THE MUQARNAS DOMES OF THE HALL OF THE KINGS: DATA FOLLOWING THEIR RESTORATION

LAS CÚPULAS DE MOCÁRABES DE LA SALA DE LOS REYES: DATOS TRAS SU RESTAURACIÓN

RAMÓN FRANCISCO RUBIO DOMENE

HEAD OF THE PLASTERWORK AND TILING RESTORATION WORKSHOP OF THE BOARD OF TRUSTEES OF THE ALHAMBRA AND GENERALIFE. PHD IN RESTORATION, UNIVERSITY OF GRANADA.

ramonf.rubio@juntadeandalucia.es

ABSTRACT During the period between 2007 and 2009, work was carried out on the restoration and reconstruction of the roofs of the Hall of the Kings, which allowed us to access the backs of the 7 muqarnas domes that cover this space, and to carry out their restoration. This intervention allowed us to access each one of them, both on the front and on the back, so that we could see the interventions carried out in the 19th century, as well as study each of the muqarnas modules in order to understand the construction systems used by the Nasrid craftsmen in a muqarnas dome. All this valuable information allowed us to adapt the treatment according to the state of conservation in an individualised manner, applying consolidation treatments and fixing polychromies, and restoring structural stability on the reverse, with new reinforcement and hanging systems.

All this accumulated experience allows us today to implement it in other cases found in the monumental complex of the Alhambra, such as the Sala de Abencerrajes, Sala de Dos Hermanas, or Sala de Ajimeces.

KEYWORDS Mocárabes, Alhambra, Sala de los Reyes, restauración, yeserías.

RESUMEN Durante el periodo comprendido entre el año 2007 y 2009, se llevaron a cabo las obras de saneamiento y reconstrucción de las cubiertas de la Sala de los Reyes, lo que nos permitió poder acceder a los reversos de las 7 cúpulas de mocárabes que cubren este espacio, y realizar su restauración. Esta intervención permitió acceder a cada una de ellas, tanto en su anverso como en su reverso, por lo que pudimos ver las intervenciones realizadas en el S. XIX, así como estudiar cada uno de los módulos de mocárabes para comprender y poder entender los sistemas constructivos que emplearon los artesanos nazaríes, en una cúpula de mocárabes. Toda esta valiosa información nos permitió adaptar el tratamiento según el estado de conservación de forma individualizada, aplicando tratamientos de consolidación y fijación de policromías, y devolviendo la estabilidad estructural en el reverso, con nuevos sistemas de refuerzo y de cuelgue.

Toda esta experiencia acumulada, nos permite hoy día poder implementarla en otros casos que se encuentran en el conjunto monumental de la Alhambra, como son la Sala de Abencerrajes, Sala de Dos Hermanas, o Sala de Ajimeces.

PALABRAS CLAVE Mocárabes, Alhambra, Sala de los Reyes, restauración, yeserías.

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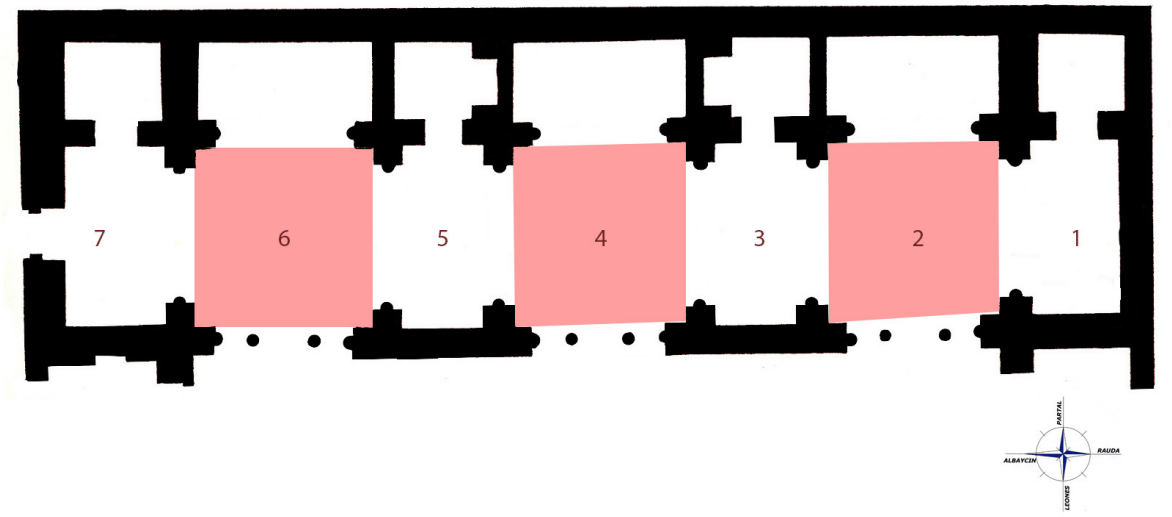


Il. 1. Plan of the Hall of the Kings with the location of each of the seven muqarnas domes.

During more than two years of restoration work on the muqarnas domes of the Hall of the Kings, numerous data were found, documents were consulted and techniques were applied during the different work processes. Undoubtedly the best source of learning during the project came from observing the processes of change and differing degrees of deterioration at specific points of the domes, where damp and structural movement had threatened their stability but also revealed their anatomy. It was possible to see the traces left by the manual application of plaster, the different phases of restoration carried out at different times, and all the different layers and materials developed by Nasrid craftsmen to construct muqarnas domes in the Alhambra Palace complex. The aim of this article is to learn more about the original assembly technique and the behaviour of the materials that were used, so that their own behaviour and changes can be diagnosed, thereby successfully managing the restoration work and guaranteeing their conservation over time.

The muqarnas vaults are located in spaces that divide the great Hall of the Kings into seven areas produced by the domes, which in turn are divided into three large domes with areas measuring 4.50 x 4.50 m. (domes 2, 4, 6), interspersed by four other smaller areas of 2.5 x 4.5 m. which have domes that are smaller in size and height (domes 1, 3, 5, 7). Although the spaces are the same and share the same muqarna block pieces, each of the domes has a different design, layout and polychroming. The assembly technique was usually the same; due to space limitations this article will focus on the study of the first great dome in the south wing, dome 2, while referencing additional interesting facts about the other domes (Il. 1).

Starting with the well-known treatises by Diego López de Arenas[1] and monk Fray Andrés de San Miguel[2], many works describe the domes' origin[3], geometry[4], the etymological origin of the terms muqarnas, muqarbas and mocárabe, their set of three shapes of triangular, rhomboidal and rectangular prisms[5], in a variety of seven basic prisms with some variants and transformations according to the space and complexity of the dome, outlining the rules of their geometry[6] and formula for their assembly process[7]. Their design is based on basic pieces such as the '*chaplón de jairas*', which provide the measurements of the different muqarna bloc-

1 LÓPEZ DE ARENAS, Diego. *Breve compendio de la carpintería de lo blanco...,* p. 41.

2 FRAY ANDRÉS De San Miguel [1577, 1652] 1969: *Manuscrito*.

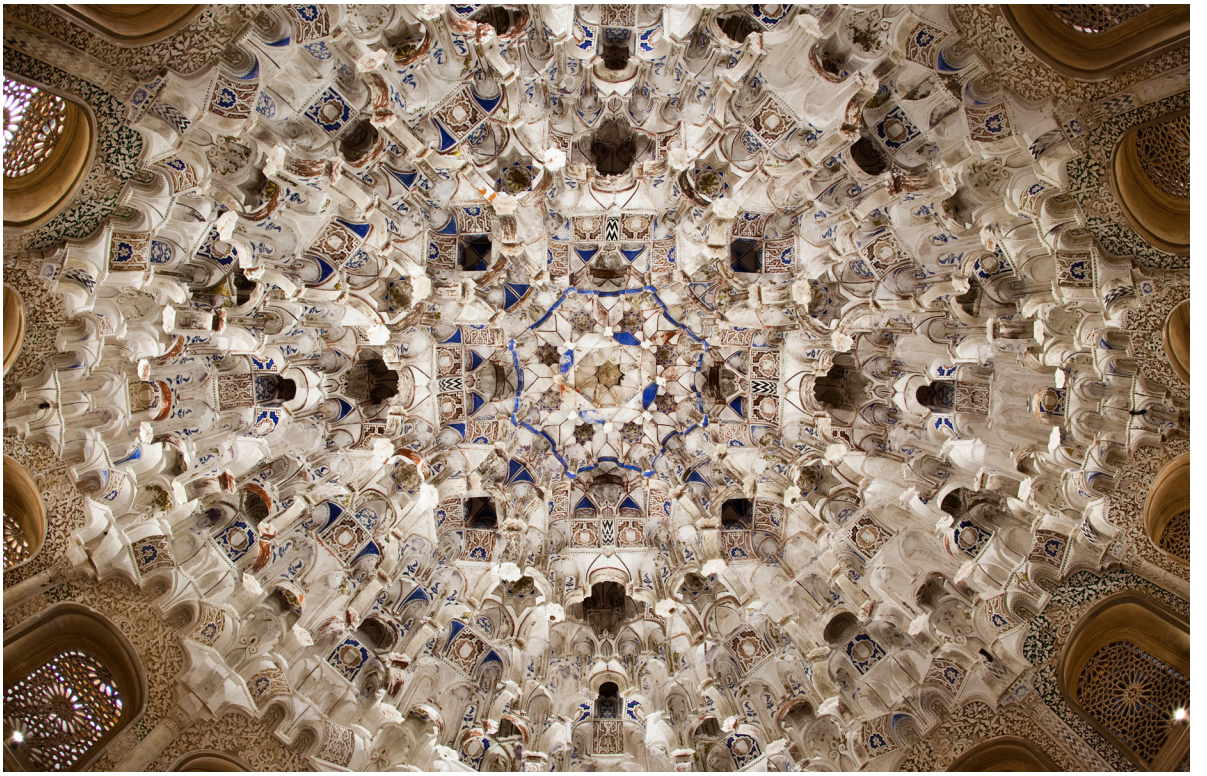
3 FERNÁNDEZ PUERTAS, Antonio. *Mukarbas Encyclopedia of Islam*.

