

THE RESTORATION OF THE PAINTINGS ON LEATHER IN THE HALL OF THE KINGS OF THE ALHAMBRA

LA RESTAURACIÓN DE LAS PINTURAS SOBRE PIEL DE LA
SALA DE LOS REYES DE LA ALHAMBRA

ELENA CORREA GÓMEZ

HEAD OF THE RESTORATION DEPARTMENT OF THE ALHAMBRA AND GENERALIFE BOARD OF TRUSTEES.

GRADUATE IN THE RESTORATION OF FINE ARTS, UNIVERSITY OF GRANADA.

elena.correa@juntadeandalucia.es

RAMÓN FRANCISCO RUBIO DOMENE

HEAD OF THE RESTORATION WORKSHOP FOR PLASTERWORK AND TILING OF THE ALHAMBRA AND

GENERALIFE BOARD OF TRUSTEES. PHD IN RESTORATION, UNIVERSITY OF GRANADA.

ramonf.rubio@juntadeandalucia.es

ABSTRACT Among the sophisticated decoration that covers the rooms of the Palacio de los Leones, the three vaults with tempera painting on leather in the Sala de los Reyes stand out for their uniqueness and artistic beauty. The vaults are a unique pictorial and technical document, as they reflect the intense coexistence between the Muslim and Christian populations at the end of the 14th century. The craftsmen and artists who participated in their manufacture created a work whose technical have no precedents in the Hispano-Muslim world. Since the 19th century, different restoration methods and products have been used that have influenced its current state with varying degrees of success and have conditioned its preservation. With the beginning of the 21st century, the conservation of paintings becomes a priority and a long process of intervention began, based on scientific criteria and methodology, involving professionals from different organizations and fields. The latest restoration has been a scientific-technical process that has lasted almost two decades, a unique and unrepeatable moment through which it has been possible to clarify certain questions and open up new avenues of research into aspects such as the technique of execution or authorship. The article describes the phases into which it has been divided, the state of conservation of the pictorial ensemble, the intervention criteria adopted and the restoration treatments followed.

KEY WORDS Vaults, painting, leather, restoration, cellulosic stucco.

RESUMEN Entre la sofisticada decoración que reviste las estancias del Palacio de los Leones destacan por su singularidad y belleza artística las tres bóvedas con pintura al temple sobre piel de la Sala de los Reyes. Las bóvedas son un documento pictórico y técnico único, pues en ellas se materializa la intensa convivencia que hubo a finales del siglo XIV entre la población musulmana y la cristiana. Los artesanos y artistas que participaron en su manufactura crearon una obra de cuyas peculiaridades técnicas no

se conocen antecedentes en el mundo hispanomusulmán. A partir del siglo XIX se han ido empleando diversas metodologías y productos de restauración que han influido con distinto grado de acierto en su estado actual y han condicionado su preservación. Con la entrada del siglo XXI la conservación de las pinturas se convierte en prioritaria y se inicia un largo proceso de intervención bajo criterios y metodología científica, que implicará a profesionales procedentes de distintos organismos y ámbitos. Su última restauración ha sido un proceso científico-técnico que se ha extendido por casi dos décadas, momento único e irrepetible a través del cual se han podido aclarar algunas cuestiones y abrir nuevas vías de investigación sobre aspectos tales como su técnica de ejecución o autoría. El artículo recoge las fases en las que se ha dividido, el estado de conservación del conjunto pictórico, los criterios de intervención adoptados y los tratamientos de restauración seguidos.

PALABRAS CLAVE bóvedas, pintura, piel, restauración, estuco celulósico.

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II.1 Final state of the central vault after its restoration. Ten people are seated on cushions on a dais with a gilt background, an imitation of damask as a sign of the wealth and opulence of the figures. The scene has been interpreted in various ways: as kings belonging to the Nasrid dynasty, a meeting of high dignitaries with the sovereign Muhammed V, an Arab council or mexuar, tribal chiefs from Granada, nobles being invested with the Order of the Band or a court in deliberation. Amadeo López del Águila, Paintings on leather in the side alcoves of the Hall of the Kings in the Alhambra, Granada. Central alcove, 2019, Alhambra and Generalife Board of Trustees, Archive.

Of the six palaces that once housed the palatine city of the Alhambra, only the palaces of Comares and Leones have survived. The Palace of the Lions or Palace of the Riyad or Garden Palace was built during the second reign of Muhammad V (1362-1391) and was built specifically as a royal residence. Its rooms are distributed around an arcaded courtyard that gives rise to exquisitely ornamented spaces where the design and technical quality of the plaster, ceramic, wood, marble and mural painting decorations reach their maximum sophistication. On the east side of the courtyard is the rectangular room known as the Hall of the Kings. This room is flanked by three side alcoves covered by wooden vaults with paintings on leather, rich Christian iconography and painted in a linear Gothic style. There are few works in the Alhambra that have aroused so much interest over the centuries. The vaults are not only a unique pictorial document, reflecting the intense coexistence between Muslim and Christian culture in the 14th century, but also their technical peculiarities and intriguing iconography

have made them one of the main focuses of interest for scholars of the Nasrid monument and medieval painting.

