A Series of Photogrammetry for Protection of Syrian Cultural Heritage

Ancient Villages of Northern Syria
Vol. 1

QALB LOZEH

Agency for Cultural Affairs, Government of Japan
University of Tsukuba
Research Center for West Asian Civilization

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All photographs used in this publication were taken by our friends who live in Idlib. Without their effort, our project was never completed. We deeply thanks them who carried out photography for our project regardless of serious danger in the great difficulty under the civil war.

CONTENTS

1. Qalb Lozeh photogrammetry project

Akira Tsuneki

Since the beginning of the conflict in Syria in 2011 much cultural heritage has been lost or destroyed. All the archaeologists who have been engaged in archaeological investigation in Syria are extremely concerned about this tragic situation, and felt something must be done to mitigate this situation. In response to this, the Agency for Cultural Affairs, Government of Japan, provided financial support for safeguarding Syrian cultural heritage in 2015. Therefore, the following actions were undertaken to investigate what could be done in the meantime: a) Research on the situation within Syrian cultural heritage during the crises (2011 – 2015), b) Public lectures and discussion of Syrian cultural heritage with the Japanese public in Tokyo, and c) Experts meeting with Syrian and Lebanese archaeologists and UNESCO officers to facilitate safeguarding Syrian cultural heritage in Beirut. As a result, the Agency for Cultural Affairs proposed further financial support in safeguarding Syrian cultural heritage in 2016. Consequently, the new project authorized by the Agency of Cultural Affairs focuses on: 1) Instruction of young Syrians on the importance of Syrian cultural heritage, 2) Documentation of endangered Syrian cultural heritage and 3) Preparing manuals for people safeguarding cultural heritage in archaeological and heritage sites in Syria.

This book is a result of the second category, i.e. 2) Documentation of endangered Syrian cultural heritage. In undertaking this important operation, it was necessary to first select a site in danger of destruction. The University of Tsukuba Archaeological Mission has been investigating an archaeological site named Tell el-Kerkh in Idlib since 1990, and is familiar with the world cultural heritage sites, "the Ancient Villages of Northern Syria". These important Roman and Byzantine architectural remains have been extensively damaged during the conflict. Our mission heard about the partial destruction of important sites in this world cultural heritage group, such as St. Simon, el-Bara, Serjira and others. These sites represent the Roman-Byzantine Villages of Northern Syria, and members of the mission determined that a documentation project for these sites should be instigated as soon as possible before further destruction occurs. A project for the accurate documentation of these archaeological sites will contribute a precise record that may be used for reconstruction should the sites be destroyed. This work is useful not only for the recording and preservation of heritage sites but also reflects the scientific and academic focal points of the research mission. As a result the site of Qalb Lozeh, one of the oldest churches in the Idlib area was chosen as the first target of a photographic survey for use in photogrammetric analysis and the creation of a 3D image.

Qalb Lozeh قلب لوزة 36° 10′ 9″ N, 36° 34′ 50″ E

The Ancient Villages of Northern Syria are one of the Syrian World Heritage sites appointed by UNESCO in 2011. This world heritage consists of over 700 ancient villages, dating to the Roman and Byzantine eras, located in the limestone mountains of northwestern Syria in the Governorates of Idlib and Aleppo (Fig. 1).

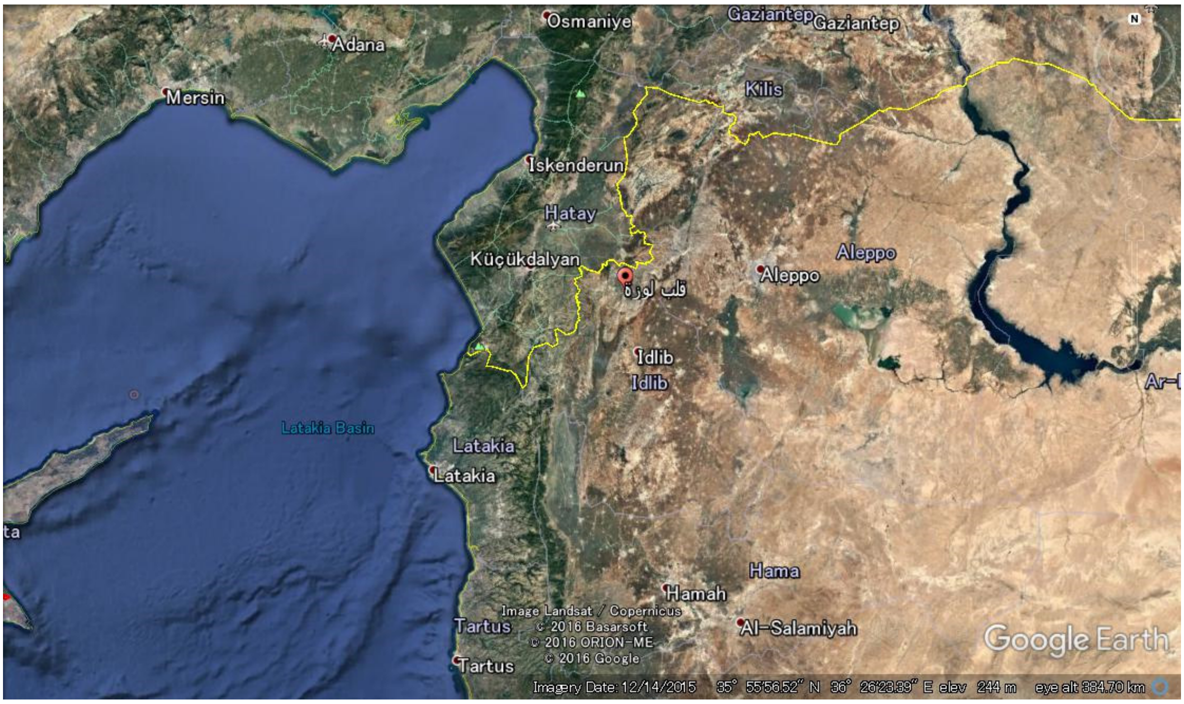


Fig. 1 Location of Qalb Lozeh قلب لوزة

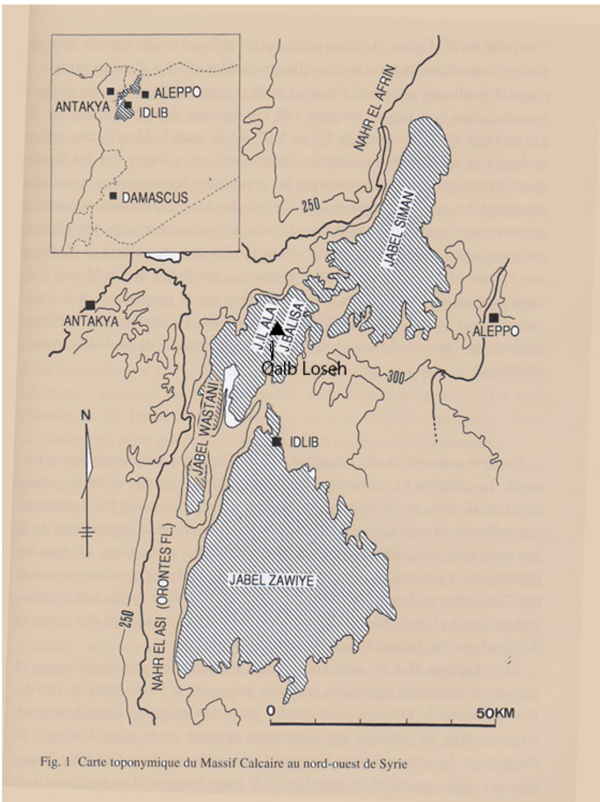


Fig.2 Limestone mountains of NW Syria

These limestone mountains sandwich the Orontes River. Westward, the Ansariye Mountains extend to the north and south, and the mountainous districts such as the Zawiye Mountains and Seman Mountains extend further to the east side. The Ancient Villages are located and had been managed in the limestone mountainous district of the Orontes east bank (Fig. 2). These limestone mountains form an environmentally heterogeneous area with the western Mediterranean seashore and the eastern Syrian Desert zone. This area is comprised almost entirely of rocky limestone however red soil outcrops resulting from weathered limestone can be found here and there. This red soil zone creates areas used for farming and villages. The precipitation is approximately 500mm a year but the resulting groundwater exits the mountainous area. Therefore, a river does not exist in the vicinity and the vegetation mainly consists of Mediterranean trees such as olive, pistachio, fig, and oak as well as grape vines.

Archeological investigation of the Limestone Mountains area began with, an investigation into Christian heritage architecture by M. de Vogüé (1865-1877) in the mid-19th century. Research on the Roman and Byzantine remains has been pushed forward intermittently since then by H. C. Butler (1920), J. Mattern (1944), G. Tchalenko (1953) and others in the early 20th century. In the late 20th century, O. Callot (1984), H. J. Marcillet-Jaubert, J. P. Sodini (1980), G. Tate (2013) and others investigated the limestone villages, clarifying the lifestyle and local history of the Limestone Mountains. Their research revealed that the limestone mountainous district of northwestern Syria was prosperous due to its olive oil production from the 1st to 7th centuries AD. The acceptance and dissemination of Christianity in this region was also very early and rapid. In this context, olive factories and Christian churches are very important in reconstructing the history of this area in northwestern Syria.

Qalb Lozeh, one of a number of well preserved old churches belonging to the Ancient Villages of Northern Syria, is located in the middle of a Druze village on the A'la Mountain. Qalb Lozeh translates as "Heart of the Almond" in Arabic. The elevation of the village is 670m, and it is situated about 50km west of Aleppo and 28km north of Idlib. Tchalenko visited Qalb Lozeh church several times and believed that it dates to the 5th century based on its Basilica architectural style, first known in Syria as the wide basilica. The site was inscribed by UNESCO as a world heritage site in 2011 as a part of the Ancient Villages of Northern Syria.

There is debate about why the early Christians in the Levant chose Old Greek Basilica style architecture for their church style. Some scholars asserted that they adopted this communal building style because it was quite different from the Roman temple style. Other scholars thought that as many people gathered during Christian worship, they needed a Basilica style public building in which they could gather.

The early Christians adopted the Roman Basilica style for their churches however they build them according to certain specifications. The churches had a relatively long east and west alignment and the domed apse was situated at the eastern end of the nave, with a doorway at the opposite end. In Qalb Lozeh, both sides of the nave have an aisle and reflect the style of a three corridor-type basilica. Qalb Lozeh is a unique Syrian Basilica style church. It has a flat wooden ceiling, and the structure consists of a series of cut stones. The colonnade is comprised of a prism not a column. Therefore, the inside is similar to the hall-type cathedral, which appeared in Europe in the middle ages. In addition the loggia at the entrance had two small towers on both sides, a characteristic of Early Syrian church buildings. Therefore, the photogrammetry project at Qalb Lozeh is very important as it facilitates documentation and preservation of typical early Syrian Church styles.

Butler, H. C. 1920 *Early Churches in Syria, Fourth to Seventh Centuries,* Princeton.

Callot, O. 1984 *Huileries Antiques de Syrie du Nord*, Bibliothèque archéologique et historique, t. 118), Paul Geuthner, Paris.

Mattern, J. 1944 *A Travers les Villes Mortes de la Haute Syrie*, 2e édition. Beyrouth.

Sodini, J. P. et al. 1980 Déhés, campagnes I – III (1976-1978). Recherches sur l'habitat rural, *Syria* 57: 1-308.

Tate, G. et al. 2013 *Sergilla 1. Village d'Apamène*. vol.1 et II, BAH.

Tchalenko, G. 1953 *Villages Anitiquities de la Syrie du Nord: Le Massif de Bélus à l'Époque Romaine*, Paris.

Vogüé, M. de 1865-1877 *Syrie Centrale, Architecture Civil et Religieuse*, du 1er au Ve sicles, Paris.

Qalb Lozeh (General view from southeast)

Qalb Lozeh (General view from southeast)

Qalb Lozeh (General view from west)

Qalb Lozeh (General view from east)

2. The process of making a 3D image of Qalb Lozeh

Sari Jammo

As a result of the chaos within the country in recent years Syria's cultural heritage is facing its greatest challenge. Many archaeological sites were destroyed; a large number of sites withstood secret excavations and vandalism and thousands of archaeological objects have been smuggled abroad. Under these circumstances and feeling a sense of responsibility toward Syrian culture properties, a project to evaluate damage, safeguard and document cultural heritage sites in the Idlib governorate was begun. The objective of the project is to provide knowledge, raise awareness and build the capacity of local people and civil volunteers interested in and passionate about safeguarding their cultural heritage for the future.

