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Evolution of Maghrebi-Andalusian Muqarnas Design: Analytical Study of Muqarnas in North Africa and Spain

Evolución del diseño de los mocárabes magrebí-andalusíes: Estudio analítico de los mocárabes en el norte de África y España

Evolução do design das muqarnas magrebinas e andaluzas: Estudo analítico das muqarnas do norte de África e em Espanha

Keywords | Palabras clave | Palavras chave

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Arquitectura islámica, Arquitectura tradicional, Oficio, Andalucía, Magreb

Arquitetura islâmica, Arquitetura tradicional, Artesanato, Andaluzia, Magrebe

Abstract | Resumen | Resumo

Muqarnas is one of the most important architectural elements of traditional Islamic architecture, although with great structural and geometrical differences across Islamic geography, leading to the emergence of many muqarnas styles. This paper looks at changes occurring in Maghrebi-Andalusian muqarnas from its beginnings to the form it takes today. This is done by using traditional muqarnas design techniques to draw and analyze models from different periods and settings in North Africa and Andalusia, Spain. We observe changes occurring at unit and plan-design level, seeking a general understanding of these developments.

El mocárabe es uno de los elementos arquitectónicos más importantes de la arquitectura islámica tradicional, aunque presenta grandes diferencias estructurales y geométricas en la geografía islámica que han dado lugar a la aparición de muchos estilos distintos de mocárabes. En este artículo se analizan los cambios producidos en el mocárabe magrebí-andalusí desde sus inicios hasta la forma que adopta en la actualidad. Mediante el uso de técnicas tradicionales de diseño de mocárabes se dibujan y analizan modelos de diferentes períodos y lugares en el norte de África y Andalucía. También se analizan los cambios unitarios y en el diseño de planta para obtener una comprensión general de esta evolución.

As muqarnas são um dos elementos arquitetónicos mais importantes da arquitetura islâmica tradicional, embora com grandes diferenças estruturais e geométricas ao longo da geografia islâmica, o que levou ao aparecimento de muitos estilos

de muqarnas. O presente artigo analisa as alterações presentes nas muqarnas magrebino-andaluzas desde os seus primórdios até à forma que assumem atualmente. Para tal, recorremos a técnicas tradicionais de desenho de muqarnas para desenhar e analisar modelos de diferentes períodos e contextos no Norte de África e na Andaluzia, em Espanha. Observámos as mudanças que ocorrem ao nível da unidade e do design da planta, procurando uma compreensão geral desta evolução.

Introduction

Muqarnas is a geometric, honeycomb-like style of decorative vaulting of uncertain origin that can be seen in abundance in Islamic architecture, appearing in almost all Muslim regions as of the eleventh century. Nevertheless, muqarnas design and features vary from period to period and place to place, and the materials and techniques used may also indicate regional affiliation. There is accordingly a body of research classifying varieties of muqarnas.

In terms of design, muqarnas can be divided into two broad groups, based on units or on cells. Given their common geography, the former may be called "Maghrebi-Andalusian" (western region of the Mediterranean) and the latter "Mashreqi" (eastern region), as most examples in the eastern region (including Central Asia, Iraq, and Anatolia) are based on cells, whereas in the western region they tend to be based on units. In this study we will discuss the Maghrebi-Andalusian muqarnas and attempt to shed light on its geometric principles, construction methods, assembly, and design. We will also survey the evolution of its elements over time.

Methodology

Our research methodology involves studying examples of muqarnas at heritage sites in North Africa and Spain, dating from various periods. We analyze these examples and consider the types of units used and the design method by means of redrawing the designs according to the technique traditionally employed by craftsmen. We seek to apprehend the evolution of Maghrebi-Andalusian muqarnas design and construction and to identify the methods traditionally employed to create these intricate and precise assemblies. We refer to the terminology used by Moroccan craftsmen today, whereas Spanish craftspeople have different terms for the same elements with origins in both Spanish and Arabic.

Emergence of Maghrebi-Andalusian Muqarnas

Muqarnas, apparently emerging in the easternmost part of the Islamic world and spreading within a century or two to distant western shores where it rapidly evolved into a system distinct from its eastern counterpart, became a hallmark of architecture in the Maghreb and Andalusia. But there are three theories regarding the initial emergence of muqarnas in this region.

According to the first, asserted by scholars such as Oleg Grabar, Maghrebi-Andalusian muqarnas appeared parallel to the muqarnas of the eastern Islamic world, without any interaction between the two (Grabar 1978: 175).

The second view, held by the Spanish historian Jacinto Bosch Vilá (1977), is that the first appearance of Maghrebi-Andalusian muqarnas was not in North Africa but in Almería in Andalusia, before the style spread to North Africa.

The third theory, of scholars such as Creswell, Georges Marcais, and Torres Balbás (Haddad 2020), traces the chronological development of extant muqarnas. Muqarnas is asserted to have reached the Maghreb region shortly after its emergence in Egypt, under the rule of the Fatimids.

To apprehend the system and structural principles of Maghrebi-Andalusian muqarnas, we must first introduce its main components and design principles along with the traditional techniques employed by Maghrebi-Andalusian craftsmen. With the terminology used by contemporary muqarnas craftsmen and the literature on Maghrebi-Andalusian muqarnas craftsmanship, the geometric properties, units, and plan angles of this muqarnas type can be described as follows.

Units of Maghrebi-Andalusian Muqarnas

Maghrebi-Andalusian muqarnas, like its Mashreqi counterpart, uses a single module scale called *mikyas*. But the feature that sets it apart from Mashreqi muqarnas is its reliance on regular units rather than multi-angled cells. The units crafted are also arranged in a regular manner in overlapping layers, whereas in Mashreqi muqarnas, each layer is distinct from the others (Fig. 1).

Additionally, although the fundamental elements of Maghrebi-Andalusian muqarnas units are diverse and challenging to enumerate, they are based on just three shapes adhering to the main scale: isosceles right triangle, rectangle and rhombus (Fig. 2). Thus the essential angles of these units are 90 and 45 degrees, with the result that many vaults with Maghrebi-Andalusian muqarnas have an octagonal basis.

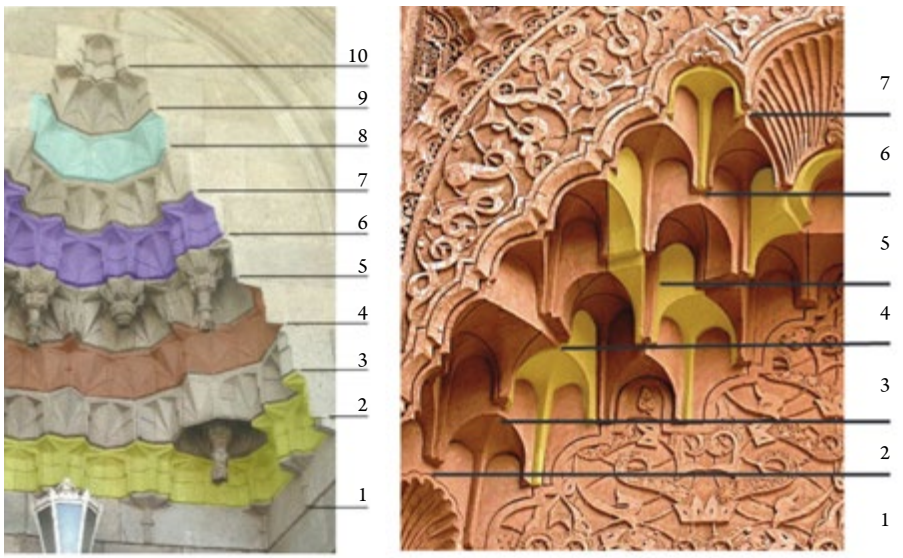


Figure 1: Muqarnas with parallel layers in Lala Mustafa Pasha Mosque, Erzurum (left), and muqarnas with overlapping layers in Ibnu Yusuf Madrasah, Marrakesh (right). We have colored the items for clarity

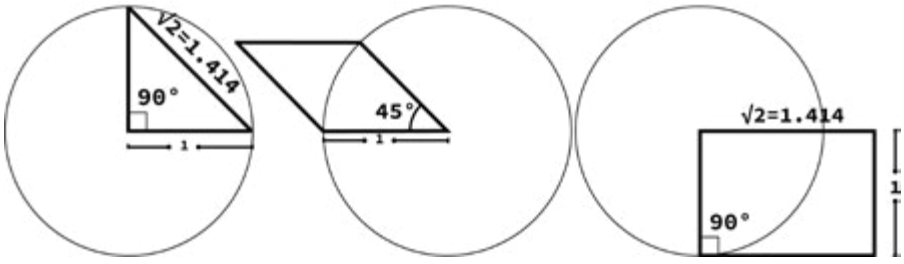


Figure 2: Basic shapes of Maghrebi-Andalusian muqarnas units

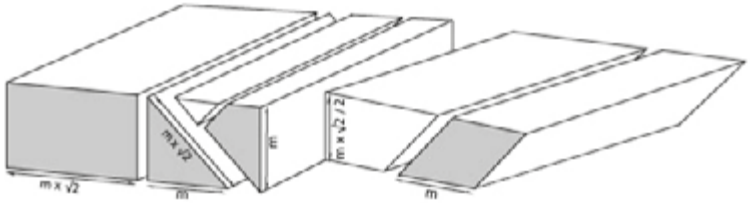


Figure 3: Cutting basic shapes to scale to make muqarnas elements

The edges of the three shapes on which the units in a layer are based always have two different lengths, one equal to the scale (*mikyas*) and the other equal to "*mikyas* × √2". The proportion that we could call "the golden ratio of muqarnas" resides in the edge measurements of the isosceles right triangle. In the counting method used by traditional craftsmen, if the length of the edge equal to the scale comprises five parts, then the length of the other edge should comprise seven parts (Velázquez 2016: 138). In some examples this module may be divided into two in the upper layers of muqarnas, with the units being adjusted accordingly, or in a muqarnas with flawed plan design (*khutta*), the craftsman may need to deviate from this scale.

To create muqarnas elements, long polygonal strips are first prepared using the three main shapes mentioned above (Fig. 3). These strips are then cut into individual pieces of a certain size, and these pieces are carved according to the template (Fig. 4).

When curved parts are cut, a specific method is followed to ensure that the curves of an element match those of the adjacent elements, and a template is prepared accordingly. The oldest known account of this method is by the seventeenth-century Spanish architect Fray Andrés de San Miguel (Velázquez 2016: 139). Nowadays muqarnas craftsmen in North Africa prepare a single element and use it as a template for all the others.

