

A STATUE OF ATHENA IN THE SANCTUARY OF APOLLO IN HIERAPOLIS (PHRYGIA): FROM THE FRAGMENTS TO THE 3D RECONSTRUCTION

1. INTRODUCTION

This article provides a preliminary presentation of a project centred on the sculptures from the main sacred area of Hierapolis in Phrygia, one of the larger settlements of Asia Minor. The excavations performed by the Italian Mission, which has been working at the site since 1957, brought to light hundreds of fragments, many of which were recovered from the levels corresponding to the abandonment and destruction of the site in the Byzantine era. These provide a database of great evidential value for the reconstruction of the statuary and the symbolic meanings that were expressed in it. For the management of this complex mass of information, a dedicated application was created, designed to support all the phases of the research. Of considerable importance is the use of three-dimensional reconstruction techniques, now applied in a growing number of fields including ancient sculpture. In the case in question, the adoption of these technologies proved to be particularly effective, since it has made it possible to compensate for the highly fragmentary nature of the materials, as illustrated in § 3-5.

2. THE SANCTUARY OF APOLLO AND THE CONTEXT OF DISCOVERY OF THE STATUE OF ATHENA

The sanctuary dedicated to the main divinity of Hierapolis occupies a large space in the monumental heart of the city (Fig. 1). The research conducted in the last twenty years has made it possible to reconstruct its organisation and phases (summary in SEMERARO 2014, 2016b), expanding and updating the limited evidence available before 2000, which resulted from the excavations conducted in the 1960s (CARETTONI 1965; ISMAELLI 2017 for the excavation data conserved in the Caretoni-Fabbrini private archive).

The area began to be used for cultic purposes as early as the Hellenistic period, coinciding with the foundation of the Greek colony of Hierapolis (towards the middle of the 3rd century BC; RITTI 2017, 274-277). However, it is clear that the monumentalisation took place in the Julio-Claudian period, to which Temple B, dedicated to the cult of Apollo, is also dated (SACCHI, BONZANO 2012).

Most of the materials pertaining to the sculptural and architectural decoration of the Roman-era sanctuary are from the levels corresponding to

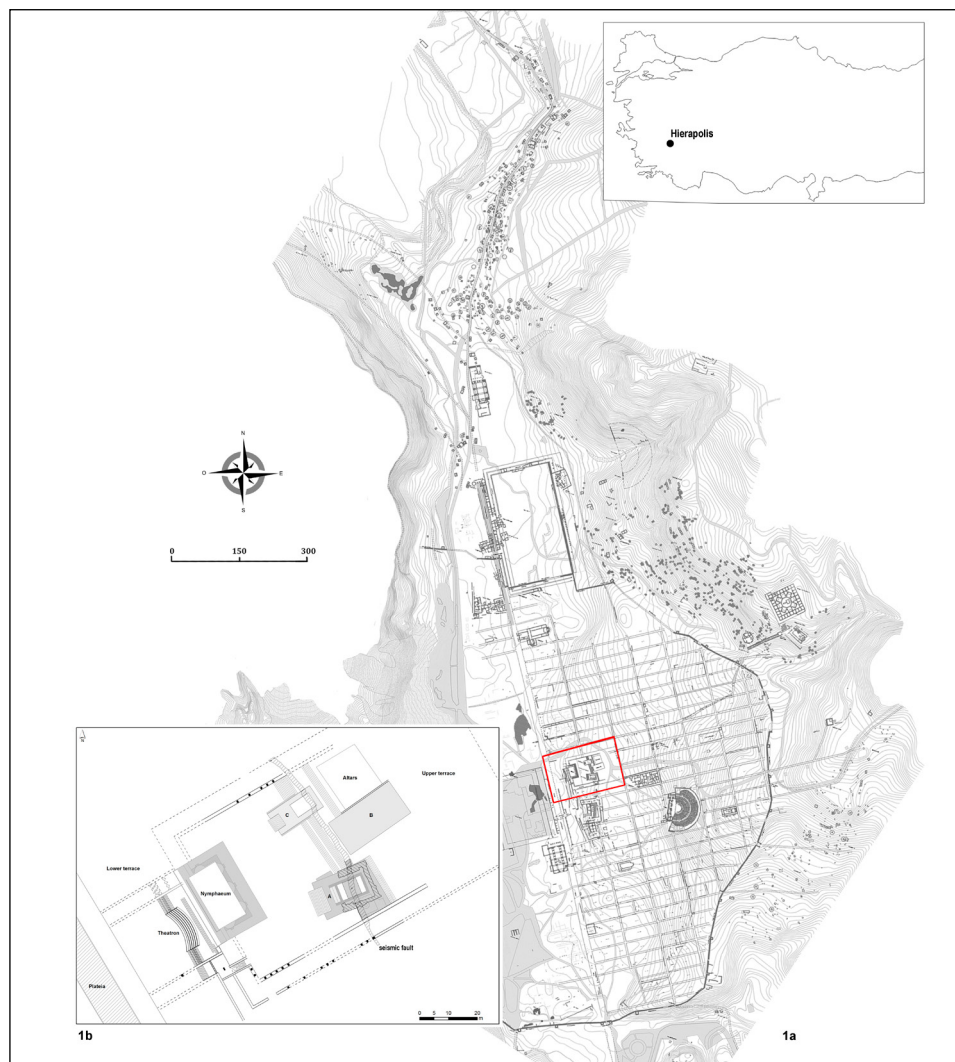


Fig. 1 – General plan of Hierapolis in Phrygia (a) showing the location and site plan (b) of the sanctuary of Apollo.

