The complex of St. Daniel in Göreme, Cappadocia

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Abstract: The complex of the church of St. Daniel, has been excavated in the same massif as Tokali Kilise, it is a little known settlement, on which there are no major studies or assumptions. The complex consists of two pinnacles, one more than 40 meters high and a second lower one. At the base of the highest peak there are various secondary rooms, with multiple entrances, probably built at the time for storing food reserves, other goods, or to be used as shelters for animals. It is worth noting the presence of tunnels connecting such rooms with shelters at high altitude, the highest was to be occupied by a hermit's cell, a feature intended to facilitate the transit of persons to and from the warehouses or, more likely, as a defensive solution. The small size of these tunnels, prevented large numbers of people from passing through them; in addition, the shape of the tunnel itself forced the invaders to proceed one at a time, creating a better chance of success for the monk in case of attack. Nearby these locations there is a chapel dedicated to St. Daniel. The presence of mural paintings in both the chapels, creates a quite interesting condition where it is possible to see different decorative solutions, from the classical “red” paintings of the aniconic graphic to more rich and colorful representations. This articulated architecture, near to organic shapes, is very difficult to describe using traditional survey solution. The digital survey of the whole church, operated using 3D laser scanner technologies by a team from the “Dipartimento di Architettura di Firenze” in 2013, was the base to develop a specific reading of the whole church and refuges system, and to create drawings to be used by visitors and scholars for easy understanding of the richness of this particular and very representative settlement.

Keywords: Cappadocia, Turkey, Rupestrian, Digital survey, Representation

The rupestrian heritage in Cappadocia

Cappadocia is located in the heart of Turkey, in central Anatolia, limited to the West by the Dead Sea, to the East by the Euphrates, to the South by the chain of the Taurus Mountains and to the North by Pontus. It’s a land known for the beauty of its landscapes and the presence of many monuments dug in volcanic tuff. This small region is dominated by two volcanic massifs: Erciyes Dagi (3,916 m) to the South of Kayseri and Hasan Dagi (3,258 m) to the Southeast of Aksaray and by hundreds of other smaller volcanoes. The eruptive activity has produced over the centuries a relevant deposit, often reaching hundreds of meters depth, mainly constituted by tuff’s layers. The layers were modeled by atmospheric agents originating the lunar landscape that spreads over this unique place: plains of volcanic residues, canyon, cliffs, badlands, pinnacles, pyramids and the so called fairy chimneys (rock’s mushroom produced by erosion). During the centuries people living in the area has used these rocky masses to create a carved underground architecture, to defend themselves from the weather, from the natural disasters and from various forms of danger. The presence of soft and easily workable rocks encouraged the development of a stone architecture that, being dug in the rock, is preserved much better than the masonry buildings. The volcanic tuff, in fact, is a soft stone that has high

performance in term of thermal isolation; this has pushed the inhabitants of the region to choose the tuff to dig their domestic and sacred spaces. In Cappadocia, the rocky environment has not resulted in city of great dimensions, neither to monumental complexes, like in the case of Petra. The most common urban systems are constituted by concentrated and scattered settlements, based on an agricultural economy: underground cities, Christian monasteries, civilian settlements as wall villages, villages and castles. The current condition of degradation faced by these places stresses the urgency of interventions aimed at consolidation, restoration and protection of this immense archaeological and cultural heritage. It would be utopic to think the entire stone habitat could be protected, but some specific intervention on the structures with historical, artistic and environmental value is still possible.

The complex of St. Daniel

Göreme is a city of the Cappadocia that is located in the province of Nevşehir in the central Anatolia. The National Park of Göreme (Göreme Milli Parklar in Turkish) also known as Göreme Open Air Museum is the main organized structure in an area enrolled in the UNESCO World Heritage list in the 1985. Göreme is the first monastery in the world which consists of more than 200 rocky churches. The monks ate, slept and prayed in isolation. It's the first example in the world of lonely monastic life and community together, led by a self-sufficient community of monks. Göreme is the birthplace of the doctrine founded by St. Basil the Great in the fourth century, when Christianity was at its peak. In the same place parish churches, monasteries, hermitages, private chapels for funerary or commemorative purposes coexisted. Among these valleys the complex of St. Daniel is dug in the same peak of the Tokali Kilise (Fig. 1). The settlement looks on one side toward her Valley of the Swords, where the pinnacles have the shape of arrows and hilts, from the other side the Castle of Uchisar, located four kilometers far in straight line, creating all the conditions to communicate with this important outpost using visual signals. The St. Daniel complex belongs to a group of rocky peaks containing some places of worship and a convent, a specific system of refuges, and two churches: one dedicated to St. Daniel (Chapel n° 10), with still intact wall paintings; the second church (Chapel n° 13), non-iconic, typically decorated with geometric red patterns. However, both churches are the examples of basic decorations; maybe the owners and/or promoters of their realization didn't mean neither to hire painters, nor to finance a complete decorative program (Fig. 3). The degradation and the fragility of the paintings in the first church (hence it is perpetually closed) and the fragmentary nature of the space make it difficult to read the complex which is still arranged in three levels along the peaks.

The defensive aspect

The locals dug deep into the peak of the St. Daniel which was a kind of refuge used to receive and protect the monks (Fig. 4). The multiple accesses that allow the entry and the exit from the communicating rooms between them, guaranteed a rapid escape for the inhabitants toward the outside. In the case of St. Daniel, the defensive heart is situated at the top of the complex, connected to the base through a system of narrow pits. A small pit was a good form of passive defense. The tunnel had two functions: it allowed an easy access to the monks and the refugees, and it made it more difficult for assailants to access. The tunnel had an additional function as it was used to support air circulation inside the shelter. Monks exchanged visual

signals with the Castle of Uchisar that informed about an imminent attack. The defensive scheme of St. Daniel resides in its form, in the use of the height to build a secure shelter. Safety was achieved by running away through the dense network of tunnels that led to the Swords Valley, the perfect safe spot. The defensive system of St. Daniel prevents the attack temporarily, but doesn't allow to stop it.