4 PRIETO VIVES, Antonio. *Apuntes de geometría decorativa: los mocárabes, El arte de la lacería*.

5 CARRILLO CALDERERO, Alicia. *Compendio de los muqarnas: génesis y evolución (siglos XI-XV).*

6 PALACIOS GONZALO, J. C. *Las cúpulas de mocárabes*. p.1025

7 SÁSETA VELÁZQUEZ, Antonio. *El juego de los mocárabes.*



Il. 2. General view of muqarnas dome 6.

ks[8], while the '*conza*' determines the proportionate measurements of the remaining pieces[9]. Other works, such as those by Aranda Pastor[10] and Gámiz Gordo[11] study groups of muqarnas vaults at the Alhambra in depth (Il. 2). However, the focus point and contribution of this work is to present all the data and experiences gathered over years of work under these complex structures, and to learn how muqarnas domes were constructed from a living material like plaster. As we were able to see, it led to an exclusive plaster assembly technique, very different from what has been studied regarding stone or wood. Theoretical ideas have been put forward because anything is possible on paper or computers, unlike the real work.

CONSTRUCTION TECHNIQUE

Designing a muqarnas dome required an initial plan drawn out on paper or similar that could be used to develop the different modules of the dome to scale. This preliminary design work is fundamental to creating a self-supporting muqarnas dome, the great challenge successfully achieved by Nasrid craftsmen. The dome is suspended in the air on its own, with the successive support of the muqarnas. Muqarnas pieces are combined to form small cupolas finished with stars, which are repeated symmetrically in a radial fashion in horizontal levels, developing further new cupolas at higher levels that gradually gain height until the final cupola crowned with the central star is completed, as can be seen in Il. 3 and 4.

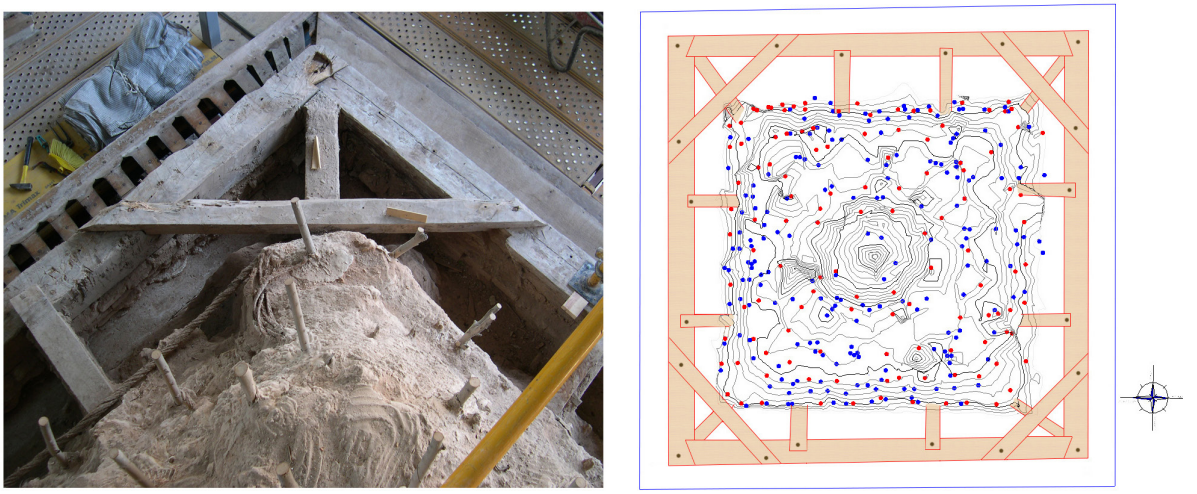
A self-supporting dome is not created by chance. Nasrid master builders knew about ground behaviour and seismic movement, which caused buildings in Granada to move continuously. They also knew to introduce lead plates into the columns between the base and capital to cushion movement and reduce damage in spaces like this one. In a muqarnas dome, work started from the base of the wooden sleepers and their

8 NUERE MATAUCO, Enrique. *La carpintería de lazo. Lectura dibujada....*, pp. 66-70 and 265-283.

9 LÓPEZ DE ARENAS, Diego. *Breve compendio de la carpintería de lo blanc y Tratado de alarifes*. Op. Cit. 1, p. 41.

10 ARANDA PASTOR, Gaspar. *La alcoba O. de la galería meridional del Patio.....*

11 GÁMIZ GORDO, Antonio, FERRER PÉREZ-BLANCO, Ignacio. *A Grammar of Muqarnas.*



Il. 3. Photographic detail of one of the corners of the reverse side of dome 2. After removing the roof, it was possible to see the sleepers, the wooden crossbeams of the cupola, a corner angle brace, the rope that fastens the cupola at its base, and the wooden braces from the 19th century works. On the right is a topographical survey with the contour lines of dome 2, and it is possible to see the wooden sleepers, which the crossbeams that the start of the dome hangs off are hooked to using grooves and fixed with nails. The location of the current stainless steel tensioners placed over the old holes from the 19th century works is in red, and the holes of the wooden braces that were also from the 19th century intervention but were not reused are in blue.

angles, giving it the flexibility of wood and leaving the whole roof independent so that it could move separately without transmitted the load and weight of the tiles, clay and wood onto the dome.

A muqarnas dome begins at the crown of the area's walls, where a structure of wooden beams or sleepers was placed, linked at their four corners and reinforced by angle braces. Here wooden struts that are shorter in length and section were inserted at a perpendicular angle; they were the initial support for the dome's starting points and their ends were embedded in the plaster of the first modules (Il. 3). Struts normally started from the same corner and several were arranged along the length of the sleeper approximately 1.5 m from each other; the number of struts depended on the dimensions of the room or dome. They were fastened to the sleepers by recesses made in the wood and square forged metal nails.

The plaster used to build these domes consisted of the basic mineral known as gypsum, i.e. calcium sulphate, which is fired and can then be mixed with water ($CaSO_4 \times 1/2H_2O$, hemihydrate). Two varieties of plaster were used in these domes: black plaster for the different muqarna blocks, and white plaster for the modules with relief decoration made with moulds. Muslim builders found gypsum near Sabika mountain, and it is also abundant in Granada province; here it came from open-air quarries about 11 km from the palace complex, in the area known as Monte Vives in Gabia La Grande municipality[12]. Gypsum is very common in its both its crystal and particularly its alabaster varieties. The alabaster variety is extremely pure gypsum and produces a very clean material after firing and grinding that was used in carved motifs. However, the gypsum used to make most of the different muqarna blocks was the crystallised variety, a darker or greyish gypsum that sometimes contained impurities such as ash from traditional firing[13].

The main problem faced when constructing a muqarnas structure out of plaster lies in the adhesive used to join and glue the different sections together i.e. the plaster itself. Plaster is a living material mixed with water and works like a glue when it comes into contact with another gypsum-based material and loses its water content. This means that builders had to be extremely precise when handling it and deft with timings; it starts to set very quickly, in a matter of seconds, meaning that it was rarely possible to correct or modify the position of a muqarna block once it was in place.

12 RUBIO DOMENE, Ramón. *Yeserías de la Alhambra...,* p.102

13 SANZ ARAUZ, David. *Análisis del yeso empleado en revestimientos exteriores...,* p.32.

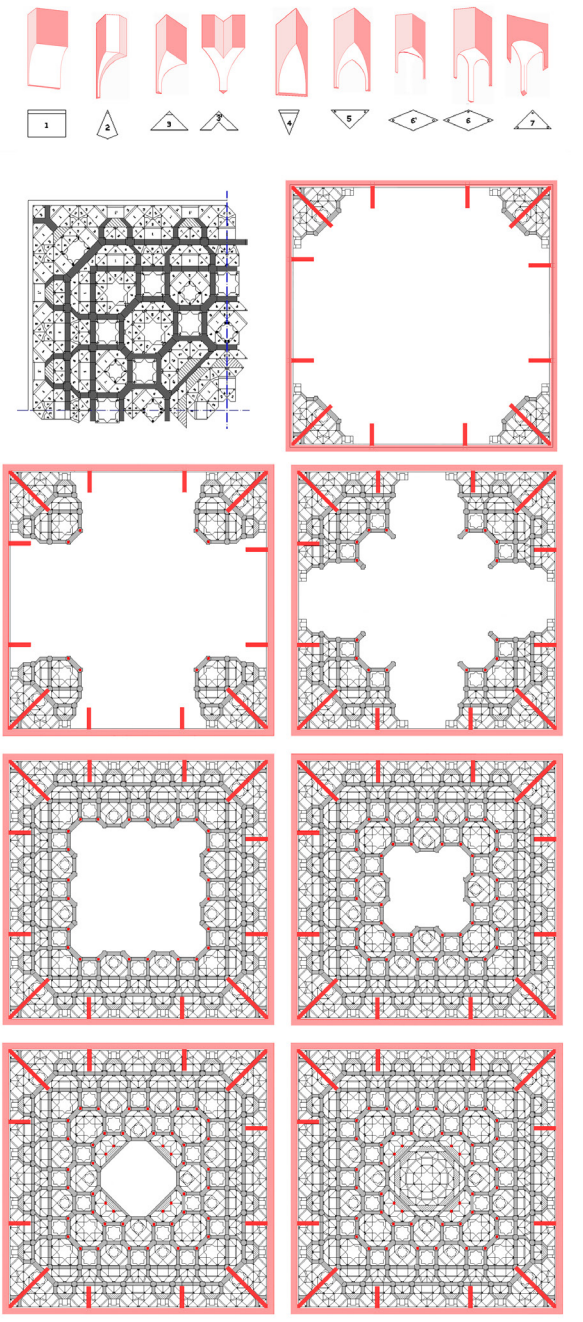
STAGES IN RAISING A MUQARNAS DOME.