the destruction and abandonment of the sacred area, a process that began in the 4th century AD, when the sanctuary was progressively dismantled and transformed into a dumping ground (SEMERARO 2007).

The exploration of these levels made it possible to recover many elements useful for reconstructing the general layout of the sacred area

in the various phases. The most extensively portion investigated to date corresponds to the median terrace, where three temple buildings stand (A, B and C) (Fig. 1b). The building most badly damaged by the removal of material in the Proto-Byzantine period is definitely Temple B, dedicated to the cult of the main divinity. The stratigraphic excavation made it possible to document a radical act of destruction that entailed the removal not only of the marble decoration, but also of a part of the travertine foundations. Indeed, part of the floor plan of the temple can be reconstructed only thanks to the ghost-walls (SEMERARO 2007, 2016a). Some of the architectural elements that enable the reconstruction of the walls are conserved because they were reused in the hall of the Great Baths, built in the 4th century AD (SACCHI, BONZANO 2012), and some because they were placed in the deposits of marble blocks created behind buildings A and C in the Proto-Byzantine period with a view to using them as a source of building materials (SEMERARO 2007).

Most of the statues recovered in the excavations of the 1960s came from the deposit behind building A (BEJOR 1991). In contrast, the sculptural fragments identified by the excavations conducted from 2001 onwards come from the levels containing dumped materials (such as the head of an *euergetes* in PELLINO 2012b) or had been reused to build structures in the Byzantine period (such as the fragments of a statue of Eros in PELLINO 2012a and those of the statue in SEMERARO 2021, 219, 223, figs. 16-10).

The context of discovery of the fragments of the statue of Athena discussed in this article is quite different. Indeed, they are from an extensive level dated to the Proto-Byzantine period, identified in front of Temple C and Temple B (Figs. 2-3), rich in marble fragments arising from the systematic destruction of architectural and sculptural elements, so small as to make identification of the objects to which they belonged extremely difficult. The layer covered the levels of the removal of the pavement in front of Temple C and the flight of steps in front of Temple B and was in turn covered by successive layers of dumped materials that accumulated in the course of the Proto- and Middle Byzantine periods. Given its composition, it can be ascribed to the destruction *in situ* of objects belonging to the sculptural decoration of the sanctuary. It can be concluded that the statue of Athena discussed in this note was probably originally positioned near the place where the fragments were discovered, perhaps in the space between the two Temples C and B.

As already noted (SEMERARO 2007), these data point to systematic destruction, which it is difficult to explain without reference to ideological motives. The dismantling of the sanctuary, and the temple dedicated to Apollo in particular, is dated to the period that saw the rise of the new Christian religion, which in Hierapolis was centred on the cult of the apostle Philip,



Fig. 2 – Hierapolis in Phrygia. View of the sanctuary of Apollo showing the location of the stratigraphic units in which the fragments of the statue of Athena were discovered.



Fig. 3 – Hierapolis in Phrygia. Sanctuary of Apollo: fragment of the aegis of the statue of Athena at the moment of discovery in a layer of accumulated marble fragments and architectural elements.

now documented in extraordinary fashion by the discovery of the saint's tomb (D'ANDRIA 2017a, 2017b).

The fate of the temple of the main pagan divinity, along with the statues of the divinities with whom the *temenos* was shared, may thus be attributed to the spiritual climate that accompanied the birth of the new centre of Christianity. The statues are cited in the epigraphical attestations (collected in RIA 2022), while very little remains of the archaeological layers, as shown by the case of the fragments of the statue of Athena.

G.S.

3. THE SCULPTURES OF THE SANCTUARY OF APOLLO: THE RESEARCH PROJECT

Launched in 2017, the project for a scientific edition of the sculptures of the sanctuary of Apollo is divided into a number of phases coordinated by the present author (SEMERARO 2021, 223-224). The first phase of activity, undertaken in 2017-2019 with further work being conducted in 2021, took place in Pamukkale, at the headquarters of the MAIER, and entailed the systematic census and cataloguing of the sculptures discovered during the archaeological research of the 2000's. The next step of the project, dedicated to the study of the recorded evidence and a review of the already published materials (BEJOR 1991, 49-61; PELLINO 2012a, 2012b; GALLI 2017), concluded with the creation of the *corpus* of the sanctuary's statues and reliefs. Today therefore, we have a complete catalogue of the sculptures of the sacred area. Integrated with the information provided by the inscribed bases from the monumental context (NOCITA 2017; RITTI 2017, 355-409), it constitutes a body of data useful for reflecting on the function of statuary types and iconographic themes inside the sanctuary and for formulating hypotheses on the meaning of the figurative programme. Furthermore, an overview of the evidence highlights key elements for understanding both the role played by local *energetai* and civic authorities in selecting the works of art that made up the sacred decoration, and the messages directed to the users of the sacred area, which served as imperial propaganda.

