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KEEP THE REVOLUTION GOING >>>

Proceedings of the 43rd Annual Conference on Computer Applications and Quantitative Methods In Archaeology

edited by
Stefano Campana, Roberto Scopigno,
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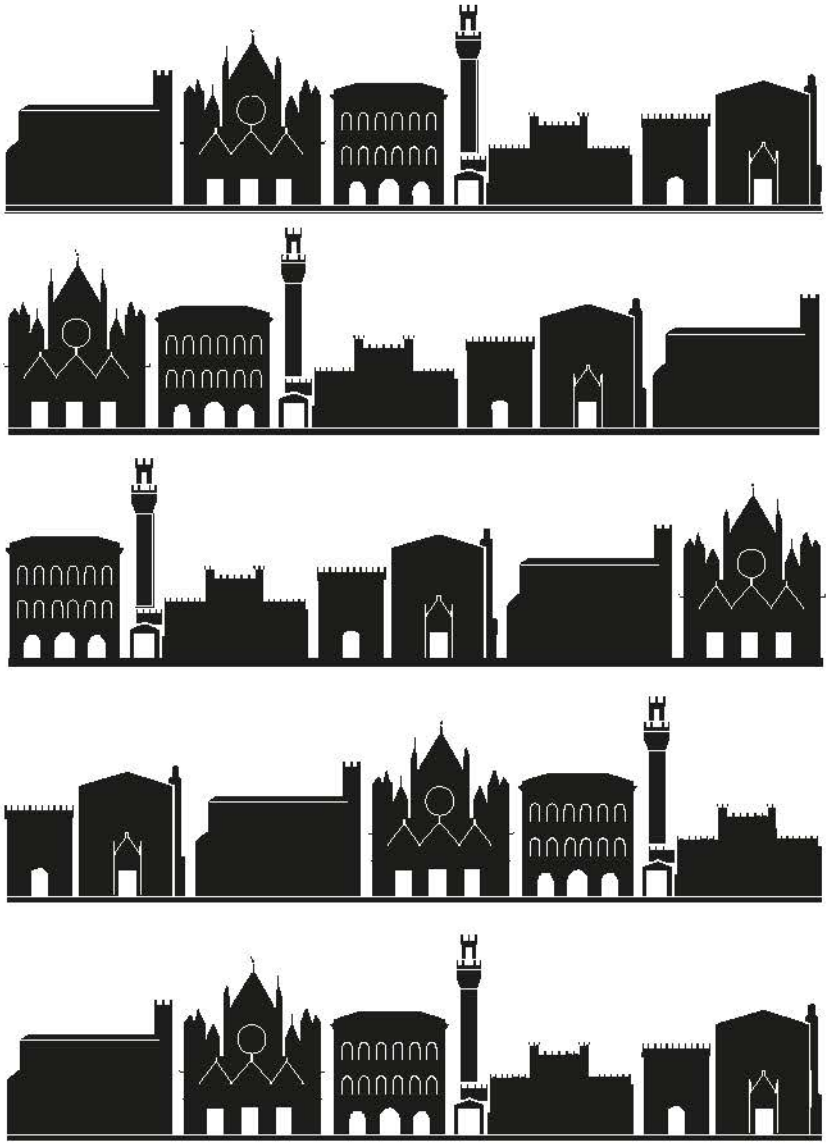

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CAA Computer Applications & Quantitative Methods in Archaeology

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Mediated Representations After Laser Scanning. The Monastery of Aynalı and the Architectural Role of Red Pictograms

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Abstract: In Cappadocian rock-cut architectures, red pictograms painted on rock surfaces were long considered only as abstract decorations of the iconoclastic period to be lately converted into polychromic frescoes, but today other interpretations appear plausible. In the Monastery of Aynalı near Göreme, pictograms both decorate the key elements and describe visual hierarchies with the secondary consequence of transforming the architecture itself into a huge representation: a sort of full-scale model to evoke existing buildings and to design its final configuration. Integrated applications of laser scanning and digital photography today allow the study of these decorations together with the actual shape of rock surfaces supporting them, and may offer innovative contributes to archaeological and historical researches on Cappadocian rupestrian architecture.

Keywords: Monastery of Aynalı, Rock-cut architecture, Rupestrian habitat, Red pictograms

Introduction

The Open Air Museum in Göreme is a large semi-circular rock *cavea* constituting the heart of a singular confederation of ancient monastic communities. It is formed by a huge number of rock-hewn churches, such as St Catherine's Chapel, the Apple Church, the Sandal Church, the Pantocrator Church, and whole monasteries that barely survived the persistent geological erosion. In 1985 UNESCO inserted such a system of rupestrian settlements into the list of World Heritage sites for its unique anthropological, historical, and artistic value.

Since 2007 an Italian National Research on the Rock-cut Architecture has been working in Cappadocia[1] to study the environment and the monuments of the rupestrian habitat in order to support Turkish administrators and cultural operators in the complex actions of preservation, restoration, and transmission of their cultural heritage (Carpiceci 2013). The first achievements of this mission can be appreciated in the Forty Martyrs Church at Sahinefendi, recently restored and open to public.[2]

In the last two years the unit of Sapienza University of Rome has been surveying a number of carved monuments and produced drawings in the area of Göreme. Despite the fact that the executors of the 2013 and 2014 survey campaigns are almost the same and despite the strong analogies between the architectural subjects, deep differences exist between the results. The former campaign focused mainly on the Church of Forty Martyrs at Sahinefendi because the restoration of its significant painting cycle was to be rapidly completed. The 2014 campaign was based on these early results and expanded them to the surrounding areas in order to define the urban context of the Sahinefendi community (Carpiceci and Inglese 2015). The ultimate goal of this latter campaign was to define the church relationships with the urban context by focusing not only on its direct surroundings, but also on other isolated groups of rock-cave rooms. These two distinct phases resulted in a complete survey of the rupestrian village of Sahinefendi, with the Church of the Forty Martyrs at the heart of the whole area.

In the Open Air Museum in Göreme, the two-year survey campaign focused on the main churches located in the semi-circular auditorium, such as St Catherine's Chapel, the Elmali Kilise (Apple Church), the Carakili Kilise (Sandal Church), Azize Barbara Kilisesi (Church of Saint Barbara), and Karanlik Kilise (Dark Church). Finally, the original survey programme has been integrated with additional settlements near Göreme such as the Church of Aynalı with its monastery, which are the main subjects of this paper.

1 Notes on methodology and practice

The data acquisition using old and new technologies and post-production processing involve a necessary critical action that affects both the operative methodology and the specific site. For a decade, the operative unit from Sapienza University has been involved with the systematization of procedures for the architectural survey in the light of emerging technologies such as laser scanning, automated photogrammetry multi-stereo-

[1] Arte e habitat rupestre in Cappadocia (Turchia) e nell'Italia centromeridionale. Roccia, architettura scavata, pittura: fra conoscenza, conservazione, valorizzazione. National coordinator: Maria Crocifissa Andaloro; scientific director of Sapienza University unity: Marco Carpiceci. The research involves three scientific areas (L-ART/01 – History of Medieval Art; ICAR/17 – Drawing; GEO/07 – Petrology and Petrography) and offers a number of different approaches to the Cappadocian environment thanks to geologists, archeologists, historians, architects, engineers, preservers, restorers, chemists, botanists, geographers, and photographers taking part.

[2] See: http://www.operaipogea.it/?p=833 (accessed on 26 June 2015).

matching, and immersive photography. In Cappadocia the goal of this unit was to collect data related to the geometric shapes and colours of both interior and outer surfaces of a number of housing and monastery settlements in the rupestrian community of Göreme, within and outside the precinct of the Open Air Museum. The objective of these surveys was to build digital models of such settlements useful to orient and guide the work of local administrators, scholars, and restorers attending the reconstruction of historical events and the requalification of places and monuments. The lack of either epigraphic or textual sources that could offer information on the life and uses in rock-cut architecture has forced scholars to interpret their function directly from the formal characteristics of the artificial caves as well as from pictographic sources (Jerphanion 1925–42; Thierry 1963; Jolivet-Levy 2006). The quest for the actual form is thus fundamental for Cappadocian heritage where each single step or niche may reveal itself as a clue to uncovering a forgotten world.

