

THE ACCURACY REQUIREMENTS AND SOURCES FOR 3D RECONSTRUCTIONS OF THE PREHISTORIC ARCHAEOLOGICAL SITES: THE CASE OF AGIOS ANTONIOS CHOMATAS (CRETE)

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ABSTRACT:

The use of 3D sophisticated visualizations and reconstructions of any preserved architectural remains is becoming more frequent in the modern archaeology. However, it is still not common during the process of reconstruction or recreation of the appearance of any preserved architecture of prehistoric (Bronze Age) Crete. The bad condition of prehistoric sites (the bad preservation of the masonry) or structure is probably the main reason for this state. But let's look at this problem from the other point of view: what is really necessary for the creation of an ideal 3D reconstruction of such sites, which complies with the up-to-date state of the archaeological and architectural knowledge and uses the modern software? In accordance with our experience and findings we think that for the creation of really good and up-to-date 3D reconstruction only the plan of the site (at least the schematic one), enough of general and detailed photos of the site (but not necessary the photogrammetric model) and architectural features, some photos of the site's surroundings incl. the Google Earth image and some photos of similar sites and/or structures/architectural features (type of masonry, entrances etc.) are necessary. In case of accepting our findings and principles by the wider academic audience (especially by the archaeologists and architects) the creation of 3D reconstruction could be – as we hope – more commonly used or even become a standard of archaeological publications.

1. INTRODUCTION

1.1 Virtual reconstructions of archaeological sites

The use of 3D sophisticated visualizations and reconstructions of any preserved architectural remains is becoming more frequent in the modern archaeology. In this way, some ancient cities (e.g. Rome reborn - <http://www.romereborn.virginia.edu/>; Byzantium1200 - <http://www.byzantium1200.com/index.html>) or individual structures (e.g. various ancient structures in Greece, Italy, Asia Minor and North Africa - <http://www.klassische-archaeologie.uni-hd.de/forschung/3Dmodelle.html>) were reconstructed. In some archaeological specializations, for example in Minoan archaeology which is concerned with the studies of prehistoric Crete (especially from the end of the Neolithic till the end of the Bronze Age, i.e. approximately 2nd half of 4th millennium – ca 1100/1050 BC), the 3D models created by computers are still applied relatively rarely. The first example of such reconstructed Minoan structure, as far as the authors know, appeared on the website of the Institute for Classical Archaeology of Friedrich-Alexander Universität Erlangen-Nürnberg in June 1998 (http://www.aeria.phil.uni-erlangen.de/ausstellung_html/lectures_html/archanes/archanes_1.html).

Referring to the development of more and more sophisticated software for architects and for general 3D modelling of any objects, the quality of few recent years 3D models has certainly

been increased. For example in the years of 2009-13 a team managed by K. Glowacki (see e.g. Glowacki – Dafedar 2010) created a virtual reconstruction of the settlement of Kavousi Vronda in Eastern Crete from the end of the Bronze/Minoan Age (ca 1200-1100 B. C.). It is dealt with the first example of computer 3D reconstruction of the whole settlement. In the course of years the series of virtual flyovers of the site (at the same time it is the first example of such initiative), have been placed on the server of Youtube.com (search for “Vronda”). Probably the most elaborated 3D reconstruction was presented by C. Papadopoulos (and G. Earl) in 2009-10 (see e.g. Papadopoulos – Earl 2009; Papadopoulos 2010). These series of visualizations of an important Minoan cemetery of Phourni (3rd and 2nd millennium BC) focus on two burial structures – sc. Tholos C and Burial Building 19 – and possess also interior views, even with very interesting details such as illumination simulation. In 2012, G. Vavouranakis published on the website of “Aegeus-Society for Aegean Prehistory” 3D reconstructions of three sites in Eastern Crete – Gournia-North Cemetery, cemetery on a little islet near the village of Mochlos (both dated to 3rd millennium BC) and the peak sanctuary of Petsofas (2nd millennium BC). Final reconstructions (in more versions) were set in the photographs of the sites in order to achieve the highest possible level of reality (Vavouranakis 2012). All the 3D reconstructions of Minoan sites mentioned hitherto have admittedly been the results of all the available sources exhaustive analysis, but they have often been realized without more considerable involvement of architects.

The bad condition of the sites (the bad preservation of the masonry) or individual structures is probably the main reason for the low number of ideal 3D reconstructions of Cretan prehistoric sites or structures. The creation of such reconstruction is then very difficult and one has to rely during the reconstruction process on the testimony of the iconographic (representation of the architecture from the area and period in question), archaeological (the similar sites or structures), ethnographical (in case of the preservation of any architectural traditions) and literary sources (if there are any preserved).