Lastly, considering the important results obtained by studies of the settlements of Asia Minor, where the study of the monumental complexes – especially the emblematic case of the Sebasteion of Aphrodisias (SMITH 2013) – entails systematic comparison of sculptural and epigraphical data with those of the buildings, it seemed appropriate to adopt this type of approach in the case of Hierapolis as well. Indeed, the project's final and more ambitious objective is to produce hypotheses regarding the arrangement of the sculptural furnishings in the space that hosted the temples. This means reconstructing the image that the sanctuary of Apollo is believed to have presented to visitors in Imperial epoch, when the sacred place played a central role in the life of Hierapolis due

as much to its key position in the urban layout as to the worship of the main polyadic divinity (D'ANDRIA 2001, 2013; SEMERARO 2008, 2016a).

As part of the project on the sanctuary of Apollo, the recorded sculptures were catalogued by means of a bibliographical review and research conducted both in the storage facilities of the MAIER and at the Archaeological Museum of Denizli-Hierapolis. This task was performed by Vincenzo Ria, who also set up a database of the DBMS type (Database Management System) using Microsoft Access. Compatible with the GIS platforms of the Italian Archaeological Mission, it holds data on statues, reliefs and inscribed and non-inscribed bases (RIA 2022). Today, the database holds records on 290 finds – 185 sculptures and 105 fragments of bases, 31 of which are inscribed, datable to the period from the late Republican age to the 3rd century AD – accompanied in many cases by the relevant virtual model (RIA 2022; *infra*, § 5). Three-dimensional models, specifically of the sculptures of the sanctuary of Apollo, constitute important work tools that facilitate the search for parallels, enabling the stylistic classification of pieces and the formulation of reconstructive hypotheses concerning statues and reliefs of which rarely more than a fragment is conserved.

The *corpus* of the sculptures from the sanctuary of Apollo is indeed mainly made up of portions of works of art, often of small dimensions, reduced to fragments in the Proto-Byzantine phase and discovered in secondary deposits in various points of the sacred area, either in dumps near the temples or reused in later constructions (SEMERARO 2007; 2021, 223-224; *supra*, § 2). These works of art include reliefs with figures whose dimensions are nearly always smaller than life (male figures in heroic nudity and clothed females; erotes), as well as iconic and ideal statues that in some cases are larger than life (RIA 2022). Indeed, the sanctuary's iconic statuary, attested by the sculptural and epigraphical evidence, is highly complex.

The images of eminent local personages, *euergetai* (PELLINO 2012b) and magistrates are accompanied by images of members of the imperial family, whose cult was probably practised in the sanctuary, as suggested by the inscription on the plinth of the female *capite velato* statue dedicated by the lady benefactor Apphias to the Dei Augusti and the *demos* (BEJOR 1991, 54-55, no. 25; GALLI 2017, 514-517). While sculptures of Trajan, Sabina, Julia Maesa and Julia Mamaea are attested by fragments of inscribed bases (RIA 2022), an exceptional piece of evidence is the colossal statue, only partly conserved, of Hadrian shown with the breastplate, next to a defeated barbarian, in a pose that clearly alludes to the theme of victory (GALLI 2017, 517-522). Just as rich is the range of ideal statues, represented in works, some in small format, that in some cases reproduce famous masterpieces of the classical world, such as the Eros of Thespieae by Lysippos (PELLINO 2012a). The images of divinities include the statue of Athena, discovered



Fig. 4 – Hierapolis in Phrygia. Statue of Athena. Left shoulder covered by the aegis.

in a fragmentary state, the 3D reconstruction of which is presented for the first time in this paper.

4. THE STATUE OF ATHENA: DESCRIPTION AND ANALYSIS

Of the statue of Athena, made of crystal white marble, 65 fragments belonging to the helmet, hair, thorax and shoulders (covered by the aegis), both arms and the long garment are conserved (Figs. 4-6). The fragments vary greatly in terms of shape and size. The height ranges from 3 cm to 27.5 cm, with most of the finds between 7 and 20 cm. Just as varied is the state of conservation of the materials, whose surfaces are frequently affected by calcareous incrustations. The largest piece (27.5×21 cm) is composed of two joining fragments and corresponds to the left shoulder and the upper part of the goddess' humerus and back (Fig. 4). Her shoulder is covered by the aegis which hangs stiffly down the back. The arm, which is lowered and touches the side of the body, is covered by the light cloth of the chiton, which forms arched and parallel folds.