The first site, Qalb Lozeh was chosen for its symbolic meaning. This site is famous for its 5th century Byzantine church and many people in Harem district are familiar with the site and consider it a magnificent building.

The team is small, comprising archaeologists, amateur photographers, students and members of the public. Some have an archaeological background but others feel a sense of shared responsibility toward heritage. The project began with available capabilities and simple equipment such as a camera. None of the members had any experience of photogrammetry in cultural heritage or 3D modeling techniques and methods.

The work necessitated acquiring the theoretical knowledge and practical skills to undertake the photography. Theoretical aspects include providing the team with simple teaching and technical information that has been translated into Arabic. Even though this work does not require special knowledge in photogrammetry or measurement, there are several tips and user techniques that could affect the end results. However, the team members were asked to read the context carefully and understand the basic principles of photogrammetry at least. Later, an online meeting was held via the Internet. During the meeting, a lecture explained the basic knowledge and simple steps for taking photos suitable for creating 3D models. Necessary information related to adjusting the camera, quality of the photos, appropriate exposure time, shadow angles, technological principles of photogrammetry, the appropriate way of taking overlapped photographs and examples of success and failure were introduced to facilitate understanding.

The practical aspects of applying learnt theoretical knowledge in the field and taking the photographs was more difficult than had been anticipated. Taking the photographs required keeping the learned theoretical principles in mind. The idea of taking photographs is not limited only to the whole parts of the building, but to cover it with continuous and overlapping images. A 3D model is mainly generated from a series of photos with continuous overlap and these photos should not be discontinuous. The photos cannot be processed well when the overlap is less than 60%. However, the appropriate and recommended overlap of the photographs should be greater than 60%. The result of the processing is proportional with the increase in the percentage of overlap and the opposing right side of the image (the recommended overlap is said to be 80-90%).

At the beginning of the work, a series of 150 photos were taken, but these were general photos covering the external part of the church building. None of the learned principles were applied and the photo series was a failure. The following, attempt placed emphasis on the principles of taking appropriate photographs and considering overlap. New sets of good photographs were received particularly for the lower levels of the church.

Difficulties and unexpected circumstances were encountered when working in the field. The ongoing security situation did not allow the team to undertake its work easily. They had to postpone intended work for days and sometimes weeks till the security conditions improved.

Lack of appropriate equipment created other difficulties and as mentioned previously, it was decided to start with just a camera. Measuring and photographing the lower levels of the church building up to a height of five meters was relatively easy, but photographing the higher elevation walls, arches, pillars and external side of the dome of the altar was more difficult. To reach the higher elevation, the team had to use long poles and/or a drone. Drones are useful in taking reliable photographs, but unfortunately, in the beginning none were available. As a result members of the team, were climbing the walls, standing on the top of the car and adjusting the focal length (zoom lens), but later problems were encountered when processing these photos. These experiences showed it is better to use the same focal length for the entire photo series, as using different focal lens resulted in blurred images.

Many typical mistakes occurred during taking the photographic sequences. One of these was the adjustment of the camera direction and location. The photographer seemingly overlapped the sets of continuous photography, however, when processing the photographs in the software, the results were poor. The reason is because the photographs were taken from one position by rotating the camera only. It is necessary to move the camera position during taking the photographs, or change the camera angle incrementally.

It was very difficult to measure and photograph the highest points of the church especially the ceiling and the apse dome above the altar. In order to achieve this, the team started looking for an appropriate method (using long poles, cranes or a drone). Luckily, they found a drone in the area and asked the drone's owner for cooperation and help. The team could use the drone once for 40 minutes. During this time several photos were taken and a short video was recorded. Unfortunately, the photos were not well overlapped and the side of the church has not been photographed. Lack of appropriate overhead photographs may result in severe skewing and holes. Hence there were large changes in angle between the overlapping photos taken from the ground and those from the drone resulting in failure in processing and combining the photos.

Measuring and photographing the entire site took about a month. In total, the team took about 3000 photographs. More photographs of missing sections are needed and the team will do their best to create a 3D model from the photographic series. However, it is the first cultural heritage-documentation project undertaken by this group. The measuring and photographing skills of the photographers gradually improved throughout the process of recording the church but further skill development is necessary. Hopefully, future projects will increase the skill level and capacity of scholars and civil organizations to safeguard Syrian cultural heritage for future generations.

Western facade

Main western entrance

Right side square tower (down)

Right side square tower (up)

Left side square tower (down)

Left side square tower (up)

Northern side facade showing two doors and northern wall arches


Apse (exterior part)


Apse (columns and windows)


Southern side facade showing three decorative doors


First door (east)


Second door (center)


Third door (west)


View from the south west

The nave of the church

Rows of columns

Second arch (south)

South side aisle

South side aisle

Southeast side room entrance

Column decoration


North side aisle

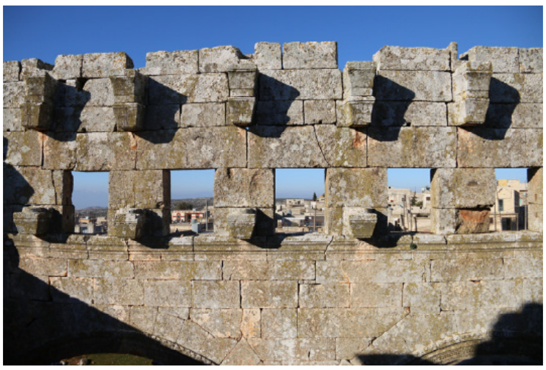

North side wall


Apse (interior part)


Apse dome


Apse dome


Dome decoration


Clerestory


Church floor in front of the main entrance

3. 3D reconstruction of Qalb Lozeh

Nobuya Watanabe

1. Background

1.1. Method and limitations

The 3D model of Qalb Lozeh illustrated in this brochure is generated by Photoscan Pro (Agisoft), the SfM software, based on the photographs collected by local colleagues in Syria. The processing result was acceptable for obtaining a general view of the church as shown in the following sections. However, there are still several missing sections in the models due to the lack of photographs. In particular, orientation and continuity of the model inside the church was distorted, probably because of the difficulty in taking appropriate sets of overlapped photographs. Thus, the final model was made by manually integrating several section models into one single model (Figure 1 and Figure 2). Automatic alignment was attempted for integration but did not create a satisfactory result. The lack of precise GCPs around the church may have affected the automatic integration of the model. At least, there are several known sets of points whose length in between gives scale to the model. Also, the directions of the vertical and horizontal axes were determined from these sets of points. The model can provide orthographic plans since the scale and direction of the axes are known. However, it should be noted that the model might include disorientation and skewness as a result of the integration procedure. The accuracy and analysis of the missing sections is expected to be resolved in future work when additional photographs are available.

Figure 1 Overview of the integrated model of Qalb Lozeh

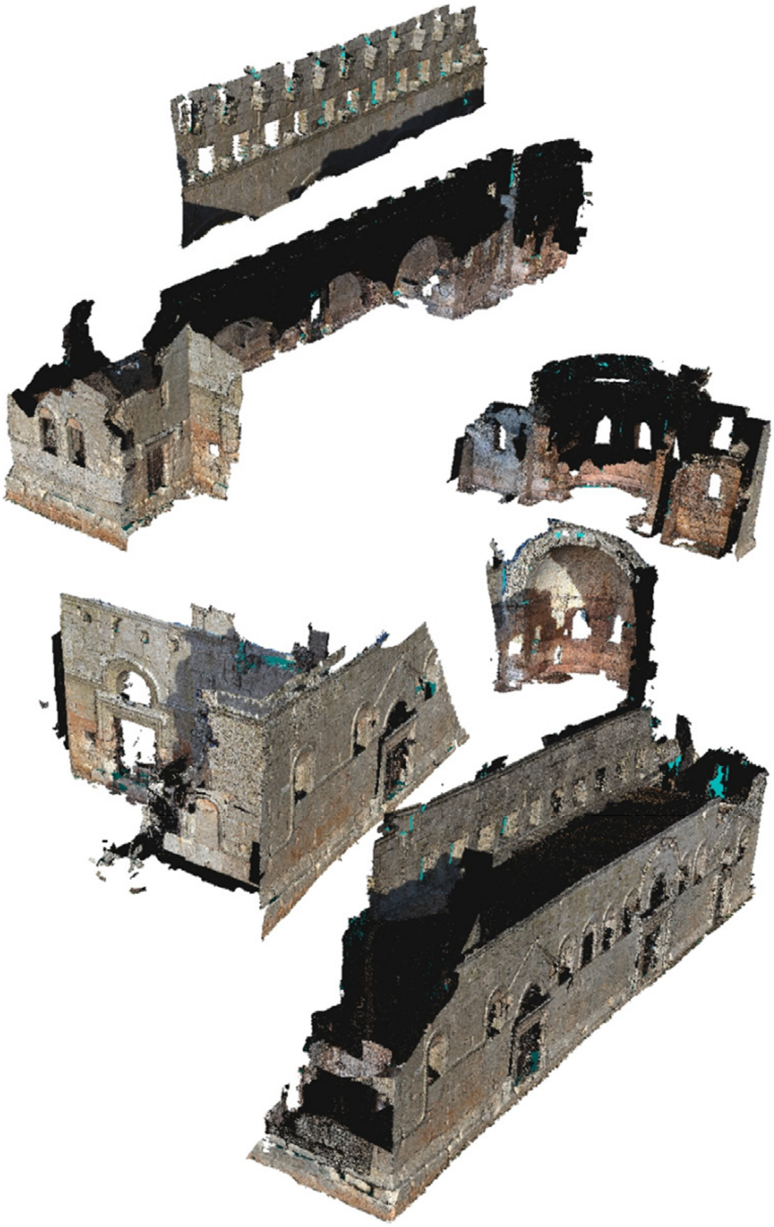


Figure 2 Separated sections of the model

1.2. The illustrated figures

There are two sets of illustrations for most figures in the following chapters. One is a realistic 3D image and the other is a gradational colored relief model. It is easier to observe the surface using the relief model while the realistic model confirms textures and colors. The color of the relief model shows the difference in distance between the overlapped models (i.e. errors when integrated). The presence of more red indicates the greater the distance between the overlap (about 9 cm in maximum).

2. Birds eye-view of the church

A birds eye-view from several stand points are introduced in this section. The outer side of the church is comparably well generated. However, the model lacks the roof of the apse, the top wall of the northern side, and the structures on both sides of the main entrance. The photographs taken by the UAV[1] augment the model of the roof in the southern section. Improvement in the photography of the higher sections of the building is required in future efforts.

[1] UAV (Unmanned Aerial Vehicle) is another name for so called drone. UAV is now one of the most important platform for taking aerial photographs, not only for just recording scenery but also for mapping purpose.