FIG. 1. SAPIENZA UNIT WORKING WITH THE LASER SCANNER IN THE GÖREME OPEN AIR MUSEUM (PHOTO F. COLONNESE).

1.1 Environmental and procedural problems

The team has faced a number of problems, primarily environmental: the rupestrian settlements are located on a plateau 1500 m above sea level, often dug several metres deep along the steep slopes of tufa and landslides, in some cases beaten by the wind. The campaign phase took place between late August and mid-September, in a warm and dry climate with a generally rarefied dusty air. According to the funds and time available, the team was composed of three members and equipped with a laser scanner. In the last few years laser-scanning technology has been both improving the precision in the acquisition of dimensional data and reducing costs and time taken. At the same time, the procedures of digital visualization offer surveyors a wide range of innovative and easy-to-use tools for both envisioning and navigating three-dimensional models.

The specific spatial characteristics of rupestrian architecture required an instrument that could be easily carried and used both in the difficult orographic conditions and in the dark narrow caves. A FARO laser scanner (Fig. 1) was preferred because of its physical characteristics of a lightweight, easy-to-handle, and powerful tool, compatible with accessibility and investigation problems presented by many sites. This results in a good compromise between the amount of equipment to be carried during the campaign, the time needed, and the quality of the data collected, ensuring a density of dots per inch able to record even the marks of excavation left by the ancient builders on the rock surfaces. The alternate use of two batteries allowed an extensive use of the laser scanner throughout the working day, but it is important to emphasize that on the hottest days, prolonged outside scanning occasionally caused overheating. This has sometimes forced operators to suspend the survey session and to switch off the laser scanner for 20 minutes in the shade of the nearest cave.

Other difficulties were caused by the presence of light, which can distort the results of the colour survey made by the digital camera integrated in the scanner (Carpiceci, Colonnese and Inglese 2015a). This problem affects both the scanning inside the caves, due to the artificial lights placed to show up the monuments and help tourists to appreciate them, and the external scanning because of the strong contrast between sunlit parts and shadows. In the former case it was enough to turn off the electric lights as most of the surveyed rooms are generally lacking doors and windows. Scanning was often performed in the twilight or in complete darkness to minimize environmental electromagnetic interference with the scanner. In the case of rooms with pictograms or painted surfaces, a specific photographic survey was made with an external digital camera and a specific lighting set to give a homogeneous light on surfaces. This procedure is necessary to capture the actual colours of the painted surface and to integrate the numeric model with proper chromatic data.

In the case of external scanning, a first *natural* solution is provided by providential clouds that pass before the sun diffusing its light. Otherwise, a supplementary lighting set should be used to reduce some critical shadows and contribute to a homogeneous aspect and colour of rock surfaces.

The survey of the interiors generally has preceded the survey of their facades or simply of the corresponding exterior rock surfaces. In this way, exterior scans were not only to be connected to the internal ones to evidence the relationship between extrados and intrados of monuments, but to offer a complete, if not exhaustive, digital model of the whole semicircular natural *caves* of the Open Air Museum.

Complications came from the vegetation growing on the natural surfaces outside the artificial caves. Bushes and little trees block the laser beam and sometimes affect both the morphological continuity between outside and inside and a correct interpretation of the surveyed elements. In any case, apart from bending some plants or keeping them lower with heavy rocks, almost nothing can be done to solve this problem except to work in winter or reconstruct the missing parts in post-production.

A further problem is related to the temporal availability of certain places. During the opening time of the Open Air Museum thousands of tourists visit churches and monasteries every day, but groups also visit the sites outside the museum precinct. Not only their bodies may interrupt the laser scanning but the vibrations caused by people walking are probably amplified by the porosity of the earth support and affect the scanning results negatively. Especially for this reason, in addition to others

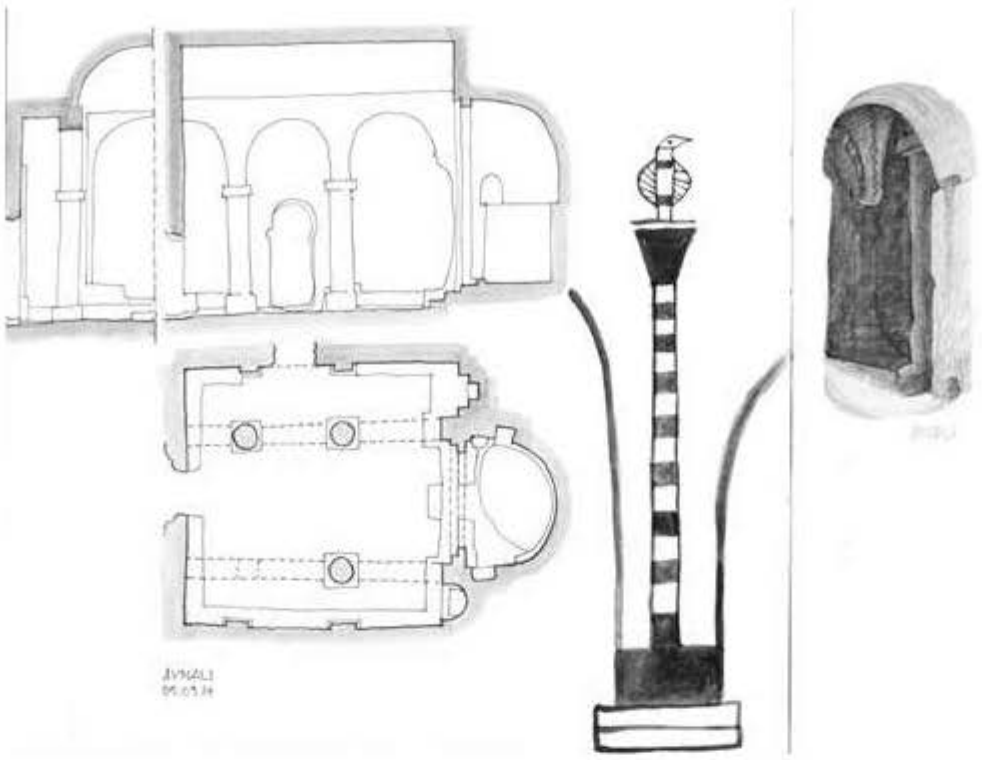

FIG. 2. GÖREME, CHURCH OF AYNALI, SKETCH FROM LIFE OF PLAN AND SECTIONS, DETAIL OF A DECORATION, ENTRANCE TO NARTHEX (WATERCOLOUR F. COLONNESE).

mentioned above, that the monastery of Karanlik Kilise — the Dark Church, *nomen omen* — was surveyed in darkness, during the evening hours from 7 to 10 pm, on three consecutive days (Carpiceci, Colonnese and Inglese 2015b).

1.2 Critical approach and representation after the numeric model

Scanning has been regularly performed through the use of reference spheres: at least three spheres must be detected in two adjacent scans to ensure their effective welding during the production phase of the general points cloud. Before each scan, the operators would search extensively in the neighbouring rooms and zones for the most advantageous point in which to place the spheres. During this operation, they made systematic observations at different heights through openings, rocks, and plants, while their bodies and minds were testing size, alignments, gradients, and spaces. This direct experience of places has been integrated not only with a canonical photographic campaign but also with sketches and watercolours (Figs. 2 & 3) drawn from life on several occasions, and has often fuelled doubts and questions that have later gradually grown to become key elements of investigation. This heterogeneous approach constitutes an antidote against the risk of relegating the knowledge of the site to the machine outcomes and provided the operators with a critical attitude to their own work, which is an essential contribution in the post-production stage.