The surface of the aegis is covered by ovoid scales, each with a raised rib in the centre. The scales, in slight relief on the goddess' shoulder but flat on the back, are separate from each other and are arranged in an orderly pattern, with the point facing downwards, in staggered horizontal rows. This arrangement of the scales is seen on various fragments which have flat surfaces and thus belong to the rear part of the aegis (Fig. 5, below). In some cases, these fragments also conserve the lower edge of the aegis, underneath which the folds of the drapery can be distinguished. The fragments of the front of the aegis have different characteristics (Fig. 5, centre). Indeed, they have a



Fig. 5 – Hierapolis in Phrygia. Statue of Athena. Fragments of helmet and hair (above); front of the aegis and raised right arm (centre); rear of the aegis (below).



Fig. 6 – Hierapolis in Phrygia. Statue of Athena. Fragments of peplos: upper part of the drapery (above); lower part of the drapery (below).

curved surface, accentuated on the goddess' bust, with the scales rendered in a more plastic way, as well as varying in size and orientation, being arranged in irregular rows and overlapping in a disorderly way.

In contrast to the statue's lowered left arm, the right arm is raised to the level of the shoulder, as documented by a fragment showing the lateral part of the aegis and the humerus covered by the chiton (Fig. 5, centre). Numerous portions of the peplos worn over the chiton also remain. They conserve the drapery of the upper part, the folds of the *apoptygma* and the garment that covered the goddess' legs (Fig. 6). Lastly, recognisable in two fragments are Athena's helmet and hair (Fig. 5, above). Although we only have fragments of the Athena of Hierapolis, the surviving evidence enables us to establish the historic and artistic framework of the statue (on Athena and her images: DEMARGNE 1984; DEACY, VILLING 2001; VILLING 2009).

The Athena of Hierapolis, of larger-than-life dimensions (a height of 2.10-2.20 m has been calculated, see *infra*, § 5), was carved so as to be viewed from all directions, as shown by the precision and detail of the individual fragments, including those belonging to the back of the statue. In order to reconstruct the volume, proportions and stance of the body, significant clues are provided by comparison with the colossal statue of Athena in Pentelic marble discovered in 1880 in the sanctuary of the goddess in Pergamon, which was subsequently taken to Berlin (AvP VII 24; DEMARGNE 1984, 978, no. 230, 1041; DAVISON 2009, 187-189, no. 36; NIEMEIER 2016). A Hellenistic adaptation (*Umbildung*) of the chryselephantine Athena Parthenos created by Pheidias for the Acropolis of Athens, the Athena of Pergamon (3.10 m high without the base) is even more imposing than the Athena of Hierapolis.

However, while the two statues differ in terms of size, other elements point to a strong resemblance. These include the aegis, the invincible defence weapon that was one of the attributes of Athena, whose appearance in iconographic sources varies although it is always represented fringed with snakes and bearing the Gorgoneion (VIERCK 1997; ROBERTSON 2001).

Of the Gorgoneion and snakes that are believed to have featured on the aegis of the sculpture of Hierapolis no trace remains. They are seen on the aegis of Pergamon, which is legible despite gaps affecting the edges and the back, modelled and smooth.

The fragmentary state of the aegides of Hierapolis and Pergamon does not obscure their typological similarities. On both statues, the aegis is broad and is worn in such a way as to cover the shoulders and bust, following the curve of the breasts on the front and covering part of the back, where it takes the form of a rigid quadrangular cloak. This similarity between the two sculptures stands out even more now, thanks to the integrative restoration of the Berlin statue carried out in 2015 (MASSMANN, WILL, WEGEL 2018, 172-174).

The restoration reveals that in the Hierapolis and Pergamon statues, taking account of the different proportions, the breadth of the shoulders and the movement and edge of the aegis are the same.

This is important because it demonstrates that the goddess of Hierapolis wears the type of aegis attested in those adaptations, such as the Athena of Pergamon, which are believed to be very close to Pheidias' original Athena Parthenos (DEMARGNE 1984, 977, nos. 220-221; KARANASTASSIS 1987, 408-411, cat. BI 12-13; VIERCK 1997, 511-512, type VIIa; DAVISON 2009, 170-172, 197-198, cat. 6.6, 6.7, 6.47, 6.48). The situation regarding the scales of the aegis is different however, since in terms of shape, size and the characteristics of the relief, the various reproductions of Pheidias' Parthenos differ from each other (DAVISON 2009, 81-83). The scales of the aegis of Hierapolis, viewed from the front, appear more plastic and are arranged more freely than those of the Pergamon Athena. The similarity of the Athena of Hierapolis to that of Pergamon is also seen in the rendering of the drapery. The two sculptures are both characterised by the long, straight vertical folds of the peplos. Separated by deep grooves, they run parallel to each other down the supporting right leg, creating light-and-dark effects (Fig. 6, below). The comparison can be extended to other parts of the garment.