This state and our previous experience with the creation of the ideal 3D reconstructions (Alusik et al. 2011; Alusik – Sosnova 2014; Sovarova – Alusik 2013) made the authors (an archaeologist – T.A. – and an architect – D.S.) to look at this problem from the other point of view: what is really necessary for the creation of an ideal 3D reconstruction of such sites, which complies with the up-to-date state of the archaeological and architectural knowledge and uses the modern software? The case study for the discussion of our findings will be the creation of the 3D reconstruction of a small rural Middle to Late Minoan/Bronze Age (2nd mill. BC) site of Agios Antonios Chomatas Site 9 (Haggis 2005, 101-102, fig. 34A), consisting of a single structure and an enclosure wall and located near the village of Kavousi on the north coast of East Crete (Fig. 1-3). Original presumptions for creating the 3D ideal reconstruction of any site or an individual construction is, however, such a preservation of a ground plan that enables – after a relevant hypothetical completion with maximally few unpreserved places – understanding of the basic architectural layout and, at the same time, perfect knowledge of the site based on a personal visit.

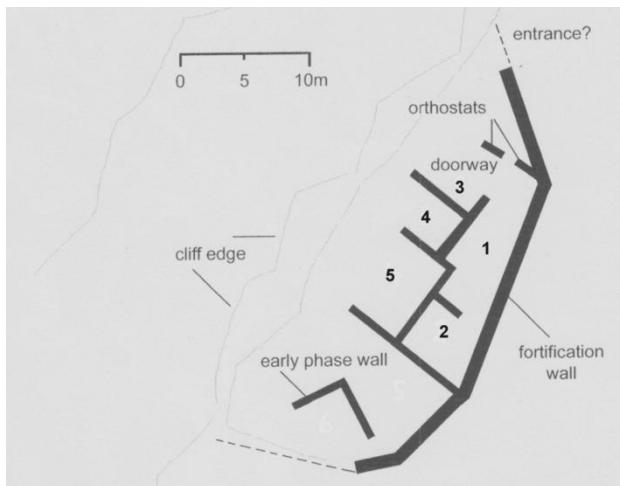


Figure 1. Agios Antonios Chomatas Site 9 groundplan

1.2 Agios Antonios Chomatas Site 9

The site (Fig.) has been discovered within Kavousi-Thrifti Survey project and has not been excavated until the present (Haggis 2005, 101-102, fig. 34A). It is located on northern coast of Eastern Crete, to the north of Kavousi village, on a plateau of the mountain massif of Chomatas, which rises up directly on the coast of Mirabello bay. Its western side is formed by cliffs, eastern side by steep slope which is formed into terraces in its higher parts. Remains of a big building of a rural character have

been preserved on one of the plateaus in the size of approximately 30 x 20 m southwards and slightly below the mountain peak (the site altitude is 213.3 m). It was enclosed by a wall along the northern, eastern and southern edges of the plateau. Unfortunately, the basement and walls of the building have been preserved to the height of maximum few dozens of centimetres and were built from rough or only partially worked massive blocks of grey limestone with the length of up to 1 m in the technique of the sc. Cyclopean or oncolithic masonry. The entrance to the walled premises of the site was probably placed in the north; the entrance into the building itself is bordered with two vertical stone blocks (orthostats). The building itself (see Fig.) consists of five main rooms and a short part of a wall to the south of it which is interpreted as remains of an older settlement phase – it is considered as a simple farm-house in our reconstruction.

With respect to its strategic and defensible position – the site has a perfect view of the whole Mirabello bay, of northwardly located islet of Pseira (with a significant Minoan settlement) and of Kambos lowland eastwardly – the enclosure wall is interpreted as a fortification what the both authors agree on and reconstruct it as a high, mostly stone wall without windows with the only entrance.



Figure 2. Agios Antonios Chomatas Site 9: the actual state of the site

Older, poorly documented settlement phase (and probably the architectural one as well) dates back to the beginning of the Middle Bronze/Minoan Age (Middle Minoan I-II phases, late 3rd (?) – early 2nd millennium BC), the main phase(s) – judging by the absolute majority of ceramics preserved on the surface – however, to the beginning of the Late Bronze/Minoan Age (Late Minoan I phase, ca 17th – 16th century BC).

2. RECONSTRUCTION PROCESS

The 3D reconstruction itself has been carried out in the architectural software of ArchiCAD, version 14 (Fig. 7-10). The presented visualisations are rather simple mass studies placed on a terrain created by software with schematically designated basic topographic characteristics. The details of architecture have not been too elaborated in details yet – software pre-set basic textures have been used (rough irregular stone; unburnt bricks; clay) and window and door openings have been left

without any filler. Their final solution and more suitable specification of façade and roof surface textures will be subject to further project stage.