The central vault depicts a gathering of personages who from the 15th-16th century have been considered the kings of the Nasrid dynasty (Il. 1), hence the name given to the room. The side vaults reproduce scenes of fighting and hunting known as the *Fountain of Youth* in the north (Il. 2), and the *Lady playing chess* at the southern end (Il. 3).

The work must have involved craftsmen and artists from different trades: skilled in woodworking, painting and leather-working, they created a masterpiece whose technique has no known precedent in the Hispano-Muslim world.

From the mid-19th century onwards, the desire for conservation on the part of those involved in said task had serious consequences for its state of conservation. The use of various restoration methodologies and products over the last two centuries have, with varying degrees of success, influenced its current state and conditioned its conservation.



II.2 Final state of the north vault after restoration: hunting scenes are set against a starry background with “the castle of love” and “the fountain of youth” as a transversal axis. The Fountain of Life or Fountain of Eternal Youth is a classic allegorical theme in which the characters preserve the body's vigour or regain their youth after bathing in its waters. Amadeo López del Águila, Paintings on leather in the side alcoves of the Hall of the Kings in the Alhambra in Granada. North alcove, 2019, Alhambra and Generalife Board of Trustees, Archive.

Its latest restoration has been a scientific-technical process of almost two decades, a unique and unrepeatably moment that has made it possible to clarify certain questions and open up new avenues of research into aspects such as the technique used or who the authors were.

TECHNIQUE OF THE PAINTINGS

Although it is not the purpose of this exhibition, it is necessary to mention certain technical aspects of the execution process that are important to understanding the degree of alteration the paintings showed before they were restored.

The wooden structure

The type of reinforcement can be classified as a false vault. These are self-supporting structures built on the ground, like inverted boat hulls, resting on beams or sleepers inserted into the building. Most of the original wood used is poplar, of the *Populus alba* species, although other species such as elm (*Ulmus* sp.), cherry (*Prunus avium* L.) or pine (*Pinus pinea* L.) have been

identified. The back of the structure was covered with a thin layer of pine tar, over which a layer of plaster was applied, ranging in thickness from 1 to 2.5 cm. Both layers contributed to the protection of the extrados of the vaults, the lower layer was spread over the entire surface and acted as a waterproof and defensive barrier against the attack of biological agents, while the upper layer of plaster only appears on the planking and provided fire protection¹.

The pictorial ensemble

The pictorial support that covers the front of the wooden structure consists of pieces of unshaven, alum-tanned leather, possibly to facilitate the adhesion and grip of the later pictorial layers that provided the paintings with a homogeneous base on which to paint. As a whole, this leather covering is made up

1. 2010. Paintings in the Hall of the Kings. Alhambra, Granada. Report on the intervention on the reverse of the paintings. Seville, 2010. Report by Gestionarte. Alhambra and Generalife Board of Trustees.



II.3 Final state of the south vault after restoration: the scene of the "lady playing chess" is at the centre of the composition, together with the rest of the hunting and fighting scenes. The game of chess was introduced in Al-Andalus in the 9th century; the board is shown vertically as in the Book of Games of Alfonso X and on this occasion the game is being played without pieces. Amadeo López del Águila, Paintings on leather in the side alcoves of the Hall of the Kings in the Alhambra in Granada. South alcove, 2019, Alhambra and Generalife Board of Trustees, Archive.

of pieces that are very irregular in size and shape, and are sewn together with a zigzag stitching called 'dogtooth' using linen thread. The leathers were attached to the wood by means of an adhesive and small bamboo pegs (Il. 4), so that the pieces of leather were arranged crosswise to the grain of the plank and adapted to the curvature of the vaults². The DNA study carried out reveals that the leather used was mainly horse hide (*Equus caballus*)³. Subsequently, a white preparation composed of calcium sulphate and animal glue, distributed in several layers, was applied to the treated leather and fixed to the structure, with a final layer of animal glue to limit the absorption of the filler. Two types of original preparatory drawings have been

identified: incised marks and reddish brush-strokes. The painting technique is an egg yolk tempera that binds the pigments. There are two types of gilding: relief gilding and mordant or mixed gilding⁴. The stratigraphic study of the polychromy did

2. 2013. The paintings in the Hall of the Kings. Conservation-restoration work on the front side. March 2013. Report by María José González López; Araceli Montero Moreno; Raniero Baglioni; Ana Bouzas Abad; Beatriz Prado Campos. Andalusian Institute of Historical Heritage.

3. 2009. Genetic research on biological samples from animal tissues obtained during the recovery of the historical remains of the Alhambra in Granada. Report by Javier Porta Pelayo, Biotechnology Consulting S.L.

4. The main original pigments identified by MO and SEM-EDX were white lead for white, azurite and lapis lazuli for blue, hematite and cinnabar for red, yellow ochre and orpiment, green earths, organic greens, bone black and gold and silver for metallic finishes.