Unlike the other statues inspired by Pheidias' Parthenos, which have bare arms and the upper arms lowered, in the Athena of Hierapolis the upper arms are covered by a chiton and the goddess is depicted with the left arm lowered and the right arm raised to the height of the shoulder. Thus, when conceiving the statue, the sculptor of the Athena of Hierapolis was inspired not only by Pheidias' Parthenos, but also by some other model. In terms of iconography, a statue of Athena discovered at Side (Asia Minor), sculpted at the beginning of the 3rd century AD, following a Hellenistic model, provides elements of comparison (İNAN 1975, 142-145). The Athena of Side and that of Hierapolis share the position of the legs and the movement of the drapery, which is arranged in long folds on the supporting right leg. In addition, beneath the peplos, they both wear a sleeved chiton, visible in both cases on the lowered left arm. In the Side statue, as shown by a fragment of the hand, the left arm held a round shield; the right arm, which is not conserved, was raised and bent at the elbow in the act of holding the lance, traces of which remain on the base of the statue (CAPALDI 2009, 33). It might thus be hypothesised that the Athena of Hierapolis held the shield in her lowered left arm and the lance in the raised right arm (the Athena of Pergamon but, as shown by the hole in the base of the statue, held the lance in her left arm: NIEMEIER 2016).

This combination of different models suggests that the Hierapolis statue was carved by a sculptor of the 'School of Aphrodisias', exponents of which were famous throughout the Roman world because they were able to

reinterpret and fuse together different prototypes in the same work, producing works that were always original (SMITH 2013; VAN VOORHIS 2018). The presence in Hierapolis of sculptures by artists from Aphrodisias is documented from the early Imperial epoch (Tomba Bella: ROMEO, PANARITI, UNGARO 2014) until the late-ancient period (*clipeus* with the portrait of Socrates: D'ANDRIA, MANNINO 2007). For the statue of Athena in question, a dating to the Julio-Claudian period could be proposed. This is based on a comparison with certain reliefs among the rich series of sculptures that decorated the famous Sebasteion of Aphrodisias (SMITH 2011, 2013). The sculptures of this prestigious architectural complex, dedicated to the cult of the *Theoi Sebastoi*, celebrated, by means of myth and allegory, the members of the imperial family, considered – in a perspective of the prosperity and eternity of the Roman empire – to be an integral part of the world of the heroes of Greece and the gods of Olympus. Among these sculptures there is a relief, badly damaged, that documents the presence in the Aphrodisias sculptors' repertoire of the standing Athena wearing a peplos, with the same arrangement of the legs as the statue of Hierapolis, holding the lance in her raised right hand and the circular shield in her lowered left hand (SMITH 2011, cat. C13).

The meaning of the statue of Athena in the context of the sanctuary of Apollo in Hierapolis is not fully analysed here. It is important to stress that in the sanctuary of Apollo, the statue, positioned in the open air, plausibly between temples B and C (see *supra*, § 2), and displayed on a base that accentuated its size, making it visible from all angles, is believed to have played a similar role to the Athena of Pergamon. Displayed in the sanctuary of Athena, in the complex recognised as the Library founded by Eumenes II, the Athena of Pergamon had no shield, serpent or column with the Nike, as is clear from the base, which has only a hole for the lance: the statue thus lacked the distinctive attributes of the Parthenos created by Pheidias for Athens (NIEMEIER 2016, 132; KÄSTNER 2018, 89; NIEMEIER 2018, 145). This consideration has prompted scholars to question whether the colossal image of Athena, positioned in the Library next to sculptures of illustrious intellectuals, was truly a cult statue: from this perspective, the presence of the goddess in that precise context could rather be explained as an emblem of wisdom and erudition as well as the patron of the arts (KAROGLU 2016, 66; NIEMEIER 2016, 132).

The same function may be suggested for the Athena of Hierapolis in the sanctuary of Apollo, where it is also possible however that the goddess occupied a central position as the protector of the craftsmen who frequented the place of worship (their corporations are recorded in inscriptions discovered in the *hieron* and other contexts of the archaeological area: RITTI 2017, 148-156, 565-568).

K.M.

5. THE STATUE OF ATHENA: FROM THE DIGITAL MODEL OF THE FRAGMENTS TO THE VIRTUAL RECONSTRUCTION

The 3D model of the statue of Athena was created within the wider framework of the research into the sculptures of the sanctuary of Apollo in Hierapolis conducted by the present author as part of a thesis aimed at identifying elements useful for reconstructing the furnishings of the *hieron* (RIA 2022). In the systematic analysis of the sculptural finds of the sanctuary of Apollo, a considerable contribution was provided by digital technologies, which enabled the creation of virtual models of many of the fragments of statues and reliefs discovered in the *hieron*. Such models are useful for identifying parallels, but they will also ensure easy use of the finds kept in the MAIER's storage facilities in future. Indeed, one of the objectives of the thesis was to experiment with new forms of documentation and new ways of accessing the archaeological record that could be replicated in any context. This would help to resolve difficulties such as those that arose during the Covid-19 pandemic, when access to archaeological sites and materials being studied was severely limited.