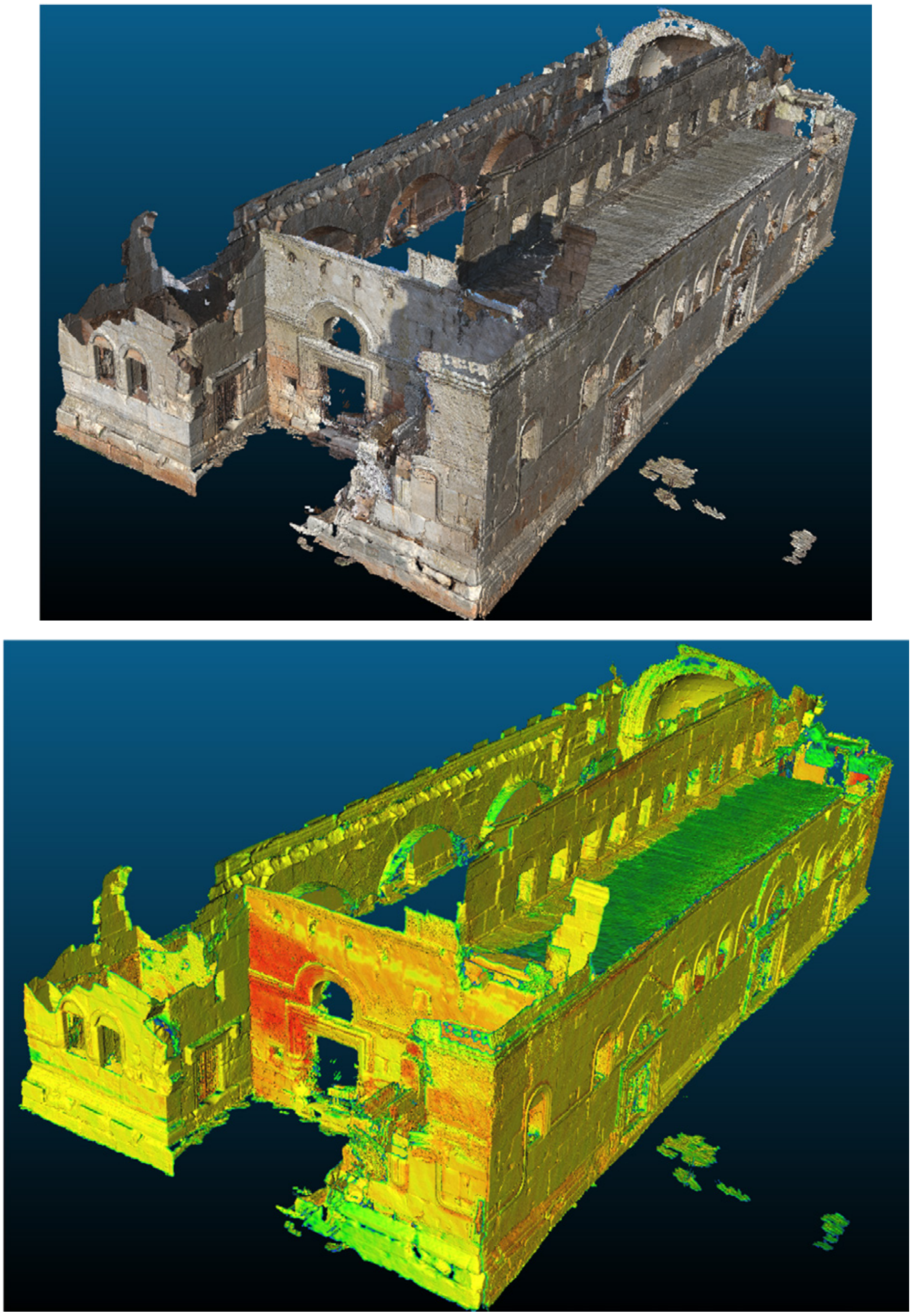


Figure 3 Birds eye-view from the south-west

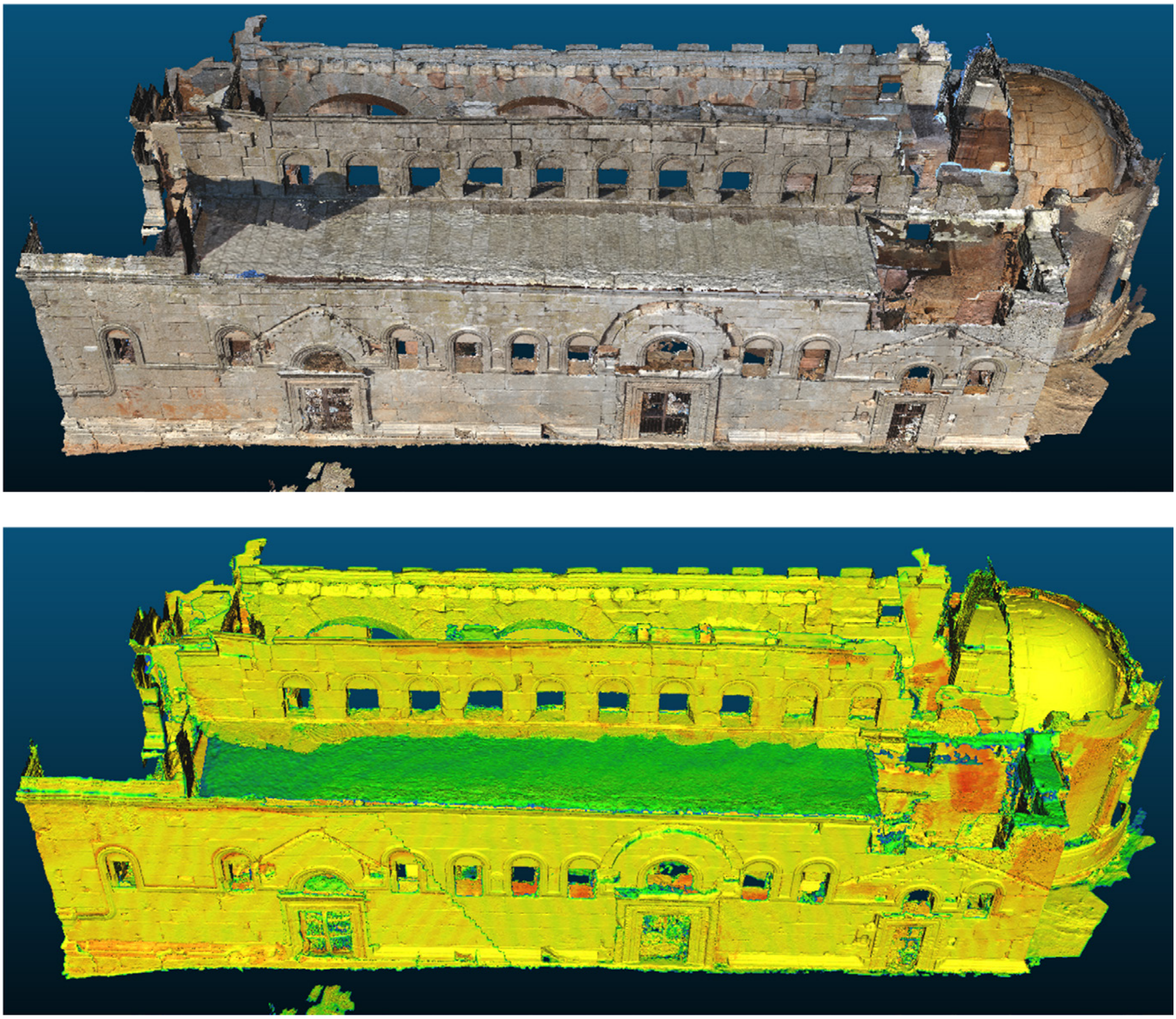
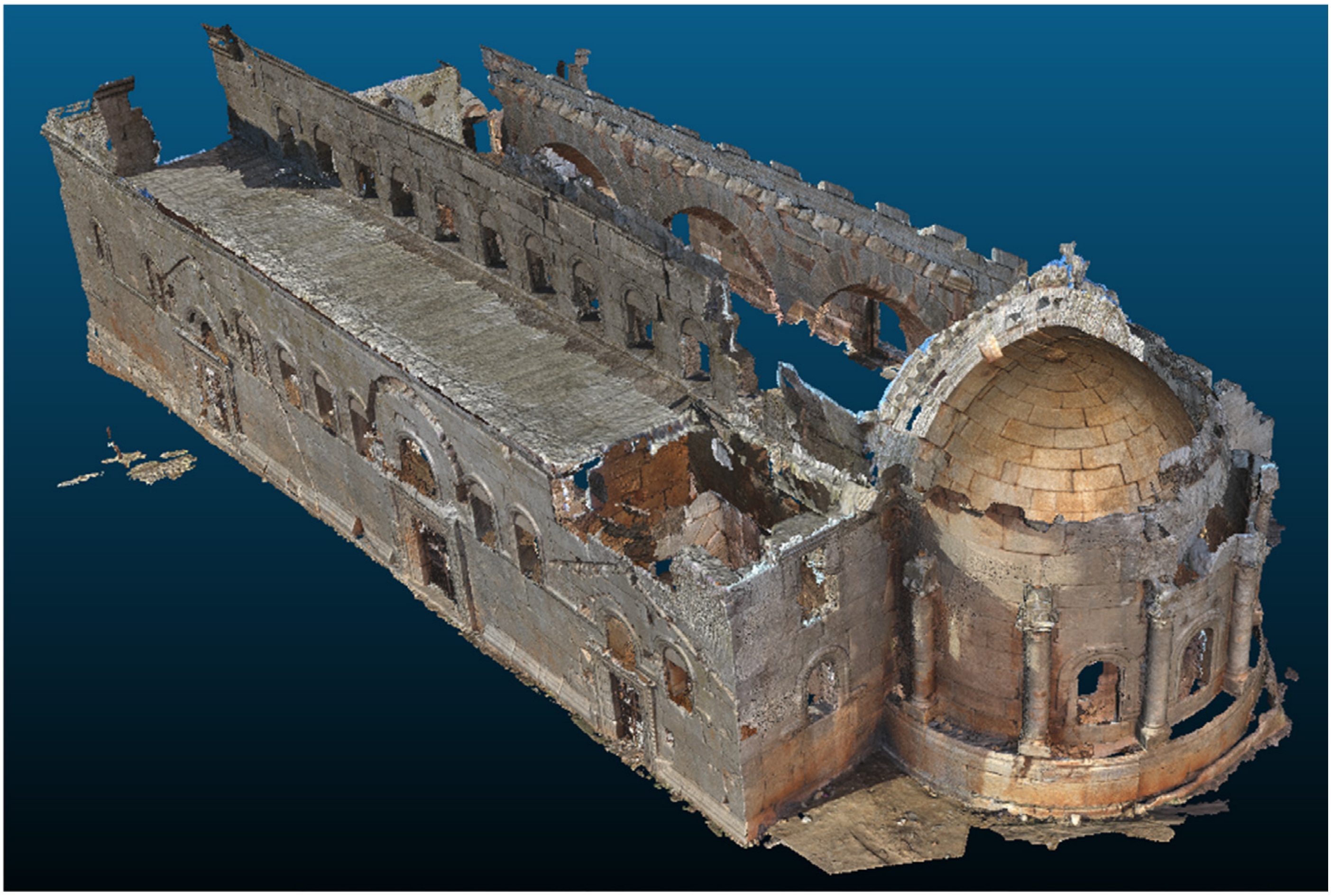