2012. Paintings in the Hall of the Kings. Room 1 "Lady playing chess" Alhambra (Granada). March, 2012. Report by Lourdes Martín García and Abel Bocalandro Rodríguez. Chemical analysis laboratories Buildings, works and infrastructure centre. Andalusian Institute of Historical Heritage.

2009. Paintings in the Hall of the Kings. Alhambra, Granada. Intervention project on the front of vaults 1, 2 and 3. Characterisation of constituent materials of the leather paintings of vault 2. March 2009. Stratigraphic study of pictorial layers. Report by M^a Luisa Franquelo Zoffmann. Department of Scientific Analysis. Andalusian Institute of Historical Heritage.

2012. Stratigraphic study of pictorial layers. Paintings in the Hall of the Kings. Room 3 "The Fountain of Youth" Alhambra (Granada). March, 2012. Report by Lourdes Martín García and Abel Bocalandro Rodríguez. Chemical analysis laboratories Buildings, works and infrastructure centre. Andalusian Institute of Historical Heritage.



II.4 View of one of the 9-mm-long bamboo pegs detached during the restoration process. Below this image, the circular alterations produced in the pictorial layer by this system of anchoring the leather to the wooden structure can be seen. Cruz Ramos Martínez, Bamboo peg; Alteration-Location bamboo pegs through the painting, 2015, Alhambra and Generalife Board of Trustees, Archive.

not reveal the existence of a final protective layer on top of the coloured layer.

BRIEF MATERIAL HISTORY

The use for which the Hall of the Kings was originally built and for which it was intended in later years is behind the state of conservation of the paintings. The suggested functions that have been attributed to this space include that it was used as a place of celebration and for court ceremonies, especially in the summer, as it was permanently open to the Palace of the Lions⁵.

5. PUERTA VÍLCHEZ, Jose Miguel. Read the Alhambra. Visual guide to the monument through its inscriptions. Granada: Alhambra and Generalife Board of Trustees, 2012, pages 190-191.

From the time of their creation to the last years of the Nasrid kingdom, they may have undergone repairs or maintenance work as a result of their exposure to external environmental conditions or possible water seepage from the roofs.

15th and 16th centuries: the first years of Christian occupation

After the conquest by the Catholic Monarchs, the citadel became part of the Crown's patrimony and the roofs were frequently repaired and adapted to the new needs. Although no specific mention has been found of any intervention on the paintings during this period, it is possible that they were subject to some kind of retouching work. Hieronymus Münzer, the illustrious German traveller, physician and scientist, on his visit to the Alcazar from 22 to 27 October 1494, refers that "when we were there we saw many Saracens decorating and restoring the paintings and other things with their finesse"⁶.

The Hall of the Kings became a chapel between 1576 and 1618, and was the seat of the parish church of Santa María de la Alhambra during the years when the church was built on the site of the former mosque. Bermúdez Pareja points to the possibility that "they were hidden in some way during the time that the church of Santa María occupied the Hall of the Kings, and it is even probable that they remained hidden for some time afterwards"⁷.

It was probably at the end of the 16th century when the gallery was built over the vaults, which involved the replacement of the independent roof structure with a continuous structure, as well as the construction of a top slab, so that it could support the weight of the gallery⁸. This modification undoubtedly changed the humidity conditions of the shell and its original ventilation system.

17th and 18th centuries: the years of neglect

After the construction and consecration of the church in 1618, it was again used as the chapel of the Royal Household until the arrival of Philip IV. During these and subsequent years, there is documentation of multiple repairs to this space, alternating with periods of semi-ruin.

Towards the middle of the 18th century the Alhambra entered a phase of decadence and abandonment that lasted until

6. PUYOL, Julio. Hieronymus Münzer. Journey through Spain and Portugal in 1494 and 1495. Alicante: Miguel de Cervantes Virtual Library, 2010, p. 99

7. BERMUDEZ PAREJA, Jesús. Pinturas sobre piel en la Alhambra de Granada. Granada: Alhambra and Generalife Board of Trustees, 1987, p. 63.

8. Paintings in the Halls of the Kings. Report by Nieves Jiménez Díaz, p. 85.

well into the 19th century. Various natural disasters may have influenced the state of the paintings during this period, such as the earthquakes of 1734 and 1822 and the rainstorms of 1736, which, together with the lack of repairs and maintenance, may have led to alterations of varying severity.

In 1764, Velázquez de Echavarría, in his *Paseos por Granada y sus contornos* (*Walks around Granada and its environs*), pointed out the poor state of conservation of the paintings when, in the dialogue between the stranger and the person from Granada, the latter commented that the vaults were in a poor state of repair:

"The paintings are badly damaged, but retain a certain air, which gives them a sense of their former splendour. It is clear that there were Arabs who knew how to use the brush. The one on the sides you see you can't know what they're about. The one in the middle dome has the portraits of the Moorish Kings".

19th century: the beginnings of the restoration work in the Alhambra

In 1812, the Count of Maule, an art dealer and collector, in his *Viage de España, Francia e Italia* noted that the paintings in the Hall of the Kings were "peeling, and he also noted that the vault of the chamber on the right as one enters was deteriorated"⁹.