It is not easy to specify all the muqarnas elements or *ferma* pieces (as North African craftsmen call them) used by traditional Maghrebi-Andalusian builders. Some examples may contain additional parts such as intermediate elements or dome keystones not belonging to the aforesaid categories. These elements are designed according to the additions required by the craftsman's *khutta* plan and added to the main elements without deviating from the *mikyas* scale. However, after referring to various books and studies on the subject and consulting Moroccan artisans regarded as masters of traditional muqarnas, we may enumerate the commonly used elements and categorize them according to their importance (primary or secondary) as shown in the table (Fig. 5 and 6):

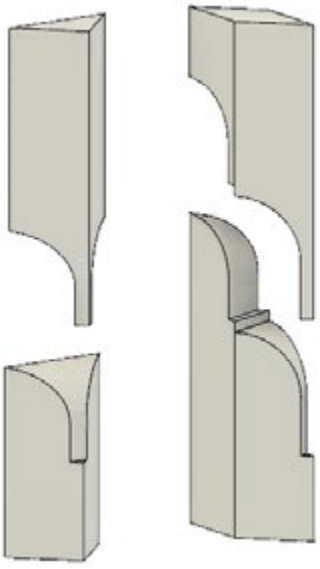


Figure 4: Cutting of muqarnas elements (*ferma* pieces)

Figure 5: Secondary elements of the Maghrebi-Andalusian muqarnas

Triangle-based elements

Dambuk

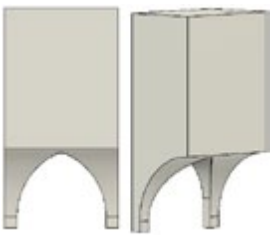
Sirwaliyya or Buja

Small Shaira

Rectangle-based elements

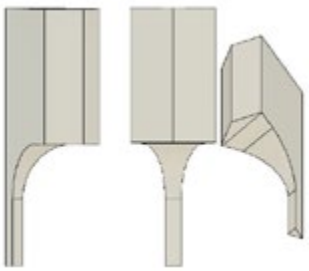
Close Tasdiyya

Open Tasdiyya

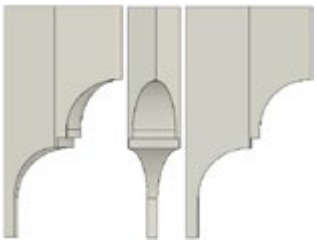


Rhombus-based elements

Luza



Katif

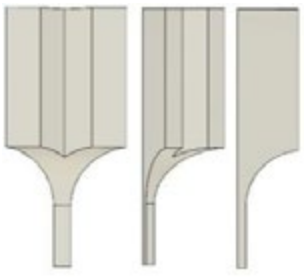


Shaira

Figure 6: Secondary elements of the Maghrebi-Andalusian muqarnas

Triangle-based elements

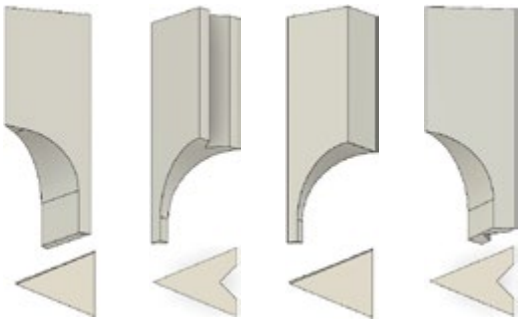
Dambuk al-Khatim



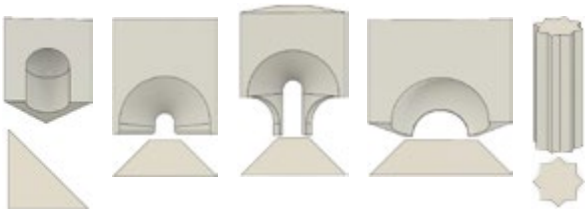
Rhombus-based elements

Sirwaliyya mina'l Katif

Different types of half rhombus-based Luza



Scale-based irregular intermediate elements



These are the commonest units, although others have been used over the years. Besides elements based on the three units mentioned above, another type often used in Maghrebi-Andalusian muqarnas, especially in vaults, is the intermediate element called *ktîb* by North African craftsmen and *medina* by Spaniards (de Arenas 1633). While this is not a primary muqarnas unit, it is often found in square or rectangular muqarnas plans and serves to connect groups of units called *ush*, meaning "nest" (Figs. 7 and 8). It may also be used to fill gaps between elements resulting from irregular design, with its thickness being adjusted accordingly. Thus it either facilitates construction or covers design flaws.

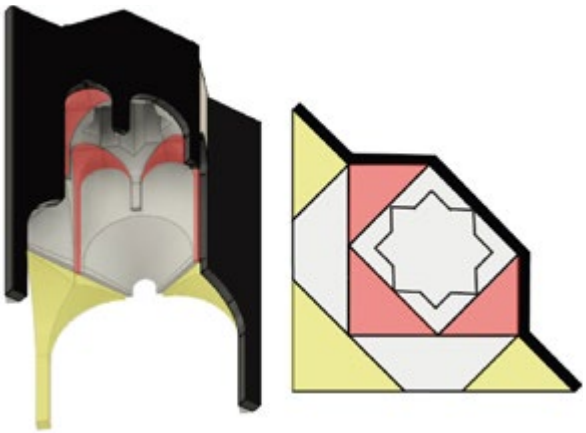


Figure 7. In the left-hand drawing, the group of colored elements is the *ush* and the black elements the *ktîb*. The right-hand drawing is the *khutta*, a plan view of the same assembly

Figure 8. The *ktib* element in muqarnas at the Qarawiyyin Mosque, Morocco (highlighted in yellow)

Khutta Plan of Maghrebi-Andalusian Muqarnas

Khutta, "plan" in Arabic, refers in the terminology of traditional craftsmen to the muqarnas plan view consisting of triangles, squares, and rhombuses.

Although some Maghrebi-Andalusian muqarnas units may appear different, they always result from the division or combination of these three basic shapes. For example, as shown in figure 9, the area in diagram (A) is filled with a triangle and two rhombuses, or three muqarnas units, while the same area in diagram (B) is filled with just one shape, or one muqarnas unit, formed by combining the three shapes in diagram (A). Such examples are widely encountered, reflecting the skill of master muqarnas builders.

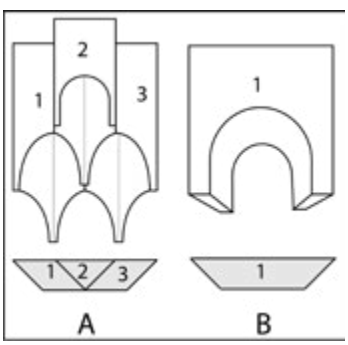


Figure 9. Muqarnas unit formed by combining three different shapes

As for *khutta* design methods, over time traditional muqarnas craftsmen developed principles for drawing and interpreting these plan views. While it is essential for the units always to be based on the three aforesaid shapes and to adhere to one specific scale, it is also necessary for adjacent edges to be of the same length.[1] Failure to adhere to this rule results in a flawed muqarnas *khutta*. To help craftsmen read the *khutta* properly, a points system was also developed; as shown in figures 11, 12, and 13, points are placed on the angles of certain shapes to indicate the lower part (the "foot"). The side without points is the top. This pointing process requires considerable imagination, especially in complex muqarnas with many units.

Muqarnas experts often draw and interpret *khutta* plans with ease, even without pointing. The earliest example of *khutta* design is attributed to Fray Andrés de San Miguel, the seventeenth-century Spanish architect and carpenter (Fig. 10). Moreover, the *khutta* designs drawn by craftsmen do not contain measurements. So a single *khutta* can be executed in spaces of different dimensions with no need for adjustment.

Muqarnas Plans of Traditional Models

We will now review some muqarnas from different periods and locations. Our field study included over seventy examples, though the limited scope of this article required us to select just a few. We therefore chose examples for analysis that exhibit features characteristic of the period to which they belong. During the process we drew plans of these muqarnas by the traditional method.

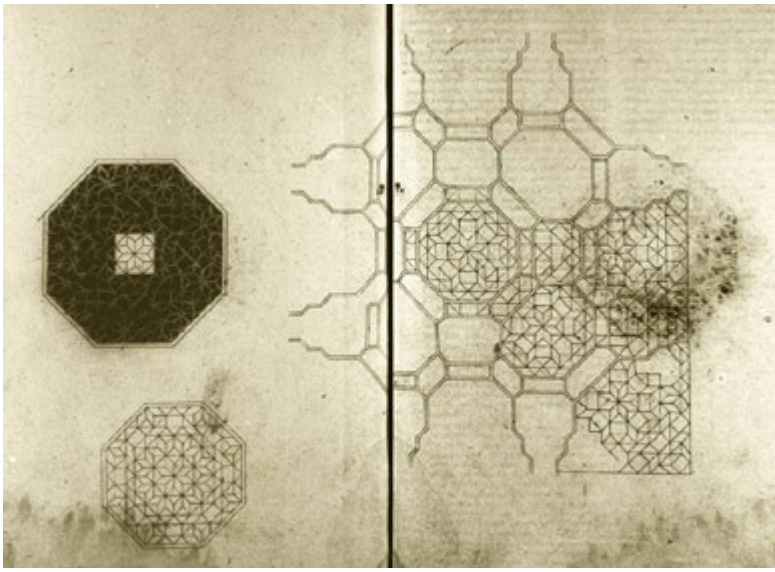


Figure 10. Seventeenth-century *khutta* drawn by Fray Andrés de San Miguel (Enrique Nuere)