In order to create the digital models of the fragments, the photogrammetric survey technique was applied (Fig. 7). This is a versatile tool used with increasing frequency because it makes it possible to create virtual models of various classes of materials directly *in situ*. In the photogrammetric survey, the input used for the creation of the 3D models consisted of the images taken with a digital camera. In this case the restitution of the object is obtained via the projection in the three-dimensional space of points and lines generated by calculating the intersection of the optical lines derived from each photograph. The latter technique is used for the construction of geometric scale models complete with textures (BIANCHINI 2008).

The principle at the heart of this process is the same as that of stereoscopic photogrammetry, in which a pair of digital images of the same object, taken from two or more different viewing points, is used to create a three-dimensional representation of it (PANELLA, GABRIELLI, GIORGI 2011, 247; LIMONCELLI 2012, 132). Photomodelling thus entails the acquisition of a series of photographic images with precise characteristics, including frames taken using a camera with a fixed focal length, and at least a 60% overlap between the various images. Fixed focal lengths are more stable and less issues are caused with calibration. A zoom camera can be used though, especially with wide angle setting and stable zoom setting. In this case the user must be careful not to change the zoom during the photo shoot or the accuracy will be affected. The photographs thus acquired are then oriented by suitable software applications, including Metashape and Zephyr, within a system of spatial coordinates that makes use of control points shared across images.

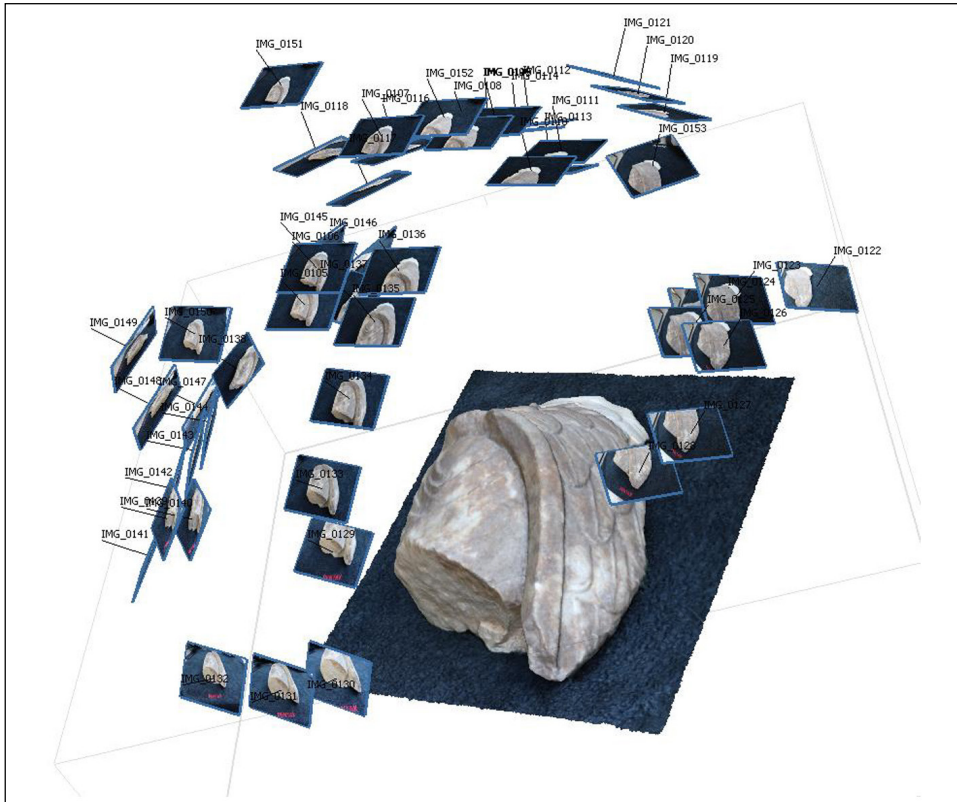


Fig. 7 – Statue of Athena from the sanctuary of Apollo (Hierapolis in Phrygia). Fragment of the shoulder with the aegis: digital model processed in Agisoft Metashape.

With the *in situ* surveying of archaeological buildings and stratigraphies, the acquired data can be extrapolated to a three-dimensional space with geographical coordinate by means of topographical survey tools such as total station or satellite-based radio navigation system like the GPS or the more accurated DGPS. In this case the result is a georeferenced metric virtual model on a scale of 1:1 (BIANCHINI 2008; LIMONCELLI 2012, 132). By means of photogrammetric survey it is possible to obtain two different types of output, configured as either a three-dimensional surface or a solid. The result in this case depends on the nature of the object and the way in which it was photographed. Specifically, while for reliefs, ceramic decoration and internal architectural features it is usually possible to achieve a three-dimensional representation of the surface, regarding all-round sculptures, external architectural features and mobile finds it is possible to perform a virtual survey of the entire solid



Fig. 8 – Statue of Athena from the sanctuary of Apollo (Hierapolis in Phrygia). Virtual positioning of the digitised fragments with reference to the 3D model of Athena Parthenos from Pergamon (<https://www.myminifactory.com/object/3d-print-pergamon-athena-208722>).

structure. The latter can be used to create physical reproductions of the object in question by means of 3D printing. Once the virtual model of the find or structure has been created, the use of suitable digital modelling software such as Blender and Cinema 4D makes it possible to act on various aspects of the 3D model, from the wireframe structure to the rendering of the textures. This in turn enables the generation of virtual reconstructive hypothesis, whose starting point is the digital model of the element in question.

