, expanding the graphic-operative opportunities of the traditional survey.

The new survey drawings of Temple II deduced from the mesh document, describe and analyse the structure, combining conventional graphic methods and the figurative possibilities inherent in the technique used, to create metrically reliable renderings. The rocky bank, the post holes and the ground plan are depicted by exploiting the synthetic rendering of the mesh, in order to present the surfaces without geometric simplifications and to provide an easy-to-understand and immediately readable reading of the plano-altimetric course; the contour lines superimposed on the mesh emphasise the course, as do the profiles and the altimetry in false colours.

The survey shows a building divided into a *pronaos*, *cella* and *adyton*, oriented NW-SE and with access to the SE. The wall structure on the façade is wider in the centre and narrower on the sides, probably to accommodate the wooden columns of the *distila* front *in antis* (Fig. 4), as already observed by Mertens (Mertens & schläger, 1983, pp. 155, 156).

Leaning against the SW side are the remains of a podium, with a length equal to the depth of the *pronaos* and a width of ca. 2.30 m, built at the same time as the temple (Stoop, 1983, p. 21) or at a later time (Mertens & Schläger, 1983, p. 153; Kleibrink, 2010, p. 118), possibly to accommodate the statue of Athena (Maaskant-Kleibrink, 1993, p. 42)[7]. Fragments of limestone, from which the podium was made, were identified by Stoop (1983) also within the masonry and, in particular, the Dutch archaeologist points to a fragment of limestone moulding "reused in the inner west wall [between *cella* and *adyton*]" (p. 23)[8]. In the light of these considerations, it is plausible to hypothesise a restoration intervention, subsequent to the building of the temple (according to Kleibrink it can be dated to the 5th century B.C., with Brocato circumscribing it to the middle of the century), to which the construction of the podium can also be ascribed. The new survey shows that the presence of limestone elements within the masonry is, however, very limited and in many cases can be attributed to restorations carried out in recent years.

[7] See the *Oikos* of the Naxians (Delos) with the colossal statue of Apollo placed on the podium leaning against the outside of the cell wall. Let us add a further example, also in Delos: *Oikos* 1 is tripartite and has a podium along the longitudinal perimeter wall.

[8] From the planimetric diagram published by Stoop (1983, p. 20) shows that the wall separating the *naos* from the *adyton* is partly made of limestone elements, but the historical photos seem to allude to a collapsed situation (Mertens & Schläger, 1983, plat. XCI b), perhaps reassembled at a time following the excavation (Stoop's plan shows the masonry intact, as does Mertens'). The current survey shows a limited presence of limestone blocks in other walls as well, probably due to modern restorations that have restored their continuity in some places with additions.

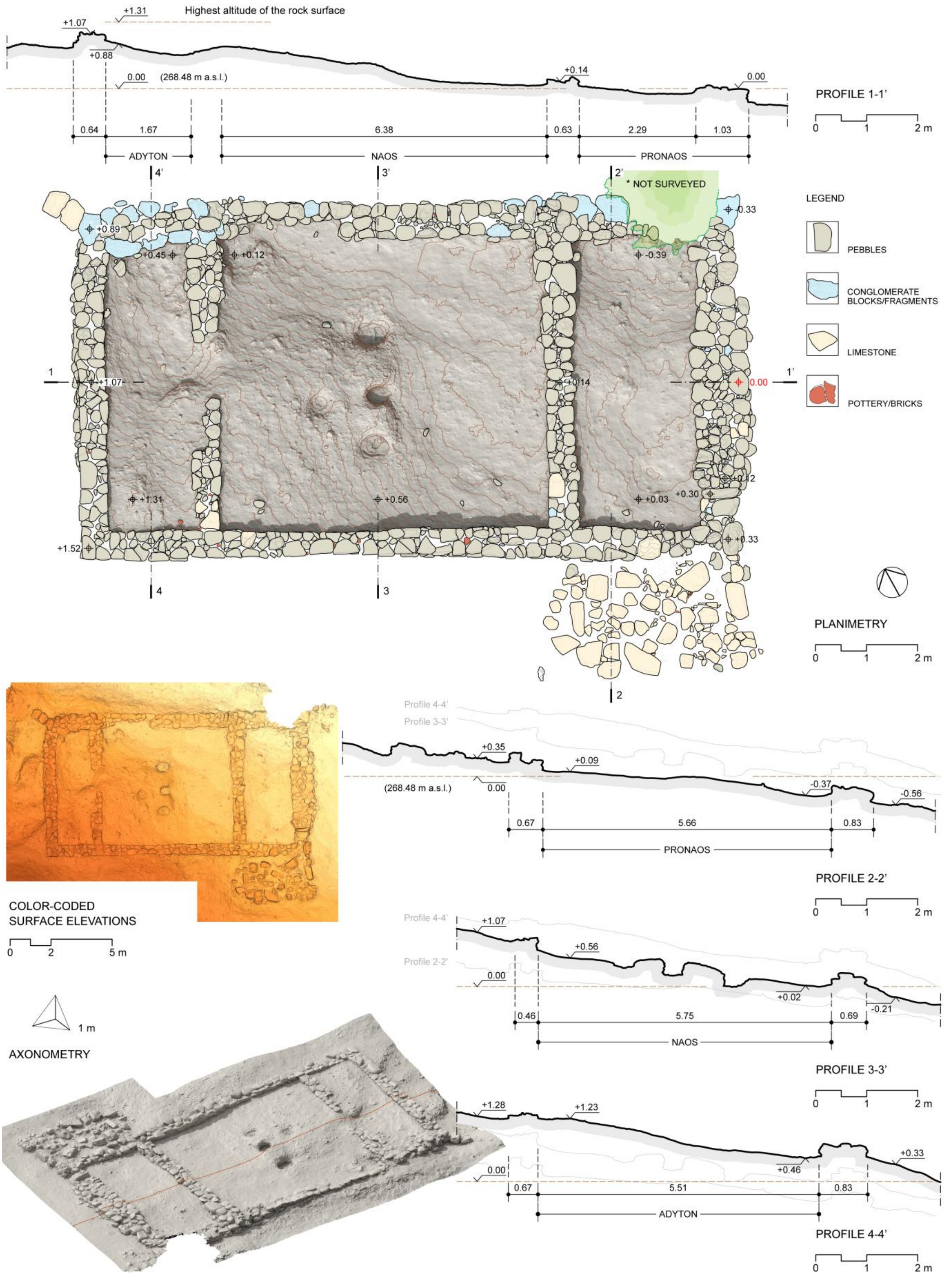

Fig. 4: Graphics of the new survey, deduced from the mesh generated from SfM-based photogrammetry