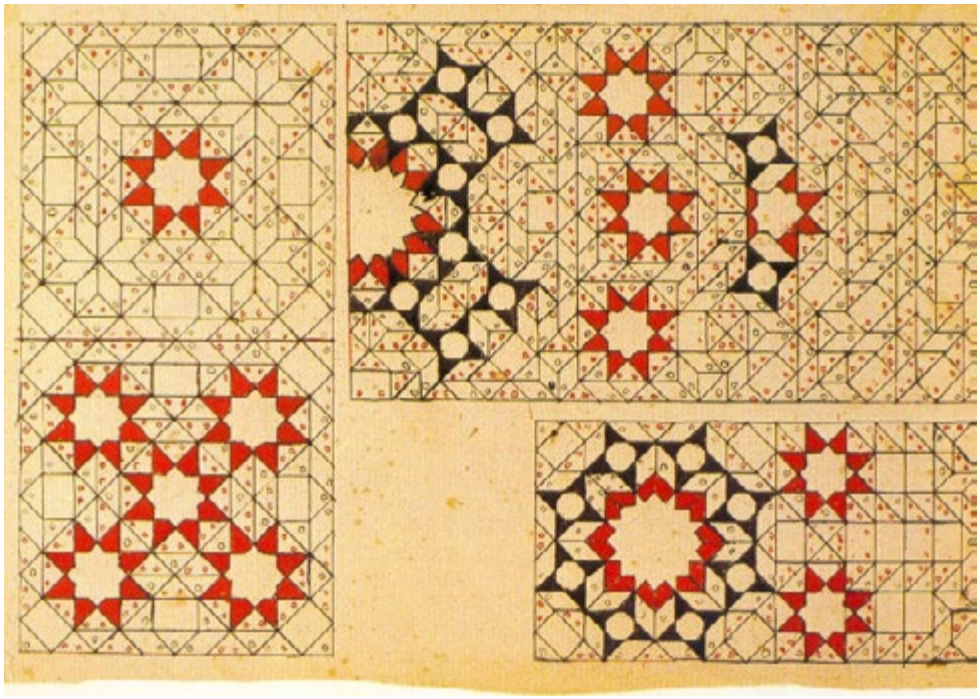
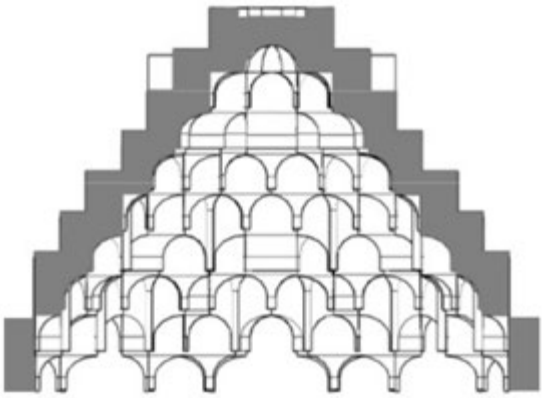


Figure 11. *Khutta* drawn by a traditional craftsman (André Paccard)



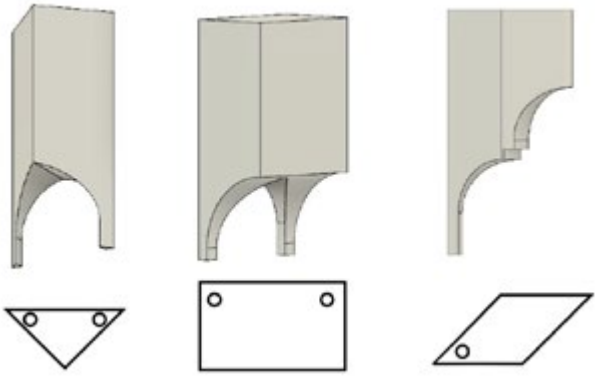


Figure 13. Determining the foot of muqarnas units with points in *khutta* plans

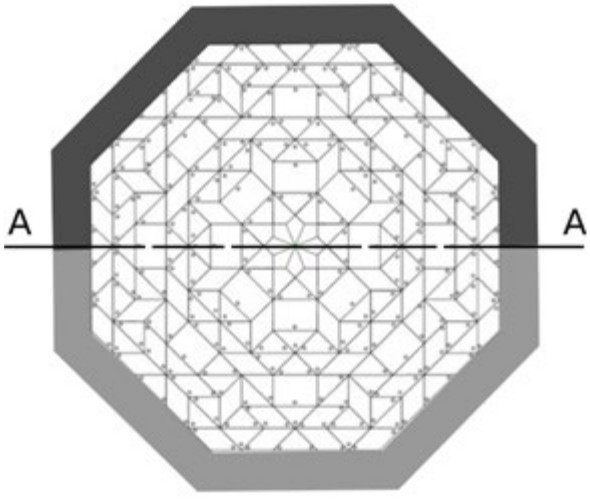


Figure 12. *Khutta* of a cupola in the Kutubiyya Mosque

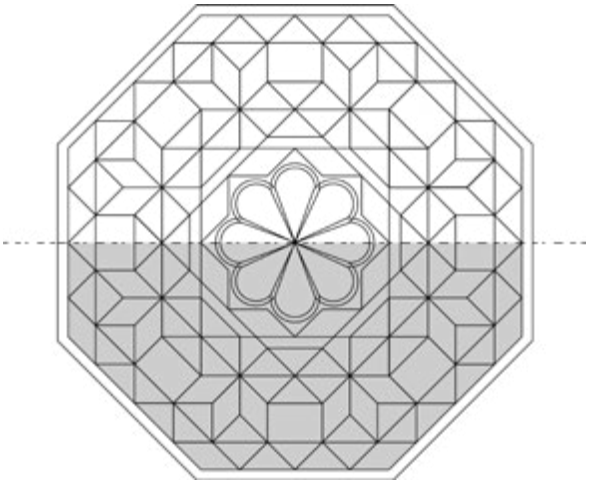
Muqarnas in the Qarawiyyin Mosque, Fez, Morocco

This model is significant in that it contains examples of the development of muqarnas from the period when the Maghrebi-Andalusian muqarnas emerged (the twelfth-century Almoravid era) and others from the "mature" period (the sixteenth-century Saadian era), letting us see both the beginnings of this muqarnas style and its development. Here we consider muqarnas examples from the Almoravid period, namely the six muqarnas domes over the central aisle.

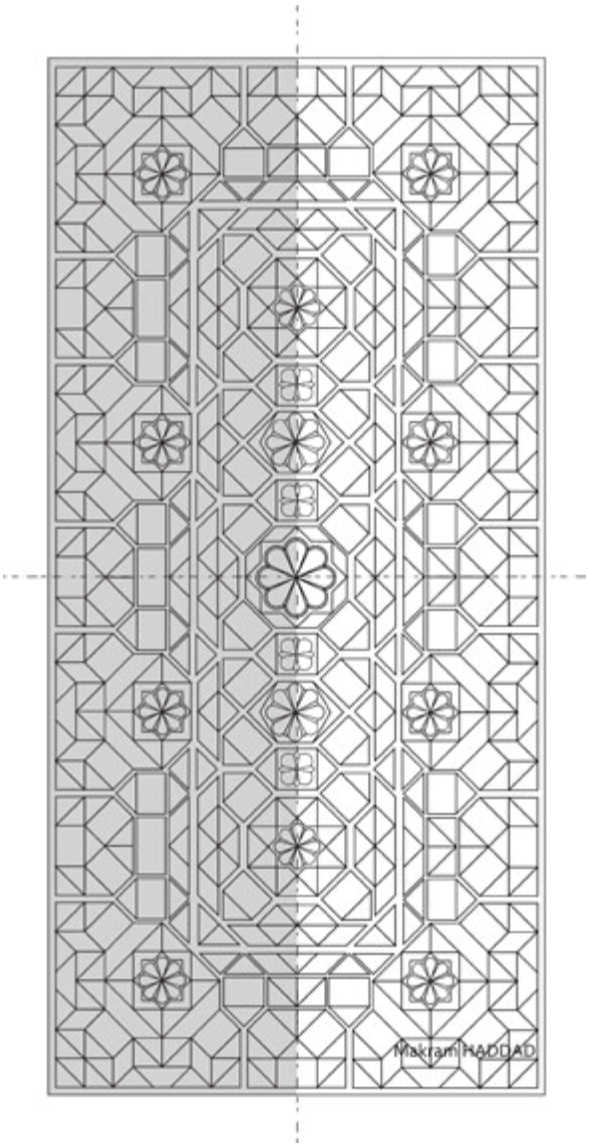
With the exception of the last one, these muqarnas domes are characterized by their large elements and the similarity of their plans, relying extensively on the use of the *ktîb* element in their *khutta* arrangement. But the final dome appears markedly different from the rest. Like eastern-style

muqarnas domes, it does not adhere to a single scale and its units do not conform to the angles typical of Maghrebi-Andalusian muqarnas (45 and 90 degrees). Given the theory positing eastern origins of Maghrebi-Andalusian muqarnas, this dome could be seen as evidence of a transition from eastern to western styles.