As mentioned above, a preliminary design was required that could be used to combine the different geometric modules, created for a square or rectangular floor plan, that made raising and closing the ceiling possible. These modules, formed by a combination of muqarna blocks, were enclosed or framed by the area known as the '*taco de medina*', until the dome ceiling is formed at each construction stage, as can be seen in (Il.4)

Raising the dome began by placing the base pieces (normally pieces 6 and 7) on either side of the starting piece or module 1, the 'conca', located on the small capital of the half columns that started from the continuous frieze or latticework gallery. This first module was the starting point for what later became the '*taco de medina*'. This element is key to the dome's development because it marked out the various spaces formed by the different muqarna blocks that would be repeated throughout the dome. The '*taco de medina*' does not have an exact measurement. Its function was to absorb assembly errors related to measurements that occur when the muqarna blocks were stuck on and therefore its thickness could vary from one side to another; the objective was to ensure that the dome was closed in as symmetrical and balanced a way as possible to make it self-supporting. These different thicknesses are even visible to the naked eye from the ground, as is the case in dome 4.

The dome was raised by sticking modules together with plaster; they detached horizontally from the wall while gaining height and shortening the enclosure of the dome[14]. At this early stage they were supported by the struts that emerge at a perpendicular angle from the sleepers (Il. 4). Whether the space was circular or square, closing the dome was controlled by a prop that started from the centre of the scaffolding or the centre of the room being decorated. A cord was hooked to it that was used to determine the radius for the geometry of the circumference; it was rolled up around the prop to mark and record measurements so the radius of the dome can be closed. According to visible, dated testimonies on the back of these domes, during this process the craftsman, drawing on his experience and taking into account the design of the dome, would assess the force of gravity and the stability of the structure being raised over one or several days of work.

14 The craftsman progressively attached the muqarna blocks and stuck them on the back to assemble the various modules of the domes, working as a central axis and closing the dome. Plaster behaves in an ideal way for this type of work because it sets quickly and glues the muqarna blocks in place, meaning the craftsman could attach pieces with plaster fairly rapidly and complete modules.



Il. 4. Different modules that make up the muqarna blocks and the phases of the dome's construction, gradually including wooden braces (red dots) and closing intermediate cupolas until the dome was finally closed.

He would evaluate the weight load supported by the modules glued together with plaster and the amount of water they carry. This is when he would attach a vertical wooden brace to the plaster modules that was embedded in the plaster and also held in place using a metal nail, while the other end was fastened to the rafters of the wooden roof. It was normally made of pine wood with a rectangular cross-section, and was inserted at the junction of the feet of several muqarna blocks, or past the *taco de medina*, where a structure with a larger surface area of plaster was created and the wood could be embedded (Il. 4, 5). The brace supported the structure while the plaster set and hardened, which also became lighter as its water content evaporated over time. (Il. 5) It would fulfil its function and continue to support the weight as another module was raised during the various stages of constructing the dome. The craftsman could always access the back of the dome in the gap left between the plaster dome and the framework rafters[15] because the brace was cut as the dome was raised to prevent transmitting and loading the weight of the tile roof onto the plaster dome and the problems that would entail. In this specific dome at least three crowns are formed by the union of the muqarnas legs and the areas formed by the *taco de medina*, each at a different height, where the wooden braces are embedded with metal nails. These pine wood braces are rarely visible on the reverse side of the dome as they have been covered up by later plasterwork. However, studying their location reveals that they are positioned in strategic horizontal locations for maximum weight bearing, according to the design of the dome and its relationship with the interior. Fig 5 shows the three brace crowns; the outer one is in black, the middle one in blue and the upper crown, which supports the lantern, is in red.

The whole process of raising a dome was aided by bracing from the new modules, on the platforms created using the scaffolding raised from the ground, which served as a support until it was completed. The structure used to shore up the different phases of the dome's construction were removed once the whole dome had been set in place and the plaster had dried, after which it lost a great deal of weight due to its water content evaporating.

The set of muqarna blocks that form the domes consists of nine modules created in black plaster using moulds; they form groups of pieces that lead to other modules, such as the crowning stars. The way these domes were created illustrates the good taste in design and decoration created using pieces decorated with relief carving, following the style set by the Nasrid craftsmen. A greater degree of complexity was required when working with the muqarna blocks because each piece used needs to be individually crafted, unlike the muqarna blocks made in black plaster.

Different modules were joined and the gaps at the join were filled by attaching new masses of black plaster, although many pieces were joined together without joining plaster and are simply glued to each other with plaster applied to the upper parts and on the reverse side in non-visible areas. Therefore, in contrast to wooden muqarnas vaults, the height of the non-visible part of the muqarna blocks adapts to its surrounding pieces or the crowning piece. This is the case with muqarna block 3 in the Hall of the Kings, which forms an eight-pointed star by joining a cluster of eight blocks; the non-visible part is cut away to attach the final plate of the star. Whenever a carved piece was inserted, it was attached so that its join used the black plaster that serves as a glue and it was also held in place by physical forces such dovetailing, guaranteeing its stability and preventing it from detaching in the future. (Il.6)

Once all the pieces had been inserted and the joins and any assembly flaws repaired, a white finishing coat was applied to the black plaster, applied in several layers as necessary, which served to[16]:

- unify the entire surface with white as a base for applying the polychroming, also softening the right angles of the corners;
- cover the plaster's pores and reduce its absorption capacity, making it possible to be more precise when drawing polychrome motifs.

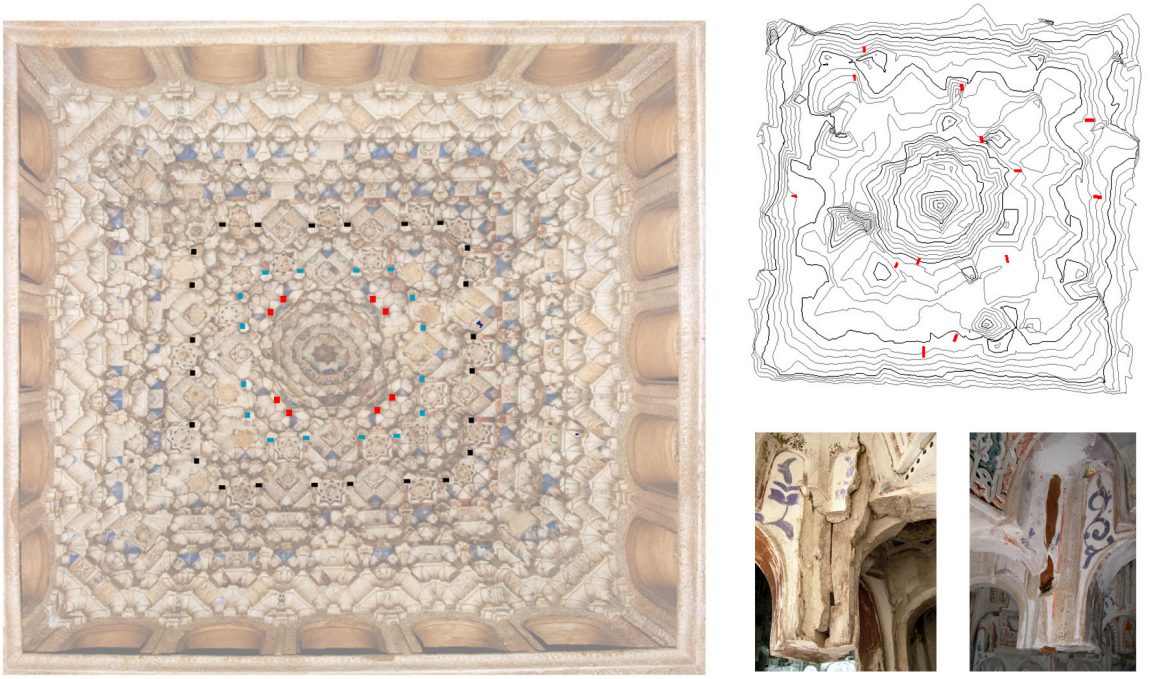
The white finishing layer was made of calcium sulphate[17] with an organic protein binder with, as in other locations, abundant fatty acids such as palmitic and stearic acid18. Although there is no conclusive data from the results of the chromatographic analyses, there is a long tradition of using egg white rather than oils, due to parallels established with Egyptian plaster craftsmen where, according to Egyptian restorers, craftsmen continue to use egg white for the final finish.

15 It should be remembered that before decorating with plaster, ceramics, etc., spaces were normally covered and finished with a roof so that work could be carried out without issues from rain and inclement weather.