After the previous disastrous period, the first consolidation and restoration works began, clearly insufficient to meet the needs of the citadel, but they represented a turning point in the way of understanding the conservation of the monument. With the triumph of Romanticism and 19th century Europe's interest in the Orient, the Alhambra became an attraction for foreign travellers, who denounced its deplorable state.

In 1831 Richard Ford, in *Granada. Writings from unpublished drawings by the author*, denounces the state of neglect of the paintings, saying that, "It would be desirable for these relics, which in any other country would be preserved under glass, to be carefully copied in full size"¹⁰.

From 1828 to 1907 a family saga of architects and restorers, the Contreras family (José, Rafael, and Mariano) were in charge of the conservation of the Alhambra. Their theoretical and methodological approach was close to the so-called stylistic restoration, in which they sometimes disregarded the need for consolidation in favour of comprehensive and disproportionate

reconstructions of the decorative elements. The repair work undertaken between 1836 and 1840 was sometimes for urgent consolidation, sometimes for ornamental restoration.¹²

In 1840, the Queen Governor, after learning of the state of ruin of the fortress, issued an official letter in which she expressed her wish "that all the old paintings and other things of merit, which are destroyed or deteriorated, be restored by the most reputable artists, either by using designs or models preserved of them, or by trying to imitate them as far as possible based on the existing ones"¹³. However, the architect José Contreras, director of works at the Royal Site and Fortress of the Alhambra from that year onwards, tells how the money was used for roof repairs.

Rafael Contreras Muñoz was not appointed as ornamental until 1847 and although he never obtained the title of architect, he was responsible for defining the criteria for intervention and directing the craftsmen who restored the decoration, supported by the architects who collaborated with him and took charge of structural issues.¹⁴

In 1853, according to the criticisms published in the *Heraldo* in said year, in which the Catalan artist José Galofre wrote about the restoration work carried out in the Hall of the Kings, the paintings were abandoned and he noted how the workers who were working on the roofs threw stones at the paintings for fun, adding that "he made a copy of what was depicted with great care"¹⁵. The architect Juan Puignaire, who worked as a restorer at the Alhambra from 1851 to 1856, responded to these criticisms by justifying the intervention that had been carried out, in which the causes of the continuous deterioration were eliminated by removing all the weight of a gallery above it and eliminating forever the damp produced in that place by the earthen boxes in which flowers were planted; and that no action had been taken on the paintings because it was not known how to do it, as they were in a very delicate state¹⁶.

Finally, the structures of the roofs of the alcoves were dismantled in 1855, with Rafael Contreras Muñoz in charge of

9. Ivi, p. 141.

10. Ivi, p. 192.

11. Ivi, p. 214.

12. BARRIOS ROZUA, Jose Manuel, la Alhambra de Granada y los difíciles comienzos de la restauración arquitectónica. In: Boletín de la Real Academia de Bellas Artes de San Fernando, 2008, No. 106-107, p. 150.

13. Paintings in the Halls of the Kings... Op. cit. (8), p. 216.

14. ORIHUELA UZAL, Antonio. La conservación de alicatados en la Alhambra durante la etapa de Rafael Contreras (1847-1890): ¿Modernidad o Provisionalidad?. Granada: Alhambra and Generalife Board of Trustees, 2008, p. 126.

15. Paintings in the Halls of the Kings... Op. cit. (8), p. 230.

16. Ivi, p. 230.

the work. At this point it became apparent that “the breakage of the timbers had contributed significantly to the damage visible on the oil paintings on the leathers of the vaults, as the weight of the roof was immediately bearing down on a wooden slatted ceiling”¹⁷. The modification of the roofs in 1855 brought with it the implementation of a roofing system consisting of individualised structures for each vault, and a rainwater channelling system, consisting of the installation of an interior gutter that triggered the pathologies caused by excess humidity, due to water seepage and the accumulation of residue on the wooden structures and paintings¹⁸. In 1857 Rafael Contreras was paid for the ingredients of paint and gold that had been supplied for the work carried out in the Hall of Justice and Hall of Ambassadors¹⁹, although there is no specific mention of what they were used for.

In 1870 the Alhambra was declared a National Monument, and after it had been separated from the heritage of the crown, it was placed in the custody of the State through the Provincial Monuments Commission. In that year, Rafael Contreras began the first documented restoration of the paintings, directed by a special commission of painters from within said commission. Among the actions carried out, the raised leathers of the central vault were replaced and their joints were permanently repaired so that they could be painted over²⁰.

In the Quarterly Report of the works carried out in the first quarter of 1871, Rafael Contreras mentioned that the leathers had been replaced on the boards of the vaults from which they were coming loose; parts of these boards had been renewed because they had turned to dust, the joints or assemblies of one and the other had been covered with a “mastic”²¹, which would absorb the expansion of the wood without falling off. Gold metal nails were used to prevent rusting, and a strictly neutral colour covered the filled parts. The list of materials purchased for the intervention includes, among others, the purchase of leather. According to Bermúdez Pareja, it was

Contreras who nailed the edges of the leathers with iron nails to replace the detached cane pegs²².