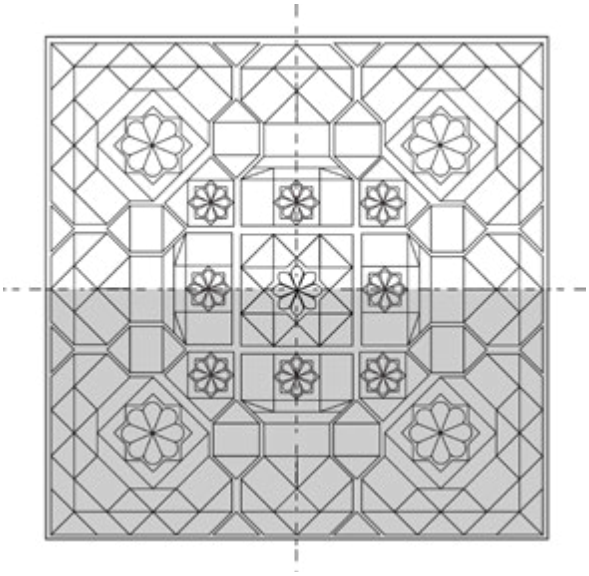
Inside Mihrab Dome



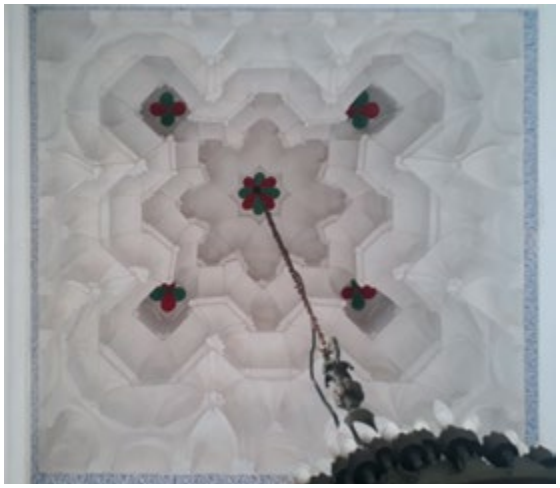
The vault of the central courtyard

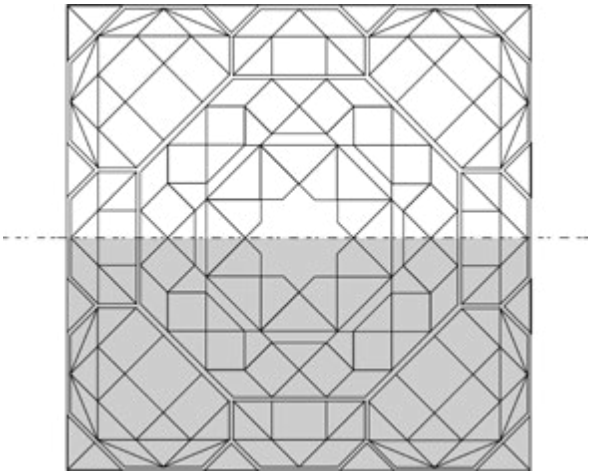


Mihrab dome

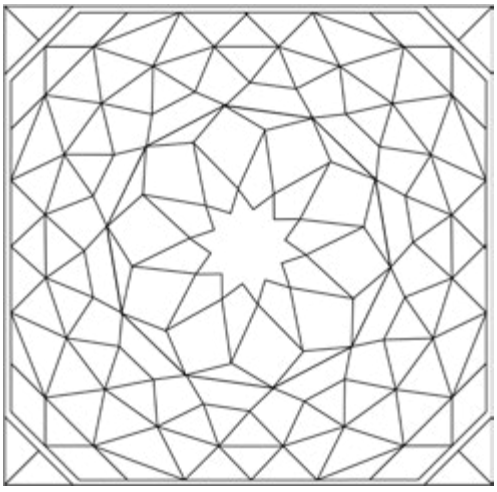


Main Entrance Dome





Dodecagon Dome



The central dome

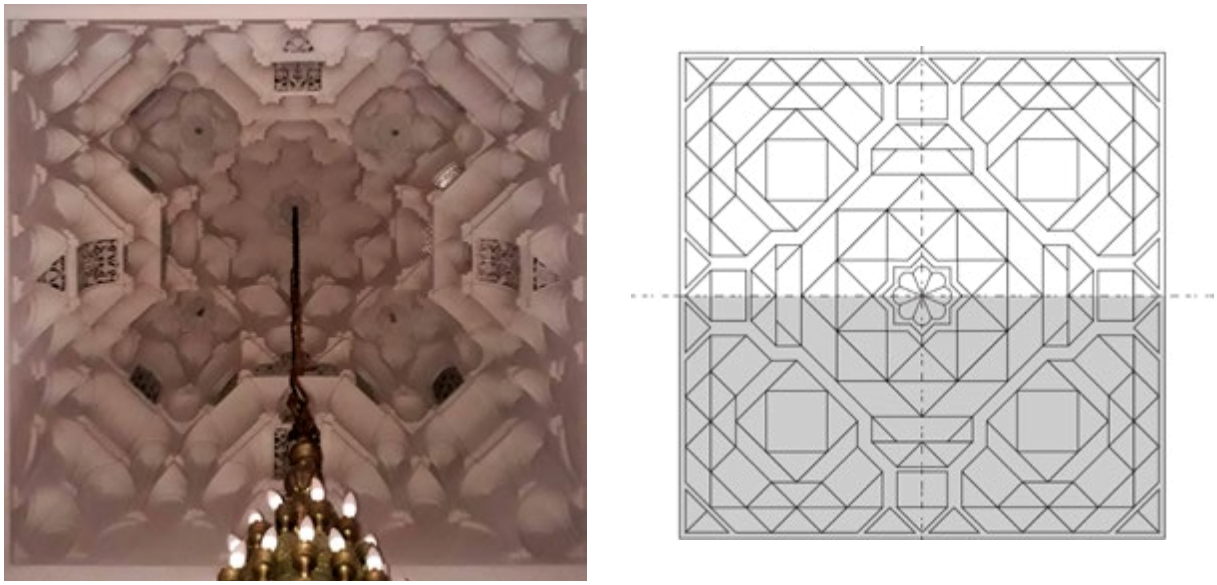


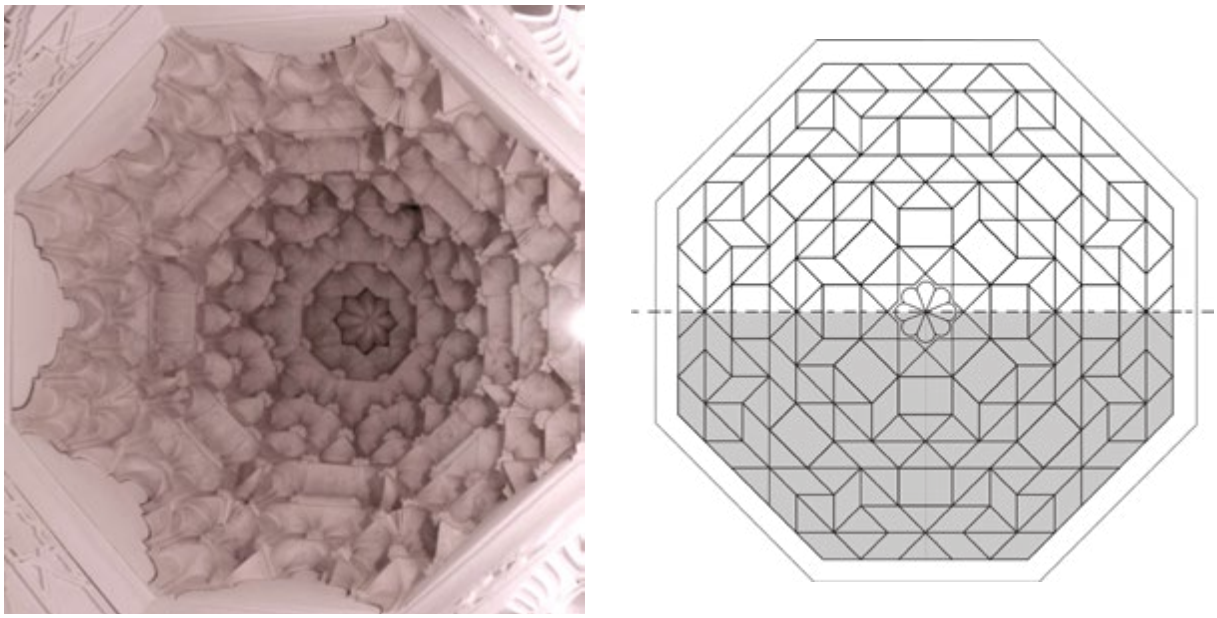
Figure 14. Muqarnas in the Qarawiyyin Mosque with *khutta* plans

Muqarnas in the Kutubiyya Mosque, Marrakesh, Morocco (1157, Almohad)

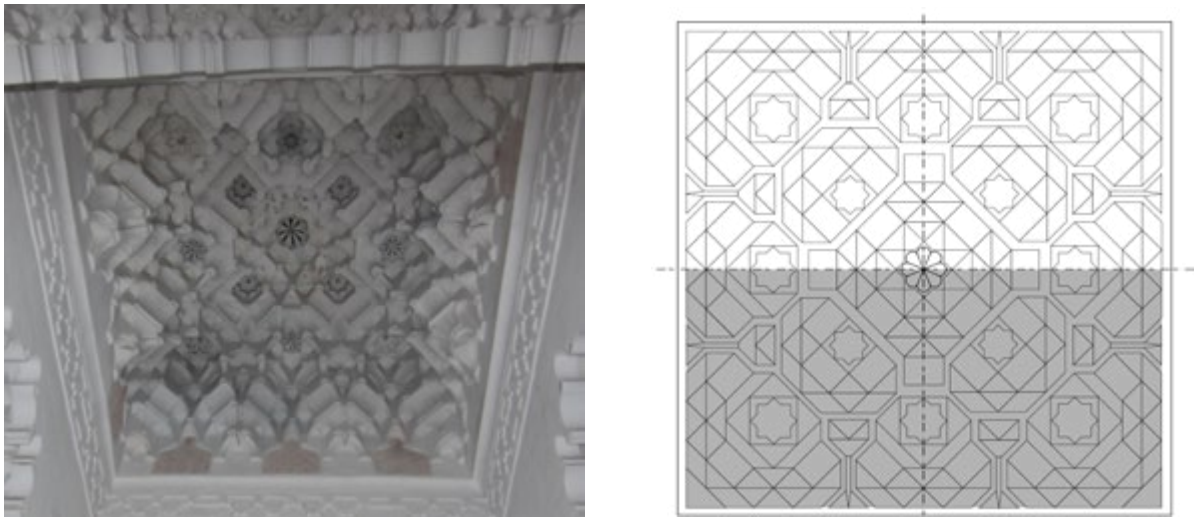
This mosque contains some of the most significant muqarnas examples from the Almohad period, in ten places: inside the mihrab dome, five domes parallel to the qibla wall, three arches under the mihrab dome, and the minaret dome. All these examples are simple and made of plaster. Since most of these muqarnas are similar in terms of elements and *khutta* arrangement, we present just three, which differ from each other schematically.

Unlike most muqarnas domes of the Almohad period, the inner mihrab dome here does not feature the *ktīb* element commonly seen in muqarnas domes of this era; instead it relies solely on the basic units. Its *khutta* also bears a striking resemblance to the *khutta* of the Qarawiyyin Mosque's inner mihrab vaulting, providing a more robust example. The red and yellow coloring in figure 16 indicates the points of similarity.