Unlike the traditional additive architecture, in which a structure can be easily read in advance to establish the most significant and exhaustive representations, rock-cut architecture requires a deeper enquiry. The absence of repetition, symmetry, sharp edges, orthogonal corners, plane or constant dimensions,

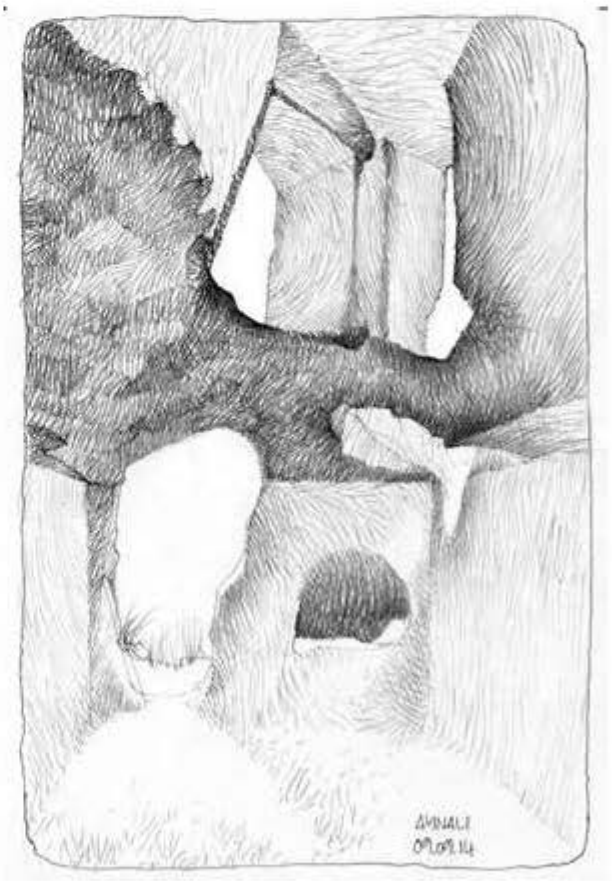

FIG. 3. GÖREME, MONASTERY OF AYNALI, SKETCH FROM LIFE OF A COLLAPSED ROOM ADJACENT TO THE CHURCH (WATERCOLOUR F. COLONNESE).

FIG. 4. GÖREME, MONASTERY OF AYNALI, VIEW OF THE TUFA CLIFF IN THE DISTANCE (PHOTO C. INGLESE).

prevents operators from applying conventional criteria for applying section and projection planes as there is no guarantee they would be able to represent spaces as well as envision and communicate their properties and qualities. Thus specific procedure and drawings have been conceived to represent these rock-cut architectures.

After registration, the numerical model (per points) was processed and translated into a meshed model (per surfaces) but the sculptural nature of rock-cut architecture makes it impossible to choose and draw lines that describe apparent contours or edges unambiguously. Therefore a contour line representation was elaborated by producing a number of sections driven by the position of the significant section plans adopted at regular intervals. A number of significant section plans have been identified according to their ability to describe the complex morphology of the settlement: horizontal plans for the plans and vertical plans for elevations and sections. In cartographical practice the equidistance (i.e. the constant gap between successive contour lines) is conventionally set at 1/1000 of the denominator of the scale of representation in metres. For a canonical architectural representation 1:50 equidistance is 5 cm, but tests undertaken with this step have not given a readable result due to the excess visual data. Finally an equidistance of 10 cm was achieved in order properly to describe the architectural shapes without it becoming a sort of confusing background noise (Carpiceci 2015).

After pasting the specific photographic shots of the polychrome pictures on the meshed model, the decorative system can be finally studied together with the architecture itself. By navigating the model, a scholar can adopt the point of view of the ancient builders and decorators, even at a height of 4 m. Paintings and pictograms can thus be studied and analysed in their actual size and position; at the same time, their deformations and irregularities can be related to the surface conformation, the hypothetical position of the artist's body as well as their visual effect from below, obtained from photographs, watercolours, and memories.

2 The Church of Aynalı and its monastery

The monastic settlement of Aynalı is about 1 km from the Göreme Open Air Museum. The church and the rooms of the monastery are on two main levels and surround a rectangular courtyard, the southern facade of which is articulated on three levels of openings and arches (Figs. 4–6). Two of the three doors in the exterior wall open into the largest room of the complex, the so-called Sala Maior: its walls, articulated by pilasters, support a barrel vault with arches and are decorated with red geometric patterns (Fig. 7). An opening in the same wall leads to a smaller barrel-vaulted room that can also be entered from the courtyard. Another room lies near this one: it is accessible from outside, but most of it is lost after the cliff partially collapsed. An opening in the internal wall of the main room leads into a cave with a curved stair leading to the upper floor, while an opening in the western wall leads to the church.

The third opening in the south face of courtyard is the main entrance to the church (Fig. 8). A small square narthex with cross-arms welcomes believers and tourists: a dome covers it, just above four primitive pendentives in the corners. A side opening leads into a side square tomb room, with a niche and benches on two sides, while the front opening leads into the approximately square church. Four large columns (with one partially collapsed) divide the church space into three naves covered by barrel vaults and decorated with red symbols: a large central horseshoe-shaped apse and two smaller ones at its sides open in the east wall with their floor as high as the continuous bench running along the base of the walls.

Smaller irregular rooms characterize the upper floor. The stairs leads into a large storey carved over the main room, with niches and shelves on every wall and two more openings. A small tunnel leads into a circular cave in the north-west corner, while the cave zigzags in the east wall leading to a cave protected by a rolling door. A narrow oblique pit connects the latter cave with the lower room, where there is a second rolling door used to protect the passage from the rectangular room with a flat

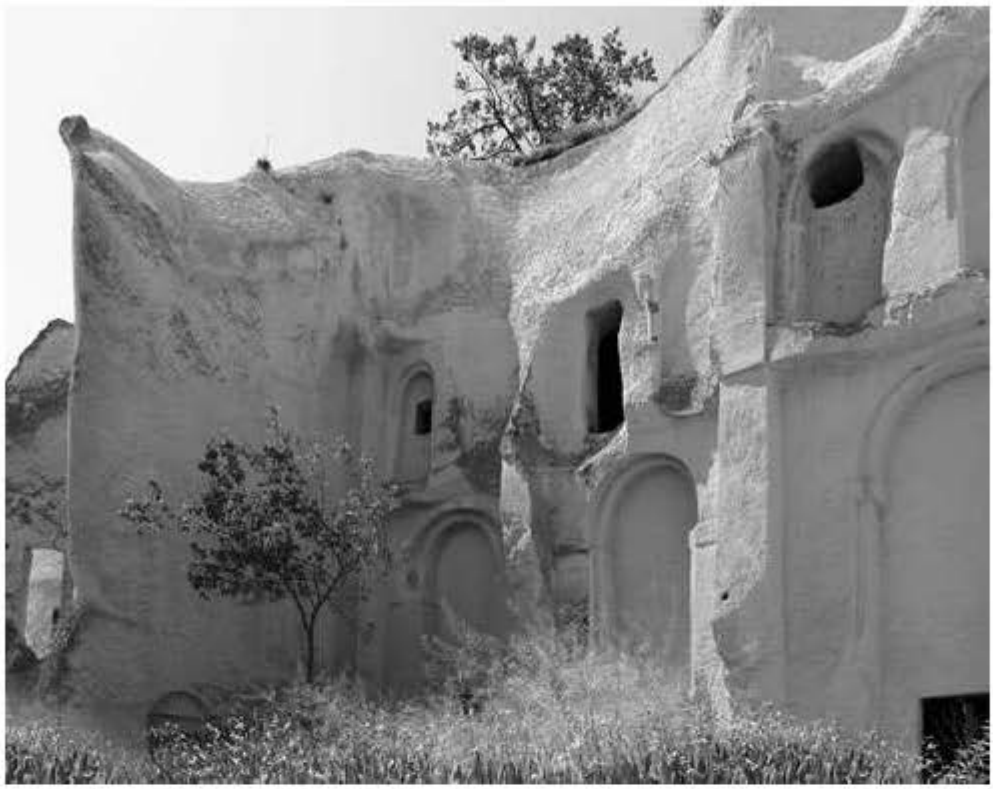

FIG. 5. GÖREME, MONASTERY OF AYNALI, VIEW OF THE COURTYARD TOWARD THE ENTRANCE TO THE NARTHEX (PHOTO C. INGLESE).