The report on the work presented by the Commission of Artistic Monuments of the Province of Granada in 1871 states how the fragments that had become detached or were about to become detached were fitted and “their edges were secured with small metal nails, and the resulting cracks plastered”²³.

20th century: new attempts to recover the paintings

Time went by and the roofs of the Hall of the Kings were frequently repaired due to rainwater leaks caused by the roofing system added in 1855. In December 1910 the architect and curator of the Alhambra, Modesto Cendoya, eliminated the leaks in the Hall of the Kings by repairing the gutters²⁴.

José Molina Trujillo, restorer of the Alhambra's plasterwork workshop, in 1932, stuck and glued the leathers with paste and glue in an elementary and defective way, with the desire to avoid further damage, and even left the date and his initials engraved on one of the figures²⁵.

Between 1930 and 1933, under the direction of the architect Leopoldo Torres Balbás, the roof reinforcement in the north area was repaired, and it was found that the heads of many of the pairs had rotted due to the damage caused to the roof. They were replaced, and bricks were placed over them. The roof was re-slatted and a new lead gutter was fitted²⁶.

Given the poor state of conservation of the paintings, in 1962 the Alhambra Board of Trustees, the entity responsible for the management of the monument, commissioned the architect and art historian Gudiol Ricart to study the damage and fix the pictorial layers. As a specialist in medieval painting, he worked directly on them, applying a surface layer of wax to consolidate the pictorial layers, using heat from a

17. Ivi, p. 235.

18. 2012, Restoration of the paintings on leather in the Hall of the Kings of the Palace of the Lions. Works monitoring report by Pedro Salmerón Escobar. Alhambra and Generalife Board of Trustees. Conservation and maintenance service. SCP-18-054.

19. Paintings in the Halls of the Kings... Op. cit. (8), p. 250.

20. Ivi, p. 305.

21. Mastic resin: a natural, soft, triterpene resin extracted from Angiosperm trees, *Pistacia lenticus*. Used to formulate binders (mixed with oil or wax), or paint vehicles, and for the manufacture of varnishes. CALVO, Ana. Conservación y restauración. Materiales, técnicas y procedimientos de la A a la Z. Barcelona: Ediciones del Serbal, 1997.

22. 1991, Report of interventions and documentation concerning the vaults and paintings in the Sala de los Reyes, by José María Velasco Gómez. APAG. Conservation/Restoration/Reports 2/1.

23. 1872, January 15. Report of the work presented by the of Artistic Monuments Commission of the Province of Granada during the year 1871. AHPG. Section: Monuments Commission. Series: reports. Roll 1841, 71.

24. ÁLVAREZ LOPERA, José. La Alhambra entre la conservación y la restauración (1905-1915). Cuadernos de Arte de la Universidad de Granada. 1977, No. 29-31, p. 142.

25. BERMÚDEZ PAREJA, Jesús; MALDONADO RODRÍGUEZ, Manuel. Report on techniques, restorations and damages suffered by the painted ceilings of the Hall of the Kings in the Palace of the Lions of the Alhambra. Cuadernos de la Alhambra, 1970, No. 6, p. 11.

26. SECO DE LUCENA, Luis. The Alhambra. Granada: Imprenta Artes Gráficas Granadinas, 1920, p. 11.

heater and applying wax-resin stuccos to fill in the missing layers of colour and leather. This action caused serious deformation and wrinkling of the leather, and consequently, detachment of the original preparation layer and its polychromy²⁷.

In 1976, the roof of the south vault was dismantled in order to study and prepare the mechanisms for lifting and transferring the vault to the workshop for restoration. This vault had a temporary Uralita roof until 1981.

In 1976, Antonio Soria, carpenter to the Alhambra Board of Trustees, restored the original frames,²⁸ and the restorer Juan Santos Ramos proceeded to fix and consolidate the priming and preparation of the first vault. The treatment consisted of filtering a consolidating fixative compound made of animal glue (fish glue), with the addition of a fungicide, a tanning agent, a surfactant and a plasticising mucilage,²⁹ with partial crimping.

In 1977 he repeated the operation on the central vault and a quarter of the third vault, work which continued until 1978, this time using an acrylic resin (Paraloid B72) in specific areas as he considered it more suitable for the type of crazing the paintings showed. In the restorer's opinion, paraffin should also have been applied with the wax in the 1960 intervention, as he found it to be more rigid and stronger.³⁰

In 1980 work began on the restoration of the area most affected by the leak in the vault of the Lady Playing Chess: the stains of the wax plaster were removed, a large number of iron and brass nails were extracted, certain areas were crimped, some fragments of leather held in place by nails were loosened, and the wood was stripped from the back of the vault to remove the leather. The Alhambra carpenter Antonio Soria Fernández replaced part of the wooden structure in this area affected by rotting fungi: boards were fastened to reduce the unevenness with screws and new maricao wood sides and planks were put in place, interspersed with balsa wood strips in the joints where it was deemed appropriate. Epoxy wood paste (Araldit) was also used to bridge unevenness and convexities. At the same time, old glue residues were removed and

the best preserved leathers were softened and stretched, as it was considered better to discard leather that was too rotten and had no paint residues. New tanned goatskins were used in their place, which were glued wet and temporarily pinned in place. After drying, the pins were replaced with specially made cane cuttings (Il. 5). After this operation, the protrusions of the pegs were shaved off and a coat of rabbit glue was applied before the animal glue was applied, followed by colour reintegration with rigatine tempera and fine mordant gold for the gilded decorations. The protective coatings were removed and the wax was removed from each area³¹.