5. Materials and construction techniques

The surviving masonry is mainly made of broken river pebbles, arranged with the split section facing outwards and lined with raw earth; the raw earth mortar, sometimes mixed with pebbles of various sizes and gravel, also abundantly fills the interstices. The construction technique – commonly referred to as "a sorelle" in the Francavilla area (Stoop, 1983, p. 19) – is widely used on the Timpone della Motta[9] and, in its simplicity, facilitates the engagement and favours the verticality of the wall faces (Fig. 5a); furthermore, the roughness of the split surface guarantees the adherence of the sacrificial layer, laid to regularise the external visible surfaces and to protect the masonry from the action of atmospheric agents.

In addition to pebbles, which are available in quantity, the wall structure consists of blocks and pieces of conglomerate extracted from the bank and reused limestone fragments, which Stoop assumes to be 'fragments' of the blocks of the opus quadratum temple, destroyed by the Crotonians towards the end of the 6th century B.C.[10] The former, roughly hewn or shapeless, are used in the substructures of the NW-SE perimeter wall, with the larger ones filling in some of the depressions in the rock surface on the side of the Carnevale stream (Fig. 5b), but above all reinforcing the NW and SE corners, extending beyond the connections between the transverse and perimeter walls. Limestone fragments form the podium outside the temple (Fig. 5c) and were used to repair/integrate the masonry[11], albeit to a very limited extent; if we extend our gaze to the rest of the acropolis, we find them in Buildings I and III, while reused limestone blocks form the base of the enclosure discovered in 1968.

For Stoop (1983), the walls, except for two, rest directly on the rock (p. 21), but in our opinion the entire wall plinth (including the substructures), as far as can be observed today, rests for the most part on a more or less thin layer of earth, placed on top of the conglomerate bank in order to summarily prepare the laying surface to receive the stone elements and to prevent the wall from

Fig. 5a, b, c: Broken river pebble masonry (a); N corner of the NW-SE perimeter wall (Carnevale stream side), made of blocks and conglomerate fragments (b); podium made of limestone fragments (c)

[9] On the masonry surveys of Plateau II, see: Brocato et al. (2019); Brocato et al. (2021). On the classification of masonry for domestic construction: Altomare (2023).

[10] On the destroyed temple, the reuse of material and the enclosure base, see Stoop 1977, 1979, 1983.

[11] For the Dutch archaeologist, the lithic material of the podium was cemented by "a whitish material" (Stoop, 1983, p. 21) and had probably been exposed to fire (see also Stoop, 1979, p. 83). The reused fragments include a piece of moulding inserted into the transverse wall separating the *naos* and *adyton* (Stoop, 1983, p. 23).

sliding down the valley; the rocky substratum, moreover, does not show any signs of levelling, as already noted by Stoop (1983, p. 19). Stoop (1983, p. 19), in fact the structure follows the profile of the rock, conforming to it.

Given the irregularity of the masonry – and considering that the restoration work has, to a certain extent, affected the original structures – it is difficult to establish a precise value for the thickness of the wall plinth at the head, but a reading of the plan yields a measurement that is around 50 cm, with some sections reaching greater dimensions – for example, the lateral ends of the structure at the façade are 70 cm – and others (a few) that go down to around 40 cm[12]. We also note that the transverse walls increase in thickness as the bank descends towards the Carnevale stream and are not buffered to the perimeter walls. The masonry on the SE side increases in thickness in the central part, reaching a thickness of ca. 1.10 m, and is configured as a foundation structure, capable of accommodating the wooden columns of the façade of the temple building (Mertens & Schläger, 1983, pp. 155, 156); on the upstream side, near the S edge, the beginning of the widening is marked by a partially hewn and vertically arranged block, a singularity that is not present on the opposite side, perhaps because it is less preserved.

The key to understanding the construction rationale lies in considering the NW-SE perimeter wall (Carnevale side) as a retaining wall, on which the transversal walls, both perimeter and interior, rest. This wall, which was originally higher than the others due to the course of the bank, was subjected to the thrust of the filling of the three rooms and, in order to effectively fulfil its static functions, has a substructure largely made of large conglomerate blocks on which the broken pebble masonry rests. Similarly, the internal transverse walls and the perimeter wall to the NW increase in thickness in the foundation and have sloping faces. Some attention to the problem of reinforcing the cantons of the perimeter masonry can be seen in the N and E corners (larger blocks and corner ring), as well as in the S corner (larger block placed vertically at the head of the SO wall); what remains of the N corner of the NO-SE perimeter wall suggests a corner reinforcement spur.

Archaeologists have differing opinions on the function of post holes. For Mertens and Schläger (1983, p. 53) all the post holes are related to Temple II, with the central one in the *naos* used to hold the post that supported the ridge beam and the others probably used for repair work, a hypothesis taken up by Kleibrink (2010, p. 115); Stoop (1983, pp. 22, 38) refers to only one pit, which is not related to Temple II, but to Building I. In our opinion, it is possible to assume that the three pits, roughly aligned along the transverse axis of the *naos*[13], housed the posts supporting the purlins of the roof; of course, the three posts were not in operation at the same time, as we will see later.