The monastic aspect

The complex of St. Daniel introduces one of the fundamental aspects of the Cappadocia, the coexistence of a white church and a painted church (Fig. 5). The lower part of the Cappadocia's churches, in fact, are decorated with wall paintings. According to some recent censuses, there are around three hundred painted churches, but those without paintings are at least five or six hundred. The analisys and interpretation of the churches of the complex is based on an architectural approach.

The Saint Daniel Chapel (Göreme n° 10)

The Chapel of St. Daniel introduces a native plan with unique aisle culminating with a simple rectangular room with an apse, preceded by a narthex (Fig. 6). Here the narthex has a rectangular plan and is topped with a barrel vault cross, it has been excavated with many graves, becoming a burial area. The nave has a barrel vault. The altar is carved into the rock and is supported on the back wall, aligned with the floor. On the side walls of the nave there is a low bench. The bench has been digged in the rock, completely integrated in the plan of the church.

St. Daniel is an example of a chapel with simple decoration, where the patrons maybe did not have the resources neither to hire talented painters nor to afford a complete decorative programme. The paintings describe three different aspects of the popular religion: the cult of the cross, the cult of the images and apotropaic figures. There are two type of paintings: aniconic and figurative. The chapel is filled with line drawings made with red and green ocher that highlight the architecture, imitate ashlar, sprinkle the walls of crosses and geometric figures and animals. At St. Daniel's chapel the painting is not only used for expressing the dogma, but it manifests the trust in the protection and in the intercession of the represented Saints. There are pictures of Daniel among the lions, St. Basil of Caesarea and two images of St. Procopius. The apotropaic figure present in the chapel is represented through a dog by the ruffled hair as allusion to the diabolic temptations that tormented the monks. The dog painted near the cross was used to neutralize the action of the Evil. The other aniconic's paintings are made with red and green ocher on white plaster or directly on the bare rock (JOLIVET-LÉVY 2002) (Fig. 7).

The chapel, according to Jolivet-Levy, it could be a testimony of the XI century (JOLIVET-LÉVY 2001). It has certainly played multiple roles and functions during the time, and it changed its nature from place of faith to warehouse, refuge, shelter and other, and has been shaped and adapted to different needs.

The Aniconic Chapel (Göreme n° 13)

The church is slightly set in a behind position in comparison to the peak of St. Daniel. The plan is divided into two parts, an older (lower), the entrance narthex, and the other more recent (highest). The building exploits the verticality to increase the sense of greatness of the place, also sees the absence of paintings (Fig. 8).

The chapel was probably a private foundation, with funeral purpose, as testified by the huge number of graves. The irregular form of the chapel is really due to the following amplification to adjust the rocky building to new demands or to the evolution of the religious rite. It is believed that the change of axle during the realization of the second part is because the chapel would have dug near too much to the external perimeter. The plan type is cruciform for both the parts, with two domes to cover the central spaces formed by the intersection of the arms. The chapel has a series of decorations in red ochre on white background representing mainly the symbol of the cross, accompanied by ornamental aniconic motives. A lot of the aniconic decorations of the Cappadocian's churches refer to a preceding period to the iconoclasm and testify the importance of the cult of the cross. However, even after the end of the iconoclasm there are examples of no-figurative paintings.

The digital survey of St. Daniel's complex

The initial phase of the documentation process for these cave churches and their surrounding environment was based on a careful and accurate digital survey. The survey campaign of the rocky structures of Göreme was operated at the beginning of 2012 in a mission based on the collaboration between DIDA (Department of Architecture, UNIFI, Florence), the DISBEC (Department of Cultural Heritage Science, UNITUS, Viterbo) and CSS (Centre for Underground Study of Genoa). These units would be later partners in the PRIN 2010-2011 (Italian National Project Relevance) approved in 2013 by the Italian Education, University and Research Ministry, in a triennial project called "Rupestrian art and habitat in Cappadocia (Turkey) and in central and southern Italy. Rock, excavated architecture, painting: between knowledge, preservation and enhancement". During the 2012 campaign, besides the monuments of the Göreme Open Air Museum, the investigation has also concerned the structures identified in the surrounding valleys as Swords Valley. During this mission many rupestrian structures were analysed as the Tokali Kilise, the Meryenmana, the St. Eustachius Kilise and others. The complex of St. Daniel, has been surveyed, instead, during the 2013 campaign, with a rich production of scans. The survey work was planned in three main solutions: photographic survey, 3D laser scanner survey, panoramic photos survey. The 3D laser scanner used in all of these stages was a phase-shift type, a Cam/2 Faro Focus 3D (Fig. 9). This unit offers good accuracy combined with easy handling, small size, low weight and a compact tripod. The working range of this instrument ranges from 0,6 to 120 meters. The surveys were completed taking numerous scan stations, all of them operated in full panoramic mode, and exploiting the characteristics of the 3D laser scanner in use, which was capable of scanning 360° on the vertical axis and 320° on the horizontal one. For St. Daniel the number of scans was 80, with a set of 16 for the interior of the main church. A set of 10 scans was used to document the aniconic church. Using a 3D laser scanner unit with a ranging noise of ±2 millimeters, the planned work was aimed to have an aligned result with an average sampling of 2 to 3 millimeters for the interiors and 5 to 10 millimeters for the external surfaces. Particular interest was paid to the possibility of bringing together the scans of the exterior parts with those of the interiors, producing a very detailed and comprehensive analysis of the relationship between shape, architectural features and organizational features, combined with the status of the erosion. The photographic documentation was taken using a Nikon D800 36.3Mp. The digital survey of the St. Daniel's complex was the base to create drawings and a model

for 3D printing to be used by visitors and scholars to understand better the richness of this particular and very representative settlement: virtual reality installations and other multimedia products for the visitors of Open Air Museum.