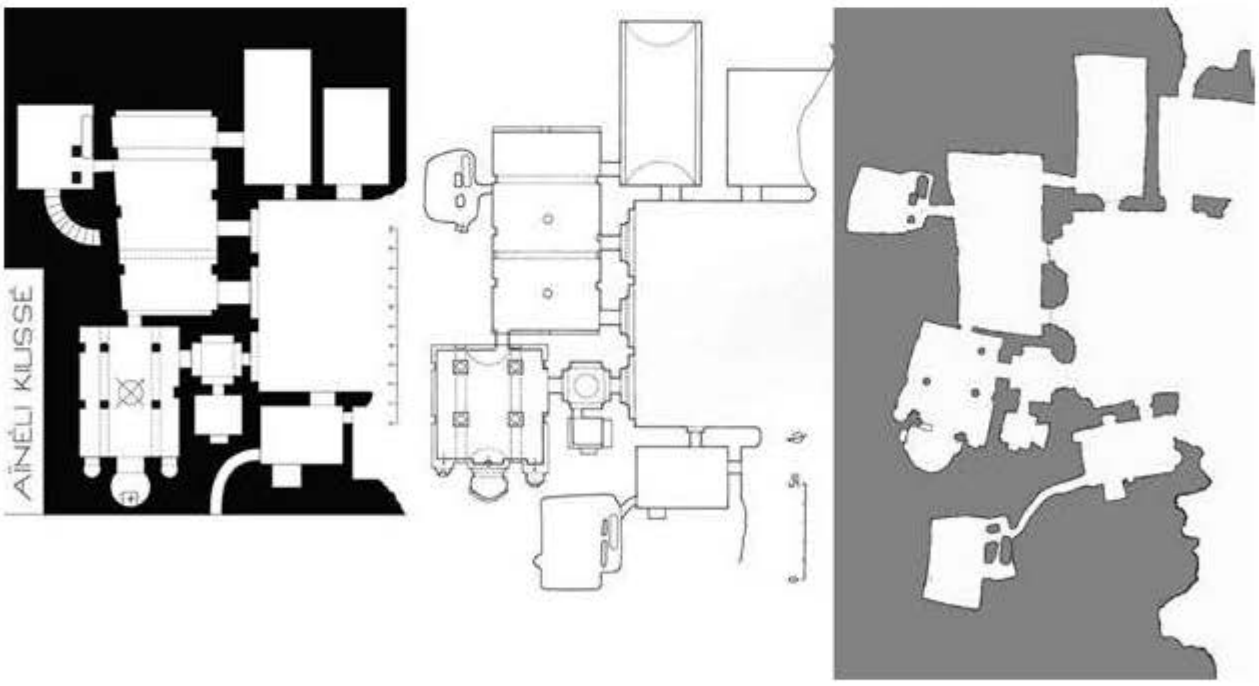

FIG. 6. GÖREME, MONASTERY OF AYNALI, COMPARISON BETWEEN THE GROUND FLOOR PLANS ACCORDING TO JERPHANION (LEFT) AND RODLEY (CENTRE) WITH THE PLAN AFTER AUTHORS' SURVEY IN SEPTEMBER 2014.

Fig. 7. Göreme, Monastery of Aynali, view of the Sala Maior toward the entrance to the church (photo C. Inglese).

Fig. 8. Göreme, Church of Aynali, view toward the passage to Sala Maior (photo C. Inglese).

ceiling behind the east face of the courtyard. The missing parts of the ceiling reveal another room above, which is a part of a linked system of rooms with stables and a winery extending along the north-east cliff, and accessible through many openings in the fallen cliff.

2.1 Functional and morphological considerations

The passage of time and the unstoppable erosive process have made it difficult to distinguish the evolutionary history of the monastery of Aynali Church. The assemblage of more than 50 scans produced in three different days have revealed the concealed relationships between the architectural volumes carved into the tuffs and allow some hypotheses on the general organization.

The general plan embodies a clear and efficient idea of the organization of interior spaces. The external openings seem clearly designed to offer a unitary mutual visibility to ensure control and defence, while the internal openings are not aligned to avoid enfilades and favour a maze-like effect.

The presence of the red decorations identify the rooms on both the ground floor and the upper floor overlooking the courtyard as belonging to an initial core. Among the decorated rooms, the small porch and the church are those whose function can be detected no doubt thanks to their form. The church has the typical *tetrantila* plan with three apses. While most of other churches of the Göreme Open Air Museum present domes arranged crosswise with respect to the centre of the main aisle, clearly showing a centric attitude, the church of Aynali displays a longitudinal structure with an uninterrupted barrel vault covering the main aisle ending with a deep apse, configuring a kind of Serliana-shape section (Fig. 9).

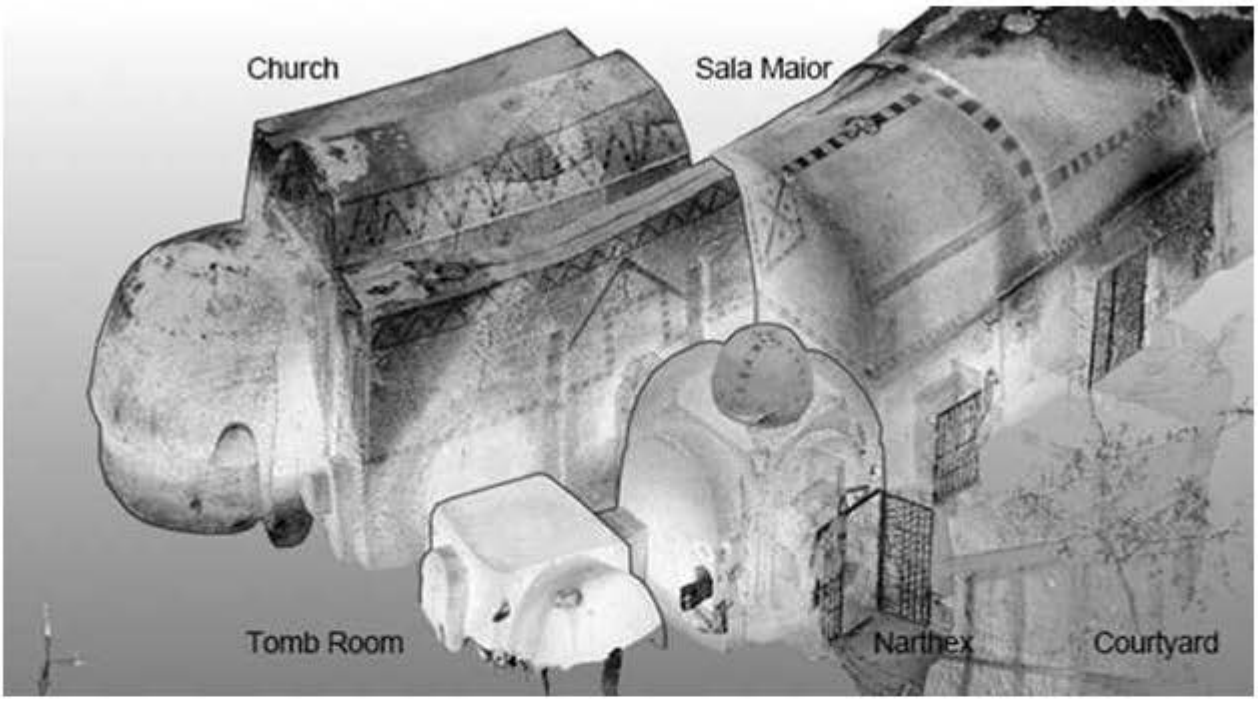

FIG. 9. GÖREME, MONASTERY OF AYNALI, AXONOMETRIC VIEW FROM THE NUMERIC MODEL AFTER POINTS CLOUD (IMAGE M. CARPICECI).