Figure 4 Birds eye-view from the south



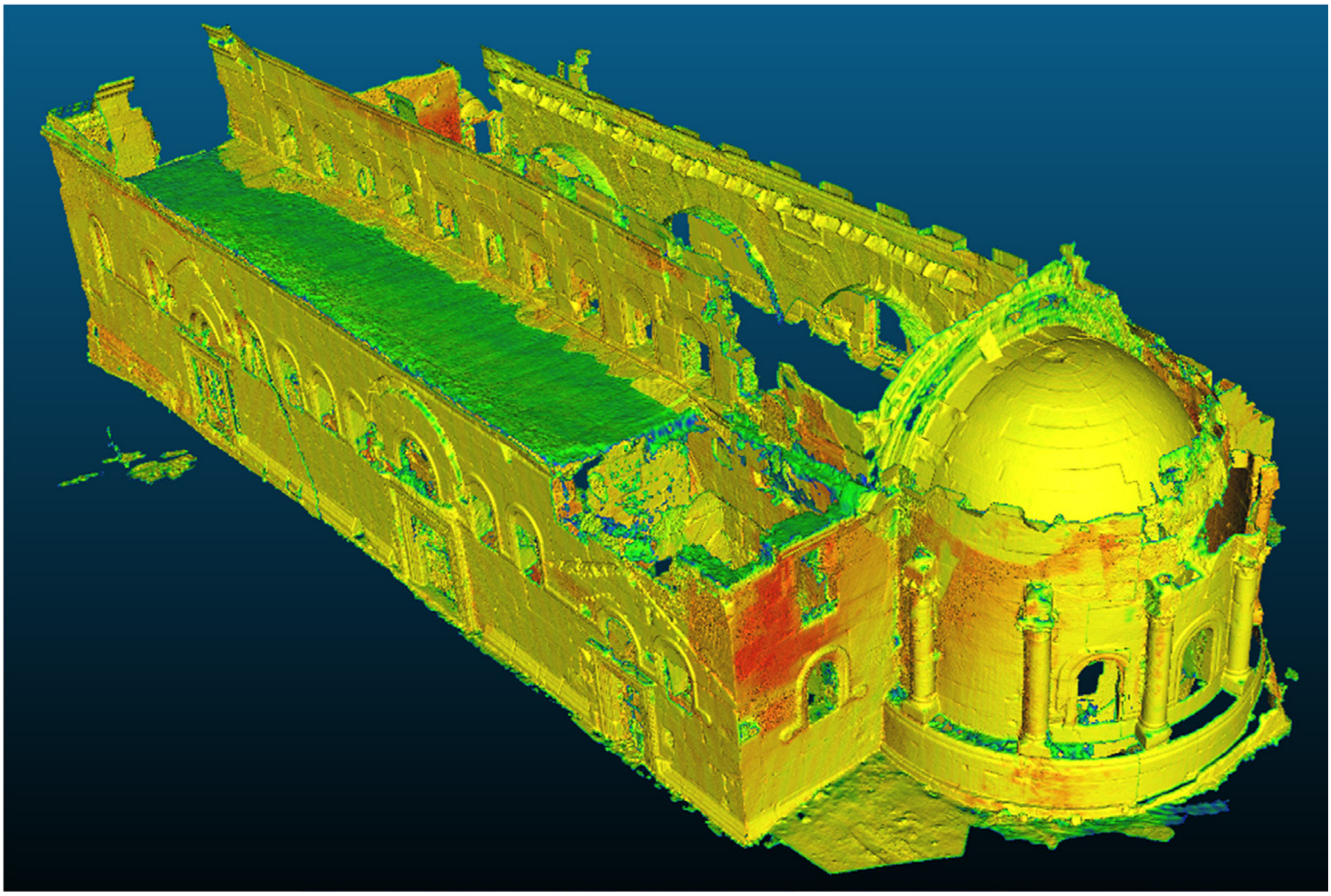


Figure 5 Birds eye-view from the south-east

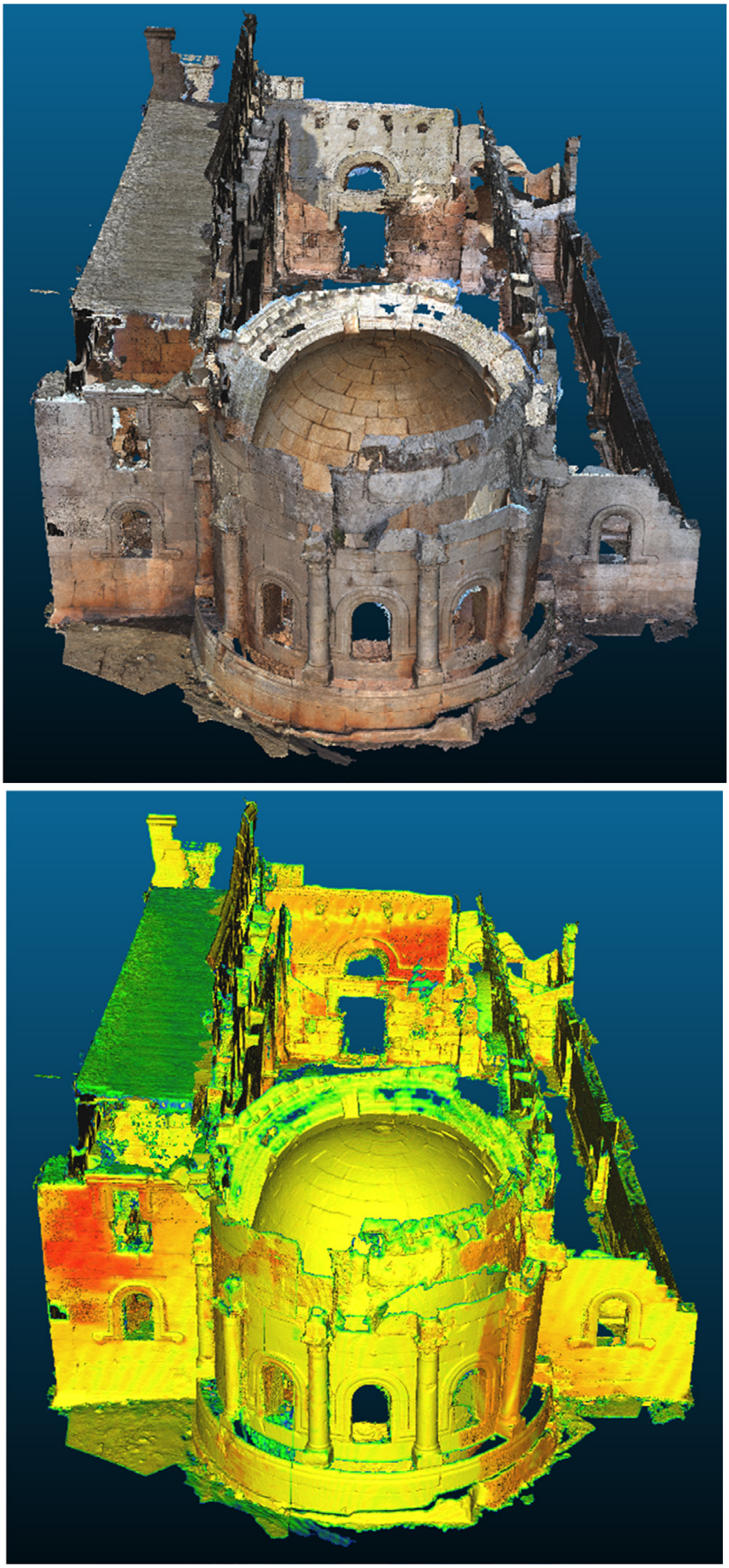


Figure 6 Birds eye-view from the east

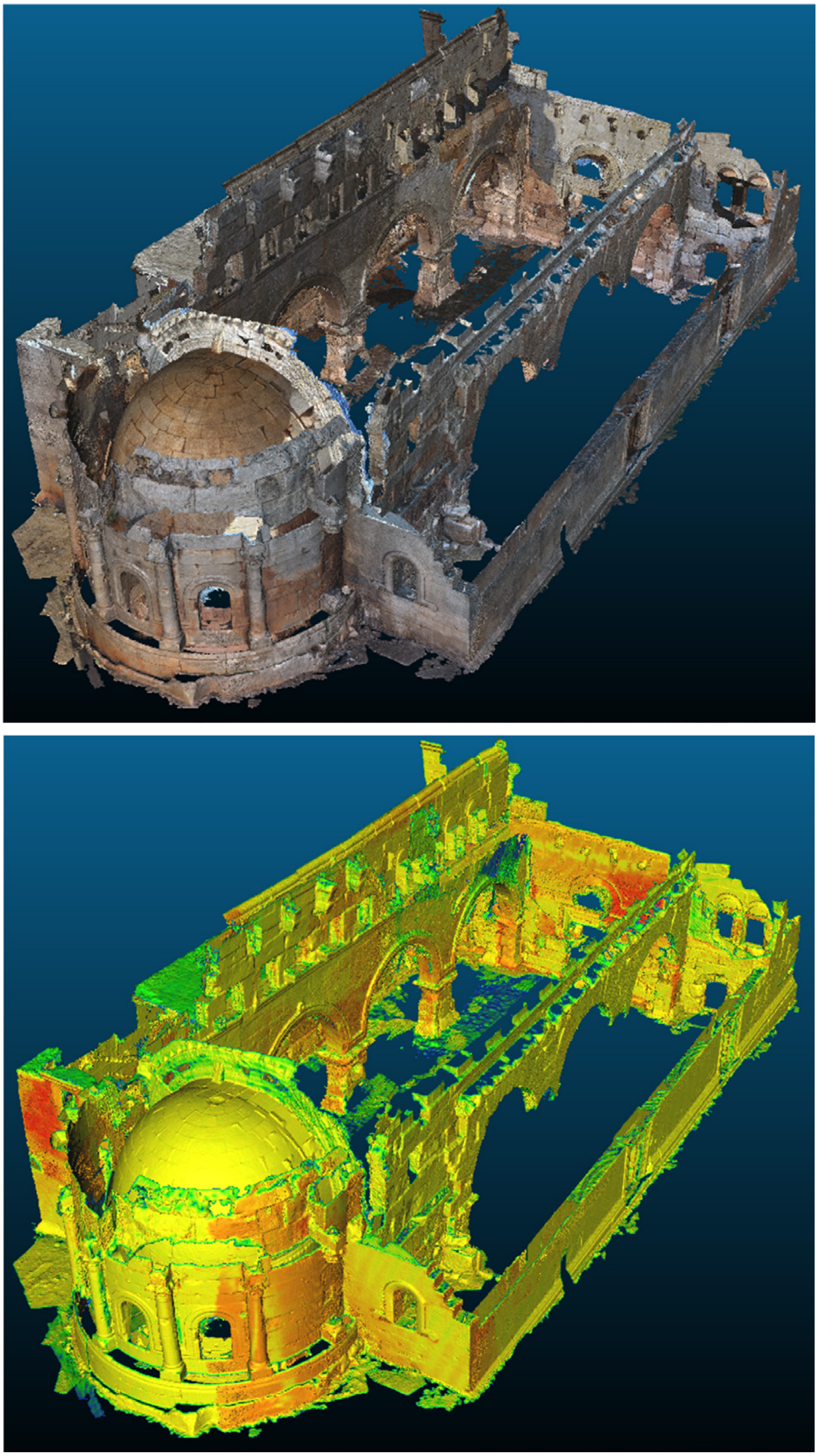


Figure 7 Birds eye-view from the north-east

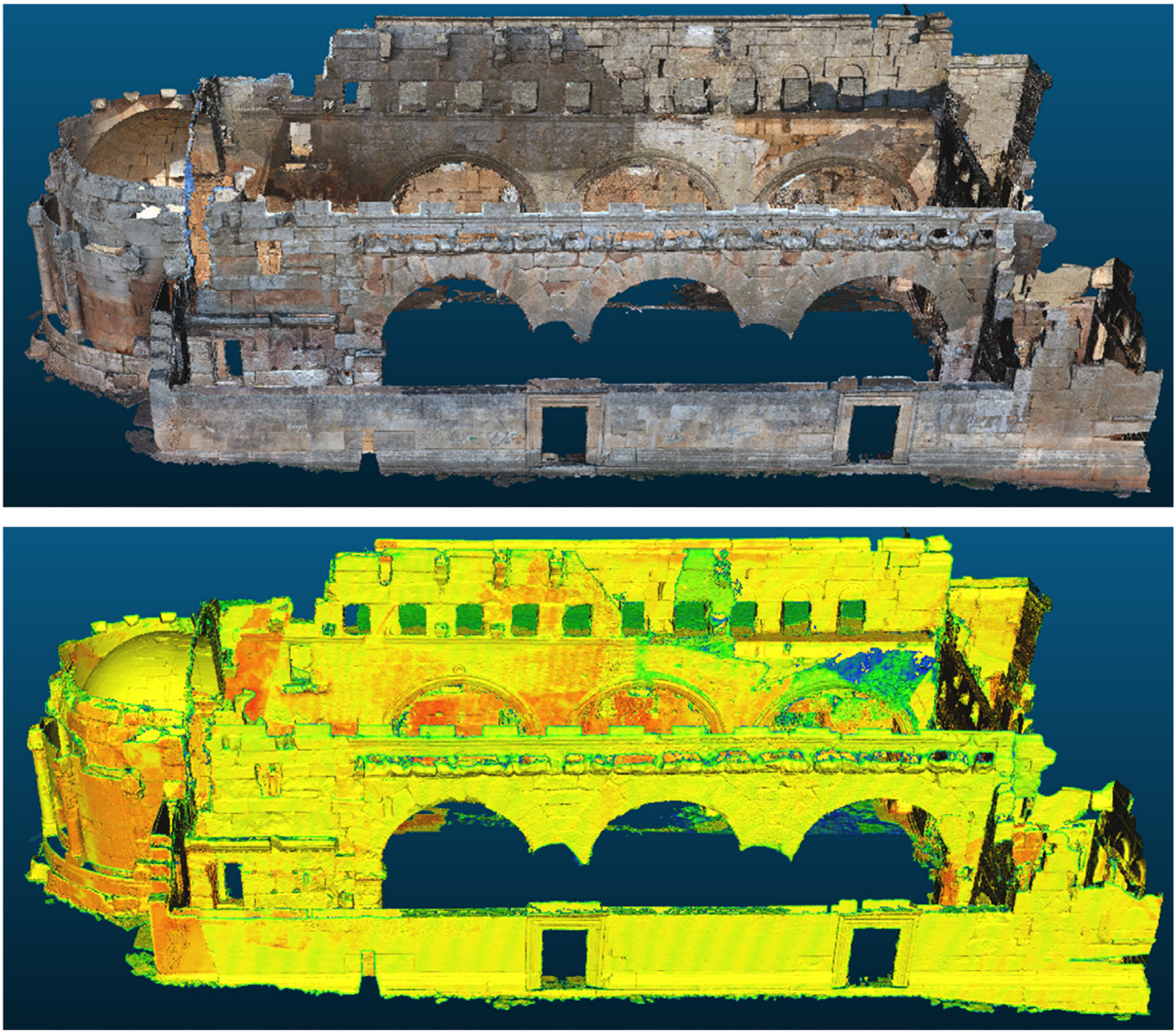


Figure 8 Birds eye-view from the north

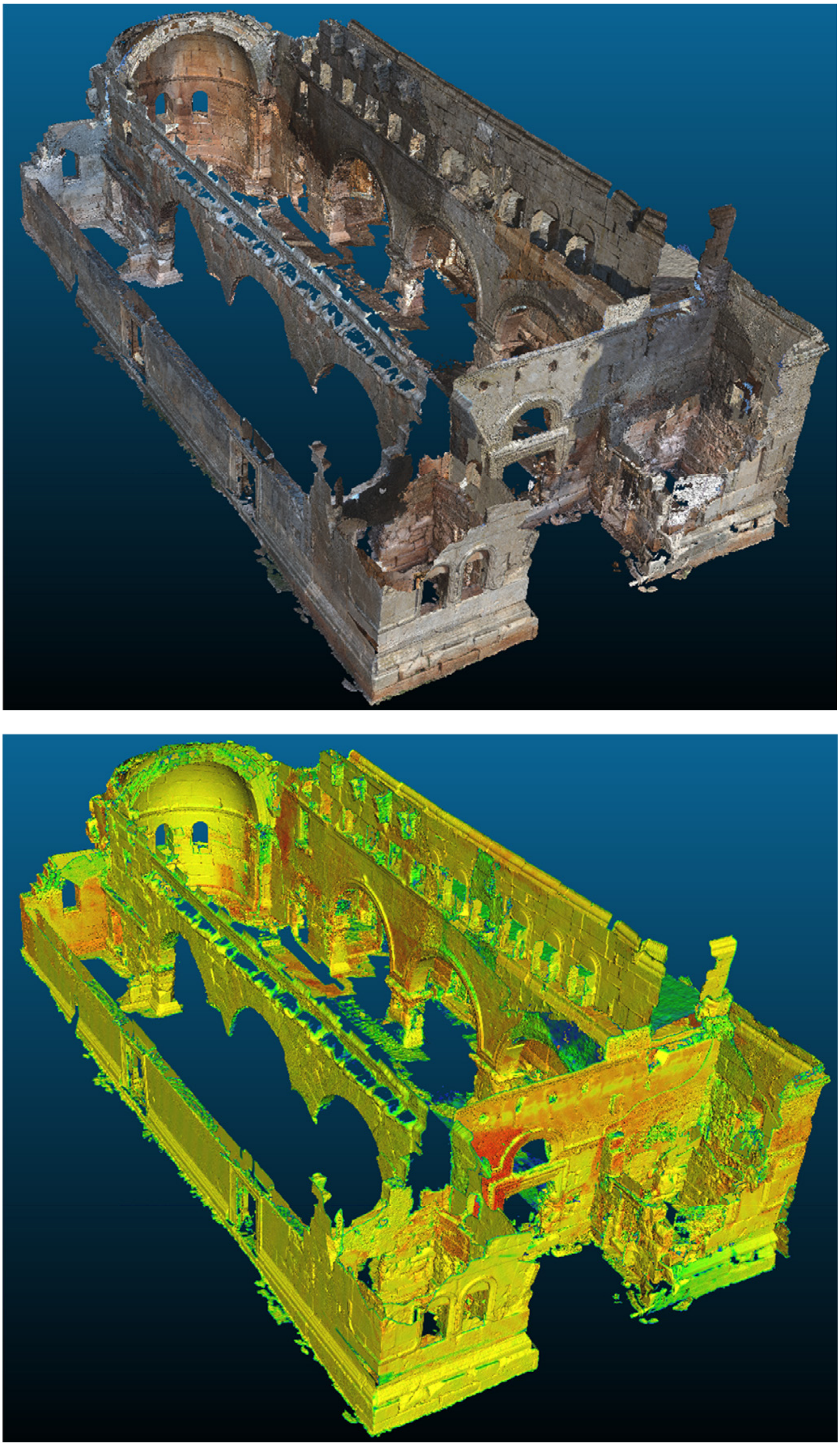
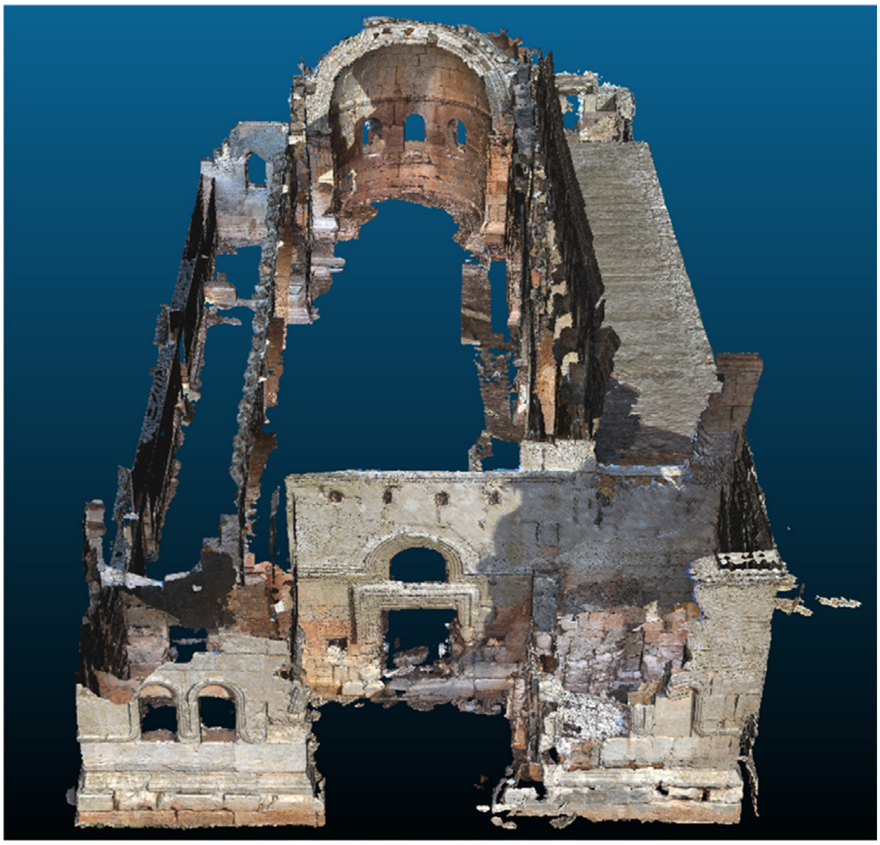