6. *Reconstruction*

6.1 Virtual reconstruction: a brief note on the state of the art

Although the objectives of this memorandum do not include defining the state of the art of virtual reconstruction of architectural works in the archaeological field, it is appropriate to formulate a few thoughts on the matter.

Firstly, it is worth emphasising the importance of a 3D survey, faithful to actual morphological and metric data, which is now an essential starting point for conducting analyses, interpretations and hypothesising reconstructive solutions (Fig. 6). Digital technologies for the representation of architectural works and archaeological sites are constantly evolving (Gaiani, 2021) and 3D reconstructions are now considered a standard practice to study and analyse a work for the purposes of knowledge, conservation, and valorisation, in accordance with the principles (interdisciplinarity, transparency, scientific rigour, etc.) of the London (2009) and Seville (2012) Charters. Recent developments relate to HBIM methodologies (Garagnani, 2021; Gaucci, 2021; Aricò, Lo Brutto, & Maltese, 2023; Pepe et al., 2021) and Extended Matrix (EM) experiences (Demetrescu, & Fanini, 2017; Demetrescu & Ferdani 2021; Mancuso 2023) aimed at defining information models that allow for the management, analysis and visualisation of different types of data in a single 3D model.

[12] Mertens (1983, p. 155) in this regard indicates the average thickness as 60 cm, which is only possible if the shoe, present in extensive sections of the masonry, is included. For Stoop (1983, p. 21) the thickness is approx. 50 cm.

[13] The holes are not evenly distributed along the transverse axis and are not dug halfway along the length of the *naos*.

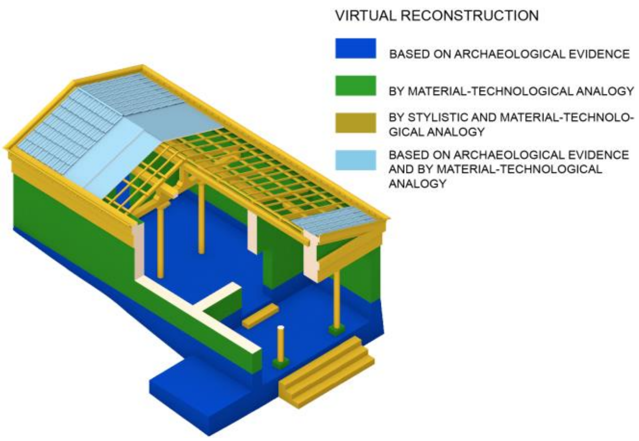

Fig. 6: Graphical diagram of the virtual reconstruction of Temple II, obtained from the 3D survey and archaeological evidence, using interpretative and analogical procedures

6.2 The reconstructive hypothesis

The above is what is left of the building and nothing else remains of the elevation, but from the very beginning, Stoop (1983, pp. 19, 22) hypothesises a mud-brick elevation, excluding the presence of a load-bearing timber frame, given the absence of holes in the plinth to accommodate the uprights. In our opinion, the hypothesis is plausible and we can reinforce it by excluding a wooden frame, with uprights housed in joists placed on the plinth, since there are no further holes in the bench, necessary to accommodate the wooden reinforcing pillars; the presence of such pillars is indispensable to ensure the stability and robustness of the frame and improve the static behaviour of the entire building. And again, Kleibrink and Sangineto (1998) agree in imagining the disappeared masonry "in unbaked bricks or clay mixed with mud" (p. 5), also by virtue of unspecified archaeological evidence found. Finally, Mertens (2006), referring to other buildings in the sanctuary, writes that 'in the ancient sanctuary on the Motta at Francavilla Marittima, [the buildings were] erected in a first phase in a wood-pile technique, developed according to local building customs (see p. 50 f.). In the 6th century B.C., more or less carefully adjusted river cobblestone plinths were used to raise unbaked walls" (p. 134).

The masonry typology of the building, characterised by a masonry plinth and a raw earth elevation – probably made of mud-bricks (adobe) – is attested in archaeological records for the period and area of reference [14] – as well as in ancient and modern written sources [15] – and was used continuously until the last century, with techniques very often similar to the ancient ones. The variability of adobe sizes (ancient and modern) does not allow the exact dimensions to be established[16], but the elevated unbaked brickwork had to have the thickness of the skirting at the top (around 50 cm), in order to have walls that were resistant to vertical loads and not excessively slender[17]. Walls covered with an aerial lime or earth-based plaster – of which no trace remains –, laid to regularise the surfaces and to protect both the adobe structure and the above-ground plinth from the weather[18].

Starting from what remains and based on the measurements deduced from the new survey, if we consider the thickness of the walls in elevation of 50 cm, a reconstructive hypothesis can be formulated (Fig. 7) in which the planimetric layout

[14] For more extensive references see: Mertens (2006); Lippolis, Livadiotti and Rocco (2007). For the first references in the Sicilian archaeological context, where evidence of adobe structures prevails, see Germanà's (2011) concise account.

[15] Ancient authors include Vitruvius, who in *De architectura* (II, 3) describes the components of unbaked bricks, their preparation and measurements, and Cato, who in *De agricultura* (XIV) recommends making the foundations of stone and lime, one foot high, on which to raise the unbaked brick wall.

[16] For a case study of adobe measurements related to Greece, see Apostolos et al. (2020, p. 1244). As far as the Calabrian regional context is concerned, raw earth was used as a building material from antiquity until at least the middle of the 20th century and, according to Cavalcanti and Chimirri (1999), the measurements of the module used in 20th-century construction vary depending on the area surveyed (38 x 18 x 16 cm, 30 x 15 x 15 cm, 27 x 14 x 12 cm); again in Calabria, according to the author's findings, in the southern area of Monte Poro and in the area of single-storey rural buildings with a clay roof, the masonry is 40 cm thick and the measurements are 40 x 20-19 x 15 cm. A similar situation occurs in neighbouring Basilicata, where V. Vitale (2013) records examples of one-storey rural buildings with a fictile roof, dating back to the first half of the 20th century, with plinths 40 cm high, 50 cm thick (some in broken pebbles) and adobe dimensions of 40 x 20 x 20 cm.