3D data treatment and modelling for settlement

After the end of the survey campaigns, each dataset of the churches of St. Daniel's complex was immediately processed from single scans to form a complete, aligned point cloud. This procedure has created specific archives with the three-dimensional descriptions of each architectural structure. Later, the surveys of single structures were going to be combined in an overall model of the rupestrian settlements of this area. The main software tools used for the first alignment of the data were Cam/2 Faro Scene and Leica Geosystems Cyclone (Fig. 10). The registering process was based on the target system (where available) and/or on the basis of morphologically recognizable features. This increased the overall time of alignment, due to operations that have always required a lot of precision from the operators in order to prevent small errors from progressively reducing the level of accuracy. Therefore, the group of scans has been processed for the development of a comprehensive model based on the point clouds that are well descriptive of all the interiors and exteriors of the two churches. The point clouds were available in variable densities, the denser for the interior (with points on a grid spaced between two and four millimeters apart) and the sparser for the outer surfaces (with points spaced generally between five and ten millimeters apart).
Once the first phase of restitution was completed, with the alignment of the individual churches done, the extraction process of the two-dimensional drawings was started immediately, which is oriented towards the production of traditional representations that are useful for reading and understanding each structure. The Leica software controls the data according to a browsable tree, with the root placed in the workstation that has the first branching one or more databases, each of which represents a set of point clouds. All information pertaining to the database is stored in a single resident format file (.imp). The model obtained consists of discrete points, so you cannot create a section with a plane. The points of this slice can be joined by a polyline that draws the section. Once drawn the polyline it can be exported in vectorial format (.dxf) and then processed with Autodesk AutoCAD software. Even if this processing is time consuming and creates useful but not impressive representation, it is important to remind that this kind of drawing is highly important for real analysis and that the process of preparation and drawing in itself is a significant process of understanding and reading (Fig. 11). This research work aims to align to a graphic job already begun by Catherine Jolivet Levy through a traditional approach but readily legible (JOLIVET-LÉVY 2001) (Fig. 12).
The following processing has led to the passage from the point cloud representation to the one based on polygonal surfaces. The need to produce a lightweight 3D digital model for multimedia and dissemination purposes was faced using common procedures based on the extraction of a normal map from the high resolution model, applying the procedures of decimation and optimization on the same model and then using the normal map over the simplified model to create a virtual enhancement of the level of detail according to the original, not simplified surface. Importing complete parts of the point cloud in Raindrop Geomagic Studio 2012, made possible to create very good quality surfaces and to generate a mesh surface free from "holes".

The file has been optimized and reduced to ¼ of the original one. The software used for the simplification process was Pixologic Zbrush, exploited for its retopology functions. (Fig. 13). This operation has produced a lighter and more manageable model, optimized and aimed to fulfil the functions for which it was intended (modelling for 3D printing). Once the operation was finished, the file has been exported in Mcneel Rhinoceros 3D to create the base for the printable object (Fig. 14). Creating these copies would inevitably cause a partial “loss” of the quality of the original, although technologically advanced solutions can produce an enhancement and offer significant added values based on advanced, but not intrusive, digital solutions: a technological clone, non-invasive and able to convey specific information. In this way, the visitors can obtain knowledge of these environments in their original shape but with some meaningful enhancement, a solution that can perhaps bring these ancient structures, nearly a thousand years after their realization, into the age of the information revolution.

Conclusions

Unfortunately, it is not always possible to preserve a place as it is forever, and this is even more evident in Cappadocia. The uncontrollable natural erosion and mass tourism are two factor of risk for this inestimable cultural heritage. The decay of these places will have no end, leading to a daily loss of data and information, threatening and destroying the rocky structures. It is difficult to intervene on these structures through operations of consolidation, because of the elevated number of finds, and because of their conformation, destined by their same nature to a process of alteration and destruction. Therefore, the problem of the fruition from the collectivity of this immense patrimony arises.

The digital technologies, applied to cultural heritage, can lead to the construction of effective and communicative models that allow approaching the vast majority of people to the cultural contents. The complex of St. Daniel, as well as other sites of the Cappadocia, one day will disappear. This will be a slow process and some restoration can extend its duration. The digital preservation of the church can be an interesting alternative, using multimedia and online solutions, but an even more interesting solution can be evaluating the possibility to create a physical clone of the church. The physical model, cloned, becomes an alternative to the reality: a technological clone, non-invasive and able to convey specific information. The creation of a didactic, interactive, virtual environment, through a copy in true size, prototypes smaller scales or through a more traditional graphic work (two-dimensional), is a valid alternative to preserve slowly disappearing sights. To create a clone means to loose something because its nature of copy, but acquiring a lot in its nature of extremely new and digitally oriented solution. At the same time the clone can be accessed from any other part of the museum or can be even mounted and unmounted for different events and needs. The ability to replicate models and their realization with synthetic materials such as PLA (polylactic acid, a thermoplastic used in 3D printers) suggests how these models are capable of supporting even long periods of exposure to the public without suffering significant damages, eventually to be replaced at the appropriate time for a low cost. In this way, the understanding of the shapes and the articulation of the system formed by the churches and the refuges can be reached in a very direct way, where the scaled representation allows visitors to understand more clearly the actual structure of the complex and the relationship between parts (Fig. 15). The set of explanatory and descriptive panels allows for complete understanding of the structure,

adding detailed information about the wall paintings, the articulation of functions, the original use of the complex and the hypothesis about its development and its characteristics relative to its original environment. The use of advanced technologies, such as 3D printing, combined with the production of a graphic work more traditional, two-dimensional, aligned to a graphic job already begun by Catherine Jolivet Levy, it is significant to understanding and reading real data. We can inspire the visitor's desire to see the original, but at the same time allow him or her to experience these copies and drawings as an opportunity to better learn and better understand the characteristics of the original itself. In this way, the visitors can obtain knowledge of these environments in their original shape but with some meaningful enhancement, a solution that can perhaps bring these ancient structures, nearly a thousand years after their realization, into the age of the information revolution.