The Sala Maior has a large barrel vault divided by three light arches and is directly connected with the church. Its original function is still uncertain but it certainly embodies the heart of the monastery. The general size as well as the openings into the courtyard, towards the last decorated room as well as the interior room with a staircase protected by a door, qualify this room as the most important for access to the monastery. It is possible that it was originally used as a refectory: perhaps the usual carved menas that can be found in all the other monasteries of this area was later destroyed because the room was destined for different uses. Otherwise, the absence of a traditional refectory in the monastery of Aynalı would raise doubts on its religious function.

The most important contribution of the scan laser survey consists in measuring by subtraction not only the rock envelope surrounding the carved rooms and plan their correct preservation in time, but the actual curved nature of all interior surfaces. The barrel vaults themselves follow lines that correspond neither to a cylindrical geometry, nor a conical one, but to a longitudinal extrusion path that gradually changes direction and angle of deformation. The resulting surfaces are recognizable as similar to cylinders and planes but despite the efforts of many scholars such as Jerphanion (1925–42) and Lyn (1985), they are hardly reducible to any elementary geometric pattern (Fig. 10) and quite correctly, recent historical studies seem to consider deformations as an essential element of plans and sections (Kalas 2009).

The mismatch between the actual carved rooms and the regular geometric scheme behind them cannot be considered simply as a technical inability, but as a specific approach by the builders. Such an efficient organization and distribution could not match an inappropriate but careful material execution of the carving process. We believe that the mismatch between the actual carved rooms and the regular geometric scheme behind them must necessarily also be the result of a precise requirement.

Both structural and aesthetic reasons could lie behind the choice of adopting curved shapes and surfaces. Empirical knowledge possibly convinced those ancient architects that formal resistance of curved shapes contributes to a better structural behaviour in both walls and ceilings. Moreover, the curved shape is the most suitable and natural one for carved architecture: the process of excavation tends to progress, placing the operators at the centre of a theoretical sphere and the movement of their arms follows an arch, too, as can be seen in the furrows on the walls.

3 The dichromatic pictograms in the Aynalı Church

Most of the artificial caves in the area of Göreme do not present painted decoration, only low-relief pseudo-architectural elements that embellish the space, while a number of them show a varied range, from pictograms to complex paintings. According to the use of colour and the level of accuracy, these decorations can be roughly classified in three categories, which sometimes relate to the different periods of the settlement. A first category is constituted by monochrome — generally red ochre — decorations painted directly onto the rock. A second category is formed by polychrome painted decorations, with wide blue and green fields added to red ochre motifs. Historians such as Richard Krautheimer (1986: 432) generally considered these monochrome pictograms as a form of aniconic decoration and used them to date the architecture to the iconoclastic period or immediately after (AD 843).

In the third category are figurative fresco-like decorations that embellish the most important religious buildings, such as the Church of Forty Martyrs and the famous Tokalı Kilise — often

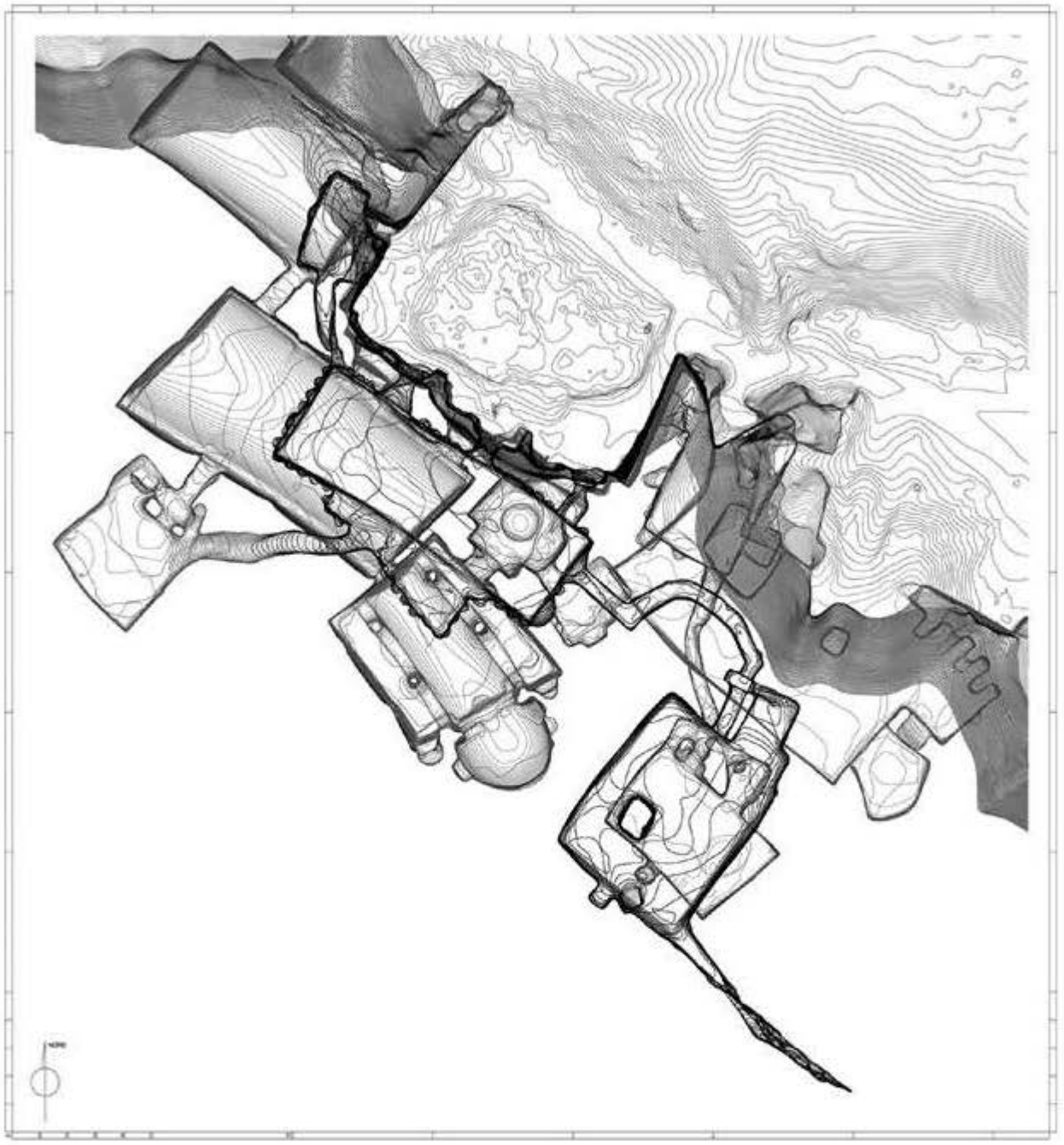

FIG. 10. GÖREME, MONASTERY OF AYNALI, GENERAL PLAN IN CONTOUR LINES (EQUIDISTANCE = 10 CM) AFTER POINTS CLOUD. IN BLUE, THE LOWER LEVEL; IN GREEN THE MIDDLE LEVEL; IN GREEN THE HIGHER LEVEL (IMAGE M. CARPICECI).

with the secondary consequence of dematerializing the interior surfaces and visually wiping out the architectural fiction of the carved parts.