In the report on the consolidation and restoration work in 1981, the restorer Juan Santos indicates that they continued working in this area, but enlarged the surface: they eliminated the wax used as stucco, varnish, consolidating compound and retouching element, and continued with the same methodology applied up to that time. The separations of the leather were glued to the wooden support with glue in the area of the figure of the lady, and continued with the reintegration of the warrior killing the lion³².

From 1982 onwards, the restorer's assistants, Antonio Zubeldía Vela and Rafael Gómez Benito, continued with the restoration work, protecting the reintegrated areas and the gilding with varnish³³, always under the supervision of the restorer Juan Santos.

21st century: The complete restoration of the vaults

With the beginning of the 21st century, the conservation of the paintings became a priority and a long process of intervention began, based on scientific criteria and methodology, involving professionals from different organisations and fields. The different phases into which the restoration has been divided, the intervention criteria adopted and the treatments followed will be developed in the following sections.

27. Report by the technical services on various works and conservation problems of the monumental complex reported by the Royal Academy of San Fernando. In: Cuadernos de la Alhambra, 1995-1996, Nos. 31 and 32, p. 331.

28. 1991, July. Report on the interventions and documentation concerning the vaults and paintings in the Hall of the Kings, by Jose María Velasco Gómez. APAG. Conservation/Restoration/Reports 2/1.

29. PRIETO MORENO Y PARDO, Francisco. Obras en la Alhambra y Generalife. In: Cuadernos de la Alhambra, No. 13, 1977, p. 181.

30. Paintings in the Halls of the Kings... Op. cit. (8), p. 500.

31. Ivi, pages 516-530.

32. Ivi, pages 530-535.

33. From the orders placed by the restorer, in addition to those specified in his reports, it is possible to determine some of the products he used in the vaults: acetone, paraloid, ox gall, borax, carbon tetrachloride, amyl acetate, Winston colourless varnish, araldit, Ubert varnish, muzzi, polyethylene glycol, polyvinyl alcohol, nail essence, Mastic glue, wax, shoe polish, paper paste, stucco, phenol and matt plaster. Ivi, p. 540.



II.5 View of the restoration work by Juan Santos Ramos, in which part of the floorboards of the south vault have been replaced. The leathers in better condition and with traces of paint were softened and tightened by temporary pins and new bamboo pegs after drying. Choin, Vault restoration processes "The Lady Playing Chess", 1980, colour slide 6x6 cm, Alhambra and Generalife Board of Trustees, Archive.

3. PHASES OF INTERVENTION

First phase (2001-2002): preliminary studies

During the first phase, preliminary studies were carried out and preliminary reports drawn up, in which the conservation problems of the support and the pictorial ensemble were determined through the study of the graphic documentation and the inspection of the upper surface of the vaults by means of micro-camera viewing. At the same time, the first chemical and morphological analyses were carried out, together with a microclimatic study of the room.

The state of conservation of the vaults and roofs made it necessary to intervene on these elements to guarantee the stability of the entire room and eradicate the main cause of the degradation of the paintings.

Second phase (2003-2015): refurbishment of the roofs and restoration of the wooden backs

The main work in the second phase was the restoration of the roofs of the Hall of the Kings and the restoration of the wooden structures on the reverse side.

During these years, a detailed study was made of the knowledge of the state of conservation of the leather, the characterisation of the materials used by means of non-destructive analysis techniques (NDT), as well as other studies that required the extraction of samples. The non-destructive analysis techniques used included the X-ray radiographic study of the three vaults (Il. 6) and the use of a prototype instrument that combines diffraction and X-ray fluorescence. This type of instrumentation allows simultaneous elemental chemical analysis and in situ mineralogical analysis at the same point in the pictorial layer.

Prior to the execution of the roof restoration work and the restoration of the wooden reverse sides, the polychromatic layers of the roof were fixed and papered over in order to ensure the integrity of the pictorial surface during the work. Safety counterforms reproducing the exact volumetry of the interior were placed under the vaults, made of extruded polystyrene and obtained from a volumetric laser register³⁴. Its function was to protect the stability of the complex against the accidental fall of materials from the dismantling of the roof, while at the same time securing the supports of the vaults during the restoration work on the backs of the vaults.

The methodology chosen for fixing and protecting the paints consisted of cleaning the surface deposits using soft brushes, latex and mouldable rubber. The detached leathers were previously moistened with a mixture of glycerol, deionised water and alcohol and mechanically fixed to the wooden support. To fix wax stuccos, a wax-resin paste (beeswax, turpentine and Dammar resin) was made and applied to the back of the raised part with a moderate amount of heat. The system of protection would comprise several levels of action, a first level in which Japanese paper was used to fix the main raised parts, a second level superimposed on the previous one, which consisted of a covering with Japanese paper, and a third level in which a layer of non-woven fabric was added³⁵ on top of the previous one. The adhesive used in all cases was an acrylic resin (Paraloid B72).