Figure 9 Birds eye-view from the north-west



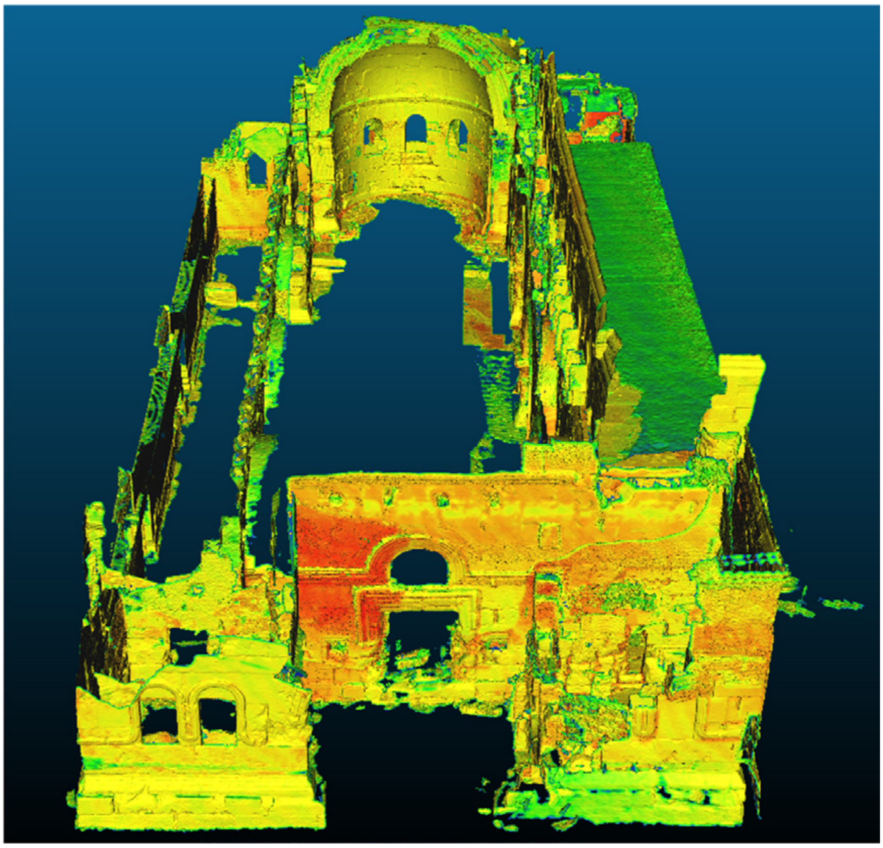


Figure 10 Birds eye-view from the west

3. Sections of the church

Areas of the church are illustrated using orthorectified photographs in this section.

3.1. Plans of outside walls

As previously stated, plans can be generated from the model taking advantage of its correct scale and orientation.

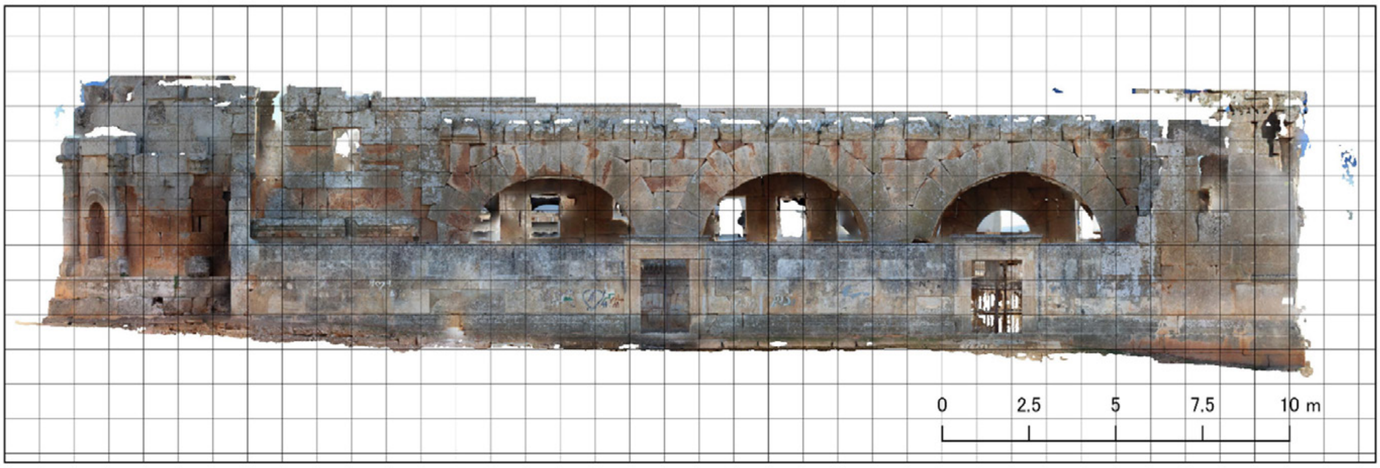


Figure 11 Plan of the lower part of the church (north).