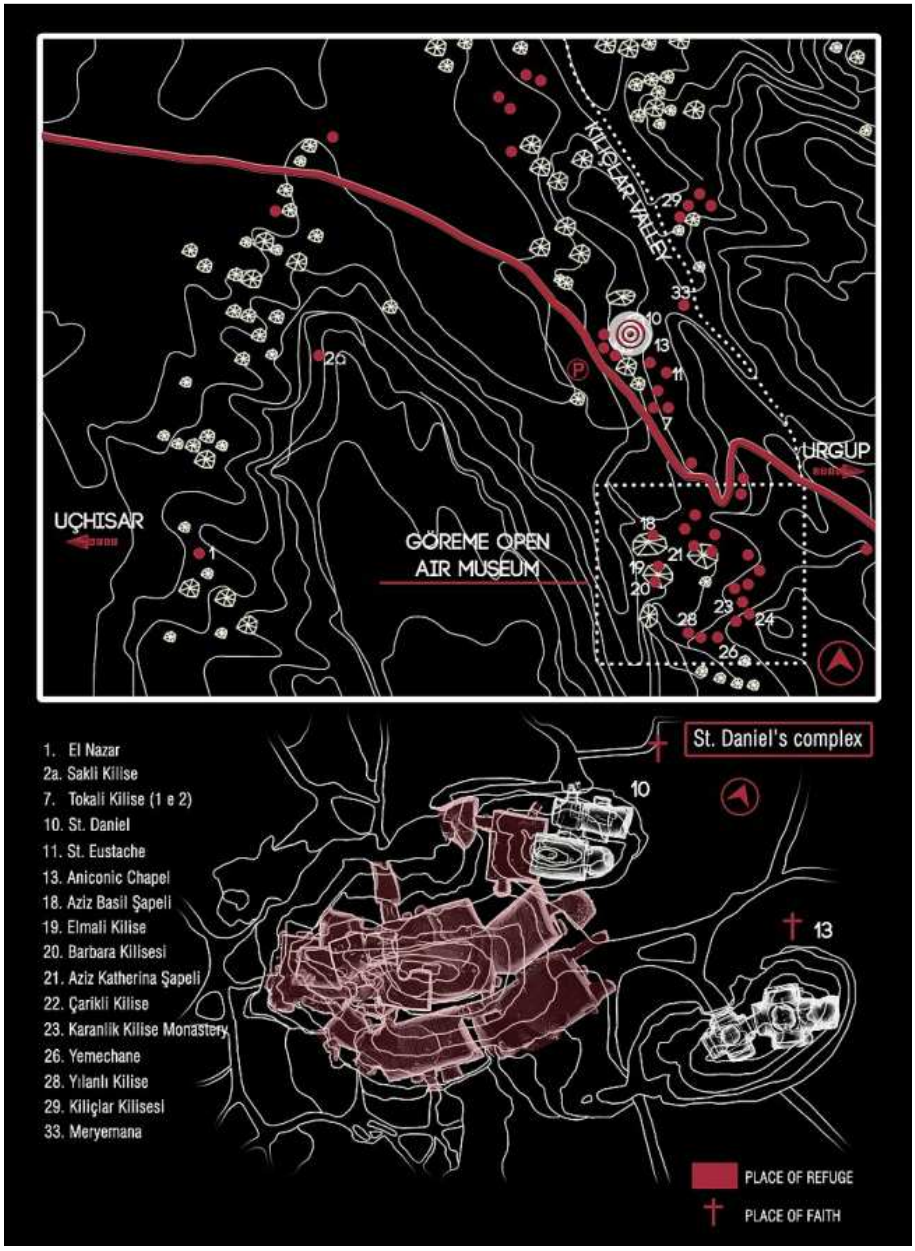

Fig. 1 – Göreme Open Air Museum map including the complex of St. Daniel (Copyright: Francesca Rafanelli)

Fig. 2 – View of the complex of St. Daniel (Copyright: Giorgio Verdiani)

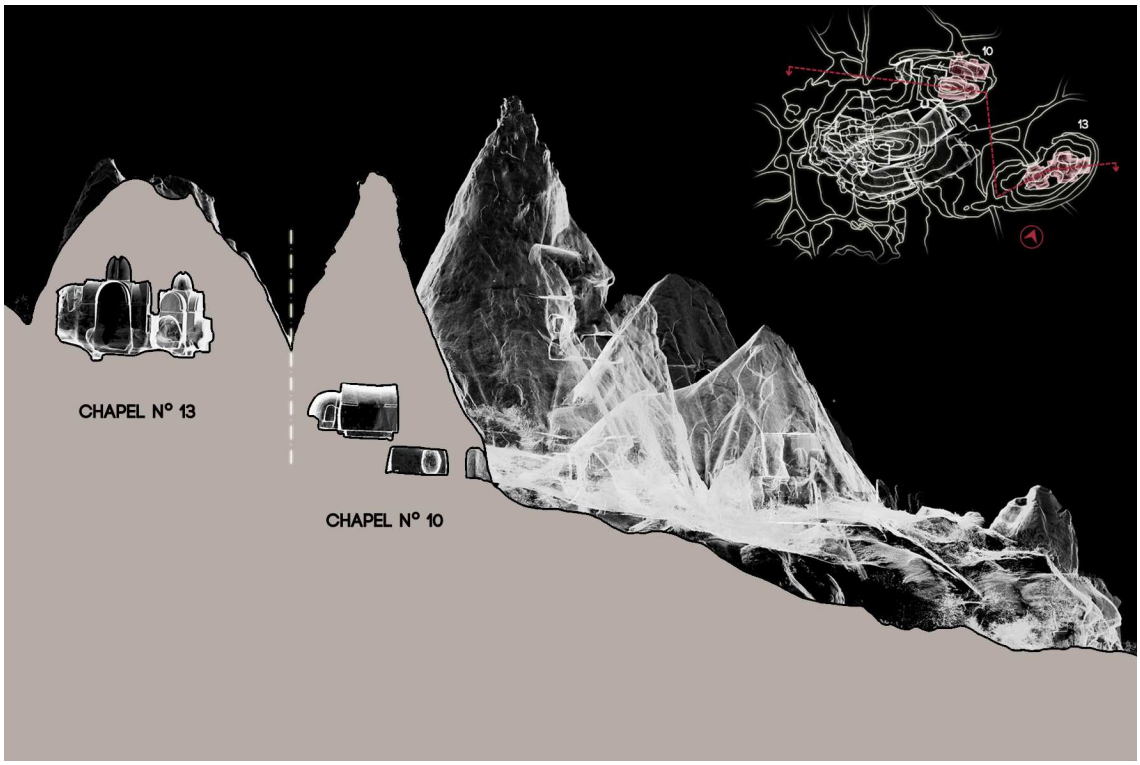

Fig. 3 – Churches of the complex of St. Daniel – section (Copyright: Francesca Rafanelli)