Once the work on the roofs had been completed and the backs had been restored, the protective paper was removed. When removing the paper, the adhesion of the paint to the paper was greater than the adhesion of the paint layers and the support to each other, making it a very difficult and painstaking process. The protective paper and surface gloss was removed with a mixture of organic solvents (Dowanol PM and ethanol). Simultaneously when the paper was removed, it was necessary to fix small flakes of paint that remained adhered to it by applying a thermoplastic polymer (2-ethyl-2-oxazoline diluted in ethanol).

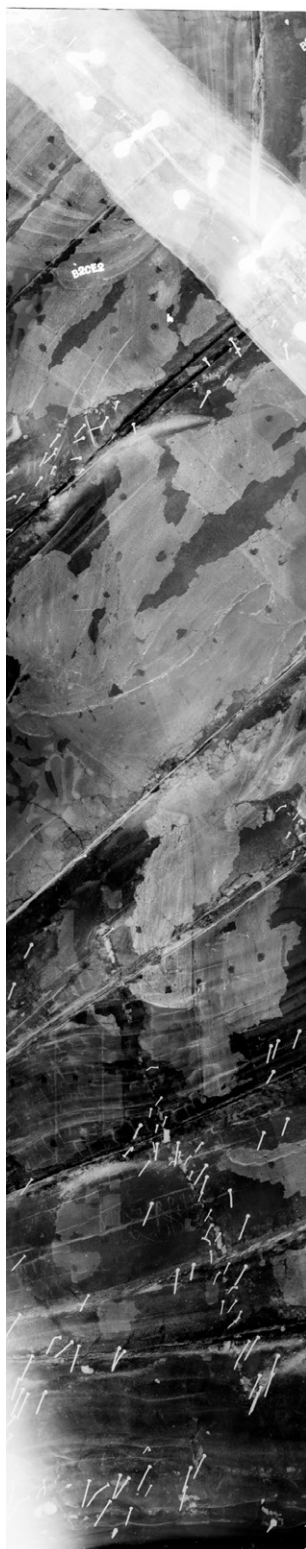
In addition to guaranteeing the conservation and stability of the pictorial ensemble, the restoration of the wooden framework made it possible to document unknown aspects such as its construction technique, the support system of the vaults and their insertion into the building.

The completion of this phase ended the problems of leaks from the roofs, which had been one of the main causes of alterations to the vaults. This last modification of the roofs resulted in the recovery of the shared roof space above the vaults as an accessible space to allow maintenance and inspection work, while at the same time improving the ventilation system of the reverse sides of the wooden structures. This space makes it possible to monitor environmental parameters both on the reverse side of the vaults and on the painted front side. Currently, data such as ambient relative humidity, ambient temperature, wood surface temperature and under-roof renewal

34. 2012, Restoration of the paintings on leather in the Hall of the Kings of the Palace of the Lions. Works monitoring report by Pedro Salmerón Escobar. Alhambra and Generalife Board of Trustees. Conservation and maintenance service. SCP-18-054.

35. Fabric consisting of continuous polyester filaments arranged in any order and welded at the crossing points by mechanical or thermal processes, which do not require the transformation of the filaments into yarns.

II.6 Digitised image of a radiographic plate of the central vault. X-rays have provided valuable information on the wooden structure and the pictorial ensemble. They show the size of the boards and distinguish between maricao and pine wood (with much more visible grain), the type of metal elements used in their construction, the areas affected by cubic rot, the size of the leathers, their faults and seams. As for the pictorial layers, we can distinguish the preparatory incised drawings, the initial bamboo pegs, the original paint delimitation, the superimposition of wax stucco and all the nails or metal points used in later interventions. Applus, X-ray B2CE2-4, 2010, radiographic plate, Alhambra and Generalife Board of Trustees, Archive.



air velocity are recorded in the space of the hood. The obverse side records data on ambient temperature, ambient relative humidity and surface temperature of the paint layer. A weather station was installed on the roof to relate the external conditions to the data observed in the vaults. This monitoring of environmental parameters makes it possible to keep track of the climatic conditions in which the paintings are conserved and to anticipate future conservation problems.

Third phase of intervention (2015-2018): restoration of the pictorial ensemble

The last phase of restoration of the front side involved direct intervention on the leather support and the pictorial layers, and was one of the most delicate stages due to their poor state of conservation.

4. STATE OF CONSERVATION

The vaults are located in a covered space, but open to the outside through the porticoed gallery that gives access to the Palace of the Lions. This semi-exposure makes them sensitive to both daily and seasonal variations in relative humidity and temperature. According to the data recorded in Granada, these oscillations can be between 40 and 50°C throughout the year, and up to 30°C per day. Relative humidity variations range from 85-90% to 60-65% in January, and from 60-65% to 30-35% in June, which correspond to the two seasons considered extreme in Granada, i.e. winter and summer. Regarding the differences detected in the thermodynamic behaviour between the rooms, there is a small difference between the central room and the side rooms and a very slight thermal stratification in the cavity of the vaults³⁶.