There were the following stages of the 3D reconstruction process:

- 1) collecting of archaeological and architectural sources – site layout; site photographs; site surrounding pictures from Google Earth; photographs and plans of similar (architecturally and chronologically) Minoan sites; original (it means from the Bronze Age) iconographical sources (representations of Minoan/Aegean structures and their construction details); architectural-ethnographical parallels (photographs of single farm houses and their remains from 19th to 20th centuries); and, last but not least, also some of already existing 3D reconstructions of Minoan structures
- 2) architect's acquaintance with the site, sources and basic facts on Minoan archaeology and architecture
- 3) analysis of sources and creation of the basic conception of the reconstruction (by both authors)
- 4) creation of 3D reconstruction (by the architect, with the archaeologist's assistance).

Herein presented 3D reconstruction is based on in-depth analysis of all available archaeological, iconographical and architectural sources, supported by functional architectural analysis of the building interior rooms from the view of the access into and movement inside the building and the purpose of individual rooms. Even though it is dealt with a rough mass study without final surface finish and architectural details – and possibly an insertion into a photograph – our final 3D reconstruction corresponds with the most actual state of Minoan archaeology and architecture knowledge.

Individual initial sources will be presented in detail in the following chapters, then basic points of final 3D reconstruction will be characterised, and the role and benefit of the architect will be discussed. Based on these, essential initial presumptions and sources will be consequently defined (including the attempt to define a sort of “minimal standard”) for scientifically precise 3D reconstruction that reflects the most up-to-date state of the research.

3. REQUIREMENTS AND SOURCES FOR THE RECONSTRUCTION PROCESS

3.1 Site plan

There exists a sketch plan (i.e. not the stone-by-stone plan) of the site created and published by its discoverer D. Haggis (see above, Fig. 1). One of the authors (T.A.) visited the site in person in 2012 and except for photographs he made there a rough drawing of the preserved architecture.

The existence of a precise plan of the site or the construction is the basic precondition for its ideal 3D reconstruction creation. With respect to frequently difficult circumstances of creating such a plan (administrative procedures, the time-consuming and expensive fieldwork and processing of the results) it is more suitable to choose a site or construction with an already existing

plan to create 3D reconstruction. Stone-by-stone plan enables to understand better (and to reconstruct) some of construction elements, but for the creation of the visualization itself even only the sketch plan is sufficient.

3.2 Photographs of the site and its surroundings

The discoverer has published only two photographs: a view of the cliff from the distance where the site is located; and one overall view of the site surface where the state of preserved remains of architecture is visible.



Figure 3. Agios Antonios Chomatas Site 9: the actual state of the site

Therefore several dozens of photographs of the site and its closest surroundings have been taken (both detail and overall views; see Fig. 2-3). To understand some topographic details and general local context the site have been localised in Google Earth application and several pictures of its surroundings up to the distance of approximately 3 km from it have been taken (Fig. 4). According to authors' opinion, it is not possible to create an authentic 3D reconstruction without a thorough photo-documentation and knowledge of the site and its surroundings, because different specific elements or details indeed reflect a specificity of a certain environment. The particular architectural solution could have been influenced not only by the place, where the site or building was precisely located, but also by the position towards the surrounding landscape as well.



Figure 4. Agios Antonios Chomatas Site 9: Google Earth image of the site's vicinity

3.3 Archaeological sources

As for the archaeological sources, it is inevitable to mention especially an extensive group of similar rural constructions (or sites) built up especially from rough or partially worked massive blocks of local stone (limestone, basalt or conglomerate; this construction technique is being labelled as “Cyclopean” or “oncolithic” masonry). But mudbricks were also used (most likely for higher storeys and parts of buildings and walls) as indicated by the findings of these bricks fragments on the surface of many sites. They are most frequently labelled as rural villas, megalithic farmsteads (an overview and typology of these constructions are presented by Schlager 2006) or guard houses where agricultural and/or military function is assumed (basic information on this construction type and their typology is mentioned by Tzedakis et al. 1989, Chryssoulaki 1999 and Alusik 2007, 124-35; see Fig. 5). Unfortunately, most of them have not been documented in detail yet (there is at least a sketch plan of a few dozens of them and only a few of them were at least partially excavated). These sites come from the Middle and Late Bronze/Minoan Age, thus from 2nd millennium BC. Some sections of masonry have been preserved in several sites up to the height of 2 metres. Houses preserved in the site of Akrotiri on Thera belong among other important architectural sources (see e.g. Marinatos 1968, 1969, 1970, 1971, 1972, 1974, 1976; see Fig. 6). A town with very fine houses (which are labelled with a Greek term “xestai”) built from half-timbered masonry, which façades have been preserved up to the height of several storeys, were covered by the volcanic sediments during a volcano eruption at the beginning of the Late Bronze/Minoan Age (Late Minoan I phase, 2nd half of 17th century BC). Of course, stone for ground floor and mudbricks, or the sc. rubble masonry for higher storeys were used as construction materials. All the walls were reinforced with wooden beams to get the better fixity and stability. “Xestai” present us lots of architectural details such as windows and doors, staircases and other interior details.