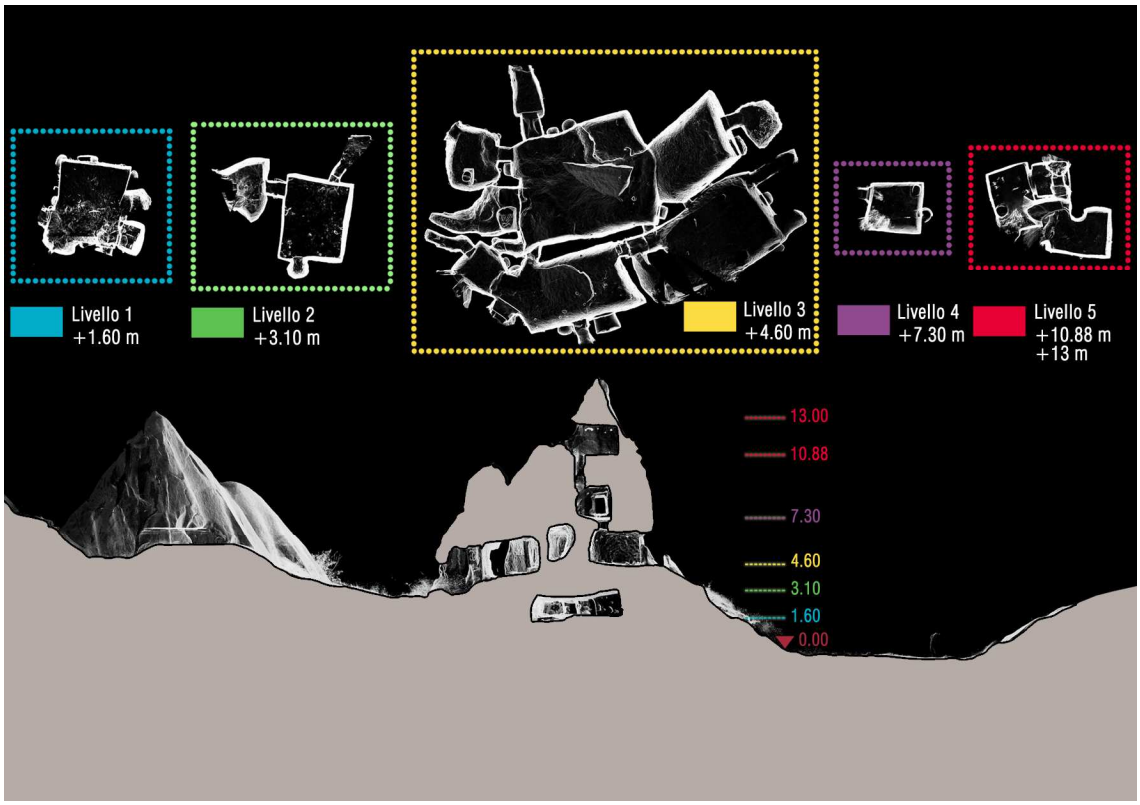

Fig. 4 – Defensive section of the complex of St. Daniel (Copyright: Francesca Rafanelli)

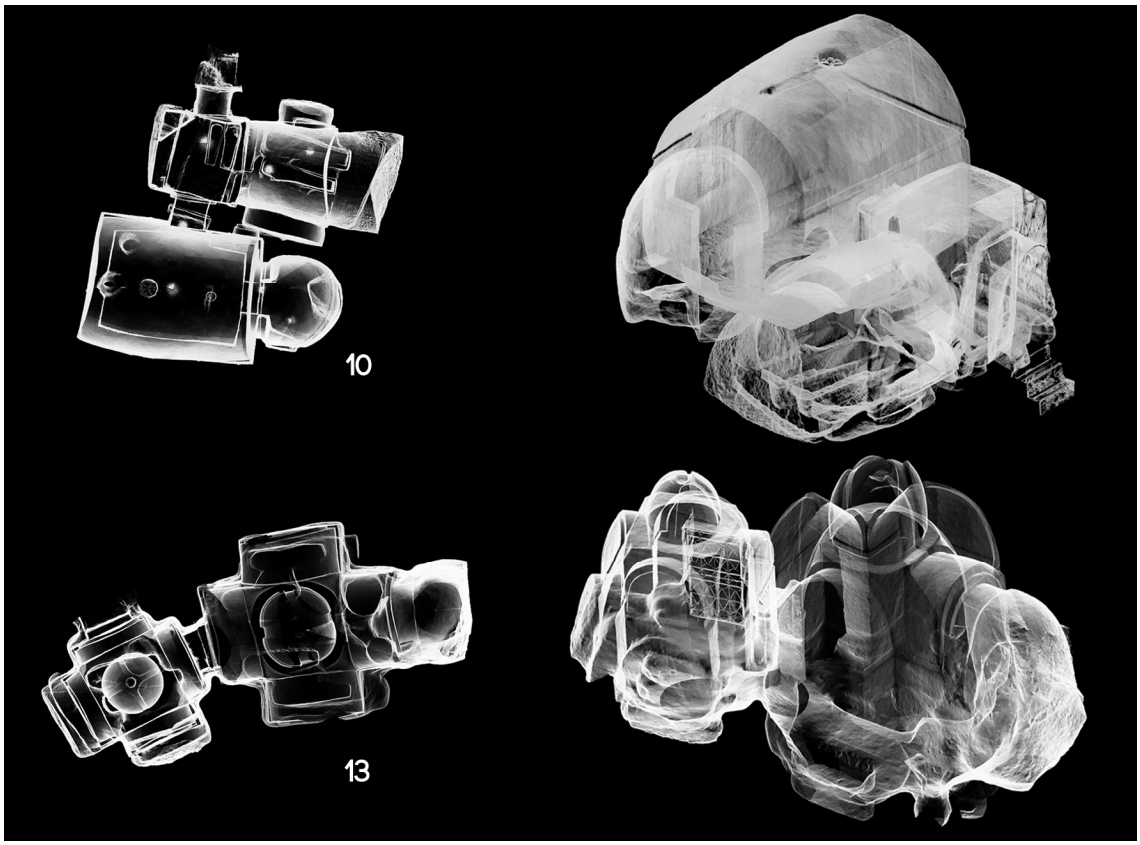

Fig. 5 – Screenshot of the two Churches of the complex (Göreme n° 10 and n° 13) – Leyca Cyclon (Copyright: Francesca Rafanelli)