[17] The minimum uniaxial compressive strength, determined in the laboratory, is between 1 and 3 Mpa, resulting in a minimum wall thickness of 40 cm, considering a single storey (Achenza & Sanna, 2008, p. 15). Also on the resistance of mudbricks and the weight of the Protocorinthian roof, see Pierattini (2017, p. 18).

[18] The use of plaster to finish elevated masonry is attested in the residential construction of the Stombi area at Sibari, with reference to the Archaic chronological horizon (Guzzo, 1974, p. 35, Table XXIII a,b). The wall structure of the plinth is 50 cm thick, in part realised using the "a sorelle" technique; for the elevation, Guzzo hypothesises mud-brick walls and roofing realised with pentagonal tiles and ashlars.

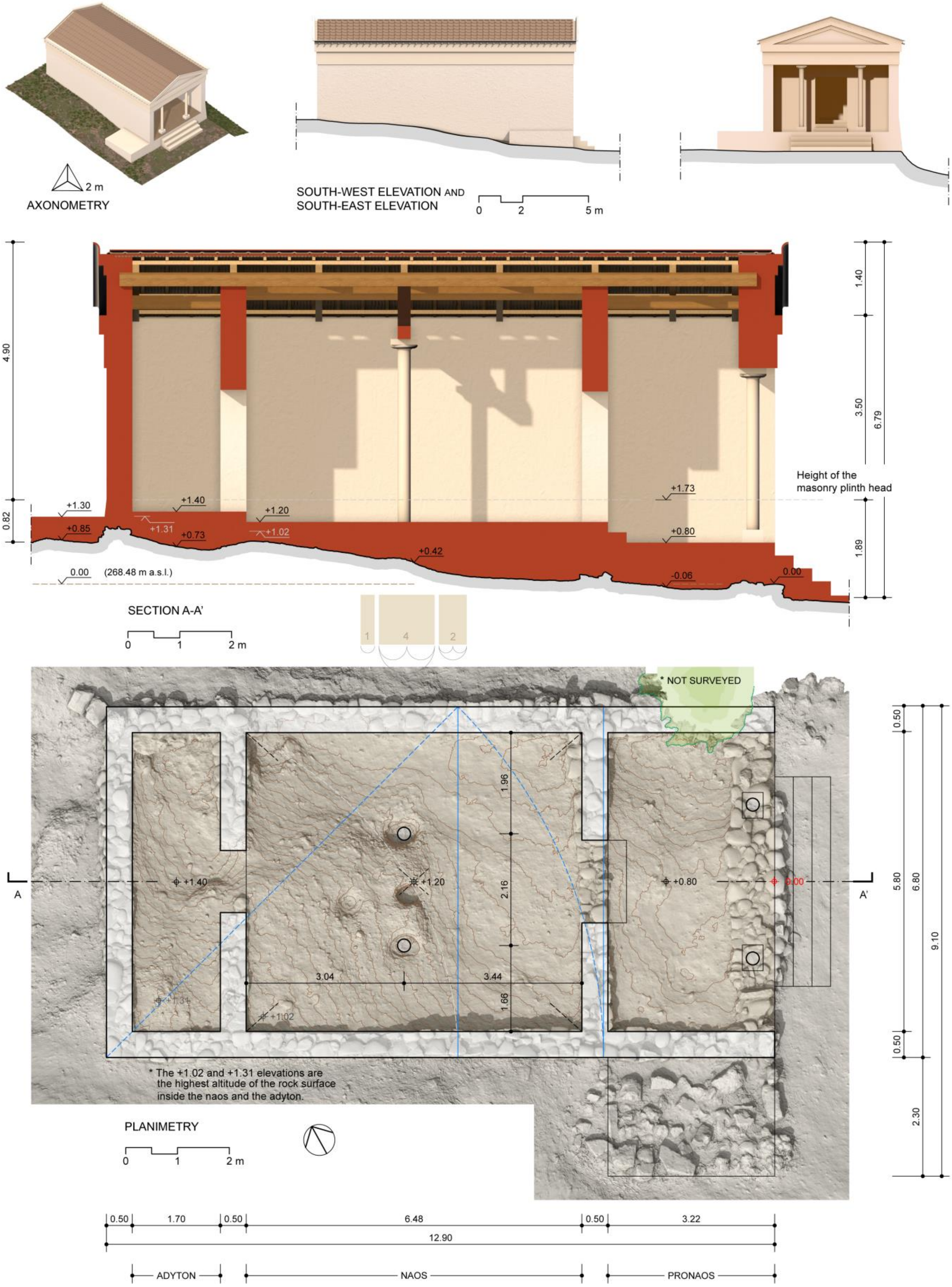

Fig. 7: Reconstructive hypothesis of Temple II

is characterised by a ratio between length and width (12.90 x 6.80 m ca.), equal to slightly less than 1:2 (1:1.9), also already noted by Mertens. A modularity can also be seen in the sequence of the interior spaces, such that the length of the *pronaos* (3.22 m), the *cella* (6.48 m) and the *adyton* (1.70 m) stand in a ratio of 2:4:1. The length of the *cella* is practically double that of the *pronaos* (4 cm deviation between ideal and measured value), while the 1:2 ratio between *adyton* and *pronaos* is less precise (9 cm deviation). The measurements suggest, albeit less strongly, the possibility that the position of the wall between the *pronaos* and the *cella* could be dictated by the diagonal rectangle, with the shorter side coinciding with the width of the building, in which case there would be a lesser degree of adherence between what remains and the hypothesised situation (8.5 cm deviation).