Figure 5. “Guard house” of Choiromandres, East Crete

In the last years, the first author has visited several dozens of sites with above-mentioned rural buildings and has taken hundreds of photographs there. With respect to the relatively bad state of preservation of most Agios Antonios Chomatatas Site 9 walls, the photographs of several best preserved rural sites have served as an initial point for our reconstruction and from

this we have derived a type of masonry, way of construction and some another knowledge concerning the interior rooms. The first author has also visited Akrotiri. The photographs of local xestai provide an evidence of design and construction of more quality and advanced architecture than is in our site in question. Therefore they will be of bigger importance only in the next stage of our project where the design of some surfaces and constructional elements (windows, doors, etc.) will be finally defined.



Figure 6. Akrotiri on Thera, view of the site

3.4 Iconographical sources

Quite a number of architectural representations have been preserved in Minoan art that mostly date back to the end of Middle and the beginning of Late Bronze/Minoan Age (2nd millennium BC) and they can become a valuable source when creating ideal 3D reconstructions of sites or structures. They show us a range of important architectural details (such as shapes of windows and doors, design of columns), they indicate materials used (stone, bricks, wood) and most of all they capture the shape of superstructure of the building including the number of floors. With respect to the prevailing religious aspect of Minoan iconography the sacral architecture or whole towns were depicted most often. The towns represented served sometimes as the background of religious scenes. In many cases the architecture is also depicted in a simplified way, or the whole construction is represented only by a column or a pillar. The best depictions of architecture have naturally been preserved in Minoan frescoes (including the Minoanizing frescoes from Akrotiri on Thera), but some architectural models, relief plates and seals or their imprints are also important. But it is neither necessary to mention an overview of at least the most important depictions of architecture herein, nor to discuss their exactness and benefit to the studies of Minoan architecture; this was a subject to lots of studies of other authors (e.g. Hallager 1985; Kontorli-Papadopoulou 1996; Nörling 1995).

But in our reconstruction – with respect to the specifics and rural character of the site – we have used the iconographic sources in a minimal way. They will be of a bit bigger value in a further stage of the project where we are going to focus on the final surface finish and filling elements.

3.5 Architectural-ethnographical sources

The first author has seen and taken photographs of many examples of traditional Cretan rural buildings which were built in 19th and 20th centuries. They were placed in the villages or they were built separately in the countryside. Lots of them have been in ruins but some of them have been still used.

Such buildings are a good example of local architectural traditions and reactions to specific conditions concerning topography, weather and available material. They represent long-lasting experience of Cretans with the life and conditions on the island and reflect a pursuit of the simplest and most effective possible way of solving the problems that can substantially influence a house construction, such as subsurface, terrain slope, prevailing direction and strength of the winds, sunshine etc. In our case the photographs of them have been used only to verify some of our initial presumptions and final hypotheses (i.e. overall building orientation or the shape of the roof), they were of a minimum meaning (rather a supportive one).

3.6 The already existing 3D reconstructions of Minoan structures or sites

Before beginning the reconstruction process itself several previously made 3D reconstructions of other Minoan buildings had been collected. But they were only used to find out the way of other specialists' work – which software they used (for architects or just for general 3D modelling), which way the terrain was indicated, if the 3D reconstruction was set into the site photograph etc. – and also to be inspired for the overall final finish of our visualisation.

4. THE FINAL 3D RECONSTRUCTION

The basic concept of the reconstruction has been created after a thorough analysis of all above-mentioned sources and assessment of their contribution. The basic scope of the building is certainly given by the size of a plateau, preserved ground plan and enclosure wall. After a detailed study of all architectural and topographic characteristics of the site we have decided to reconstruct the main building as a partially two-storey, the second floor has been built above the western part of the building towards the sea. A long space in the eastern part of the site adjacent to the bounding wall has been reconstructed as a walkable roof or a "terrace" where the rooms of the second floor open to. The ground floor of all the buildings in our reconstruction has been carried out in stone as massive irregular blocks, the upper floor from mudbricks reinforced with wooden beams (but these are not visible in the final images). A short section of the wall southward from the building has been interpreted by the authors as a simple production extension – workshops, kitchens or any similar room(s) which were better to situate outside the main rural building due to spatial and practical reasons (i.e. noise, smell).