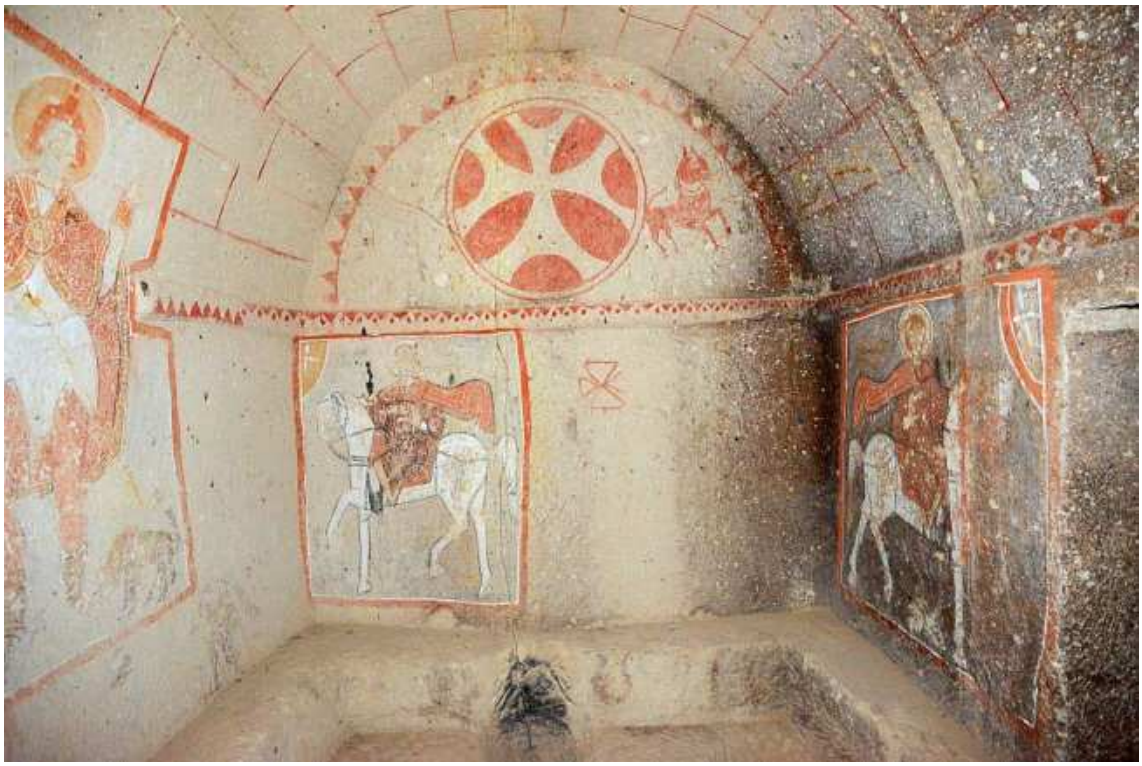

Fig. 6 – View of the inside of the St. Daniel's Chapel - Göreme n° 10 (Copyright: Giorgio Verdiani)

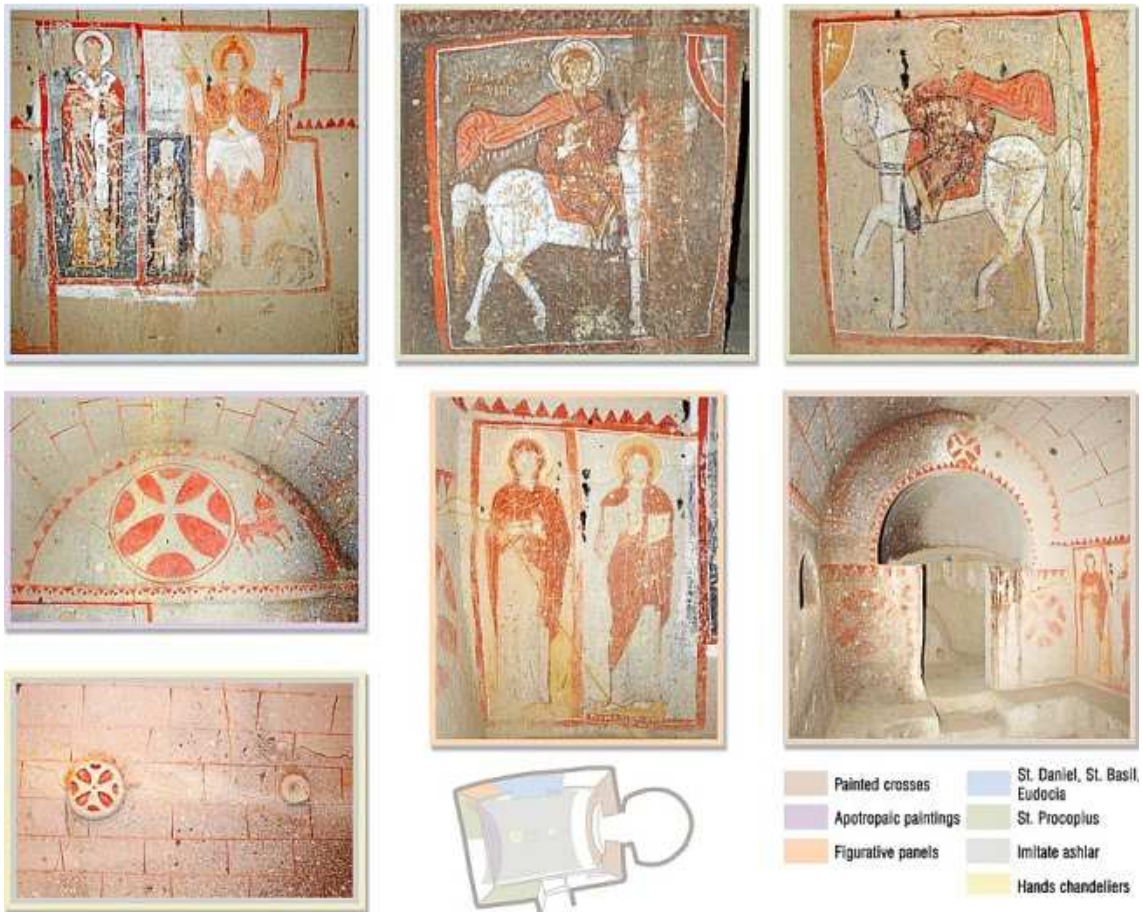

Fig. 7 – The paintings of the St. Daniel's Chapel - Göreme n° 10 (Copyright: Francesca Rafanelli)