The red monochrome decorations in the Aynalı church and the Sala Maior belong to the second category and beyond the aesthetic function, contribute to their spatial sense as an architectural semantic tool. The most obvious feature is, for example, the demarcation in light and dark bands of all the intrados of the arches (Fig. 11). In some cases this band also runs through the ridge generatrix, as in the case of the Sala Maior and in the subdivision in four of the intrados of the narthex dome. In the pseudo-refectory chiaroscuro bands run horizontally around the perimeter of the room demarcating the impost line of the barrel vault. In this case an alternation between light and dark fields along the southern wall is duplicated on two overlapping bands creating a chequered cornice. In the Sala Maior the band running along the impost line is formed by a chequer motif with triangular fields in place of rectangles (Fig. 12).

In his *Cave Monasteries of Byzantine Cappadocia*, Rodley (1985: 62–63) gives an accurate description of the red signs decorating the interior space of the Aynalı church. "The arches

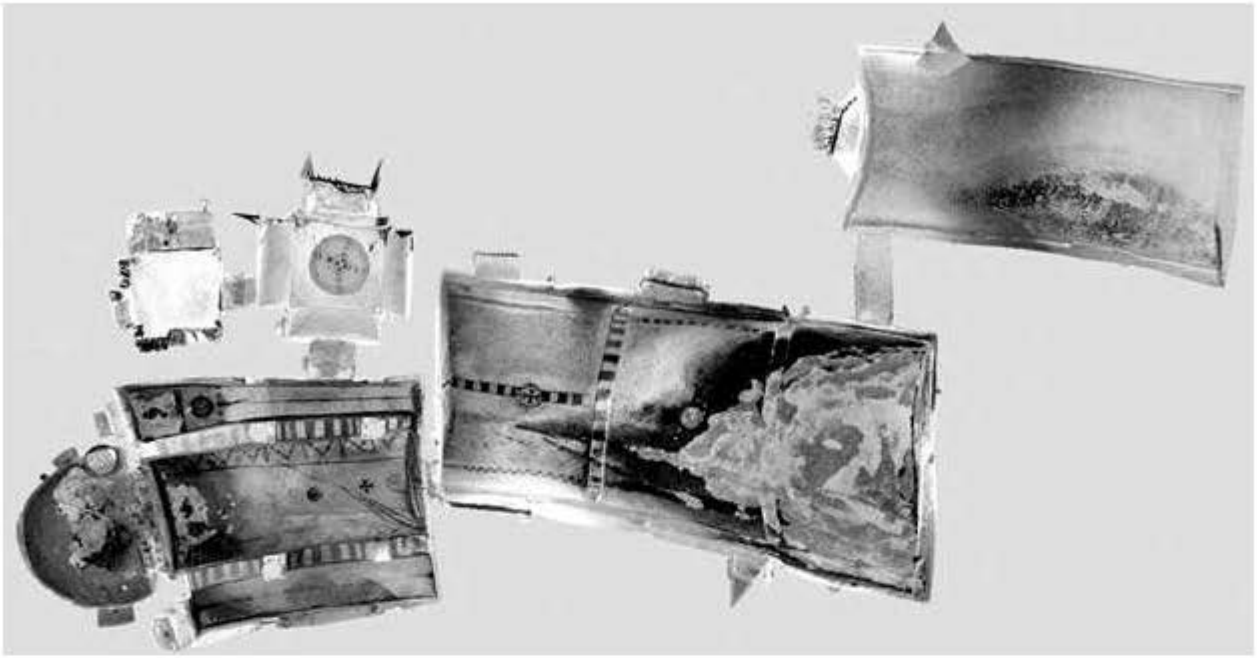

FIG. 11. GÖREME, MONASTERY OF AYNALI, *IPOGRAFIA* (BOTTOM-UP ORTHOGONAL PROJECTION) FROM THE NUMERIC MODEL AFTER POINTS CLOUD (IMAGE M. CARPICECI).

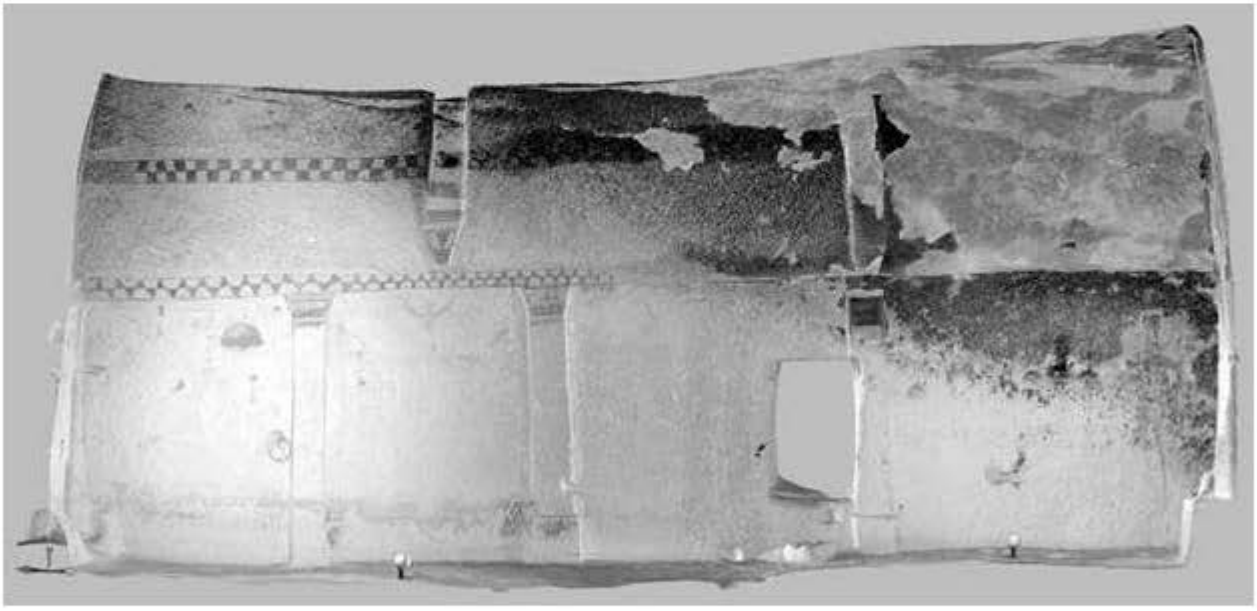

FIG. 12. GÖREME, MONASTERY OF AYNALI, ORTHOGONAL PROJECTION OF THE SALA MAIOR SOUTH-WEST WALL FROM THE NUMERIC MODEL AFTER POINTS CLOUD (IMAGE M. CARPICECI).

of the arcades are rimmed with red and rectangles of "domino" patterns. A line of ten medallions containing various motifs (…) runs along the crest of the barrel vault. The vault is divided into two registers each side by red bands, below which are broad zig-zag bands of red and white chequer pattern (…) [and] painted pillars topped by devices of various forms (…). In the lunette above the apse another cross, enclosed in a kite-shaped border, is surmounted by a medallion containing a vertical eight-lobed pattern, flanked by two quadrupeds (…). A chequer pattern rims the recess in the east wall and the soffit of the apse arch is similarly decorated. In each spandrel flanking the arch is an equal-armed cross. The apse has a cross in a kite-shaped border in the conch and a chequered "cornice" below the conch. North and south walls of the naos have a chequered band painted at the level of the arcade capital and another at the tops of the walls, decorated with a zig-zag pattern, above the painted band