16 RUBIO DOMENE, Ramón. *Técnicas de trabajo con moldes en la yesería nazarí...,* p. 547

17 de la TORRE LÓPEZ, Maria José. RUBIO DOMENE, Ramón. CAMPOS SUÑOL, María José. *Estudio mineralógico-petrográfico de yeserías islámicas...,* p. 695

18 CORREA GÓMEZ, Elena; RUBIO DOMENE, Ramón. *La restauración del Oratorio del Partal...,* p. 126.



Il. 5. Location of the different wooden brace crowns which serve as support in the process of raising a dome. Their location in the photograph doesn't exactly match the topographic survey, as they weren't placed exactly perpendicular to the dome and have moved and leaned.
Il. 6. Detail of attaching 'conza' module 1, made of white plaster with relief carving, using black plaster and dovetailing. Dome 7.

COLOUR STUDY

With regard to the polychroming, the system used differs in some respects from techniques used to paint flat motifs in the West, as shall be discussed below. Nasrid craftsmen used pure, unmixed colours; this helped to ensure that there were no variations between motifs painted in the same tone, whether they were painted by the same craftsman or at different periods of time19. To achieve this effect, they followed the Nasrid polychroming technique found in other buildings that have already been described20; basic colours such as red, blue and black were used alongside the white background of the final priming layer, while yellow tones were provided by gold leaf, which was applied in sheets to a layer of adhesive size21.

Non-destructive analyses performed on dome 2 using the Raman micro-spectrometry technique detected the presence of several pigments in the different colours[22]:

-Black tones – carbon was detected, identifying it as a black obtained from burning natural organic matter, such as lamp black.
-Blue tones – a greater presence of lazurite with green tonal variations was detected. Lapis lazuli pigment was also applied to a few spaces. This pigment has been compared, using the fluorescence of its natural minerals and their impurities, with other samples from the mines of the Afghan region of Badakhshan, confirming that the lapis lazuli pigment used in the plasterwork decoration of the Alhambra was brought across the Mediterranean from Afghanistan. Due to its remote origin and costly method of extraction, this pigment had a value equal to and sometimes higher than that of gold. The presence of another pigment synthesised from 1828 onwards, artificial ultramarine, has also been detected, and its use is therefore attributed to 19th century restoration work.
-Red tones – the presence of cinnabar (HgS) was detected as a pigment from the Nasrid period. It is applied very delicately to outline certain motifs. Red tones made from lead minium -(Pb_2O_3) have also been identified; they were applied in large quantities to more exposed motifs, such as the "*taco de medina*", and often had colour variations in brown tones, corresponding to 19th century retouching work.

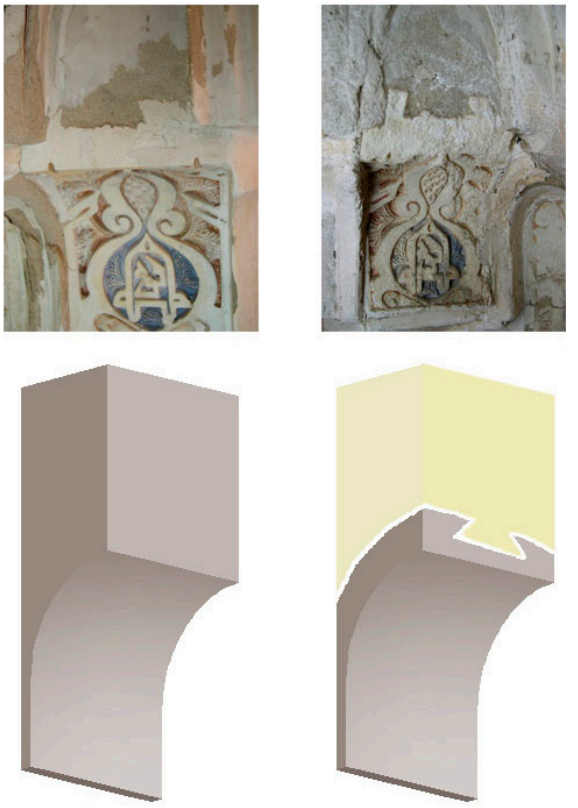
The technique used to apply the colour differs greatly depending on whether the motifs were in relief or flat:

19 CORREA GÓMEZ, Elena; RUBIO DOMENE, Ramón. *La restauración del Oratorio del Partal...,* Op. Cit. 17, p. 126.

20 CORREA GÓMEZ, Elena.; RUBIO DOMENE, Ramón. *La restauración del Oratorio del Partal...,* Op. Cit. 17, p. 125.

21 RUBIO DOMENE, Ramón. *Yeserías de la Alhambra...,* Op. Cit. (n. 12), p.186

22 DOMINGUEZ VIDAL, Ana; de la TORRE LOPEZ, Maria Jose; RUBIO DOMENE, Ramon; AYORA CAÑADA, Maria Jose. *In situ noninvasive Raman microspectroscopic....* p.5766



Il. 7. Different muqarna blocks carved in relief using moulds, and their location in the muqarnas dome. They also have their own colour variants.

When the modules have carved relief motifs made by moulding, (Il. 7) the unevenness created by the carving acts as a contour line that separates the colours, and normally a red or blue background colour alternates with the colour of the carved motifs. Blue is usually used for plant motifs, red for backgrounds and gilding for epigraphic motifs, ribbons, shells, scallops, etc.

When the modules have flat motifs painted on one of the faces of the prisms, they usually feature plant or epigraphic motifs (epigraphic motifs only appear on the corbels above the pilaster capitals at the start of the muqarnas between the latticework.) These are painted by first applying the mass of colour to the shape being depicted, and then outlining it with a line of black paint to give the motif its shape. This line is applied firmly and confidently, although it does not always match the previously used colour and sometimes this first colour is visible outside the black line. However, the line is always joyful and decisive, typical of a confident and expert hand, which is why we believe that these motifs are original to the dome, together with some traces of red tones, regardless of whether they have also been retouched on occasion. Il. 9).

One of the most common flat painted motifs found on the plaster muqarnas is a plant motif in blue on the white primer background, framed by a red ribbon. They are paired two by two in the spaces created by the arches of modules 6 and 7, as can be seen in the location plan. There are two size variants: the motif identified in red created by module 7 is taller and narrower than the motif identified in blue produced by module 6. The shape of these plant motifs adapts and varies depending on the space, indicating that they were painted freehand without a template, although these motifs were not produced like those above and do not have a black outline. (Il.8)

Gold leaf decoration was a typical feature of plasterwork at the Alhambra[23], and is not exclusive to Nasrid decoration. In 12th–13th century Mongolian plasterwork in Iran, gold leaf was also applied to highlight certain motifs[24]. It was always applied to the surfaces of carved motifs, and gilding has never been found in the backgrounds. This work method is easy to understand; it would be very difficult to use gold leaf in the tiny spaces and to gild the backgrounds precisely. The work would also take far too long, and would lose the effect produced when light is reflected on the gilded planes of the upper parts of the carving.

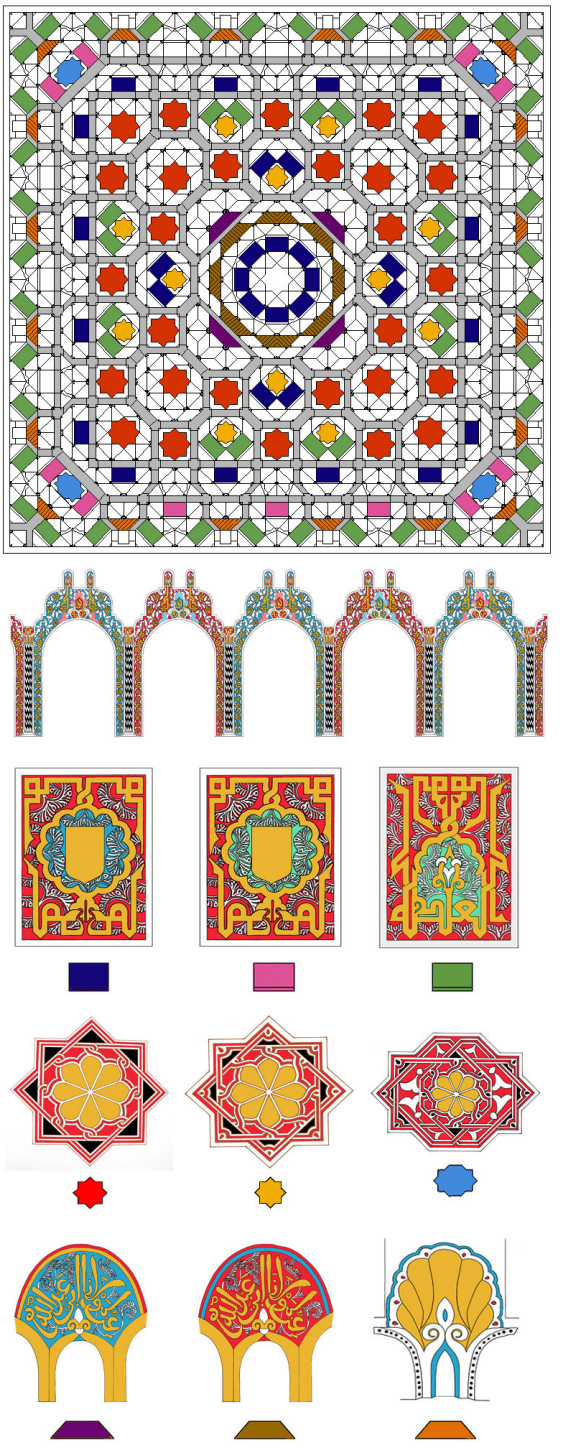
In rare instances other shades are found in the motifs, such as green and brown. These are not Nasrid pigments; as seen on other occasions, they are created by the chemical composition changing due to the passage of time, and were applied in restoration work probably dating from the 19th century or earlier.