In the specific case of the 160 selected sculptural fragments of the sanctuary of Apollo, this approach entailed taking a number of photographs *in situ* that were suited to the photogrammetric survey of each find and the subsequent conversion to a virtual model. The photographs were taken in the storage facilities of the MAIER and the Archaeological Museum of Denizli-Hierapolis using a Reflex Canon Eos 250D camera with an EF-S lens (18-55 mm). For each find for which a 3D model was required, 70-200 photographs were taken, depending on the size and complexity of the sculpture in question. The photographic sequences of each fragment, designed to cover the entire surface of the find, were then processed using Agisoft Metashape. For each sculptural find to be digitised, the photographs were aligned, the point cloud was generated and the polygonal meshes calculated.

Of the digitised finds, 65 – only 5 of which are contiguous – belong to the statue of Athena. In order to develop a hypothetical reconstruction of

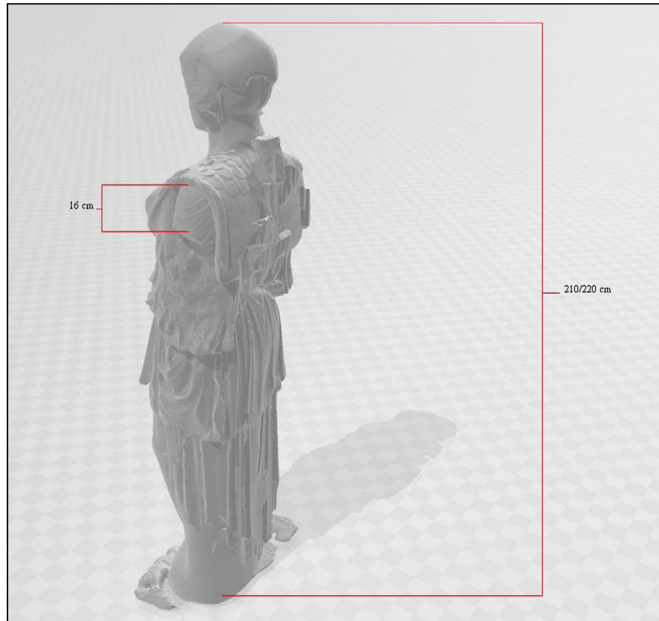


Fig. 9 – Statue of Athena from the sanctuary of Apollo (Hierapolis in Phrygia). Calculation of the statue's proportions on the basis of the digital positioning of the fragments.

the statue, the virtual models of the individual fragments were positioned with reference to the virtual model of Athena Parthenos from Pergamon (designed by J. Fisher and available on the digital model sharing platform <https://www.myminifactory.com/>), a sculpture identified as useful for reference and comparison on the basis of its stylistic features and the rendering of the aegis and the clothing. The positioning of the fragments, performed with the help of the open-source digital modelling application Blender, proved to be of fundamental importance. Indeed, the limited overall volume of the finds meant that by naked-eye observation alone they could only be generically attributed to the figure's aegis and clothing (four fragments belonged to the hair and the shoulders). In contrast, the use of digital technologies made it possible to precisely position 70% of the identified fragments (Fig. 8).

The work digitisation and virtual positioning of the fragments also made it possible to determine the sculpture's original height. Specifically, once the fragment of the left arm of the Athena from Hierapolis had been positioned with reference to the digital model of the statue from Pergamon, it was possible to compare the proportions of the surviving limb and the rest of the sculpture (Fig. 9).

It was thereby calculated that the statue of Athena from the sanctuary of Apollo was larger than life, with a total height of 2.10-2.20 m.

As well as the creation of virtual models of the fragments, the recourse to digital technologies as part of the research on the sculptures of the sanctuary of Apollo saw the start of experimentation with 3D printing as a means to physically reproduce the digitised finds. This entailed the use of both Fused Deposition Modelling (FDM), which has been deployed in museum contexts for some years now, and other innovative printing techniques including stereolithography. In both 3D printing systems, the various parts of the model are formed by means of the creation of a succession of layers, adhering one to the other, creating a solid stratification that constitutes the structure of the object. In more detail, FDM consists of depositing thermoplastic filaments, layer by layer, on the object as it is formed. Thermoplastic filaments such as PLA or ABS are extruded through a nozzle heated to between 220 and 250 °C and deposited in a semi-solid state on to the printing plane, where it tends to solidify in a few seconds (KAFLE *et al.* 2021, 2-4).