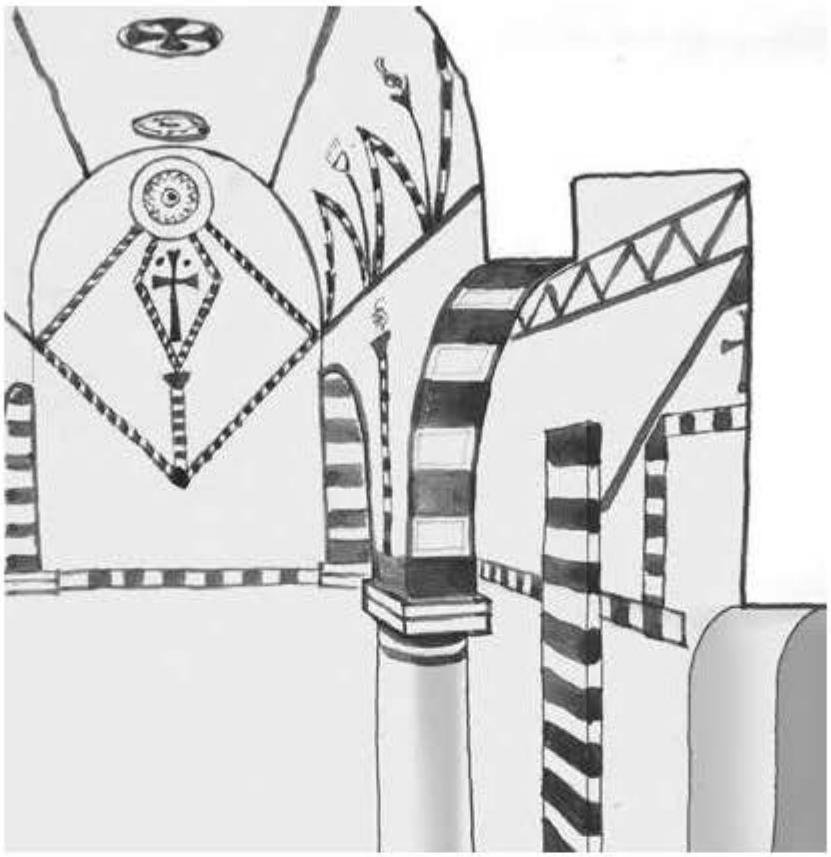

FIG. 13. GÖREME, CHURCH OF AYNALI, SKETCH LOOKING TOWARDS THE PASSAGE TO SALA MAIOR (WATERCOLOUR F. COLONNESE).

of the north aisle is a painted keyhole shape with a gable above it; there is a further keyhole shape in the equivalent position on the south aisle wall. A red band runs along the ceilings of both aisles and the ceiling of the north aisle also has two medallions in square frames at the east end. The naos entrance in the north wall is flanked by carved pilasters, painted with the domino pattern, which end about 1 metre above the entrance; a painted gable links them. The painted band rises above the entrance to form three sides of a square. A similar arrangement is found in the opposite space on the south wall where, however, there is no entrance'.

Most of these geometric decorations are easily recognized when compared with architectural elements in buildings of the same area and period. As testified by the pictures, most of them show a predominant geometric character and are generally used to describe and highlight the rock-cut surfaces according to those elements, which play the figurative role of architectural components such as columns, pilasters, capitals, architraves, and cornices. A number of examples can be suggested: the red and white ""domino" pattern' on the arches of the arcades evokes a dichromatic masonry arch; the 'broad zig-zag bands of red and white chequer pattern' on the low part of the barrel vault can be easily interpreted as the representation of triangular lunettes opening in the vault itself; the horizontal red lines on the upper part of the columns and the pseudo capital describe the specific parts of a Doric order such as abacus, echinus, collar, and so on; the 'carved pilasters, painted with the domino pattern' with a 'painted gable' linking them and a 'painted band' forming 'three sides of a square' remind one of the sort of alterpiece or triumphal gateway to the square narthex and the square tomb room, as in a traditional church chapel (Fig. 13).

Other pictograms are quite abstract representations of decorative elements used in Roman and medieval architecture. The 'painted pillars topped by devices of various forms' or the 'medallions containing various motifs' look like a direct transposition of decorations seen elsewhere; even the recurring chequer bands could be interpreted as the visual effect of rotated brick patterns in the wall, as can be seen, for example, in the Byzantine church of St Theodore in Athens (12th century). If confirmed, this aspect could be quite interesting as the pictograms are depicting their visual effect rather than brick edges.

Some pictograms instead represent archetypical symbols like crosses and swastikas as well as animals and natural elements, such as birds and plants. Some of them could be representations of existing icons from either religious or military standards: 'the pillar carrying birds, in particular, may be seen as distant country cousins of roman eagles' (Rodley 1985: 62). But other pictograms, such as the 'two quadrupeds' and some of the birds, could be considered as a picture of something Cappadocian artists had seen and depicted from life.

There is something special in the pictograms of Aynali church that was generally neglected by scholars: they are not monochrome and light-grey painted signs can often be

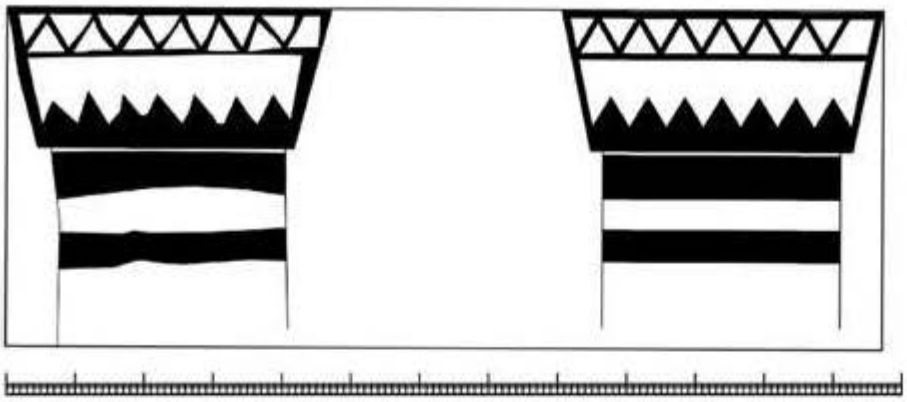

FIG. 14. GÖREME, CHURCH OF AYNALI, SCALE DRAWING OF THE PICTOGRAM ON THE SIDE WALL OF THE SALA MAIOR (DRAWING C. INGLESE).

seen near red ones. The grey signs seem to play at least three contemporary roles in relation to the red ones. Sometimes they are below the red signs, as a construction scheme for the most complex figures. Sometimes they define the role of the blank areas as a semantic complement of the red adjacent fields, like the white tassels of the domino pattern on the arches of the arcades, where grey points and filled circles characterize them according to many different schemes. Finally grey paint is occasionally used as a substitute for red in some decorative patterns, as can be seen in the kite-shaped chequered band around the cross on the wall of the main room, just above the entrance to the church (Figs. 14–17).

3.1 Rock-cut architecture as a 1:1 model

The red decorations of the Aynalı Church, like other churches of the same period and area, must be primarily considered as the very last stage of architectural achievement. Their depiction is to be connected to some sort of apotropaic process of sanctification, which was imposed by the need to use those spaces as soon as possible, only in few cases delaying the moment of the creation of the more articulated decorations. Even if these pictograms appear to be the result of hasty and rough work, their symbolic value and meaning should not be underestimated. First of all, the presence of a second colour on the walls of the church of Aynalı, even if only a light grey, gives the pictograms a sense of permanency as if appositely designed to represent the architectural visual definition elements in a definitive way. Secondly, the form and colour seem to have been conceived to work together to support the architectural fiction: some carved forms can be rough and approximate because the colour gives them an optic contribution to denote their specific role. On the other hand, the pictograms can be monochromatic or dichromatic, as the element is already characterized by its form and position in the architectural envelope. This is an interesting way of economizing efforts and shortening the time of construction without renouncing a correct visual identification of the parts.