- For example, the lead sulphide present in the reddish pigments that contain lead rusts and turns these tones black, after passing through various ranges of browns[25]; these tones are very common in different areas of the Alhambra's plasterwork (Hall of the Abencerrajes [Sala de de Abencerrajes], the Ladies' Tower [Torre de las Damas], etc.). A case study of the dark red

23 de la TORRE LÓPEZ, Maria José; DOMINGUEZ VIDAL, Ana; CAMPOS SUÑOL, Maria José; RUBIO DOMENE, Ramón; ULRICH SCHADEE; AYORA CAÑADA, Maria José. *Gold in the Alhambra...*

24 RUBIO DOMENE, Ramón. *Yeserías del periodo mongol del S. XII-XIII en Irán...,* p. 567

25 CORREA GÓMEZ, Elena; RUBIO DOMENE, Ramon. *La restauración del Oratorio del Partal...,* Op. Cit. (n. 17), p. 127



Il. 8. Arrangement of polychrome plant motifs on the flat surfaces of the panels.

tone on the medina block of dome 6 revealed how lead minium changes. It initially darkens when plattnerite is formed and ends with a total loss of colour because lead dioxide is a strong oxidising agent; it slowly transforms into anglesite, which is more stable and white in colour. Small amounts of cinnabar have also been found among the grey stains that are the remains of red pigment[26], with black stains of mercury chloride ($HgCl_2$) formed by oxidation and fading, a process known about since antiquity and described by Vitruvius.

- A similar process occurs to the green copper sulphide tones of atacamite and paratacamite, as described by Owens Jones[27]. These greenish tones are the result of the blue pigment lazurite, an unstable mineral compound, transforming.[28] .

After studying the painted motifs on both the flat surfaces and carved motifs on the seven muqarnas domes of the Hall of the Kings, it can concluded that although original polychroming from the Nasrid period remains, significant retouching was carried out during 19th-century restorations[29] and earlier works. Repainting was performed on both the original colours of blue, red, black and gold, and on blank surfaces which had already lost their painted Nasrid motifs where, by observing the symmetry with other areas of the dome, it was possible to know which motif was missing.

Several different craftsmen applied these overpaints. They can be difficult to detect and distinguish when the overpaint was applied over an existing painting and was only intended to strengthening the intensity of the lost colour. However, the quality of the motifs varies greatly in areas where drawing is required, and these parts have a hesitant line that lacks quality. This lack of finesse suggests that it may have been the plaster craftsmen who applied the colours, and although many of these craftsmen have left their names written on the different modules, so far none of these names can be distinguished as

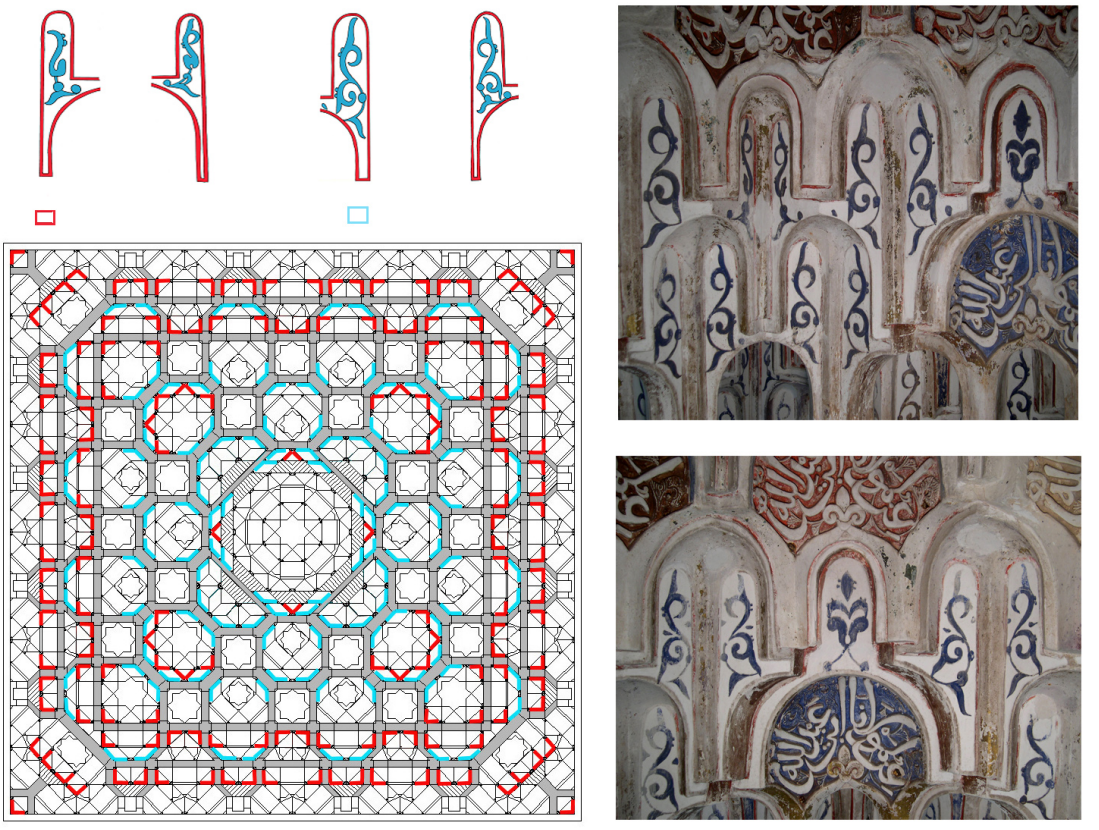
26 DOMINGUEZ VIDAL, Ana. de la TORRE LOPEZ, Maria Jose. RUBIO DOMENE, Ramon. AYORA CAÑADA, Maria Jose. *In situ noninvasive Raman...*, Op. Cit. (n. 21), p. 5766

27 JONES, O. and GOURY, J. *Plans, Elevations, Sections and Details of the Alhambra*. p.164

28 DOMINGUEZ VIDAL, Ana. de la TORRE LÓPEZ, María José. CAMPOS SUÑOL, María José. RUBIO-DOMENE Ramón; AYORA CAÑADA, María José. *Decorated plasterwork in the Alhambra investigated by Raman...* p. 1009.

29 In 1857, Rafael Contreras was paid for the ingredients of paint and gold that had been supplied for work being carried out in the Hall of Justice and the Hall of Ambassadors, although there is no specific mention of what they were used for. JIMENEZ DIAZ, Nieves. *Pinturas de las Salas de los Reyes*... p. 250

Il. 9. Polychrome technique with red and blue background tones silhouetted in black. Motifs located in the upper part of the central lantern of dome 2.



Il. 10. Detail of the signatures found in the carved coat of arms motifs in the central part of dome 2. It reads: "Manuel Tamallo año 1856" and "Salamanca doce de Septiembre de 1856".

plasterer or painter[30]. Il. 10).

The colours applied by Rafael Contreras and his craftsmen in the 19th century are totally opaque and completely cover the final white tone of the Nasrid plasterwork when applied directly. In these domes he repainted and retouched the existing colours but did not apply the white tone of white lead that he used as a base when preparing the new plasterwork used in the Hall of the Beds[31]. However, he did use the same pigments, including natural cinnabar or synthetic vermilion for the red tones, synthetic lazurite for the blue tones, Scheele or Esmeralda green for the green tones, and lamp black for the black tones (mixed with haematite for the brown tones)[32] . The result was very heavy decoration and perhaps the biggest difference between the original Nasrid shades and the colours applied in the 19th century is the opaque quality of the later work. This was due to two reasons:

1.- The Nasrid colours were applied transparently, with little body, rather like a gouache; the white surface of the base wasn't covered and the technique was more like a type of watercolour. This was probably due to the organic binder of egg white or oil, depending on the fatty acids identified.

2.- Nasrid polychroming is lighter and more transparent due to the white primer base, which has an orange tone underneath created by the layer of mould release agent, leading to a white base with greater warmth and luminosity.

RESTORATION CRAFTSMEN

The dates that have been discovered on the muqarna modules at a height of roughly 10 m reveal that restoration work was performed in 1856; signatures can be seen on dome 2 by craftsman "*Manuel Tamallo 1856*" and another worker who signed as "*Salamanca*" on the "*doce de Septiembre de 1856*" [twelfth of September 1856]. It appears that further restoration work was carried out eleven years later, when the date 1867 was etched on a carved motif of a coat of arms, without the craftsman's name.

The undated signatures of two new craftsmen, "*Antonio López*" and "*Juan Manuel Garrido*" were also found at the same height in this dome. So far, only the former has been found continuously in the account books for restoration work on the Hall of the Beds in Comares Baths between 17 November 1866 and February 1867; these dates also alternate with work in other places[33]. It is also possible that this signature could have been left by master builder Antonio López Lara, who is known to have carried out significant work at the Alhambra between 1841 and 1843, and who continued to carry out works such as dismantling the roofs of Abencerrajes, Two Sisters [Dos Hermanas] and the Hall of the Kings in 1846[34].

The name "*Francisco Alonso Rodriguez*" also appears on dome 1 and although it is undated, he was mostly likely the craftsman responsible for its last restoration in the 19th century.

The initials "*JMT*" were found at a great height in dome 6. This corresponds to José Molina Trujillo and therefore repairs must have been made between 1910 and 1954, the time he worked at the Alhambra, when he may have performed some reconstruction work and sealed any cracks. Restoration work on the roof of Abencerrajes and Two Sisters is dated from 1915.[35]And closer to the present day, work was performed by his son Antonio Molina Gualda, who installed the latticework in the Hall of the Kings with his partner Enrique on 31 August 1963[36] .