The difference in height of the rock on which the temple is set suggests floor levels at different heights for the three rooms, with an ascending trend towards the *adyton*, to which further steps must be added to reach the *pronaos* (Stoop, 1983, p. 19; Mertens & Schläger, 1983, p. 156; Kleibrink & Sangineto, 1998, p. 5). This solution was also adopted in Buildings I, III, and V, as a necessary adaptation to the site and its layout, but in line with other Greek-western examples, whose altimetrical organisation is not exclusively referable to contingencies dictated by the site[19]. Even in this case, the scarce archaeological evidence does not allow us to determine the exact extent of the differences in height of the individual rooms, which can be defined conjecturally on the basis of the geometric data from the survey, through which it is possible to position – with a certain degree of freedom – the floor of the *cella*, which must have been located slightly higher than the highest point of the rock (corner O of the room), where Stoop (1983, pp. 21, 22) found tiles in the vicinity of the bench, which he considers to be in collapse; similarly, the level of the *adyton* was dependent on the highest elevation of the rock within the room.

The perishability of the materials makes the reconstruction of the roof extremely difficult. Useful clues and reasoning for defining the type of roofing and architectural decoration concern:

- findings of Corinthian tiles and roof tiles, both in the sacred area and on the Plateau II[20], suggest a Corinthian roof;
- the fragments of architectural terracotta, belonging to two different temples and dated to the 2nd and 3rd quarters of the 6th century B.C., relate to double-pitched roofs with gables (Mertens & Schläger, 1983, pp. 160-166, 168);
- some pieces of baked clay, marked by the reeds and recovered in the holes of Building III, are interpreted by Stoop (1983, p. 25) as parts of the roof canopy. The pieces of fired clay may also be related to the wooden phase of the temples (7th century) and not exclusively to the masonry phase (late 7th century), but in any case they are indicators of a construction method used on the Timpone and it is safe to assume the continuity of use of the technique;
- for Mertens and Schläger (see above) at least the post hole in the centre of the *naos* served as a support post for the ridge purlin.

The evidence listed suggests that the building in the mid-6th century or shortly afterwards was covered by a two-pitch Corinthian roof, built according to a scheme in which the purlins rested on the gables of the transverse walls and supported the false rafters and other elements of the roof (the small warp, the woven reeds, the clay layer and the roof covering).

In our opinion, the greater span of the purlins of the *naos* required uprights both to limit the deflection and to lighten the load on the plug walls. A first phase, with a single post placed in the centre of the room to support the ridge beam (as already hypothesised by Mertens and Schläger), was followed by a second phase, in which a more articulated system was opted for, with two posts, connected by a horizontal member, carrying the ridge beam and two purlins, one per pitch (Fig. 8).

In the case of the single pole, the position of the central pit, slightly shifted to the left in relation to the axis of the building, is not due to construction inaccuracy, but is a static-functional expedient adopted to offset the support of the ridge beam of the *naos* in relation to those of the *pronaos* and *adyton*; in this way, the load of the beams

[19] In the presence of the *adyton*, it is not uncommon for the levels of the chambers to be articulated upwards, as occurs in Temples C and E (phase III) of Selinunte – to mention the first that come to mind – dated to the mid-6th century and 470 B.C. respectively. On the not only functional nature of the level changes along the processional route of the first temple of Hera at Poseidonia see Mertens (2006, p. 142).

[20] Recent excavations on Plateau II reveal a significant quantitative prevalence of tiles belonging to the Corinthian type over the Laconic type (Brocato et al., 2019).