Fig. 8 – View of the inside of the Aniconic's Chapel - Göreme n° 13 (Copyright: Giorgio Verdiani)

Fig. 9 – CAM2 Laser Scanner Focus 3D (Copyright: Giorgio Verdiani)

Fig. 10 – Screenshot of the complex of St. Daniel pointcloud – Leica Cyclon (Copyright: Francesca Rafanelli)

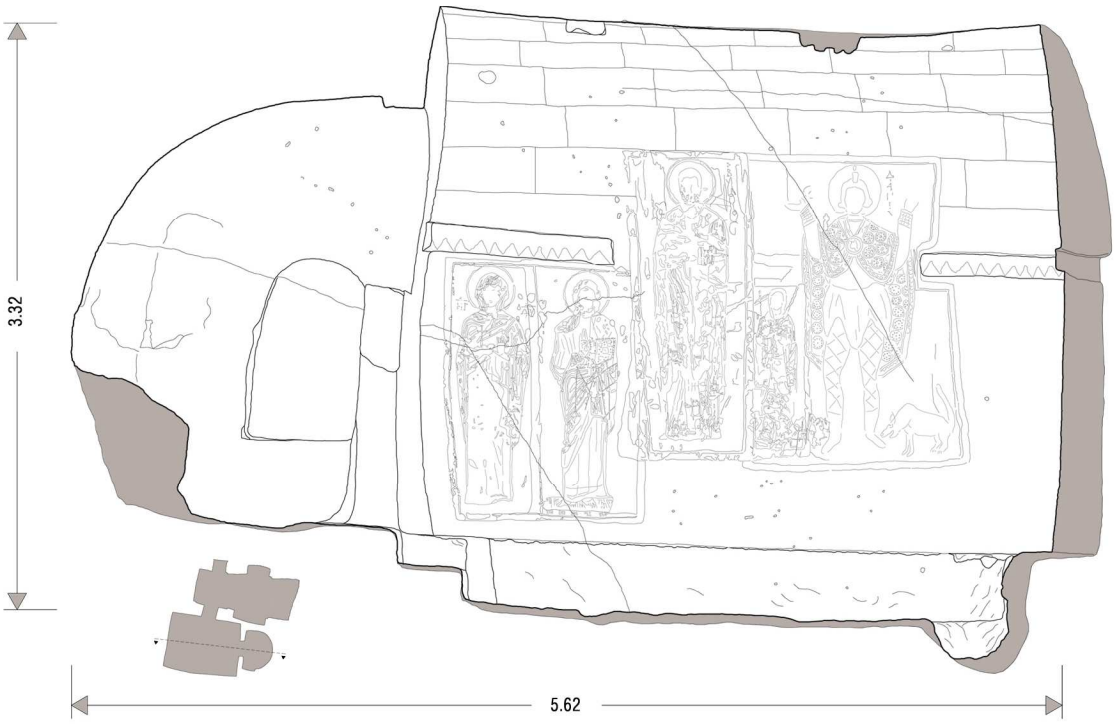

Fig. 11 – St. Daniel's Chapel (Göreme n° 10) – Section (Copyright: Francesca Rafanelli)

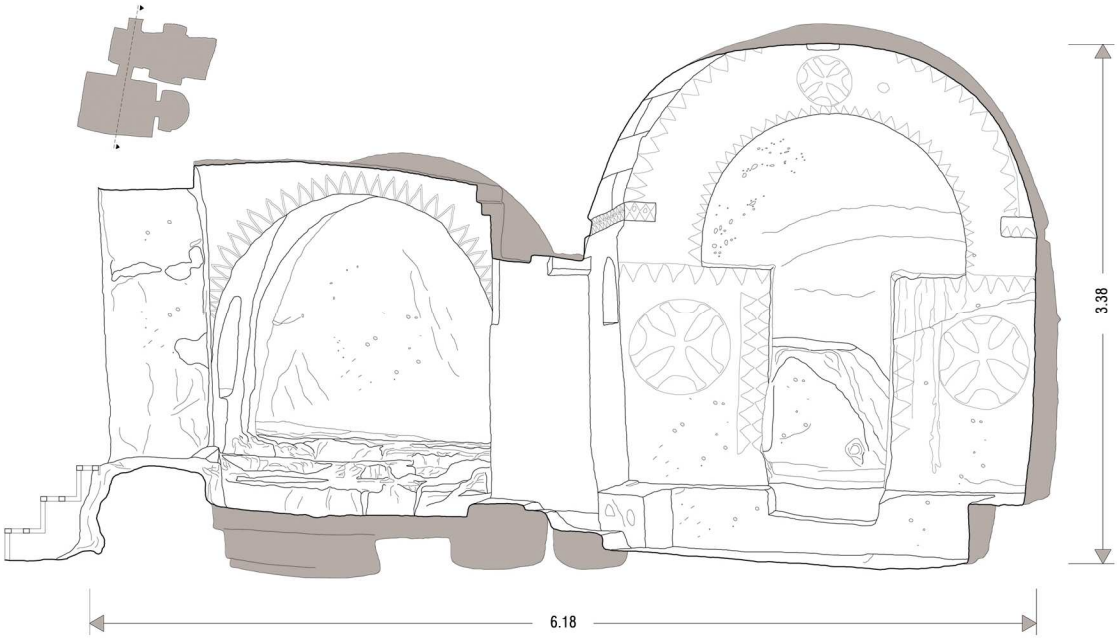

Fig. 12 – St. Daniel's Chapel (Göreme n° 10) – Section (Copyright: Francesca Rafanelli)