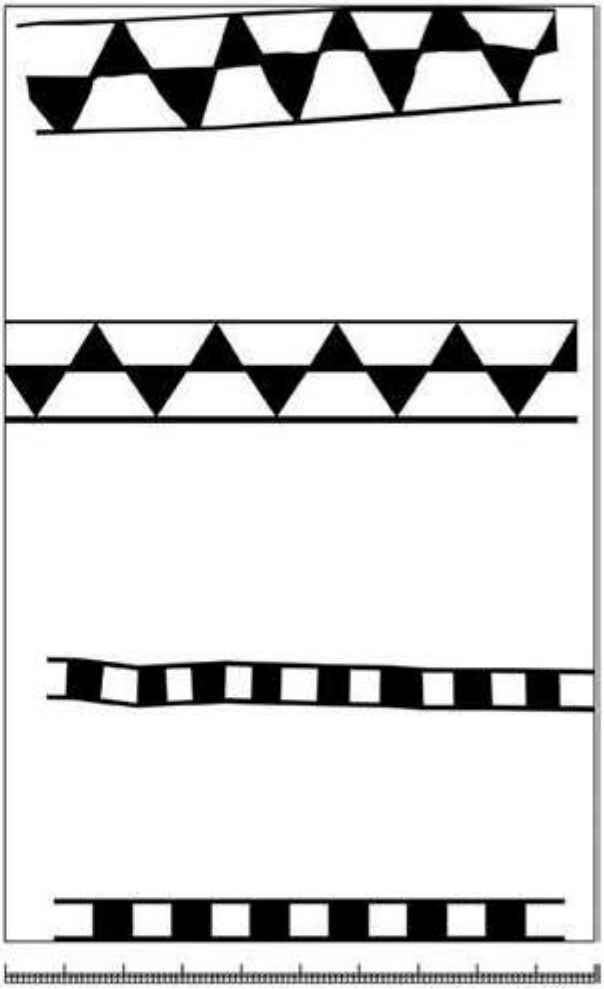

FIG. 15. GÖREME, CHURCH OF AYNALI, SCALE DRAWING OF THE PICTOGRAM ON THE SIDE WALL OF THE SALA MAIOR (DRAWING C. INGLESE).

While in *traditional architecture* the elements of the orders describe the visual hierarchies and structural behaviour of the parts, in Cappadocian rock-cut architecture this function is filled by red pictograms, with the secondary consequence of transforming architecture like that of the Aynalı Church into a huge representation, a sort of full-scale model (Colonnese

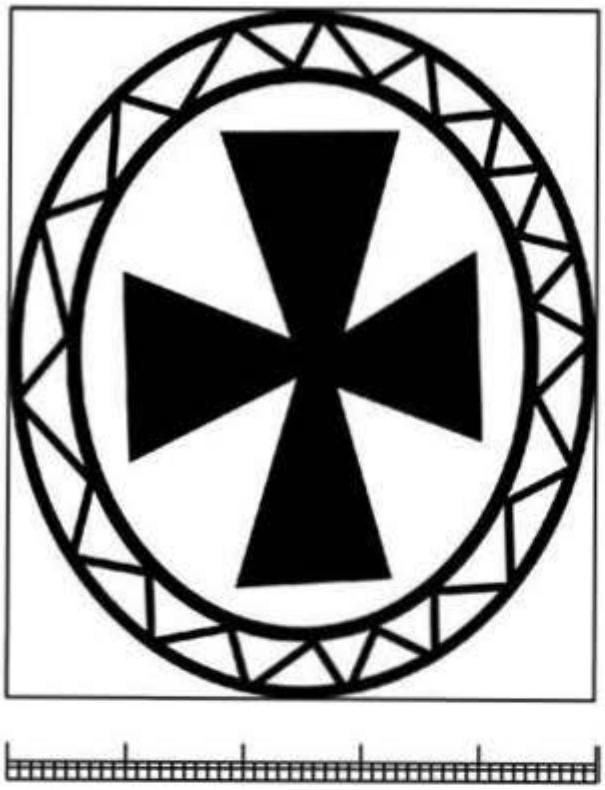

FIG. 16. GÖREME, CHURCH OF AYNALI, SCALE DRAWING OF THE PICTOGRAM ON THE VAULT OF THE SALA MAIOR (DRAWING C. INGLESE).

2015) with two different meanings. Firstly, it is a model through which the church itself is gradually designed and perfected, like in a sort of sculptural *direct forming*, as defined by George Bauer (1981); secondly it is a model referring to existing traditional churches, through both its spatial typology and most of its depicted decorations. It could even be defined as an intertextual work as most of its depicted parts require a 'cooperative interpretation' (Eco 1979) by the people looking at them, who should be aware of their representative mission as well as the distant buildings they refer to.

4 Conclusions

Laser scanning technology has proved particularly suitable and effective in the process of the acquisition of metric data from the artificial caves that form the rock-cut settlements in Cappadocia. In a rocky territory subjected to aggressive erosion, such scans have an intrinsic importance both as a three-dimensional mould of places of great historical-documentary and artistic value, and as a tool to screen the erosive process itself. Some expedients have been developed to overcome some of the environmental and functional difficulties. For example, the chromatic survey of the interiors, especially in the case of pictorial surfaces, has required a photographic integration with controlled lighting conditions.

The knowledge developed by operators through both direct experience of places and sketches and pictures, has been useful to lead the post-production and representation after the model that has resulted in the development of orthogonal projections; this is possibly the most affordable way visually to transmit metric information and spatial relationships between the

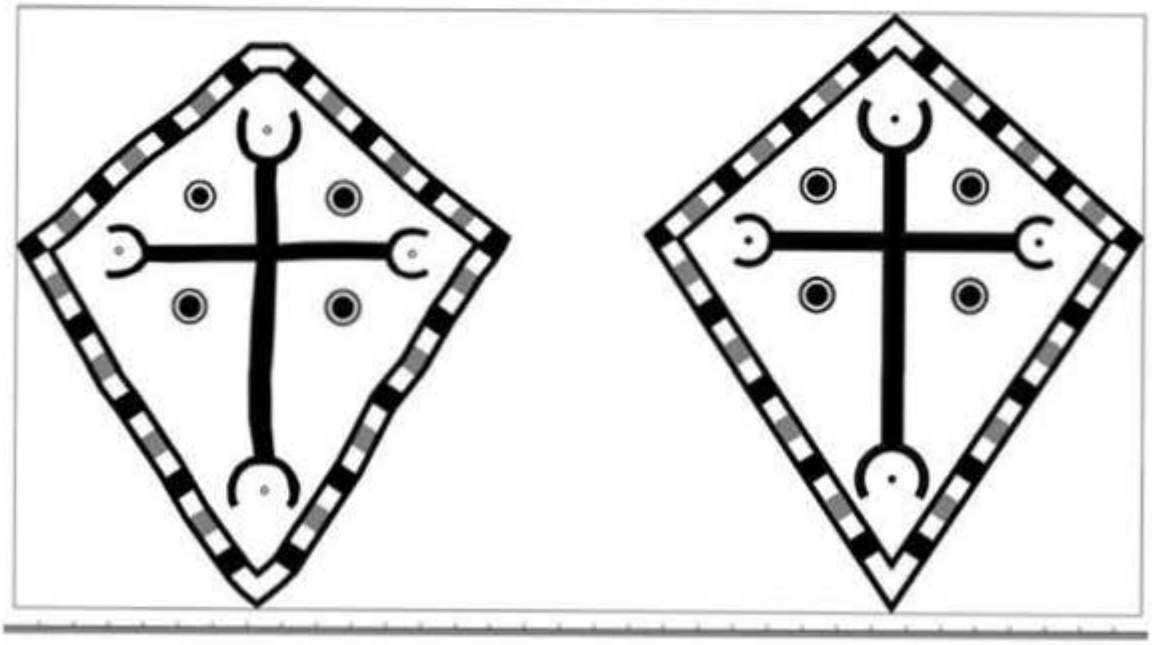

FIG. 17. GÖREME, CHURCH OF AYNALI, SCALE DRAWING OF THE PICTOGRAM ON THE WALL OF THE SALA MAIOR (DRAWING C. INGLESE).

various environments and between these and the outside. Plans and sections have highlighted the inherently curved geometries that characterize the carved spaces and which cannot be ignored or reduced as a consequence of the technical limits of the manufacturers, but offer themselves as a key to interpreting both uses and construction periods.

The meshed model with the application of the internal photographic maps has allowed the study of decorative elements in their true form and location, according to their execution and visual effect, in order to evaluate their iconographic role in the Aynalı Church and its monastery.

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