In 1847, after he was made the Alhambra's restorer-decorator, Rafael Contreras began to work with a workshop specialising in casts and he tried to manage all the work on the palace from this base. The workshop had few craftsmen; painters were hired on a daily basis when they were needed to paint the

30 In his restoration memoirs of August 1864, Rafael Contreras criticised 16th century restoration work on the colour for its lack of detail and precision. This comment makes it clear that colour retouching had already been carried out in the 16th century, although its scope is unknown. Contreras' comment can also be seen as a justification for his own restoration work and a great deal of poor quality retouching work can be found in these domes in addition to work previously found in the Hall of the Beds [Sala de las Camas]. (GONZÁLEZ PÉREZ, Asunción; RUBIO DOMENE, Ramón: *El taller de vaciados de Rafael Contreras...,* p.119).

31 GONZÁLEZ PÉREZ, Asunción; RUBIO DOMENE, Ramón. *El taller de vaciados de Rafael...,* Op. Cit. (no. 35), p.119.

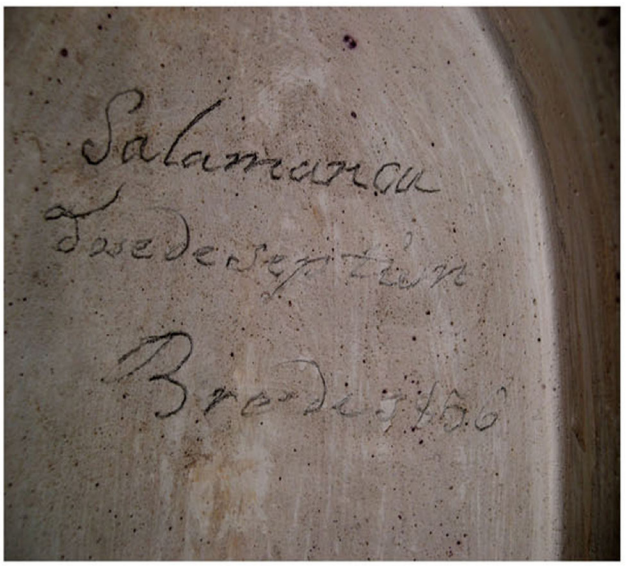
32 ARJONILLA Paz; AYORA CAÑADA, María José; RUBIO DOMENE, Ramón; CORREA GÓMEZ, Elena; DE LA TORRE LÓPEZ, María José; DOMÍNGUEZ VIDAL, Ana. *Romantic restorations in the Alhambra monument...*, p. 4

33 It is important to note that, to establish the approximate dates of these restoration works, restoration work on the reverse side required removing the tiles and the entire roof to restore the roof rafters and attach the new braces. This process required time, both for the work itself and for the additional equipment to be installed. At the same time, the plaster roof of the dome was drilled. This means that to attach the brace, work had to be performed on the interior and scaffolding used to be able to access the whole dome.

34 BARRIOS ROZUA, Juan Manuel. *Alhambra Romantica: Los comienzos de la restauración...*, pp. 112-113

35 SÁEZ PÉREZ, Mari Paz; RODRÍGUEZ GORDILLO, José. *Estudio constructivo – estructural...*, p. 25.

36 RUBIO DOMENE, Ramón. *Yeserías de la Alhambra...,* Op. Cit. (no. 12), pp. 100-101.



Il. 11. Part of a pilaster and capital at the start of the muqarnas dome in dome 7, dissolved by rainwater..
Il. 12. View of one of the corners of dome 4, where it is possible to see the 19th century holes made to fix the wooden braces that penetrate the thick plaster of the dome.

plaster and wood decorations[37]: and in tough economic times the officials worked as painters themselves[38].

STATE OF CONSERVATION

The domes' location explains their current state of conservation. They are located at the eastern end of the Courtyard of the Lions [Patio de Leones], where there is a great slope between the south side of the *Rauda* (dome 1) and the north side of the Partal (dome 7). This has meant that the area has had to be reinforced on various occasions[39]. When a gunpowder mill exploded that was located on the Albayzin side of the banks of the River Darro, next to the church of San Pedro and San Pablo, serious damage was caused to the walls and towers[40]. Dome 7 of the Hall of the Kings was badly affected by this explosion, as was the dome of the Hall of the Muqarnas [Sala de Mocárabes], which was badly damaged and could not be restored at the time. This neglect resulted in progressive deterioration that led to its collapse years later, and the dome that can be seen today, designed by Enrique Ledesma, was built in 1614.

The domes have also suffered the direct effects of seismic tremors, historically the most damaging earthquakes in Spain, which the building materials of the Alhambra have withstood[41]. Major earthquakes had already been detected that affected the walls and towers[42], as well as other materials and spaces such as the Palace of Alixares which was destroyed by the 1431 earthquake[43]. It was followed by many others in the Granada basin zone, such as the earthquakes of 1526, 1806, 1884, 1911 and 1956. This initial damage probably led to the need to perform the restoration work of 1537–1547 when the great muqarna dome in the Hall of the Two Sisters was rebuilt[44].

As was mentioned above, serious damage was found in dome 7 on the north side of the Hall of the Kings. It had previously been restored between the end of the 19th century and the beginning of the 20th century, when cracks were covered with plaster

37 SERRANO ESPINOSA, Francisco. *La Familia Contreras (1824–1906)...*, p. 110.

38 GONZÁLEZ PÉREZ, Asunción. RUBIO DOMENE, Ramón. *El taller de vaciados de Rafael...*,. p. 103

39 CEA RODRIGUEZ, Cristina. *La Alhambra. Análisis y documentación...*, p.22

40 BERMÚDEZ PAREJA Jesús. MORENO OLMEDO, María Angustias. *Documentos de una catástrofe en la Alhambra*. p. 79

41VIDAL SÁNCHEZ, Francisco. *El Terremoto de Alhama de Granada de 1884 y su impacto*.

42 M.A. RODRÍGUEZ-PASCUA (1), M.A. PERUCHA, P.G. SILVA (2), J.L. GINER ROBLES (3), R. PÉREZ-LÓPEZ, GARCÍA GUTIÉRREZ, G.B. *Evidencias de efectos arqueológicos de terremotos...*

43 AZAÑON, Jose Miguel. AZOR, Antonio. BOOTH-REA, Guillermo. TORCAL, Federico. *Small-scale faulting...*, p. 226

44 SÁEZ PÉREZ, Mari Paz; RODRÍGUEZ GORDILLO, José. *Estudio constructivo – estructural...*, p. 14.

and plasterboard and some of the modules were rebuilt due to significant displacement. They were significantly deteriorated and were at risk of detaching because previous restoration work had only tackled the problem from the inside. The first of the large domes, number 2, had also experienced important lateral movement and sliding, deforming the central star, as can be seen today, but there was no subsidence[45]. Dome 1 has been restored the most thoroughly and many of its modules have been reconstructed in plaster. In addition to the fairly successful reconstruction of its muqarnas domes, its painted motifs were also reconstructed with a less happy result. Module reconstruction focused on the north side and on the frieze of half-columns where the majority of changes were caused by water entering from the roof. This water dissolved the plaster and the different layers of the muqarnas modules.

All these actions, together with the neglect and abandonment suffered by the monument, especially in the 17th and 18th centuries[46], caused modules in the domes to become displaced. Large cracks opened and the roofs and ceilings broke, causing water to come in. This meant that the room had to be re-roofed in 1644 when the clay under the tiles was replaced, but it seems that the wooden roofs weren't raised[47]. There are also later descriptions of the great rainstorms of 1736; the polychroming and white primer layer was lost at the places where water entered, and consequently the plaster was weakened, ultimately dissolving and disintegrating[48]. Il. 11).

This level of change meant that restoration work was carried out on the domes on several occasions. In 1820, tiles were repaired by José de Salas. The exact site isn't specified but it probably wasn't a large project because only 350 reales were paid[49]. In 1827, master builders José de Sales and Antonio Agustin Garrido pointed out that the roofs of the Casa Real had not been touched for many years, and in 1828 new governor Francisco de Sales Serna[50] undertook a great deal of work on the roofs. Traveller Charles Rochfort tells us about the neglect and significant deterioration of the Alhambra on his first visit before the earthquakes of 1822, and the good impression given by the new works being undertaken in 1830 on his second trip[51].

There is information dating from 1853, the middle of the 19th century, when Catalan artist José Galofre's criticism of the restoration work carried out in the Hall of the Kings was published in the Heraldo. He commented on activity by workers who were working on the roofs, although the extent and location of this restoration is unknown[52].

After 1866, Rafael Contreras describes work that was carried out on the east pavilion of the Courtyard of the Lions, on the intercolumniation in the courtyard, the gallery of diamonds and arabesques in the north pavilion and earlier, in 1861, on the south pavilion gallery[53], but there is no specific information about work on the domes.

In the first restoration works, the whole dome was also braced at different heights to prevent cracks and fissures along its edges from continuing to open. Ropes with several several braided cords were placed around the perimeter (Il. 3) and fixed to some of the wooden struts while others were used as a tourniquet to give it the final tension and attach it with plaster. Although this system has been lost in most of the domes, it can clearly be seen in dome 6. The rope is firmly attached and hidden with plaster, and does not currently perform its original function. We believe that it is not an original system and may correspond to work by Contreras or even earlier.

One of the first works to restore the domes consisted of attaching wooden braces made of sticks, measuring about 2 cm in diameter and between 50 and 100 cm in length, to the plaster at one end and to the roof framework rafters at the other. These braces from the first intervention were fixed

45 This dome and its adjoining space were the areas that were impacted the most by these forces of change, and they coincide in several aspects that are be outlined below:

-It is the only dome of the three large ones that has no traces of colour in its decorative plasterwork panels on the walls below the latticework. It is also the only dome with the coats of arms of the Catholic Monarchs embedded among the geometric and plant motifs of the plasterwork.