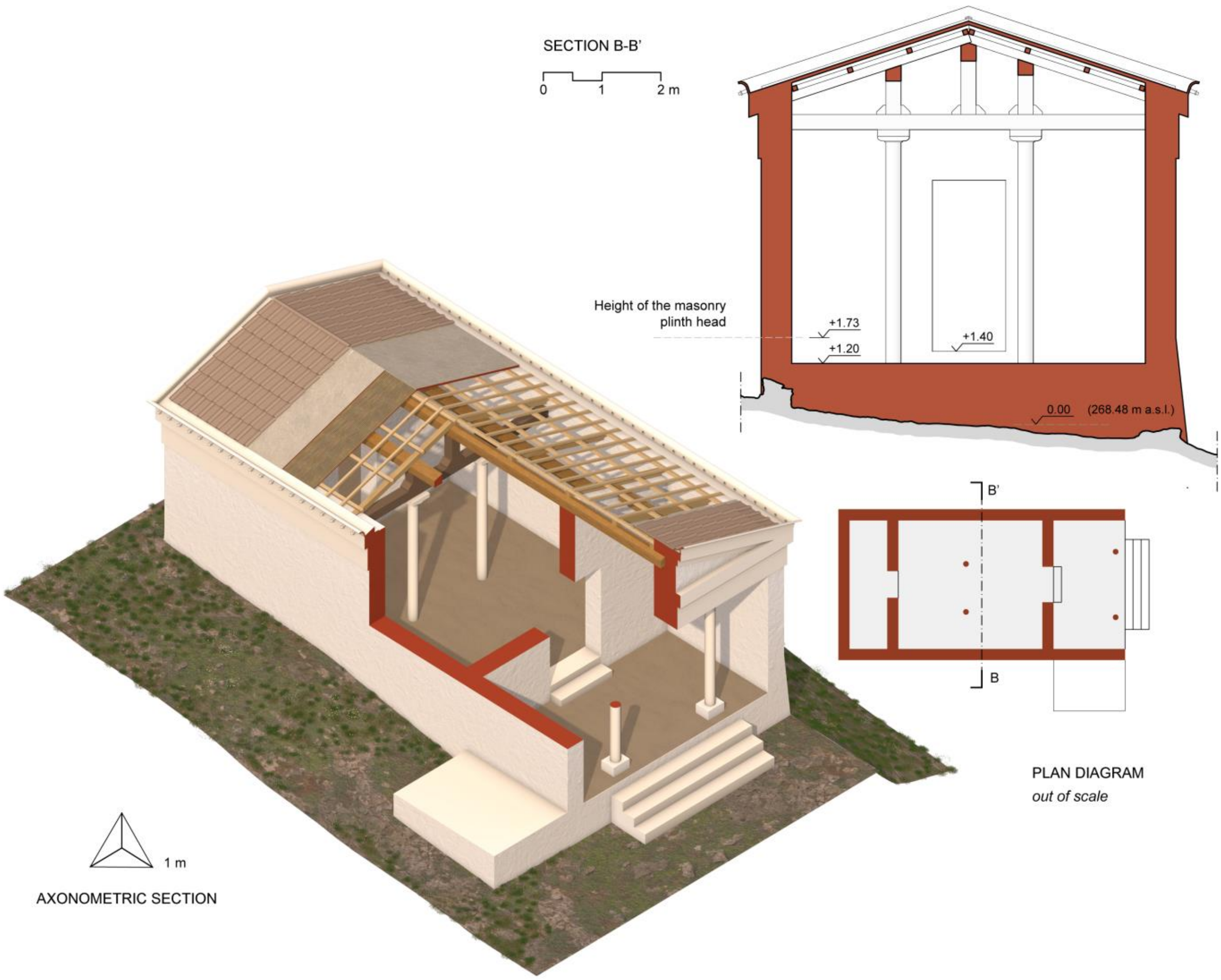

Fig. 8: Hypothetical reconstruction of the roof, considering a structural scheme with two breaker columns and a supported beam connecting them and extending to the horizontal ones located on the longitudinal walls

transmitted to the backbone walls was distributed over a greater surface area.

The change from one to two supporting columns could be due, though not necessarily, to the transformation of the thatched roof to a fictile one. Replacing it with a pair of breaker columns, connected by a beam, guaranteed both an improvement in the static behaviour of the structure and the possibility of leaving the view of the entrance to the *adyton* unobstructed. In this phase of the building's life, among other possibilities, a beam that connected the columns and extended as far as the beam dormants located on the longitudinal walls was hypothesised. The beam supported by the two wooden columns carried three vertical elements[21], a central one supporting the ridge purlin (*columen*) and two lateral ones supporting the purlins (*cantherii*). On the latter, one per pitch, rested the false struts (*templa*), which supported the small warp, the clay layer and the roofing mantle (ashlars and pentagonal tiles).

Similarities and constructive analogies for the wooden roof framework can be deduced from literature (e.g. Hodge, 1960; Ruggeri, 2018, 2022) and from the decorations – painted, spared or carved into the rock – of Etruscan tombs: the motif of a painted element[22] supporting the *columen* is

[21] The presence of wooden elements placed at the foot of these elements to stiffen the connection with the horizontal beam is plausible.

[22] On the nature of the painted element, see Roncalli (1990); on the architecture depicted in the tombs of Tarquinia, see Marzullo (2017).

recurrent in 6th-5th century B.C. tombs from Tarquinia; a wooden framework supporting the roof – either supported by pillars or pilasters spared in the rock or depicted in relief on the back wall – can be found in some Ceretan tombs, such as in the pillared hall of the Mengarelli tumulus (second quarter of the 7th century B.C.), in the Tomb of the Painted Animals (late 7th century B.C.), and in the Tomb of the Painted Lions (second half of the 7th century B.C.), as well as in the left chamber of the Cima tomb at S. Giuliano (third quarter of the 7th century B.C.) and in the central chamber of the Campana 1 tomb at Mount Abatone (second half of the 7th century B.C.); in the Tomb of the Lionesses (necropolis of the Montarozzi at Tarquinia, 530-520 B.C.) six wooden columns with capitals are painted, ideally supporting the structure of the sloped ceiling, with the *columen* supported by the king post painted in the gable space of the back wall; straws spared in the rock, although referring to flat ceilings, are very common and, to mention the first examples that come to mind, are present in the Maroi *tumulus* (Banditaccia) and in the aforementioned Cima and Campana *tumuli*. And again, the painted tomb GM 1 in the Mereo Caves (perhaps first quarter of the 6th century B.C., in any case no later than the middle of the century) (Naso, 1999) has a first chamber characterised by a vaulted intrados with the *columen* protruding out of the rock and painted, as well as three *cantherii* and nine *templa* per slope, depicted in red; on the back wall is painted the gable cage formed by three lateral king posts (or piers?) and a larger central one, holding the *cantherii* and the *columen* respectively.

Finally, the findings of fragments of twelve architectural terracottas in the sacred area lead one to imagine, also for this temple, a fictile architectural decoration and perimeter borders with *sima* and gargoyles, although without being able to go into the details of the architectural ornamentation.

7. Conclusions

The 3D survey of Temple II, carried out by means of digital photogrammetry based on SfM techniques, has made it possible to obtain new, metrically reliable and high-resolution textured graphic restorations, which are indispensable for documenting the state of things and preparatory to the 3D reconstruction, as well as useful for future conservation and enhancement interventions. The comparison between the new plan and the previous ones, obtained using traditional methods and tools, reveals a series of discrepancies, so much so that they are not entirely superimposable; in addition, the Stoop and Mertens plans were drawn before the consolidation and restoration work on the masonry remains, and some of the differences with the current situation record the additions made to the masonry.

Particular attention was paid to the reading of the masonry structures in order to understand the construction rationale and the technical devices adopted. One can detect a shrewd use of 'poor' materials (river pebbles, blocks and pieces of conglomerate extracted from the bank, raw earth), readily available in situ and easy to work, as well as executive skill in their assembly. Although the building technique is not particularly advanced, the builders were aware of the static-constructive role of the individual parts and the problems to be faced, which were solved by increasing the thickness of the walls in the foundations and profiling them as a scarp, reinforcing the cantons, defining the thickness of the masonry plinth according to the buoyancy, enlarging the footprint area of the masonry to accommodate the columns of the façade, etc.