Inside Mihrab Dome



Mihrab dome



Minarate's Dome

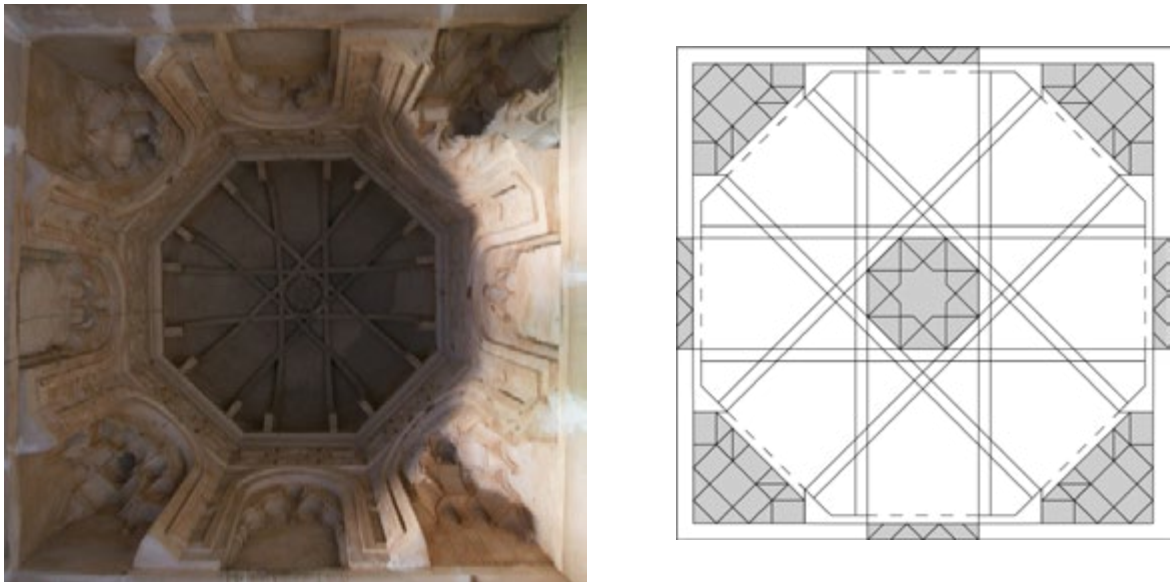


Figure 15. Muqarnas in the Kutubiyya Mosque with *khutta* plans

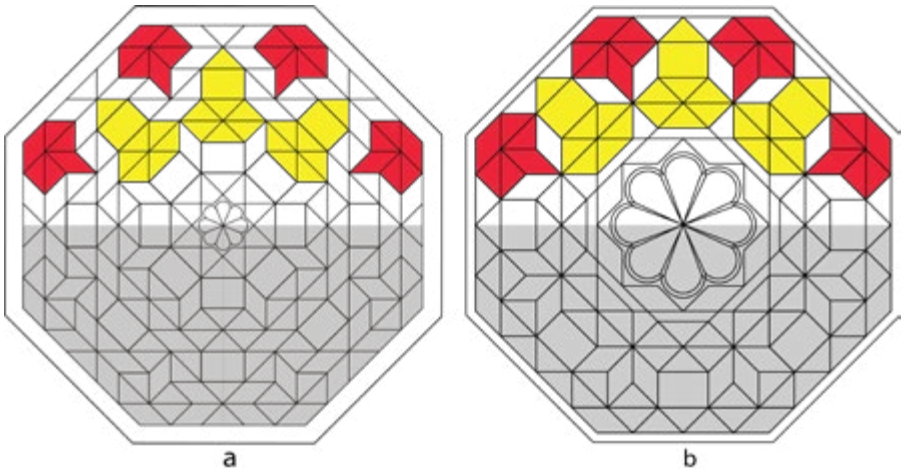


Figure 16. (a) *Khutta* of the inner mihrab dome in the Kutubiyya Mosque; (b) *Khutta* of the inner mihrab dome in the Qarawiyyin Mosque

Muqarnas in the Kasbah Mosque, Tunis, Tunisia (1235, Hafsid dynasty)

The mihrab dome of the Kasbah Mosque is regarded as the only known example of muqarnas from the Hafsid period. Most studies on muqarnas work have overlooked this example, and in fact we found no consideration of this dome in the sources examined.

Yet with its square pattern, this muqarnas is a crucial example for our study, as it serves as a transition between those of the Almohad and Marinid periods, with Almohad characteristics and also some aspects to be found in the Marinid age.

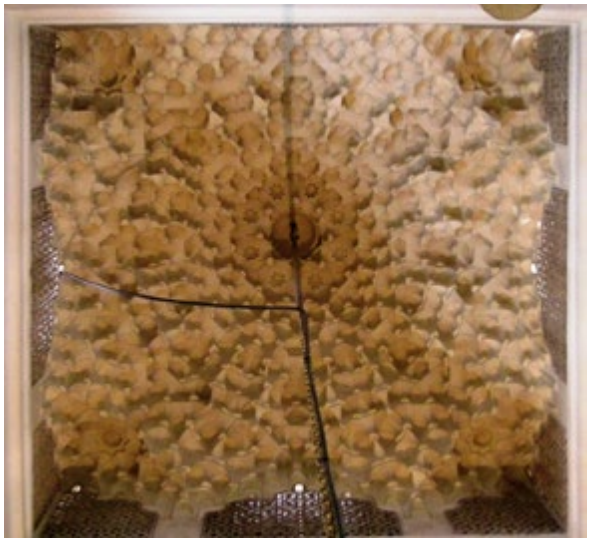
Specifically, the shapes of the units used resemble those of Almohad style, whereas the *khutta* design is more like those of Marinid muqarnas. The most notable similarity is the type of elements around the small non-central domes. In Almohad examples, there are always four elements called *dambuk bi'l khatim* arranged around such domes, with a triangular form. But in the *khutta* here, the domes are surrounded by eight elements called *luza*, as is frequently seen in muqarnas plans of the Marinid period (Fig. 18).

Muqarnas in the Sidi Boumediene Mosque, Tlemcen, Algeria (1353, Marinid Dynasty)

The main entrance dome of this mosque is one of the most significant examples of the Marinid period, and indeed of the history of Maghrebi-Andalusian muqarnas. Here we see that the difficulty of transitioning from a square to an octagon in the *khutta* design has been completely resolved (Fig. 19).

The dome, some 4 meters in size and on a square plan, is made primarily of plaster. The muqarnas, which appears to have undergone no repairs since its construction, is part of the entrance portico decoration. On the upper part of the two side surfaces under the square dome is a muqarnas cornice, as was first seen in the main entrance dome of the Great Mosque in Fes el-Jdid (1276) and is found in many works of the Nasrid period.

The *khutta* forms an octagonal system around the center, with stars arranged in a sixteen-pointed pattern (Fig. 20).



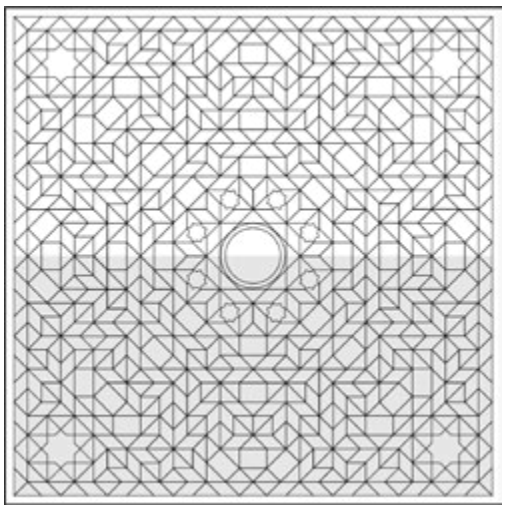
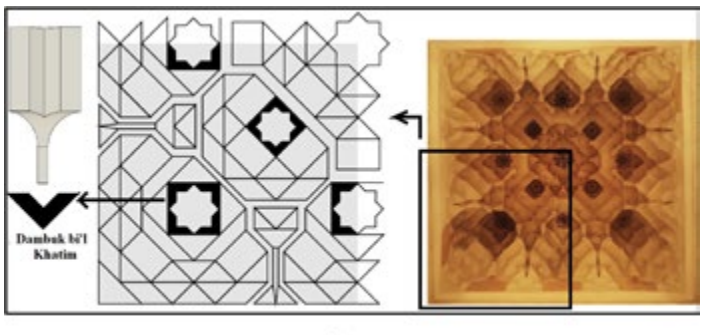


Figure 17. Muqarnas in the Kasbah Mosque with *khutta* drawing



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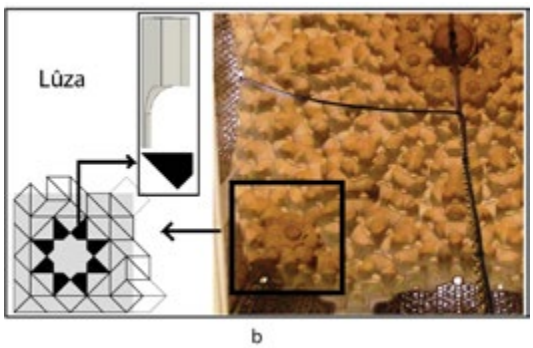

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Figure 18. (a) View of the mihrab dome in the Kutubiyya Mosque; (b) View of the mihrab dome in the Kasbah Mosque

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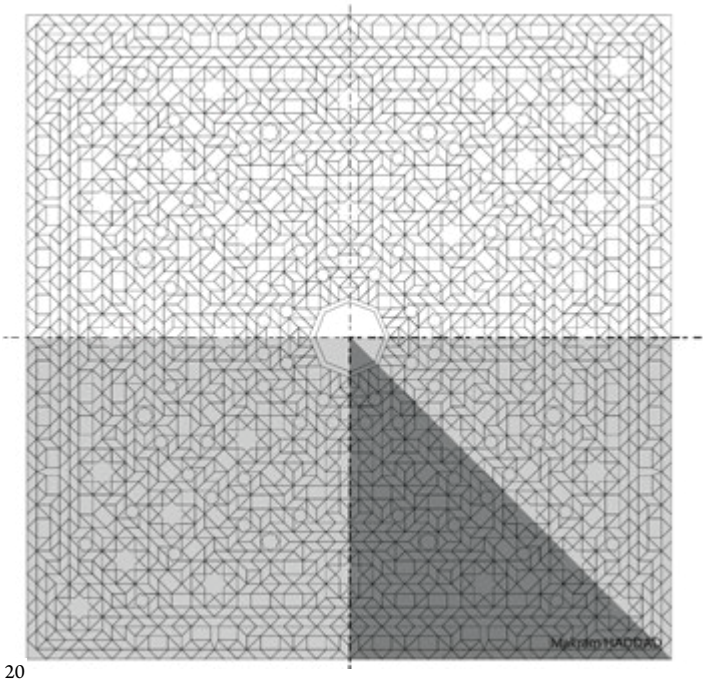

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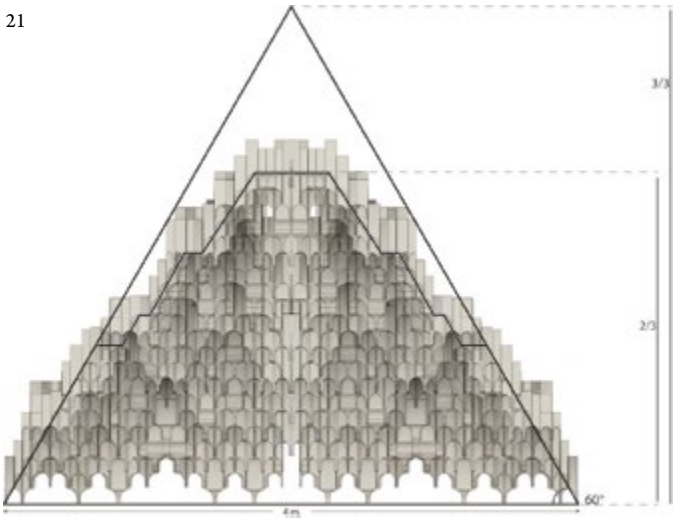

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Figure 19. Entrance dome muqarnas of the Sidi Boumediene Mosque

Figure 20. *Khutta* of the entrance dome muqarnas of the Sidi Boumediene Mosque

Figure 21. 3D model section of the Sidi Boumediene Mosque muqarnas, in which by manipulating the direction of muqarnas elements the craftsman was able to reduce the height of the structure

Muqarnas in the Alhambra, Granada, Spain (as of 1238, Nasrid Dynasty)

This palace, which contains the most abundant examples of muqarnas in the Maghreb and Andalusia and perhaps in the whole Islamic world, has become a symbol of Maghrebi-Andalusian Islamic art. While the monumental complex has great architectural significance, its most remarkable feature is the abundance of muqarnas.