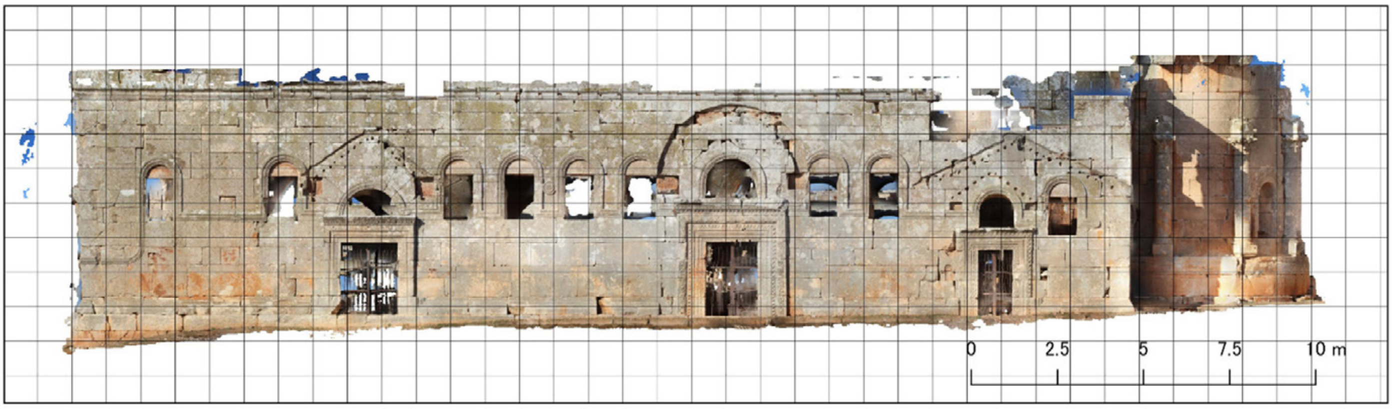


Figure 12 Plan of the lower part of the church (south)

3.2. Inside walls

The walls inside the church are illustrated by slicing the model in half. One of the advantages of using this method is that it is possible to slice and to observe any section. Consistency of the walls is acceptable in most parts of the model. However, discontinuity with the apse is noted (Figure 13).

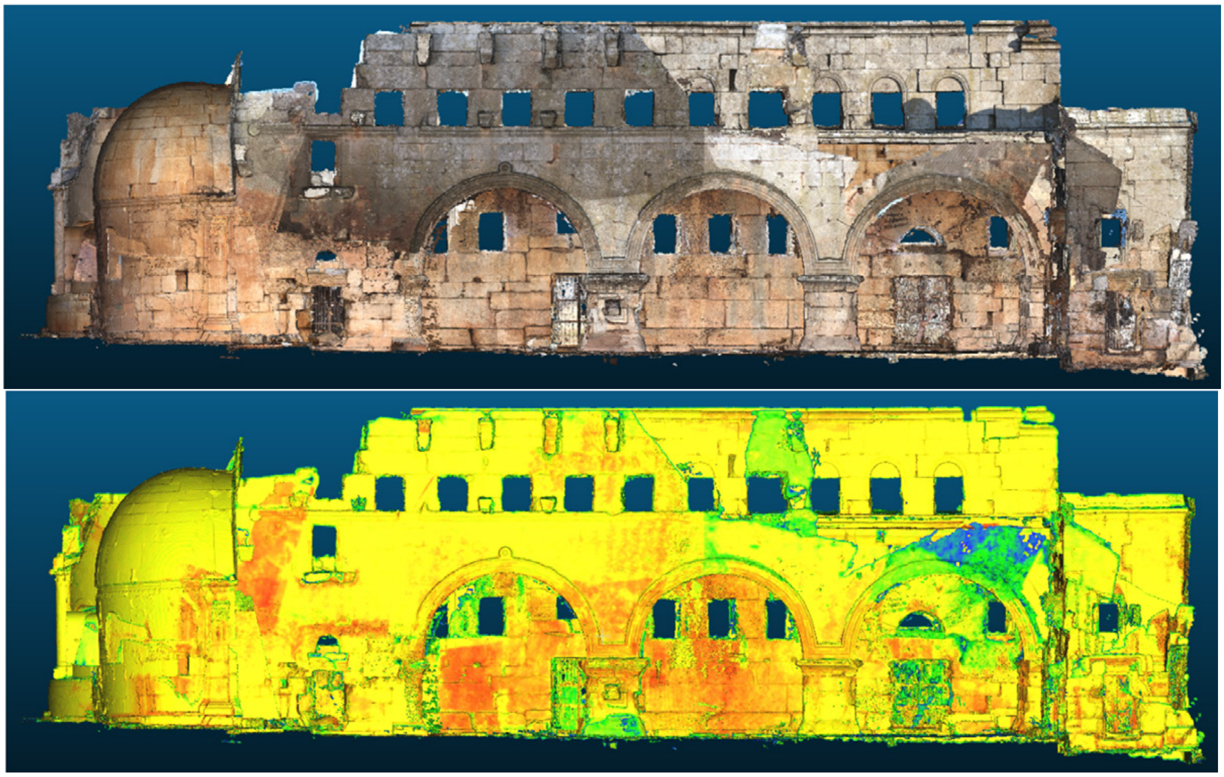


Figure 13 Section of the inside walls (the southern wall from the north)

The inner side of the northern inside wall could not be processed. Thus, the section on the outer side is shown (Figure 14). The model also lacks the pillars that actually exist in situ at the site.

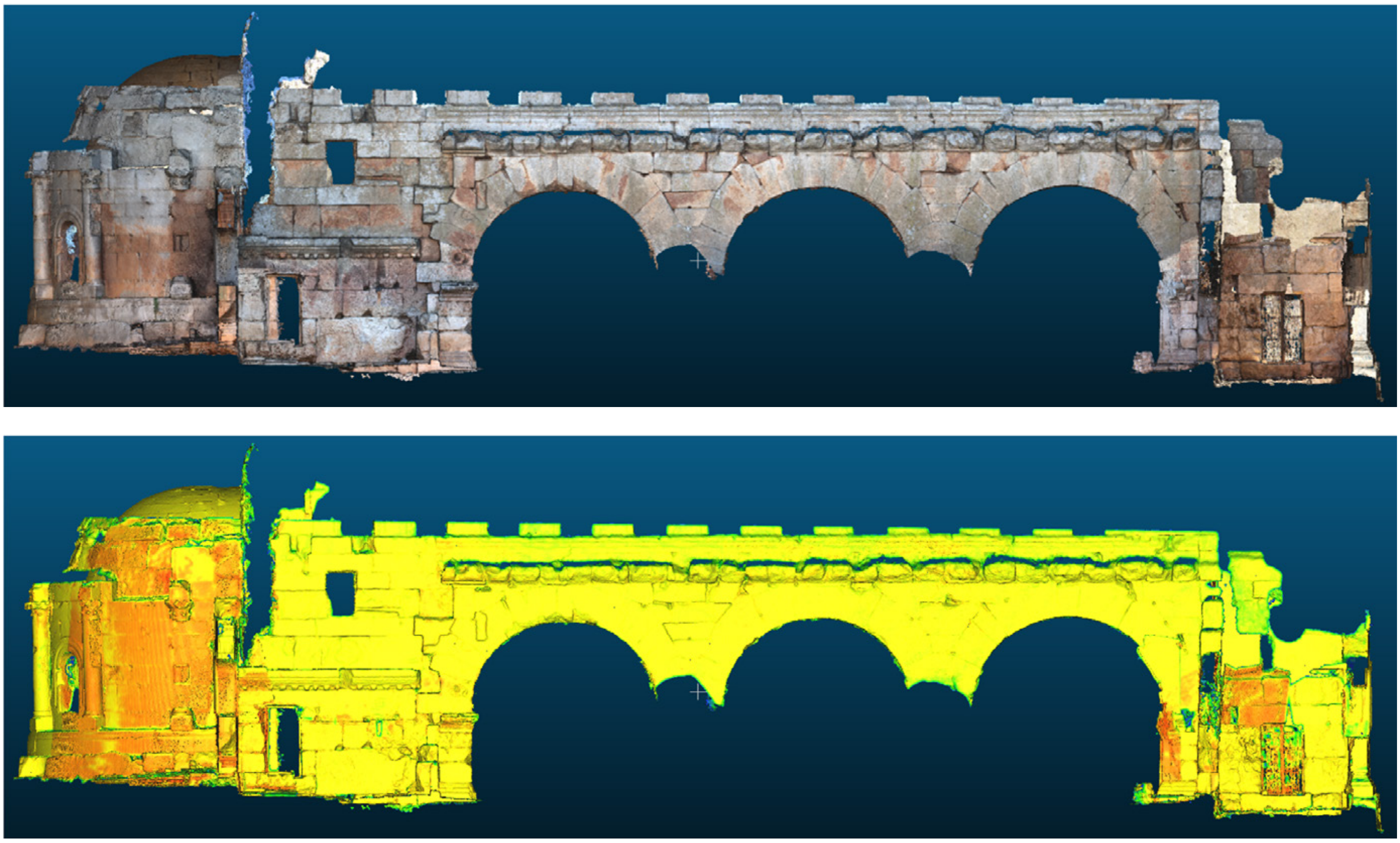


Figure 14 Section of the inside walls (the southern wall from the north)

The front section of the apse shows the left wall structure to be skewed, likely as a result of the reconstruction. The right wall has duplicate errors, which occurred when integrating the models.

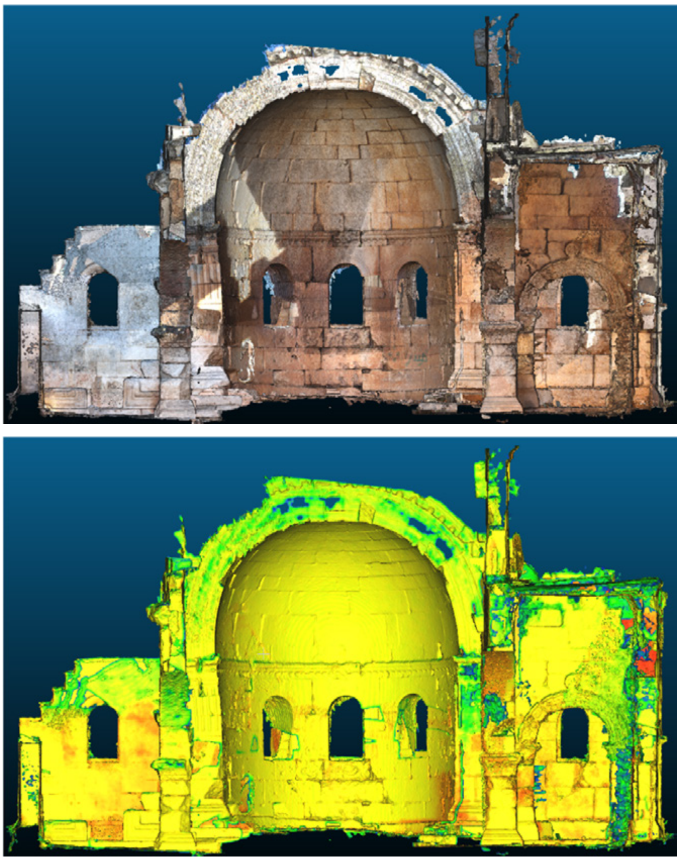


Figure 15 Front section of the apse (from the west)

3.3. Top views and plans

The church was horizontally sliced at several heights to illustrate the top views. The floor is not shown because only a portion of it could be generated in the model.