The final ideal 3D reconstruction (Fig. 7-10) of the site has been based on the above-mentioned basic concept supported by a functional architectural analysis of interior rooms of the building from the viewpoint of the access into and movement in the building and the purpose of individual rooms. Therefore,

according to our opinion, there were mostly magazines on the ground floor (eastern parts; rooms 1-2) and workshops/kitchens (rooms 3-4) or the room (no. 5) where the inhabitants stayed during the day. The dwelling rooms themselves were situated on the first floor, over the western part of the ground floor (rooms 3-5). The open space in the eastern part of the first floor (above the stocks no. 1-2) served as a balcony and, at the same time, as a defensive platform from the inside of the fortification.



Figure 7. Agios Antonios Chomatas Site 9: ideal 3D reconstruction of the site

Based on the sources analysis and summary of the archaeological facts the basic points of the final 3D reconstruction have been defined by both the authors. With respect to the fact the site has not been excavated, it is not possible to deduce the purpose and equipment of individual rooms based on the analysis of the findings. Therefore the only possibility was to carry out a functional architectural analysis that was nearly exclusively in the architect's management. The final alternations of rough mass 3D reconstruction – such as the placement of the windows, doors and staircase(s) and setting of the interior communication pattern – have been carried out by the architect as well. Her fundamental benefit consists in the application of static, construction, functional and technological knowledge and rules. Herewith, an application of purely "construction-technological" aspect, it means verification, clarification and completion of imaginations of functional, static and engineering-constructional functioning of the building, will be used in the process of creation of the ideal 3D reconstructions of Minoan structures, together with "artistic-historical" and "archaeological" viewpoints.

5. CONCLUSIONS

The authors assume that it is necessary to apply the latest computer technologies and sophisticated software in modern archaeology. According to their opinion, it should become a standard in the near future that in case of publishing the sites with preserved architecture, an ideal 3D reconstruction should be created, even though sometimes objective archaeological reasons prevent these aims to be carried out. As was mentioned above, the initial presumptions for creation of such a reconstruction must be a preservation of the ground plan in such a condition which enables to understand the architectural

dispositions and also thorough knowledge of the site based on a personal visit.

After the actual reconstruction process was finished, the authors were able to finally evaluate the meaning, potential and value of the individual categories of the sources for the reconstruction. It was absolutely clear that some (categories of the) sources had been important and absolutely necessary, but the other ones had had only the character of an „added value“, i.e. had helped to find an easier architectural element or expression. On the basis of their experience and findings the authors believe that for the creation of really good and up-to-date 3D reconstruction of a rather simple structure used primarily for habitation (that means e.g. an usual town or rural house, farmstead etc.) only the following three categories of sources are necessary: 1) the plan of the site (at least the schematic one; Fig 1); 2) enough of general and detailed photos of the site (but not necessary the photogrammetric model), its architectural features and some photos of the site's surroundings incl. the Google Earth image (Fig. 2-4); and 3) some photos of similar sites and/or structures/architectural features (type of masonry, entrances etc.; Fig. 5-6). These three categories of sources, the satisfactory state of preservation of the site and good personal knowledge of the site and its close vicinity can be defined as the minimal standards for the creation of an ideal 3D reconstruction (Fig. 7-10). The actual reconstruction in the special software should be done by the architect – and not by just a specialist in 3D software modelling – in close collaboration with an archaeologist. Only the architect is able to fully cope with the functional and structural rules and practical aspects and details of the reconstructed structures, i.e. statics, inner partitions, air-flow, and structural details such as windows, doors, staircases etc. So, in authors' opinion, there are not so many accurate sources necessary for the creation of the up-to-date 3D reconstructions.

The authors hope that this paper contribute to the discussion what are really the prerequisites, sources and accuracy requirements for the creation of the scientifically reliable 3D reconstruction of the prehistoric archaeological sites or structures. In case of accepting our findings and principles by the wider academic audience (especially by the archaeologists and architects), the creation of software 3D reconstruction could be – as we hope – more commonly used or even become a standard of archaeological publications.

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Figure 8. Agios Antonios Chomatas Site 9: ideal 3D reconstruction of the site



Figure 9. Agios Antonios Chomatas Site 9: ideal 3D reconstruction of the site



Figure 10. Agios Antonios Chomatas Site 9: ideal 3D reconstruction of the site