We lack space here to present all the Alhambra muqarnas that we have studied and redrawn. Some of the most notable models are to be found in the Hall of the Two Sisters and the Hall of the Abencerrajes, and since the one in the Hall of the Two Sisters has been already analyzed by scholars such as Jules Goury and Owen Jones (Goury and Jones 1834: 100), we focus here on that of the Hall of the Abencerrajes.

The *khutta* plan here consists of eight muqarnas compositions arranged around an eight-pointed star within a square frame (Fig. 22). The central muqarnas contains over three thousand elements and the surrounding ensembles a total of more than two thousand.[2] The *ktîb* element is used to connect muqarnas elements arranged in *ush* clusters. None of the literature, except for Takahashi, provides a drawing of the dome's *khutta*. Takahashi's drawing lacks detail and overlooks the *ktîb* element, resulting in the distortion of many units,[3] so our drawing (Fig. 23) may be the first detailed depiction of this notable work of muqarnas.

We have also identified and illustrated the placement of the 23 different units used in the *khutta* (Fig. 24).

Figure 22. Muqarnas dome in the Hall of the Abencerrajes (Wikimedia)

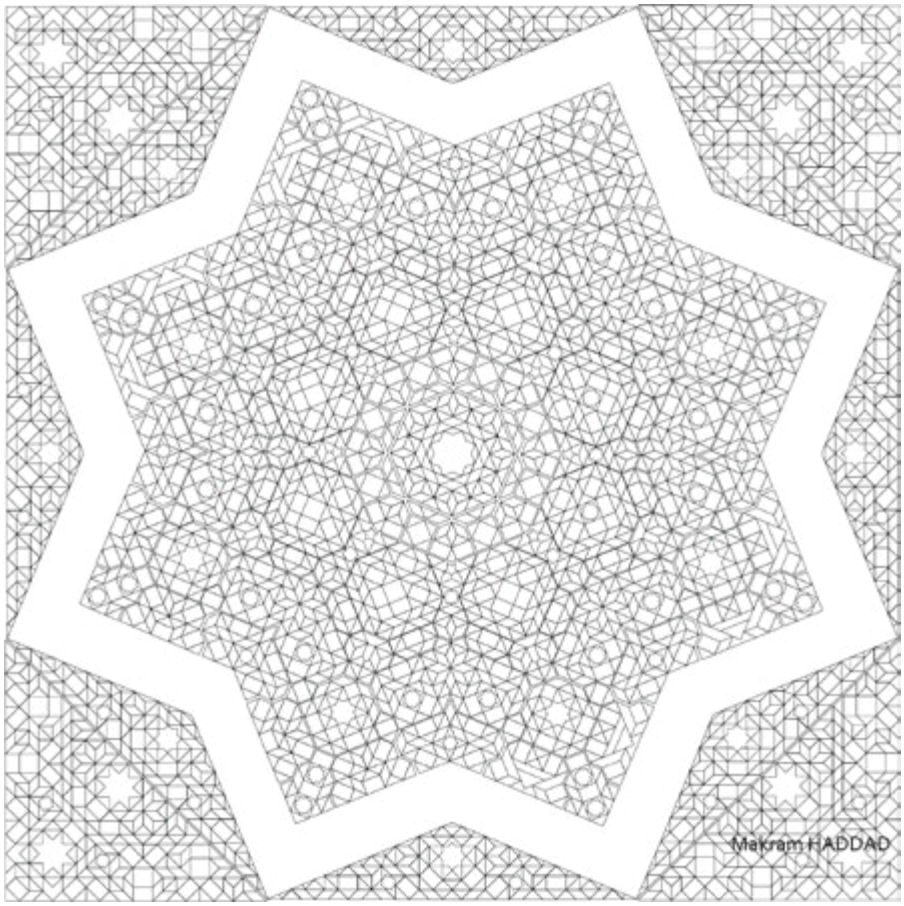


Figure 23. *Khutta* of the muqarnas dome in the Hall of the Abencerrajes

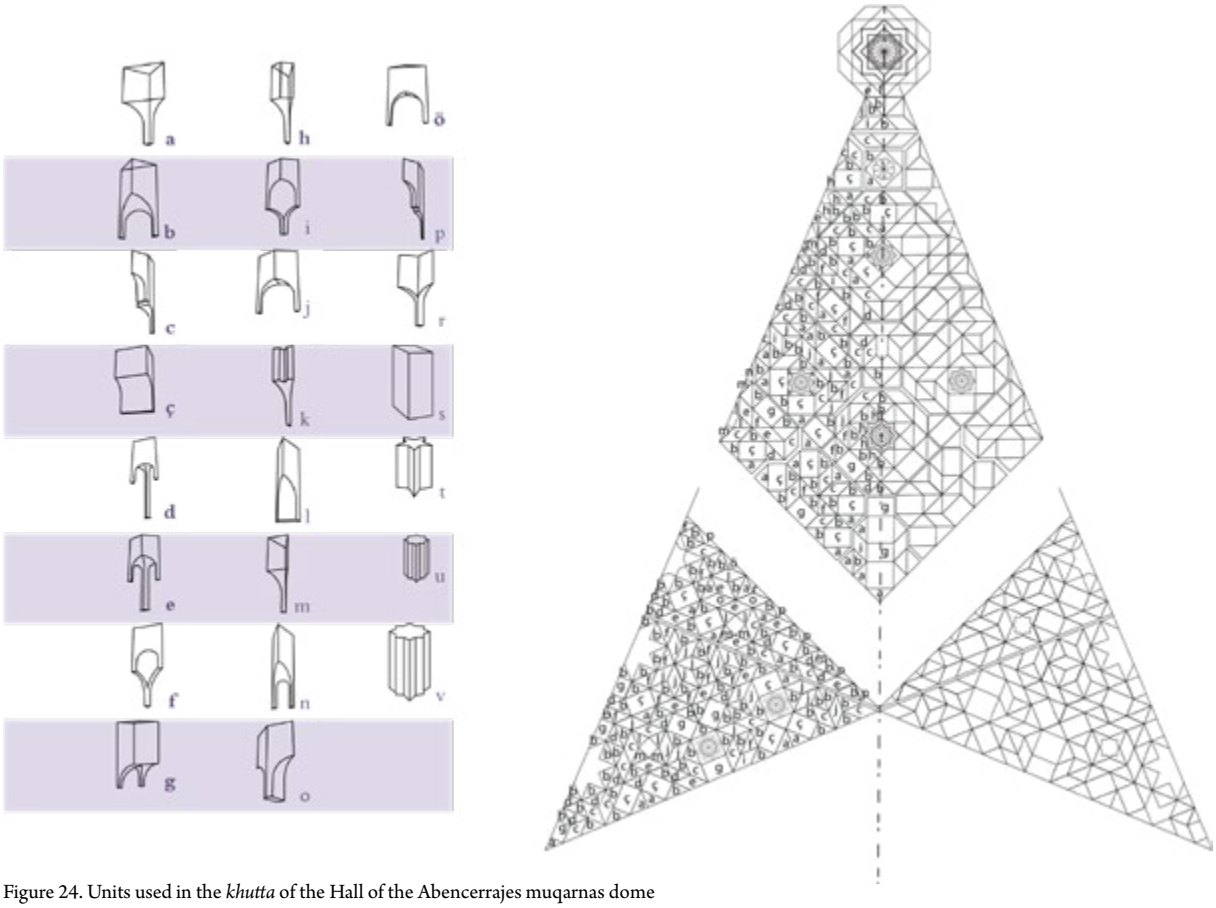


Figure 24. Units used in the *khutta* of the Hall of the Abencerrajes muqarnas dome

Muqarnas in the Madrasa of Granada

The Madrasa of Granada has a colorful wooden muqarnas dome featuring an octagonal *khutta* successfully arranged without the use of the *ktîb* element. The single scale and the basic units are consistently observed.