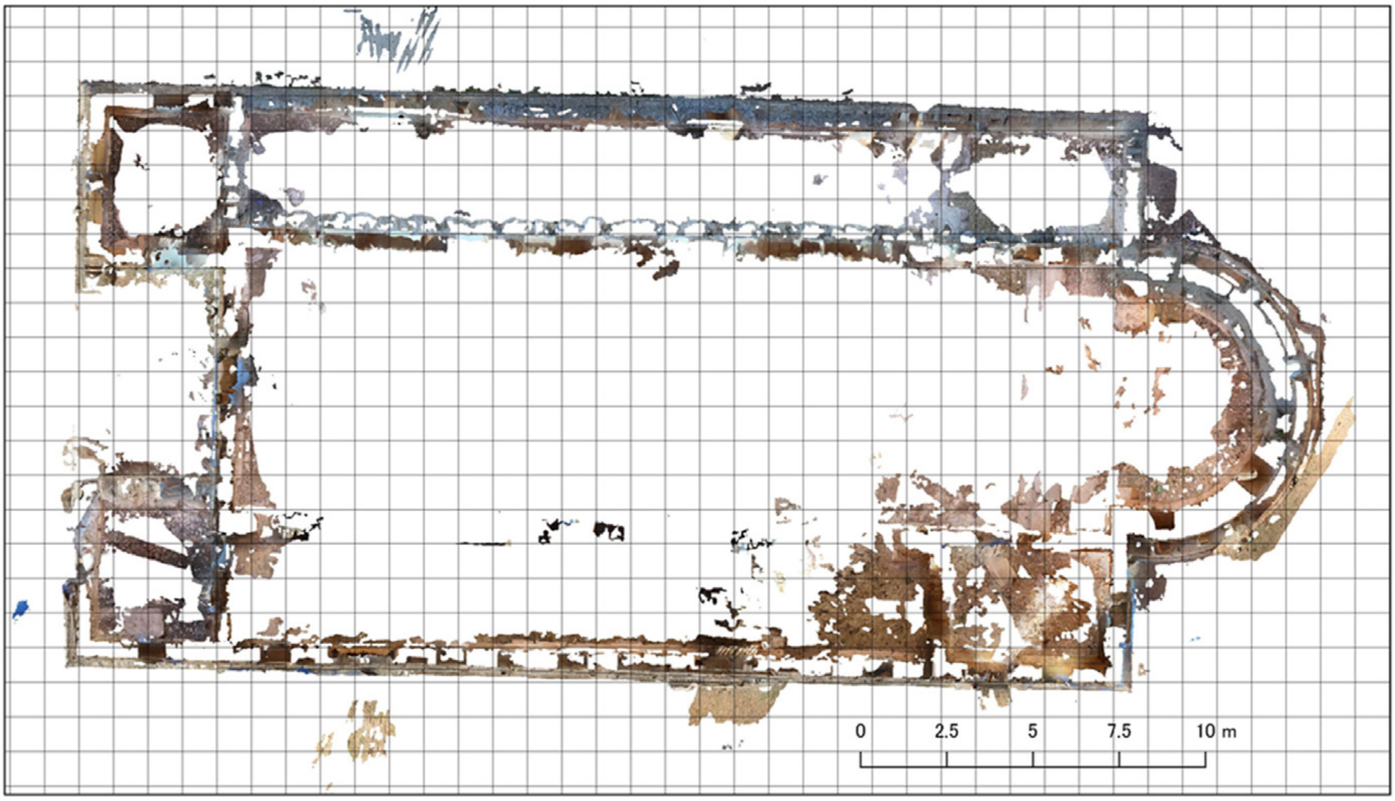


Figure 16 Horizontal slice near floor level.

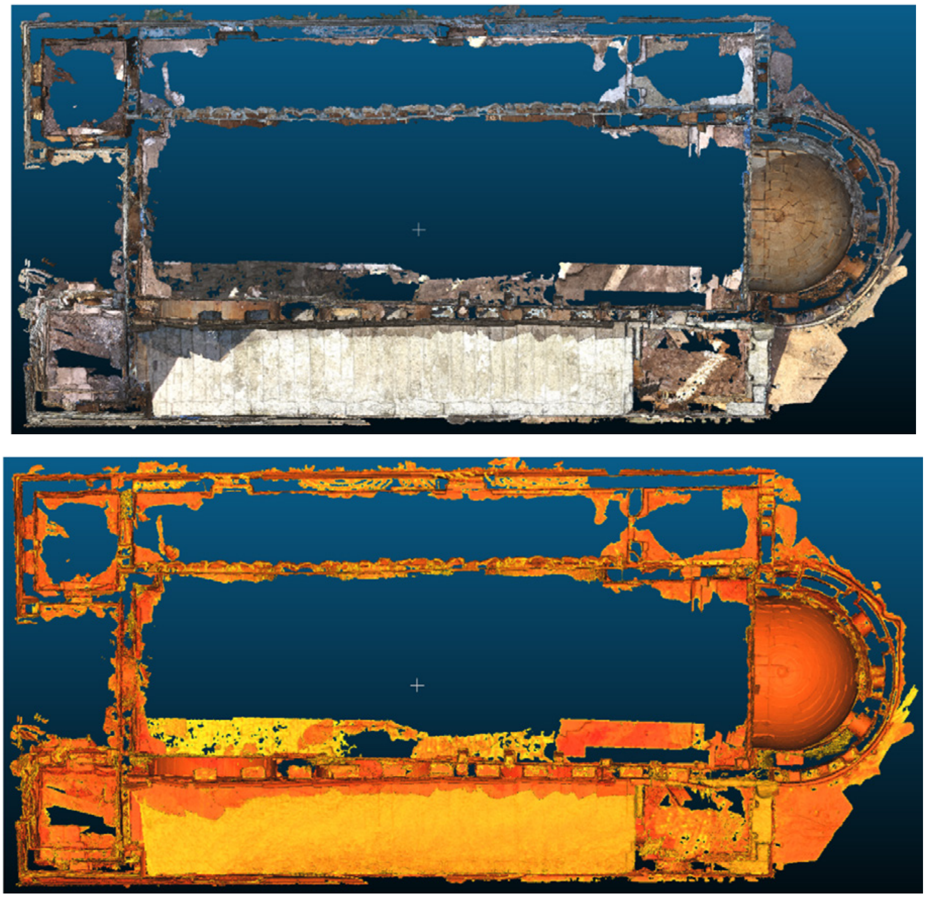


Figure 17 Horizontal slice near the lower roof.

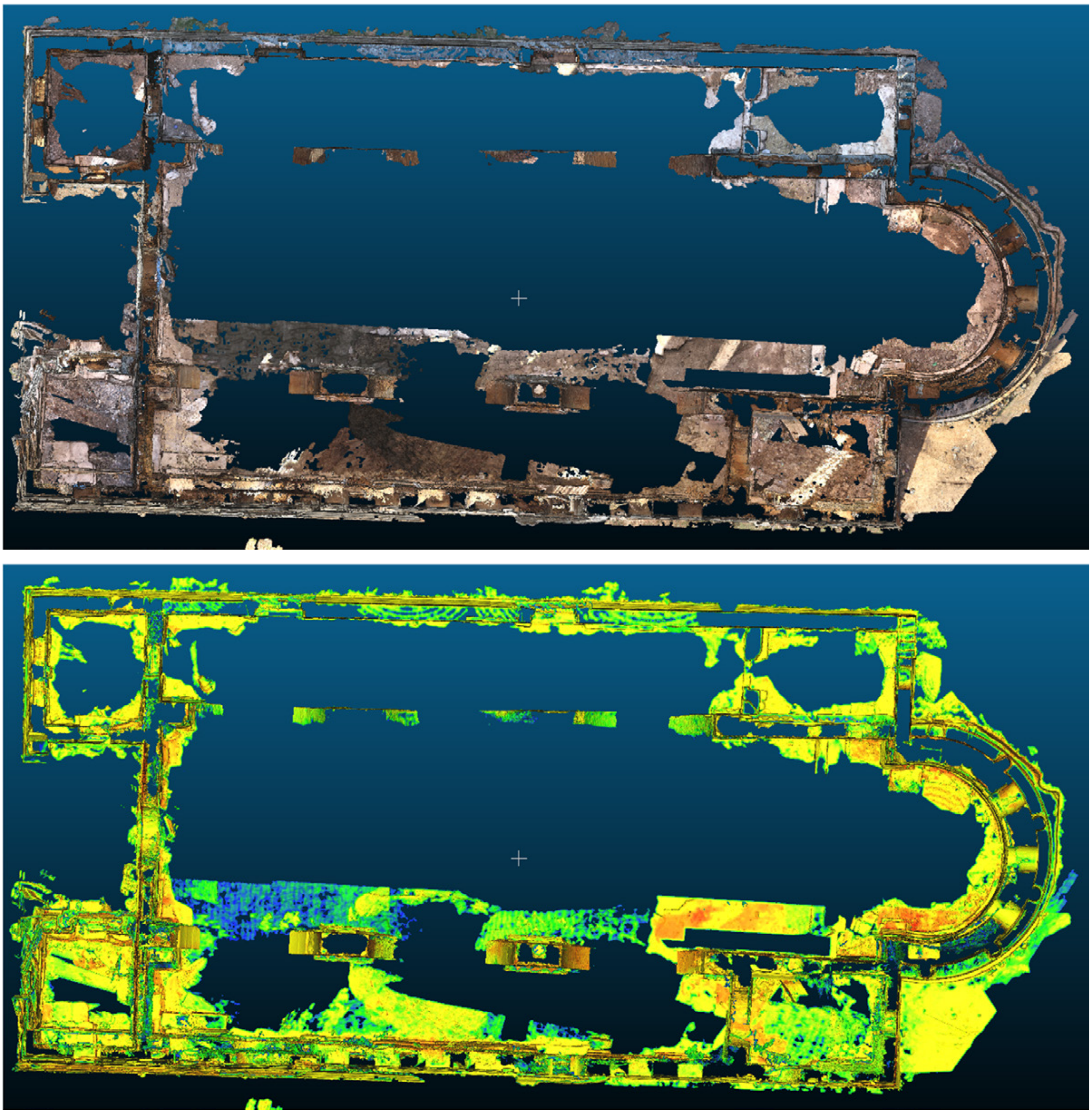


Figure 18 Horizontal slice around 3 m from the ground.

The creation of a top plan was attempted using the above figures. However, the area inside the dotted circle in Figure 19 shows the areas which are mostly un-modeled or clearly skewed.

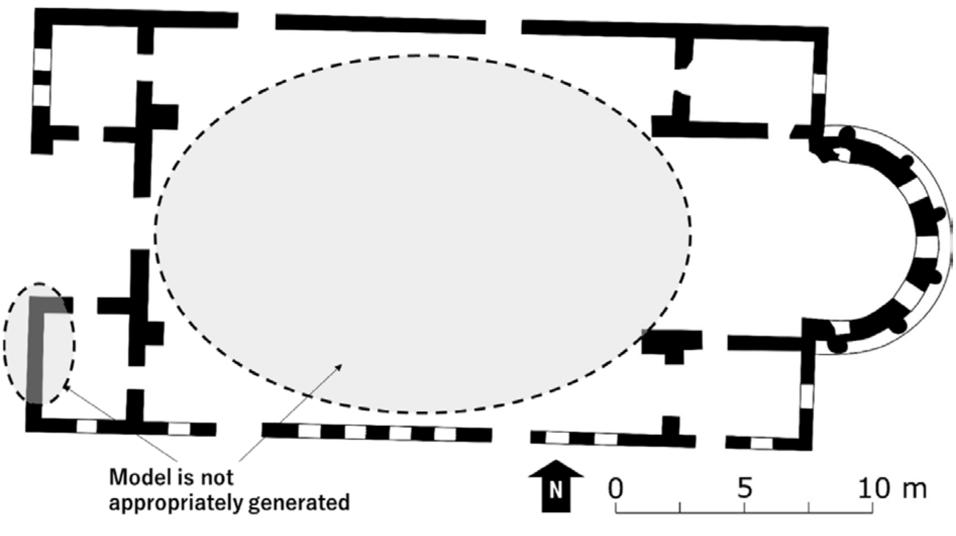


Figure 19 Top plan of the church

4. Comparing the components

The plans (orthorectified photographs) of the components of the church are listed and compared in this section.

4.1. Entrances

The basic square shape in the wall is common for all entrances. However, the decorations around the entrances in the southern wall are all different while they are same in the northern wall. The biased location of the symbol (next paragraph) in the south may imply that the south side of the church is more decorative than the north side.