-Dome 1 is next to this space, and many of the muqarnas modules on its north side have been reconstructed. This area coincides with the wall that divides it from dome 2.

-The vault with the painting on leather of the "*Lady playing Chess*" is next to these spaces. It is the worst preserved and is the only one that had to have fragments of leather replaced due issues with damp, as well as wooden structures due to rotting.

46 MUÑOZ COSME, Alfonso. Cuatro siglos de intervenciones en la Alhambra..., p.159

47 VILAR SÁNCHEZ, Juan Antonio. *Obras en la Alhambra. File 152-1...*, pp. 60-65

48 RUBIO DOMENE, Ramón. *Yeserías de la Alhambra...,* Op. Cit. (no. 12), p.122

49 BARRIOS ROZUA, Jose Manuel, *La Alhambra de Granada y los difíciles comienzos...*, p.133

50 BARRIOS ROZUA, Jose Manuel. *La Alhambra de Granada y los difíciles comienzos...*, Ibidem, p.136

51 LÓPEZ-BURGOS, María Antonia. *Granada. Relatos de viajeros ingleses (1802-1830).* Melbourne: Australis Publishers, 2000, pp. 120-122.

52 JIMÉNEZ DÍAZ, Nieves. *Informe pinturas de las Salas de los Reyes...*, p. 230.

53 AHA Legajo, Book 16-4, 1866

into the thick plaster on the back of the dome using very hard black plaster that was firmly pressed down. The sticks were all from the same tree species, had already lost their bark and had a rough texture with lengthwise edges; the tree species has not yet been identified. These poles are currently cut a few centimetres above the plaster layers on the back of the dome. They were probably cut during the second restoration works and are in an advanced state of deterioration, with evidence of damage by wood-eating animals, and in some cases they have disappeared entirely, leaving only the hole behind. During Contreras' restoration, many of these braces were probably found to be rotten while others were cut when replacing the roof framework, and because they made it difficult to place the set of new rafters on the new roof.

When new braces were installed in the 19th century in a second round of restoration works, some of the holes left by the old ones were used and the same technique as the first was repeated. New wooden poles were also inserted but using a different species of tree, as seen by the texture of its bark and the density of the wood. During these second works in the 19th century, established by the graffiti and dates that feature on several parts of the muqarnas as described above, new holes were opened from the back of the dome to attach the new wooden braces. On occasion the hand drill used to make the holes pierced the thickness of the plaster and randomly came through on the front of the muqarnas, losing the polychroming and gilding. Il. 12).

Attaching wooden braces to the plaster was helped by making rebates and notches in the appendix at the head to make it grip, so that it goes from larger to smaller and works as a stopper embraced by the plaster. It was attached to the framework with square-shaped forged metal nails. The end of the brace that was attached to the plaster worked well in most cases. The same isn't true where the brace was anchored to the framework with forged nails because the pole has turned green and has created gaps where it has dried out. The nails used to attach it were also frequently too large for the diameter of the pole, making it split, and no hanging force is exerted on the dome.

The species of wood used has not yet been identified, but we think that it is a common type of wood that would have been easy to find in the vicinity (Alhambra forest), as they are simply sticks from trees or bushes, with their typical deformations and no special treatment that distinguishes them.

In both restorations, new layers of plaster were applied to fix the wooden braces in place and to reinforce cracks and cupolas. Although black plaster was used, and today different shades appear, it is very difficult to differentiate one period of restoration work from another. Wooden braces of this type have also been observed in the large muqarnas domes in the Hall of the Abencerrajes [Sala de Abencerrajes], Hall of the Two Sisters [Sala de Dos Hermanas] and Hall of Ajimeces [Sala de Ajimeces][54]. Restoration work was probably also performed on them in the 19th century. Architect José Contreras, director of the works of the Royal Site and Fortress of the Alhambra describes this work as being included in financial entries on roofing work that covered timbering the roofs, and replacing plaster ridges and lime mortar,and not as muqarna ceilings, suggesting that after 1840 money was spent on roof repair work[55].

In general, the plaster is in good condition and only shows signs of cohesion problems at points where it has been directly impacted by rainwater due to leaching, where the white finishing layer has also lifted. The changes produced by rainwater filtration are rather surprising. Damp has caused the interior of the plaster to dissolve, and loss depends on the level of change; rounded rough 'warts' have been produced that are currently stable and very hard. These 'warts' have appeared in different places, especially on the edges of the carved motifs of the domes 1 and 7, and were probably caused by damp acting slowly on the organic binder of this layer (probably egg white), when water circulated through the pores of the plaster under this white layer.

In terms of the state of conservation of the polychroming, the paintings show different types of alternation depending on the colour. Polychroming in the muqarnas domes is above the line of latticework, and the domes were completely closed at the top. Temperatures would have varied according to the season of the year; summer would have been a damaging time because, in addition to high air temperatures, the terracotta roof also transmits indirect heat as it warms in the sun. Together these factors create a large pocket of hot air that is not renewed, and it has slowly damaged the binders in the pigments and the adhesive size used to apply gold leaf, causing both to disintegrate. Today, much of this decoration has been lost. In terms of the colours, the range of blue and black tones that are currently visible are stable. In contrast, the red tones

54 In the last series of restorations works carried out on the roof of this room in 2020, it was also possible to verify the use of the technique of hanging the muqarnas dome by using wooden braces attached to the roof rafters, and the two different types of wooden braces corresponding to two different stages of restoration were also identified.

55 BARRIOS ROZUA, Jose Manuel. *La Alhambra de Granada y los difíciles comienzos…*. Cit. (no. 43), p.150

Il. 13. Detail of module 3, polychrome in vermilion-red applied in the Nasrid period, which has been hidden since the 19th century under a layer of

(both cinnabar from the Nasrid period and lead red from 19th century restoration works) have changed and have a greyish appearance due to the action of chloride ions (cinnabar) or the oxidation of mercury sulphide, which also turns to greyish tones[56] as has been seen above. However, due to the way they were applied and their quality, it is thought that the red tones found mainly in the '*taco de medina*' module of domes 2 and 6, and in some other carved motifs, belong to repainting applied in the 19th century in a dark shade of red with a lead base, imitating the deteriorated vermilion. It is worth noting that a red vermilion-coloured remnant has been found on the face of muqarna block module 3 in dome 2. This polychrome muqarna block module was under a layer of black plaster applied in the first restoration works, which hid and protected it from the direct action of both light and air over time. This means that it is in good condition and has a very intense colour, which gives us an idea of how intense the original Nasrid red would have been, and the great polychroming and intensity that these domes would have originally shown. Il. 13).

With regard to the gilding, it has significantly detached from its support due to changes to the size used as an adhesive; in most cases it appears to be an alloy of false gold where oxidised tin gives some iridescence to these metallic finishes[57]. It is highly likely that these finishes were also used in earlier restorations, and gold and false gold leaf have been used to restore the monument since 1499[58].

RESTORATION PROCESSES.

Restoration work began once the phase of removing the old wooden roof had been completed, and scaffolding had been built on the inside of each dome. The following steps involved analysing materials and polychroming, running topographical studies, 3D scanning, and surveys of all the data that were of interest for understanding the different phases of restoration performed in each dome, as well as their initial construction in the Nasrid period.

3.1. Reverse.

A great advantage when restoring these domes was being able to work on the reverse side, once the roof had been removed. The first process carried out on all the domes was removing loose plaster from recent restoration works, and cleaning and removing dust and soil from all the layers of plaster that originated from the old clay cover under the roof tiles. This was done mechanically using vacuum cleaners and brushes.

-Repair of cracks and fissures.

As mentioned above, most of the stars closing the different cupolas were loose, with hardly any plaster mortar to glue them together. To attach them, and to repair cracks and strengthen structures that had detached from the lower layers, new reinforcement was applied, moistening the area with water to help apply and subsequently attach the new plaster masses. These were applied by mixing esparto grass fibres that had also been moistened with water.

56 AYORA-CAÑADA, María José; DOMINGUEZ VIDAL, Ana; de la TORRE LÓPEZ, María José; RUBIO DOMENE, Ramón. *Investigación de yeserías mediante espectroscopia Infrarroja...,* p. 808

57 RUBIO DOMENE, Ramón. *Yeserías de la Alhambra...,* Op. Cit. 12, p. 187.

58 VILAR SANCHEZ, Juan Antonio. *Los Reyes Católicos en la Alhambra*, p.92

plaster that was applied to this module.
Il. 14. Levels of collapse in dome 2 showing the deformation of the central star and how it has fallen towards its north-west vertex which, as can be seen

-Structural fixing work (special case for dome 7).

Particular work was required for dome 7; due to its location at the northern end of the hall it had suffered greater damage from seismic movement, explosions, damp, etc. This meant that many cracks ran through the bulk of the dome, with displacement at its vertexes, and some of the muqarna block modules that formed motifs in the central cupolas had fallen off. Il. 14) This deterioration probably occurred prior to restoration work carried out during Rafael Contreras' time, when some cracks were covered with plaster and the corner modules were reconstructed. The first work we performed was to remove any plaster mortar that no longer fulfilled its function in order to lighten the weight. Once the dome, location and direction of all cracks had been studied, a fastening mesh was built and its fastening points could be adapted according to the presence and direction of the cracks. The mesh was made of fibreglass cord fixed with plaster and esparto grass fibre. It joined the entire dome, making all the detached areas solid. The number of fastening points in the mesh could be increased according to the needs of each area. Il. 15).