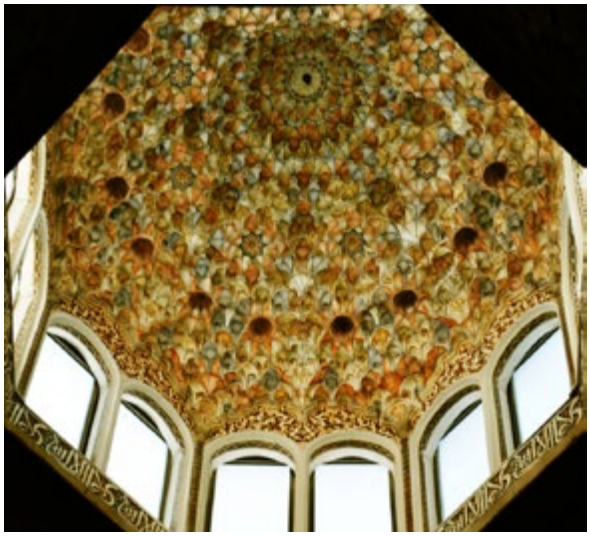


Figure 25. Muqarnas dome in the Madrasa of Granada (Archnet)

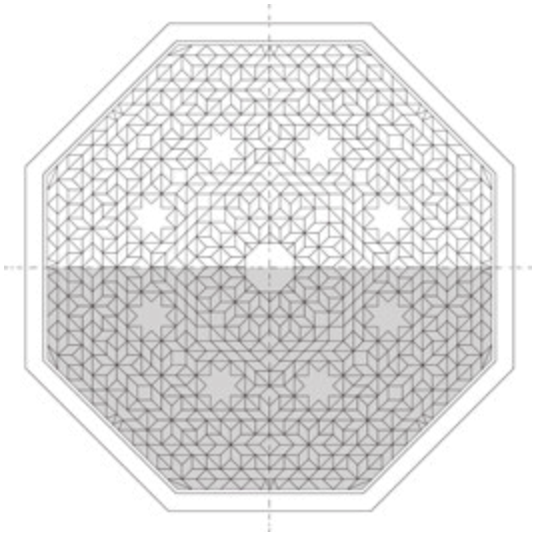
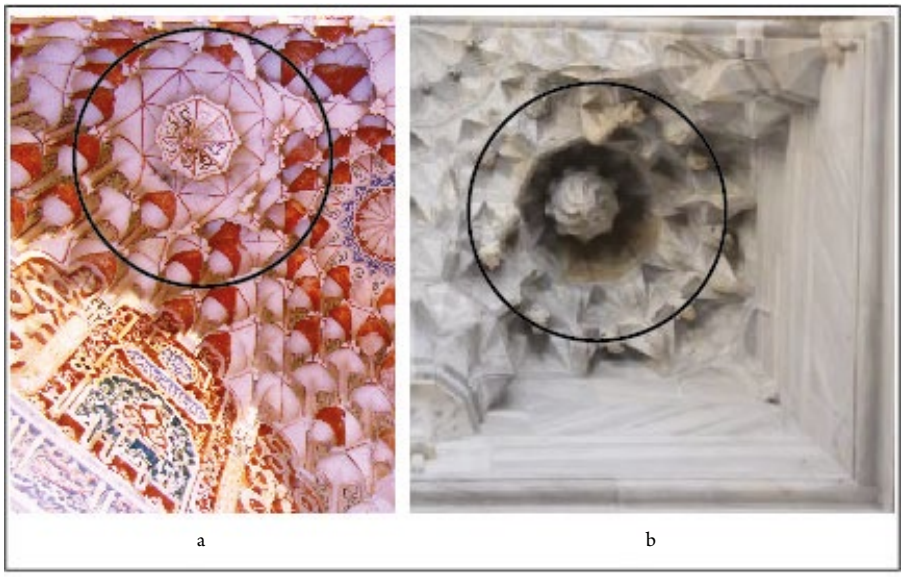


Figure 26. *Khutta* of the muqarnas dome in the Madrasa of Granada



a b

Figure 27. (a) Symmetrically aligned *katif* elements in the Madrasa of Granada; (b) *Püskül* element in Üç Şerefeli Mosque

Figure 28. *Piña de mocárabes* in Palacio de los Condes de Gelves

Below the dome is an octagonal ring adorned with a muqarnas frieze along with sixteen windows, two on each side of the ring. Below, a muqarnas squinch at each corner facilitates the transition from the square plan to the octagonal muqarnas composition.

The arrangement of these unique muqarnas squinches at the corners is the result of a beautiful design conception. In the center of each squinch is a sixteen-pointed star-shaped *shashiya* (cupola) flanked by two muqarnas masses reminiscent of the *püskül* element of Ottoman muqarnas. These masses are formed of symmetrically aligned *katif* elements and are of the type that later appeared extensively in Mudéjar architecture, with other elements added to this simple arrangement to form what is known as a *piña de mocárabes.*

Muqarnas in Bab Doukkala Mosque, Marrakesh (1570, Saadi Dynasty)

This mosque contains several examples of muqarnas, of which we examine three: the inner mihrab dome, the main mihrab dome, and the arches below it. Interestingly, the *khutta* of the three examples mentioned is an exact copy of the same elements in the Mouassine Mosque (Marrakesh, 1563), and even the muqarnas decoration has been copied exactly.

Inner mihrab dome: This cupola dome, like all those of the same type, has an octagonal base. Six types of element arranged in thirteen layers are used. Due to its octagonal form, there is no *ktîb* element, and all units are at 45º, adhering to a single scale. In the part of the dome adjacent to the mihrab wall, two triangular areas between it and the wall are carved with muqarnas unit projections, and a full-size *khutta* has been drawn (Fig. 30). Here muqarnas squinches were probably going to be built, but finally for some reason were not.

Mihrab dome: This muqarnas dome before the mihrab is square in plan, with eighteen layers made up of ten element types. Although the use of ktîb is evident in parts, this does not affect the overall muqarnas composition, and removing the ktîb elements would not alter the khutta. The purpose of ktîb here is not to fill the gaps between elements, as commonly observed elsewhere, but rather to fit the muqarnas into the dome and to join the ush clusters.

In this example, the transition from square to octagon has been successfully achieved while adhering to the khutta scale. As at the Mouassine Mosque, some muqarnas elements here are adorned with simple engravings and painted black.

Mihrab arches: The arches before the mihrab are decorated with muqarnas, enclosing the space beneath the dome on the south, west, and north sides. The muqarnas elements and arrangements used in these arches closely resemble those of the dome, thus achieving a cohesive aesthetic.

The design of the arches is like that of the muqarnas arches found in the Kutubiyya Mosque, of the Almohad period. But on closer examination, differences in muqarnas composition between the two periods become apparent. Specifically, the muqarnas elements of the Bab Doukkala arches are smaller and shorter than those of the Kutubiyya Mosque. This difference is attributable to the shorter foot portion of the Bab Doukkala muqarnas elements, resulting in a smaller overall size.

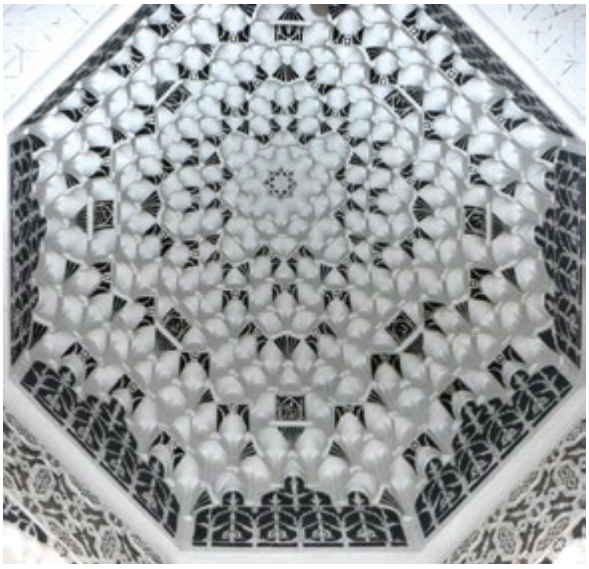


Figure 29. Inner mihrab muqarnas in the Mouassine and Bab Doukkala Mosques

Figure 30. Full-size muqarnas units drawn at the corners of the Bab Doukkala inner mihrab dome

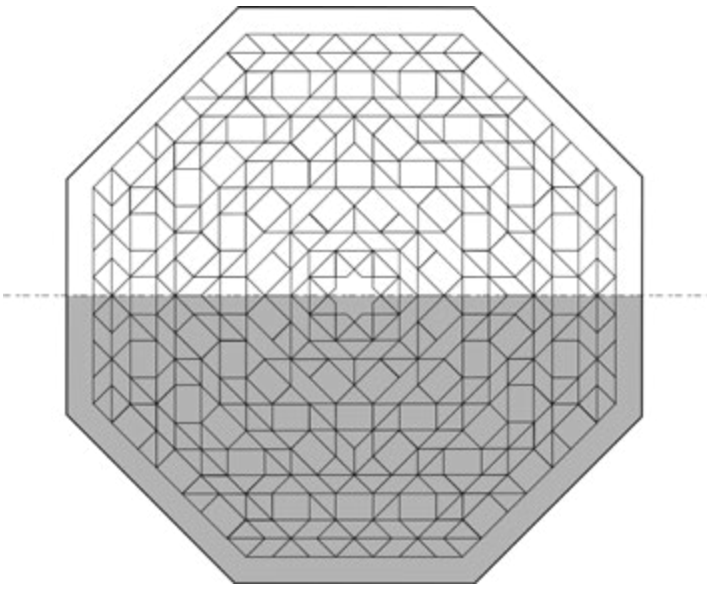


Figure 31. *Khutta* of the Bab Doukkala inner mihrab dome

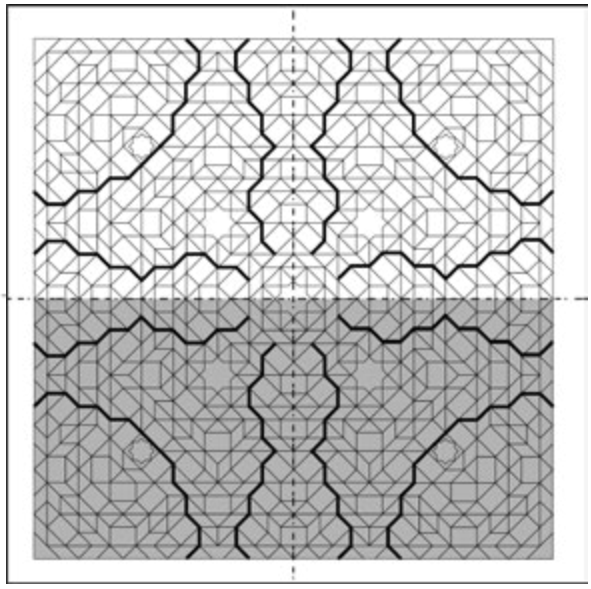


Figure 32. *Khutta* of the Bab Doukkala inner mihrab dome (*ktîb* lines highlighted in black)