Starting from previous studies, the new survey, the interpretation of what remains and proceeding by analogy, a 3D reconstruction of the temple has been proposed. It is a temple *in antis*, divided into a *pronaos*, *naos* and *adyton*, and covered by a two-pitch Corinthian roof. The proportions found in the plan (1:2 ca.) and the ratios between the depths of the *pronaos*, *naos* and *adyton* (2:4:1) suggest a building organism born of a unified design action. Initially, a single pole almost in the centre of the *naos* collaborated in supporting the ridge beam, which was later replaced by a more complex system with two poles connected by a horizontal structure.

REFERENCES

Achenza, M., Sanna, U. (2008) (Eds.). *Il manuale tematico della terra cruda*. Roma, Italy: DEI.

Altomare, L. (2023). Tecniche costruttive in muratura tra Crotoniatide e Metapontino. L'edilizia domestica del VII e VI sec. a.C. *Thiasos, 12*, 79-96.

Apostolos, M., Arakadaki, M., Kotsopoulos, S., Sinamidis, I., Mikrou, T., Frangedaki, E., & Lagaros, N.D. (2020). Earthen Architecture in Greece: Traditional Techniques and Revaluation. *Heritage*, *3 (4)*, 1237-1268. https://doi.org/10.3390/heritage3040068

Aricò, M., Lo Brutto, M., & Maltese, A. (2023). A Scan-to BIM approach for the management of two Arab-Norman Churches in Palermo (Italy). *Heritage, 6,* 1622-1644. https://doi.org/10.3390/heritage6020087

Brocato, P., Altomare, L., Capparelli, C., Perri, M. (2019). Scavi nell'abitato del Timpone della Motta di Francavilla Marittima (CS): risultati preliminari della campagna 2018. *FOLD&R Italy*, *452*, 1-23.

Brocato, P., Altomare, L., Canonaco, M., Capparelli, C., Carroccio, B., Ferraro, G., Lucarelli, G., Perri, M., & Zappani A.A. (2021). Francavilla Marittima (CS): indagini archeologiche nell'abitato del Timpone della Motta (2017-2019), *Thiasos, 10.1*, 287-319.

Brocato, P. (2022a). Residenze per l'élite enotria o templi greci nell'insediamento del Timpone della Motta (VIII-VII sec. a.C.) a Francavilla Marittima? *Thiasos, 11*, 255-277.

Brocato, P. (2022b). Un tempio arcaico per Athena sul Timpone della Motta a Francavilla Marittima (Cs, Italia): alcune osservazioni sui vecchi scavi di M.W. Stoop nella zona sud ovest dell'acropoli. *FOLD&R Italy*, *544*, 1-21.

Brocato, P. (2024). Tra vecchi e nuovi scavi nell'insediamento del Timpone della Motta (Francavilla Marittima, CS-IT). *BABesch*, *99*, 103-117.

Cavalcanti, O., & Chimirri, R. (1999). *Di Fango, Di Paglia… Architettura in terra cruda in Calabria*. Soveria Mannelli, Italy: Rubbettino.

De Lachnal, L. (2007). Francavilla Marittima. Per una storia degli studi. In F. Van Der Wielen-Van Ommeren F. & L. De Lachenal (Eds.), *La dea di Sibari e il santuario ritrovato. Studi sui rinvenimenti dal Timpone Motta di Francavilla Marittima* (pp. 15-81). Roma, Italy: Istituto Poligrafico e Zecca dello Stato.

Demetrescu, E, & Fanini, B. (2017). A white-box framework to oversee archaeological virtual reconstructions in space and time: Methods and tools. *Journal of Archaeological Science: Reports, 14*, 500-514. https://doi.org/10.1016/j.jasrep.2017.06.034

Demetrescu, E., & Ferdani, D. (2021). From field archaeology to virtual reconstruction: A five steps method using the Extended Matrix. *Applied Sciences*, *11*(11), *5206*, 1-23. https://doi.org/10.3390/app11115206

Gaiani, M. (2021). From manual data entry to IOT-based design archaeological andarchiteectural heritage information systems. In S. Garagnani, A. Gaucci, P. Moscati & M. Gaiani, *ArchaeoBIM: Theory, Processes and Digital Methodologies for the Lost Heritage* (pp. 33-66). Bologna, Italy: Bononia University Press.

Garagnani, S. (2021). The role of BIM in (virtual) archaeology. In S. Garagnani, A. Gaucci, P. Moscati & M. Gaiani, *ArchaeoBIM: Theory, Processes and Digital Methodologies for the Lost Heritage* (pp. 123-154). Bologna, Italy: Bononia University Press.

Gaucci, A. (2021). ArchaeoBIM. In S. Garagnani, A. Gaucci, P. Moscati & M. Gaiani, *ArchaeoBIM*: *Theory, Processes and Digital Methodologies for the Lost Heritage* (pp. 67-122). Bologna, Italy: Bononia University Press.

Germanà, M.L. (2011). Earth in ancient Sicilian architecture. In S. Mecca, S. Briccoli Bati, M.C. Forlani & M.L. Germanà (Eds.), *Earth/Lands. Earthen Architectures in Southern Italy/Architetture in terra nell'Italia del Sud* (pp. 167-188). Pisa, Italy: ETS.

Guzzo, P.G. (1974). I risultati degli scavi. In *Atti e Memorie della Società Magna Grecia, n. s. XIII-XIV (1972-1973)* (pp. 35-45). Roma, Italy: Società Magna Grecia.

Hodge, A.T. (1960). *The Woodwork of Greek Roofs*. Cambridge University Press.

Kleibrink, M., & Sangineto, M. (1998). Enotri a Timpone Motta (I). La ceramica geometrica dallo strato di cenere e materiale relativo dell'edificio V, Francavilla Marittima. *BABesch*, *73*, 1-60.

Kleibrink, M. (2010). *Parco Archeologico "Lagaria" a Francavilla Marittima presso Sibari*. Guida. Rossano, Italy: Grafosud.

Kleibrink, M. (2011). Schizzo biografico sull'archeologa Olandese Maria Wilhelmina Stoop e le sue relazioni di scavo a Timpone della Motta 1963-'65. In *IX giornata archeologica francavillese* (pp. 7-33). Francavilla Marittima-Castrovillari, Italy: Tipografia dìArte Patitucci.