-Installing humidity, temperature and inclinometer sensors.

During the course of the renovation work the wooden props installed in during Contreras' time were removed and replaced by stainless steel tensors. One the holes located in the upper part of the central crown of dome 4 was used, where a sensor was installed to record humidity, temperature and seismic movement using an inclinometer. Data is recorded on a computer located in a room near this room, which is used to study the behaviour of the entire structure and to analyse data recorded over time.

-Natural ventilation system in the central star

To improve conditions for the polychroming and gilding on the upper part of the dome, and taking into account that the central stars at the top of the small cupolas that crown all the

domes were loose, these stars were reattached on small truncated plaster blocks that raise them several centimetres above the crown of the cupolas. This is imperceptible when viewed from the ground but allows air to flow in and out. This minor process ensures hot air that accumulates in this area can circulate, especially in summer, as the roof also has small vents in two tiles on each of the four sides of the domes (2, 4, 6), which encourages air circulation and renewal. Il. 16).

-Installing the new hanging system.

Due to the problem caused by the wooden braces installed during Rafael Contreras' time, it was decided to remove these braces because most did not fulfil the function for which they were designed, as has been seen above. Instead, taking advantage of the hole that had opened up in the original plasterwork over the bulk of the dome, new stainless steel tensors were installed to ensure that the dome would hang in the event of any detachment. Prior to their installation, each hole was studied to assess its suitability because the number of existing holes and braces was greater than the number of new tensors that would be installed. Joint action was also taken from inside the dome to fix and seal some of the holes with the new tensors.

Stainless steel bolts were placed in the holes in the thickness of the dome that were attached with plaster and esparto grass tied to a steel cable, and mechanically fastened at the other end to the wooden rafters of the new roof with a stainless steel through bolt. The length of the tensors was enough to ensure that they will not experience any load unless a situation occurs in which the dome detaches and possibly falls. Il. 17).

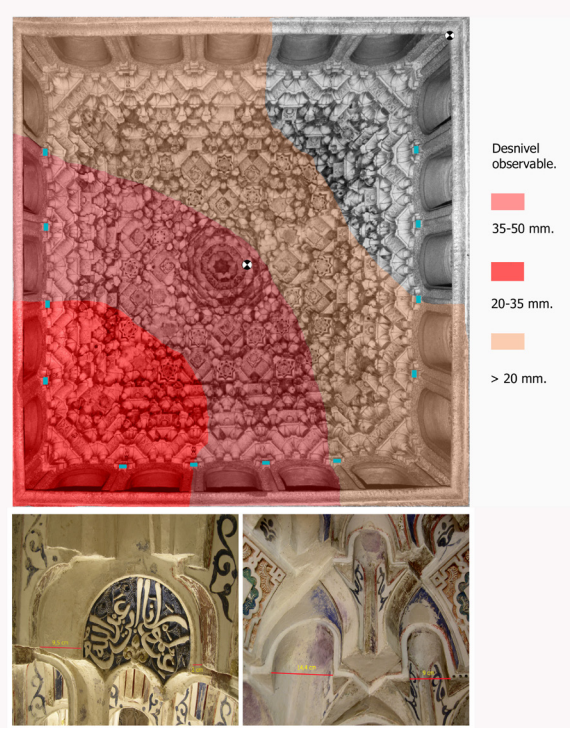
OBVERSE.

-Reconstructing support cracks.

The large cracks that hindered the readability of some of the modules were rebuilt, as were cracks found at the foot of the parapets, making these elements firmer and more secure. Larger cracks were filled and some of the loose elements were reattached. Alhambra plaster-based mortar was used in all these reconstructions due to its fluorescent properties, so that the restoration work could be located using ultraviolet light radiation. When necessary, due to the size of the fissures or cracks, esparto grass was added as a natural fibre to reinforce masses in cracks and large areas of loss. (Il.18)

In cases where the plaster had disintegrated due to damp, several coats of ethyl silicate were applied as a consolidating agent to restore its stability.

in the images below, sometimes reaches up to 7 cm. The image above shows large forged angled nails (in blue), which were introduced in later 19th century works to guarantee its stability and prevent it from collapsing. These angled nails were also used in dome 6.



Il. 16. Diagram of the new circuit designed to promote air circulation in the upper part of these domes, created by raising of the central plaster star and installing ventilation tiles on the roof.
Il. 17. Installation of stainless steel metal braces on the back of the domes, fixed to the wooden rafters of the new roof.

Il. 15. Restoration process that involved placing a fibreglass mesh fixed with esparto grass mixed with plaster on the back of dome 7.

-Cleaning the preparation base and polychroming.

As these are tempera paintings with no protective layer, dust and dirt, and any water-clay patinas applied in the last restoration works, were removed with a scalpel and soft brushes. On occasion it was necessary to use an eraser, due to soot from candle smoke, and in specific cases, such as dome 1, layers of lime were lifted that concealed the original polychroming. This was extremely delicate work because it was carried out directly on the layer of polychroming.

-Fixing the gilding.

The gilding was treated by applying an acrylic resin (Acryl 33) emulsified with water, and applying pressure where necessary to reattach it to the plaster support. Most of the gilding had detached and a very high percentage had been lost.

-Consolidating the polychroming

Finally, polychroming that was unstable due to irregular damp was treated by applying acrylic consolidating treatment such as Paraloid B-72. The iron nails found embedded in the plaster were also treated with corrosion inhibitors and corrosion protection coatings, while the original wooden braces, which were also embedded in the plaster, were treated with wood nutrients.

CURRENT RESTORATION PROCESSES.

The five openings generated by the lattices were used to install LED spotlights, taking advantage of how deep these spaces are until they close on the outside. The spotlights are hidden from view from the ground and make the domes more visible because the highest parts of the cupolas were very dark. Partial enclosures of reversible glass are due to be installed on the outside to prevent large amounts of wind-born dust and dirt from entering while also leaving the upper part of these lattices open to help ventilate these spaces.

Work is currently continuing on the plasterwork in this room and the walls under the muqarnas domes are being restored.

ACKNOWLEDGEMENTS

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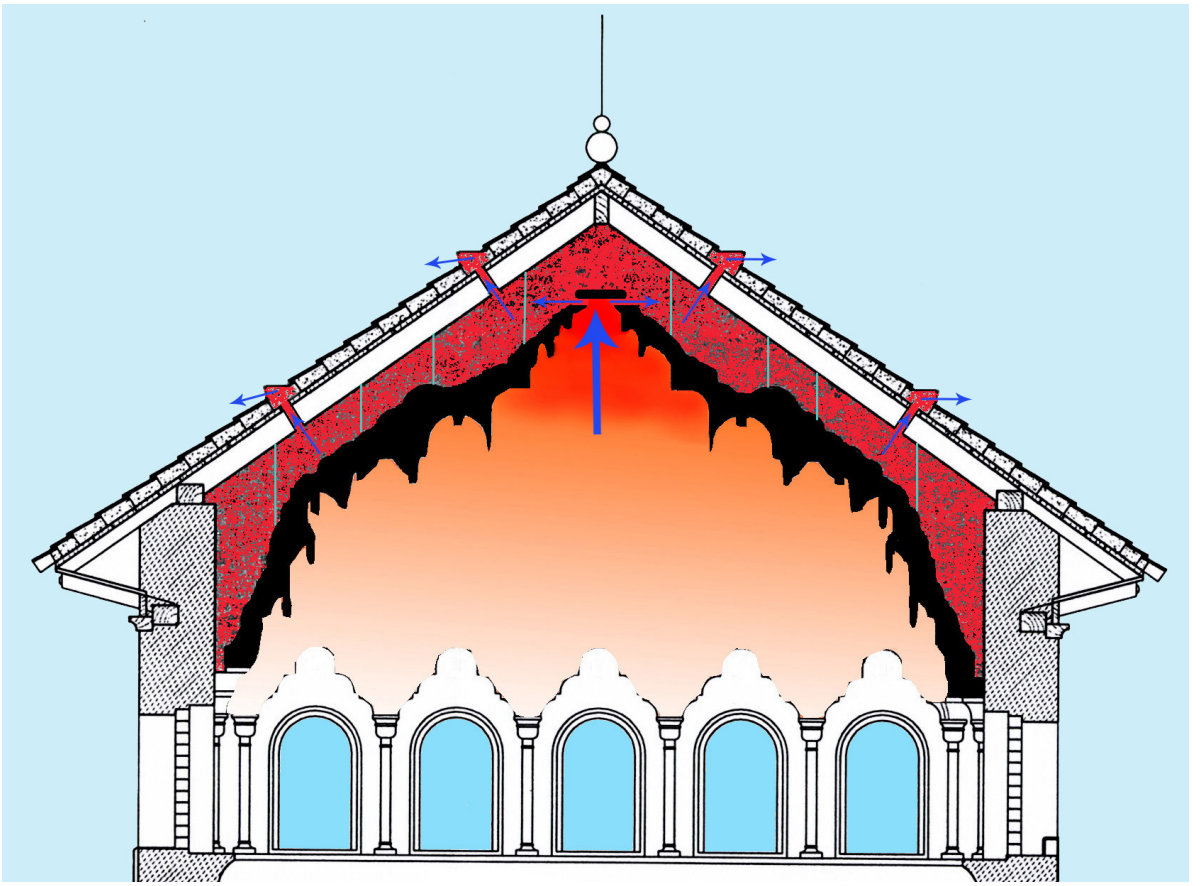

Il. 18. Photograph taken with ultraviolet light showing a detail of the final phase of restoring volume to dome 7, with work on all cracks and fissures using Alhambra plaster-based mortar.