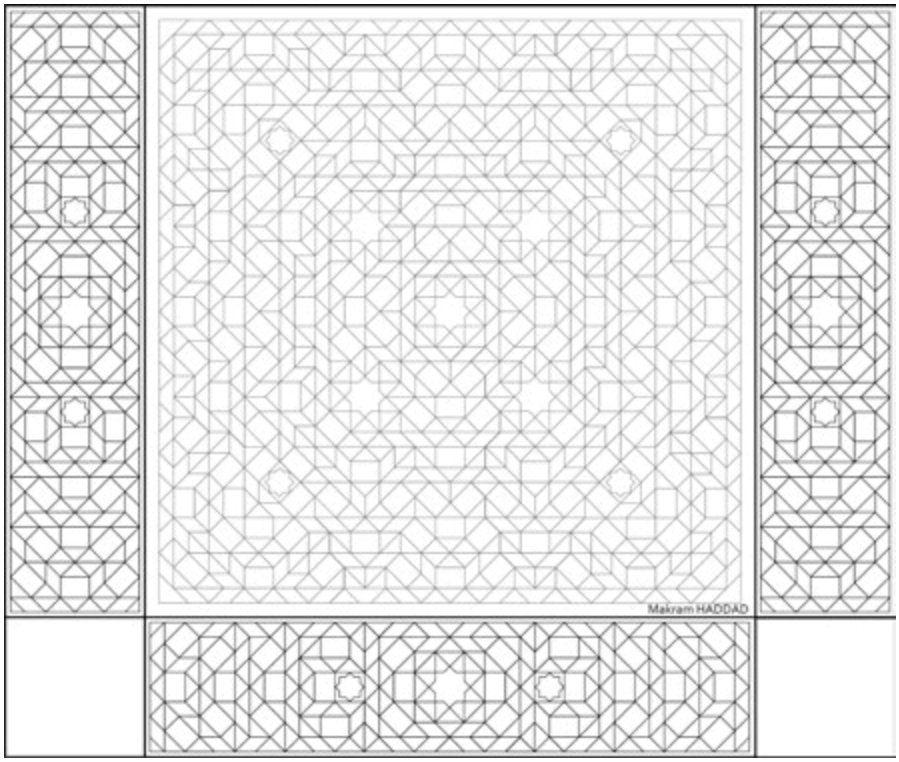


Figure 33. *Khutta* of the mihrab arches in the Bab Doukkala Mosque

Conclusion

On examining examples of muqarnas from the Almoravid period, when Maghrebi-Andalusian muqarnas first appeared, we find that the elements were not yet shaped according to a specific template. Some basic elements were beginning to emerge, but there are also primitive elements not encountered in subsequent periods. Some of these are among the three basic shapes of Maghrebi-Andalusian muqarnas, but their three-dimensional form is not found in later periods.

Others, while appearing similar in their basic elements, have shapes in plan that do not conform to the mature Maghrebi-Andalusian muqarnas and are therefore inconsistent with the scale; examples would be the octagonal dome in the central courtyard and the rectangular dome of the Qarawiyyin Mosque, among others.

In this period, in addition to the two different primitive elements mentioned above, there are further elements that do not adhere to the scale, such as are not encountered in subsequent periods.

Another characteristic of this time is that the elements are larger compared to those of subsequent periods. Over time the size of elements decreased, and from the Marinid period onward, almost all muqarnas were made of small components.

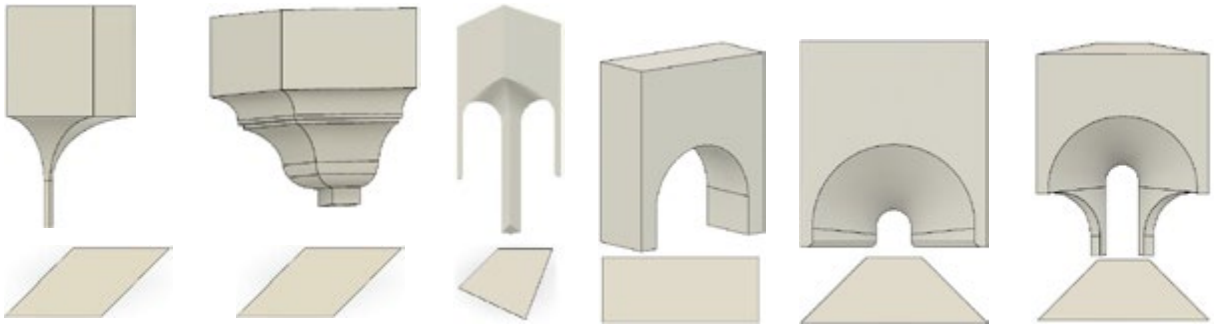


Figure 34. Primitive muqarnas elements

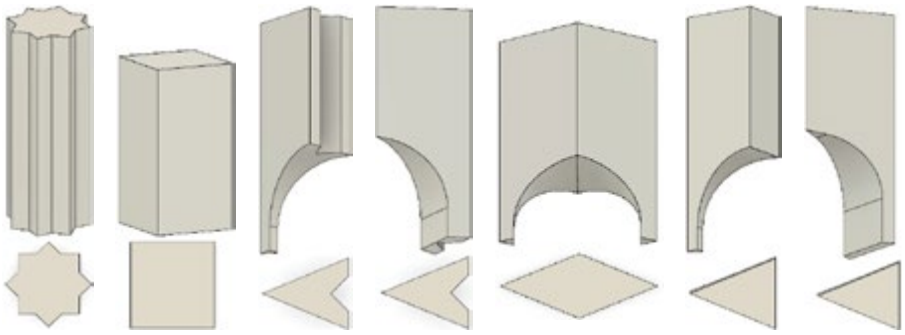


Figure 35. Muqarnas elements added and widely used in the Marinid era

During the Almohad period, new elements such as *sirwaliyya mina'l katif* emerged, while other elements began to disappear. The reason for this is likely that areas filled by primitive elements could now be filled with basic elements instead. Additionally, in this period muqarnas compositions not based on square or octagonal shapes were no longer made, so the units began to adhere to the "90º–45º" principle, thus taking a significant step toward standardization.

During the Marinid period, muqarnas elements underwent a transformation. The large units seen in the Almoravid and Almohad periods disappeared, giving way to smaller typical elements as primitive components were replaced by standard shapes.

To reduce the height of muqarnas, a new unit emerged resembling the *taht* element of the Mashreqi muqarnas type, called *mihraz* by modern Moroccan craftsmen (element 1 in Figure 35), and began to be widely used in domes. In addition, the *sirvâliyya mina'l katif* (element 5 in Figure 35) began to be used extensively, especially in domes. This element also contributed significantly to reducing muqarnas dome height (Fig. 21).

After the Marinid period, muqarnas elements took on a fixed form, and we begin to see these later examples in work of the Nasrid and Mudéjar periods in Andalusia, the Saadian era in Morocco, and the subsequent stages all used largely the same elements, albeit with differences in design, decoration, and application.

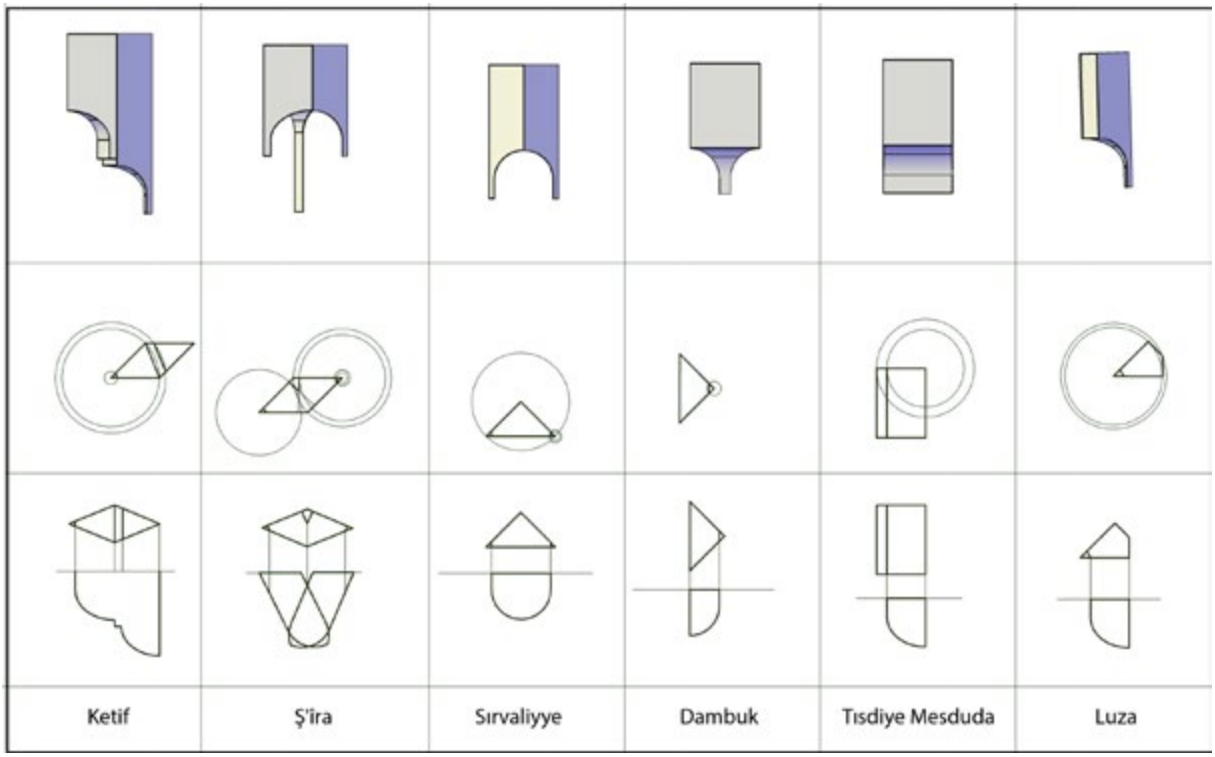


Figure 36. Shapes of the main muqarnas elements since the Marinid era

Furthermore, as of the Marinid period, the use of muqarnas was no longer confined to certain architectural elements only. We now find muqarnas in domes, capitals, friezes, ceilings, and doorways, with new forms of composition emerging, such as the *piña de mocárabes* of Mudéjar art.

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[1] The earliest muqarnas examples do not always adhere to these rules. But as muqarnas units began to adopt certain patterns, such rules came to apply in the Maghrebi-Andalusian muqarnas style.

[2] As counted when we drew the plan of these domes.

[3] http://www.shiro1000.jp/muqarnas/data/034/034c--.gif (01.03.2024)

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Biography | Biografía | Biografia

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A freelance Tunisian designer and researcher living in Bosnia and Herzegovina, he obtained a professional master's degree in Design from the University of Tunis (2013) and a master's degree (2015) and PhD (2019) in Islamic Art History from Marmara University in Istanbul. His research focuses on traditional Islamic architecture and decoration. He produces work using traditional carving techniques on wood, plaster, and other materials.