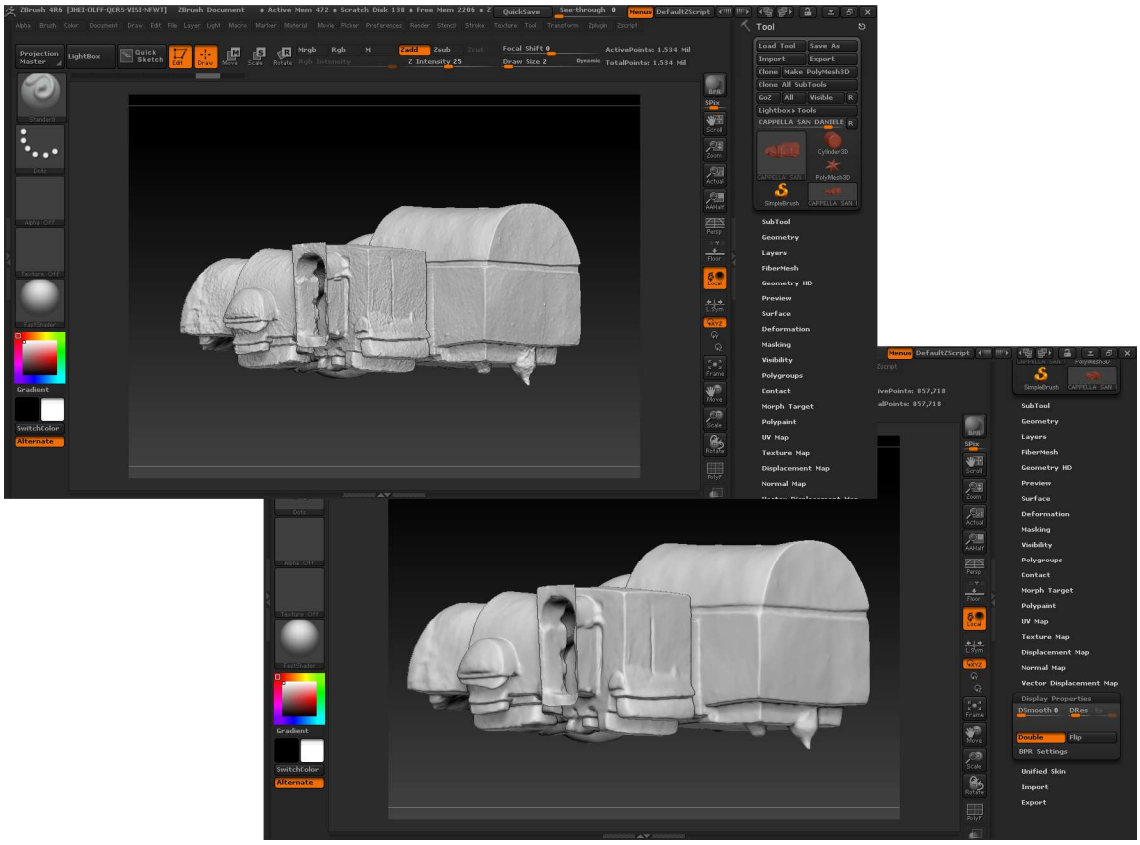

Fig. 13 – Screenshot of the St. Daniel's Chapel (Göreme n° 10) mesh – Mesh high (up), Mesh low (down) - Zbrush (Copyright: Francesca Rafanelli)

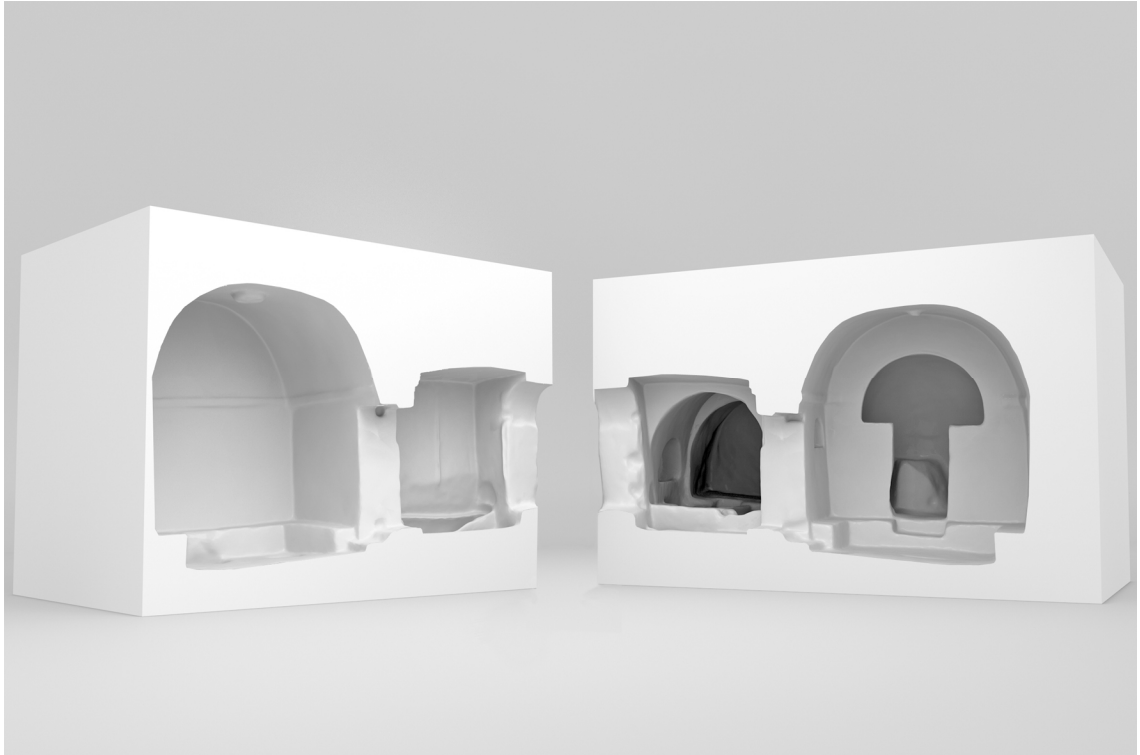

Fig. 14 – St. Daniel's Chapel (Göreme n° 10) – 3D model (Copyright: Francesca Rafanelli)

Fig. 15 –A suggestion of use of the clone of the Church inside a Museum (Copyright: Francesca Rafanelli)

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