Kleibrink, M., & Pace, R. (2018). Materiali e Culti sul Timpone della Motta a Francavilla Marittima. In C. Malacrino, M. Paoletti & D. Costanzo (Eds.), *Tanino De Santis. Una vita per la Magna Grecia* (pp. 121-130). Reggio Calabria, Italy: MArRC-Kore.

Lippolis, E., Livadiotti, M., & Rocco, G. (2007). *Architettura greca. Storia e monumenti del mondo della polis dalle origini al V secolo*. Milano, Italy: Bruno Mondadori.

London Charter (2009). *London Charter for the Computer-based Visualization of Cultural Heritage, Draft 2.1-2009*. Retrieved from www.londoncharter.org.

Maaskant-Kleibrink, M. (1993). Religious activities on the 'Timpone della Motta', Francavilla Marittima– and the identification of Lagaria. *BABesch, 68*, 1-47.

Maaskant-Kleibrink, M. (2003). *Dalla lana all'acqua. Culto e identità nell'Athenaion di Lagaria, Francavilla Marittima*. Rossano, Italy: Grafosud.

Mancuso, G. (2023). ArchaeoBIM ed Extended Matrix. Analisi e potenzialità di due processi per l'elaborazione di modelli informative. *Archeologia e calcolatori*, *34.2*, 123-142.
doi 10.19282/ ac.34.2.2023.07

Marzullo, M. (2017). *Spazi sepolti e dimensioni dipinte nelle tombe etrusche di Tarquinia*. Milano, Italy: Ledizioni.

Mertens, D., & Schläger, H. (1983). Francavilla Marittima - Acropoli sulla Motta - Die Bauten auf der Motta. In *Atti e Memorie della Società Magna Grecia, n. s. XXI-XXIII (1980-1982)* (pp. 143-171). Roma, Italy: Società Magna Grecia.

Mertens, D. (2006). *Città e monumenti dei Greci d'Occidente. Dalla colonizzazione alla crisi di fine V secolo a.C.* Roma, Italy: L'Erma di Bretschneider.

Naso, A. (1996). *Architetture dipinte. Decorazioni parietali non figurate nelle tombe a camera dell'Etruria meridionale (VII-V sec. a.C.)*. Roma, Italy: L'Erma di Bretschneider.

Naso, A. (1999). Nuovi dati sulla necropoli etrusca di Grotte del Mereo (Capodimonte). *Studi Etruschi*, 63, 75-122.

Paoletti, M. (2018). "Kleom(b)rotos, figlio di Dexilaos, (mi) dedicò". L'offerta di un atleta vincitore ad Olimpia nel santuario di Francavilla Marittima. *Analecta Romana Insituti Danici*, *XLIII*, 7-24.

Pepe, M., Costantino, D., Alfio, V.S., Garofalo Restuccia, A., & Papalino, N.M. (2021). Scan to BIM for the digital management and representation in 3D GIS environment of cultural heritage site. *J. Cult. Herit*, *50*, 115-125. https://doi.org/10.1016/j.culher.2021.05.006

Pierattini, A. (2017). Origini dell'architettura lapidea in Grecia, 700-650 a.C. In *Quaderni dell'Istituto di Storia dell'Architettura*, *67*, 5-18.

Roncalli, F. (1990). La definizione pittorica dello spazio tombale nella «età della crisi». In *Crise et transformation des sociétés archaïques de l'Italie antique au Ve siècle av. JC. Actes de la table ronde de Rome (19-21 novembre 1987)* (pp. 229-243). Rome, Italy: École Française de Rome.

Ruggeri, N. (2018). Columen, cantherii, transtra et capreoli: intorno alla genesi delle incavallature lignee. *Restauro Archeologico*, *26 (2)*, 30-51. https://doi.org/10.13128/RA-23413

Ruggeri, N. (2022). Evoluzione della carpenteria lignea dei tetti in Grecia tra età arcaica e classica. Alla ricerca di tracce di incavallature. *Restauro Archeologico*, *30 (1)*, 54-73. https://doi.org/10.36253/rar-12989

Seville Charter (2012). *International Principles of Virtual Archaeology*. Retrieved from http://sevilleprinciples.com/.

Stoop, M.W (1977). Francavilla Marittima - B) Acropoli sulla Motta - IV. Un recinto e un gruppo di anfore. In *Atti e Memorie della Società Magna Grecia. Nuova Serie XV-XVII (1974-1976)* (pp. 156-167). Roma, Italy: Società Magna Grecia.

Stoop, M.W. (1979). Note sugli scavi del santuario di Atena sul Timpone della Motta (Francavilla Marittima, Calabria), 1-2. *BABesch*, *54*, 77-90.

Stoop, M.W. (1983). Note sugli scavi del santuario di Atena sul Timpone della Motta (Francavilla Marittima, Calabria), 4. *BABesch*, *58*, 16-52.

Vitale, V. (2013). La tradizione delle tecniche edilizie in terra cruda in Basilicata: dalle evidenze archeologiche alle tipologie moderne. I casi di studio di Chiaromonte e Senise (PZ). In *Studi e ricerche della Scuola di Specializzazione in Beni Archeologici di Matera (SIRIS) 13* (pp. 71-87). Bari, Italy: Edipuglia.

Vitruvio (1993). *De architectura* (trad. L. Migotto). Pordenone, Italy: Edizioni Studio Tesi.

Zancani Montuoro, P. (1977). Francavilla Marittima-premessa. In *Atti e Memorie della Società Magna Grecia, n. s. XV-XVII (1974-1976)* (pp. 7-8). Roma, Italy: Società Magna Grecia.

Zancani Montuoro, P. (1983). B) Acropoli sulla Motta. In *Atti e Memorie della Società Magna Grecia, n. s. XXI-XXIII (1980-1982)* (p. 142). Roma, Italy: Società Magna Grecia.