In contrast, 3D printing by means of stereolithography (SLA) is based on photopolymerisation, a technique that uses bands of short-wave light (UV < 400 nm) to solidify the layers of resin inside a tank containing the liquid polymer (MELCHELS, FEIJEN, GRIJPMA 2010, 6121-6130; KAFLE *et al.* 2021, 2-4).

The motif to be created is obtained using a laser beam controlled by the printer's firmware, which is projected on to the layer to be solidified, one after the other, thereby forming the three-dimensional model. In 3D printing of the SLA type, the thickness of the layer is determined by the quantity of energy emitted by the light source and the time of exposure of the resin to the ultraviolet source.

Despite the greater complexity of the printing and post-production phases, this 'additive manufacturing' technology has numerous advantages over FDM 3D printing techniques. For example, using SLA 3D printing, it is possible to obtain models with ten times the level of detail with respect to FDM, a difference that translates into a rendering of the surfaces that perfectly reflects the original model. In this case, the 3D printing of both the individual fragments and the proposed reconstruction of the sculptures such as the statue of Athena sought to evaluate new ways to support future heritage projects. These range from the non-invasive restoration of finds (by 3D printing the missing parts) to the creation *ex novo* of reconstructive hypotheses (by 3D printing the entire model), to be positioned *in situ*. The latter approach has already been successfully followed in the context of Hierapolis, as part of the restoration of the adjacent cultic complex of the Ploutonion. In this case, a hypothetical reconstruction of the colossal statue of Hades with Cerberus, discovered in the course of the excavations conducted in the area,

was created by carving marble blocks in the shape of the three-dimensional model generated from the laser scanning surveys of the discovered fragments (D'ANDRIA 2019).

A further innovative potential use involves the insertion of reproductions in 'phygital' displays in which the archaeological context or museum space is completed by digital media and interactive tactile installations.

V.R.

6. CONCLUSIONS

The case study discussed in the preceding paragraphs makes it possible to highlight the significant contribution of digital applications to the study project centred on the sculptures of the sanctuary of Apollo in Hierapolis. Indeed, digital technologies have played a fundamental role in the research since the start, facilitating the registration and management of the acquired data, with the aim of reconstructing the arrangement of the sculptural furnishings in the area of the temples. Of particular interest is the use of 3D modelling techniques to reconstruct the sculptures' original appearance despite their extremely fragmentary condition. The method applied, discussed in this paper with reference to the marble statue of Athena, discovered in a highly fragmentary state in the 2005 and 2006 excavation campaigns, complements the detailed historical, artistic and iconographic analysis, using digital reconstruction and restoration technologies to produce working hypotheses that get as close as possible to reality. It was thus possible to reconstruct an image of the goddess by means of comparison with the famous statue of Athena in the Library of Pergamon, making a considerable contribution to the reconstruction of the cultic landscape of the sanctuary of Apollo in Hierapolis. Indeed, by virtually placing the tiny fragments of marble in their exact position, it was possible to digitally reconstruct an image in the round of the statue, which is believed to have stood in the open-air outside the cult buildings. Starting from these observations, it will be possible to formulate more precise reflections on both the role of the statue of Athena inside the *temenos* and the symbolic relationships between the important cities of Hierapolis and Pergamon in Asia Minor.

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ABSTRACT

In 2005-2006 the excavations in the Sanctuary of Apollo conducted by the Italian Archaeological Mission in Hierapolis in Phrygia (MAIER) brought to light about sixty fragments of a larger-than-life marble statue of Athena. This paper presents the discovery, highlighting the role played in the research by digital technologies, especially 3D modelling and reconstruction techniques, the application of which mitigated the highly fragmentary nature of the evidence. The first section of the paper highlights the importance of the context of discovery of the fragments, which were found, together with other sculptural and architectural elements, in front of Temple B, in a deposit of discarded material related to the destruction *in situ* of part of the sanctuary's decorations in the Byzantine period. The second section describes the plan drawn up by the MAIER to publish a comprehensive scientific description of the sculptures of the Sanctuary of Apollo. The project aims to reconstruct the sculptural decoration of the sacred area in the Imperial period, combining information on the types of statuary and the iconographic subjects and themes with excavation data and the epigraphical documentation from the sacred area. The project includes the study of the statue of Athena, for which this paper provides the description and the results of the historic and artistic analyses. The final section is centered on the process that led from the creation of the digital model to the virtual reconstruction of the statue of Athena and, lastly, to the 3D printing of the reconstructive hypothesis. Digital models were created for many of the sculpture fragments of the Sanctuary of Apollo. Saved in a database designed to store data on the sculptures, these models facilitate the study of the documentation and have proved to be extremely useful for the dissemination of the finds to the public, especially in problematic situations that limit or impede access to the evidence, as was the case during the Covid-19 pandemic.