(A)

(B)

(C)

(D)

(E)

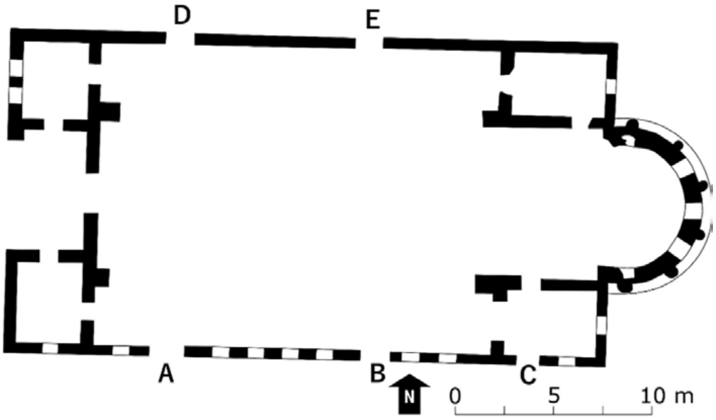
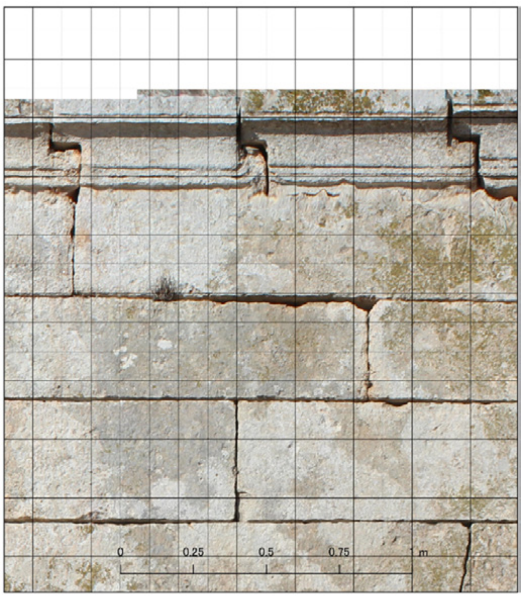


Figure 20 Comparison of the entrances in the wall

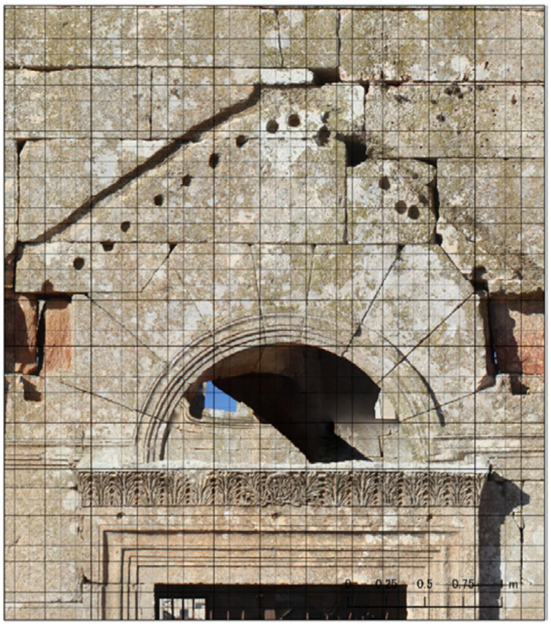
4.2. Masonry

Several characteristic masonries observed in the church are shown in the following figures. Again, the figures are orthorectified.

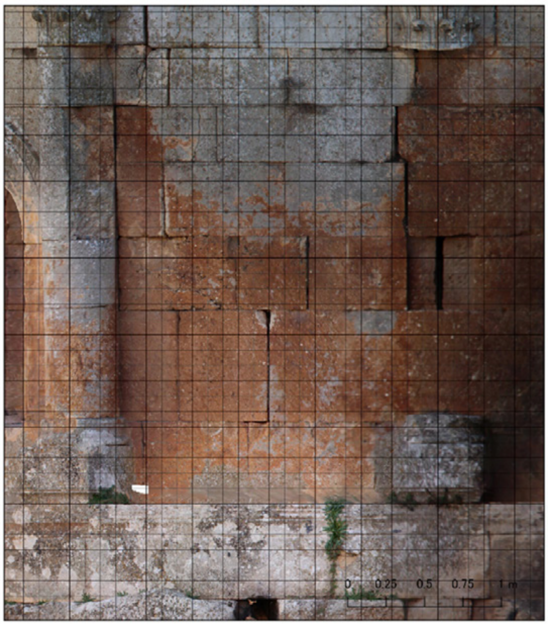


1(A)

(B)

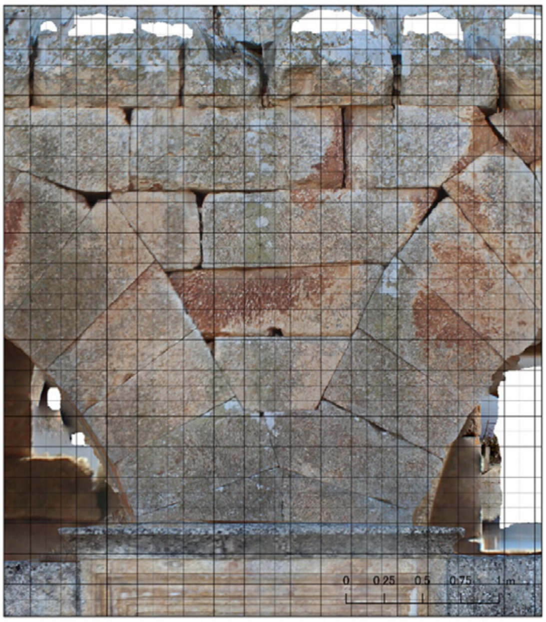


(C)



(D)

(E)



(F)

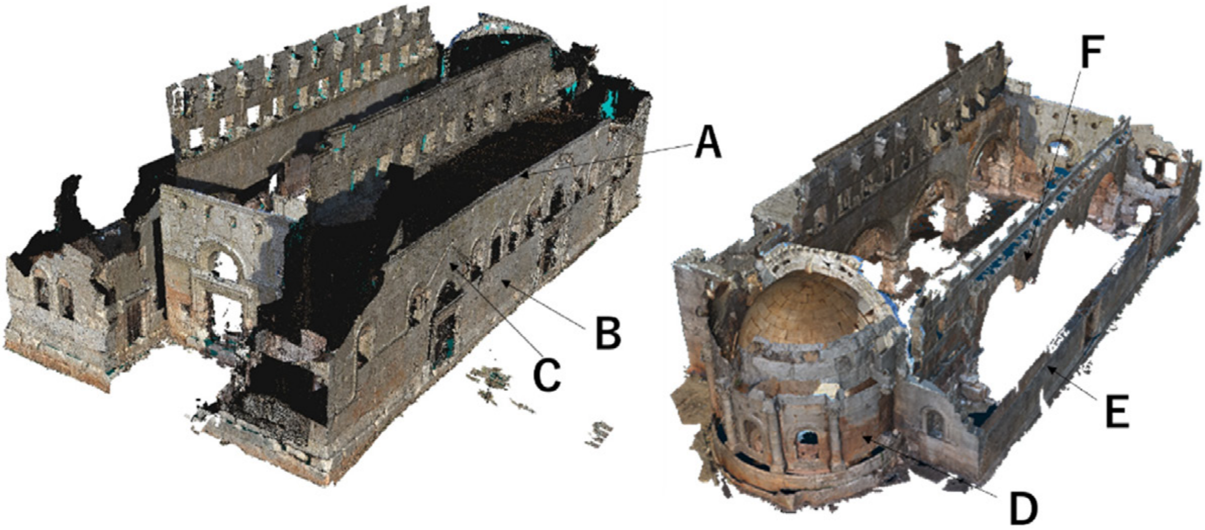


Figure 21 Masonries observed in the church

4.3. Symbols

The representative symbols observed in the church are shown in the following figures. All of the listed symbols are present on the outer side of the southern wall. Symbols were not observed on the northern wall, or at least they cannot be known from the model.

Figure 22 The symbols observed in the church

5. Attempt at 3D visualization

The use of a UAV will cover the dead spot in photographing. It is especially difficult to take photos of roofs and the surrounding landscapes. Not only the structure itself but also the landscape can be quite important to give context about the site of interest. A UAV can easily obtain this “landscape” information. However, it may not be easy to use a UAV in some countries and areas. In this case, Google Earth is another solution for adding this kind of information. Integration of UAV derived data and Google Earth will be introduced in this section.

5.1. Model generated from the UAV

The figures here are generated from the UAV, using 4K images cropped from the movie taken by a DJI Phantom3. The ground, the floor, and the roof are properly modeled since the camera was set to vertical. However, lack of photographs on the side of the walls and inside the church hinders the completion of an appropriate model.

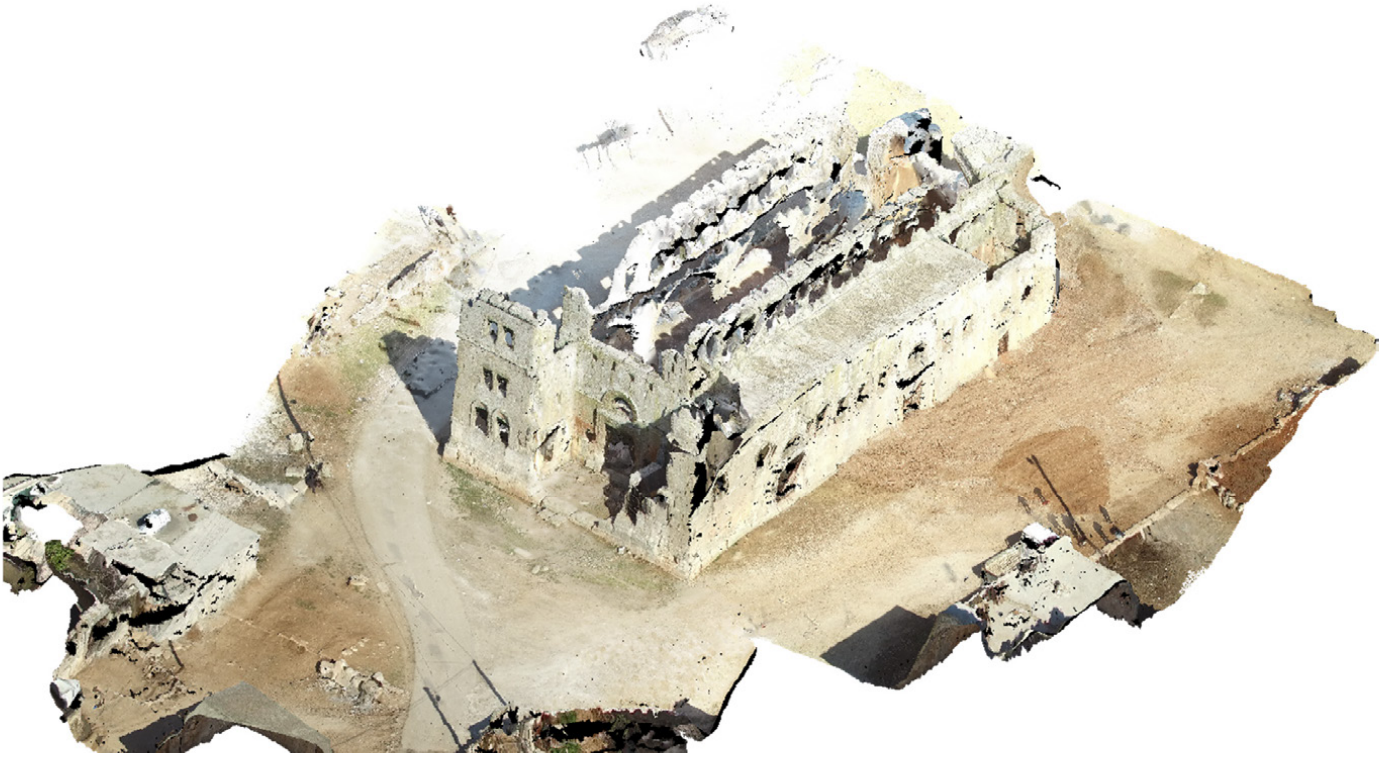


Figure 23 Birds eye-view from the south-west (model generated from the UAV)

Figure 24 Zoom up to the church from south-west (model generated from the UAV). Part of the southern wall is badly skewed.

The UAV derived data (floor and ground) and the result from the handheld camera (church) were combined (Figure 25). The result was mostly successful, although there were several gaps, which could not be filled. The photography area around the church was limited because of safety reasons. Of course a UAV is capable of taking a wider extent if the circumstances allow.

Figure 25 Combined model derived from the UAV and the hand held camera.

5.2. Combining the model with Google Earth

The model was combined with Google Earth satellite imagery using Sketchup (Trimble) (Figure 26). The surrounding landscape can be observed from this result. As a result, the geographical context of the church and its surrounding enironment can be understood.

Figure 26 Model combined with Google Earth satellite image

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