Alterations to the leather

With regard to the state of conservation of the leather, the deformations and other alterations to the panel are the cause of many of the pathologies observed in the protean support and pictorial layers. Leather is a highly hygroscopic material that constantly undergoes wetting and drying processes in response to external climatic variations, leading to physical and mechanical variations and significant chemical changes and reactions³⁷.

36. 2002. Oggetto Alhambra. Indagine microclimatica della Sala de los Reyes. Report by Carlo Cacace.

37. 2007. Paintings in the Halls of the Kings in the Alhambra. Granada. Update of the 2002 emergency project. Granada. March 2007. Report carried out by Predela, Conservación y Restauración de Obras de Arte, S.L.

Water from seepage and condensation phenomena on the paint layer and the leather have played an important role in modifying its water content and in the appearance of deformations and hardening of the leather. Other factors that may have influenced the water content of the protean support, although in a localised manner, has been the use of inadequate lighting systems, as they constitute a source of heat that increases the temperature of the illuminated object. In addition to the intrinsic ageing of the material, this hardening has been favoured by the effect of dissolution and migration of the original adhesives and those from other restorations.

The application of repainting and hot wax fillings also influenced the water content of the leather and favoured the contraction movements of the fibrous tissue, already altered by water seepage. It also modified its hygrometric exchange capacity with the environment³⁸.

However, analyses of shrinkage temperature, pH, moisture content and free fat content indicate that the material is only slightly deteriorated and is generally in an acceptable state of conservation. The analysed leather is not affected by Red Rot. Visually, the characteristic pink colour of this pathology is not visible, indicating that it has not been exposed to high temperatures or pollution. The pH of the leather is 5.9, which places it outside the range for this type of alteration (between 4.2 and 4.5).³⁹ The pH of leather under normal conditions is between 3 and 6. The pH measurements made on several fragments are within this range, so there is no acid degradation.

Separation of the leather support from the wooden structure has occurred due to the continuous movements and dimensional variations caused by the absorption and desorption of water from said materials. The movement of the wooden planking and the leather itself has led to tears and rips in the leather covering and the seams. There are missing parts in the leather support of different sizes and shapes due to the loss of larger pieces or small fragments (II.7).

Deposits and dirt from the reverse side of the vaults have accumulated between the wood and the leather, resulting in their separation.

After episodes of high humidity and loose leather, drying under non-stressed conditions has induced the formation of deformations: creases, ripples and general loss of consistency⁴⁰.

The iron or brass metal nails, used in interventions such as that of 1871, have oxidised and produced rust stains and holes in the leather. There are also dark-coloured stains due to washouts and partial spot gelatinisation of fibres and impregnation of adhesives and migration of tannins from the wood.⁴¹

In terms of biodeterioration, the woody elements have reached and maintained water content values above 20% for prolonged periods of time, a necessary condition for the development of rot fungi⁴² in the wood, an alteration that has occurred occasionally in the elements located under the water filtrations in the three vaults. Therefore, over time the leather has also repeatedly reached humidity and temperature levels critical for the risk of microbiological attack. In addition, the wax-resin layer reduces the evaporation phenomena of moisture absorbed by the leather through infiltration from the back of the vaults, contributing to a suitable ecological habitat for many microbiological species at the leather-wood interface⁴³. Damage caused by non-active microbiological fungal contamination (*Aspergillus niger* and *Paecilomyces* sp.) has only been detected in a localised area between the wood heavily attacked by rot fungi and the remains of the leather of the central vault.

Alterations of the pictorial layers (primer, coloured and gilded layers)

Water infiltration caused the dissolution of the original adhesives used in the bonding of the leather to the wood, as well as those of the preparation layer, resulting in lifting and loss due to lack of adhesion. On the other hand, there is a serious lack of cohesion between the preparation of the paint layer and the leather support.

In general, cracks and fissures can be observed, usually coinciding with the joints between the wood and leather pieces, craquelure, flaking or bubbling, small missing parts that expose the original preparation, and large missing parts (II.8).

38. 2012. Granada, Alhambra, Palace of the Lions. Painted vaults in the Hall of the Kings: intervention project. 17-19 December 2012. Report by Mariabianca Paris and Anna Valeria Jervis. Istituto Superiore per la Conservazione ed il Restauro, Rome (Italy).

39. 2007. Paintings in the Hall of the Kings. Alhambra, Granada. Phase: implementation of emergency intervention project: preliminary fixing and protective facing, detection of "red rot" degradation in the leather. Seville, April 2007. Report by Inmaculada Sánchez Romero. IAPH.

40. 2012. Granada, Alhambra, Palace of the Lions... Op. cit. (37)

41. Ivi.

42. 2008. Granada-Alhambra, Research and intervention project on the paintings on leather in the Hall of the Kings. Biological Research 1st report. Coordination: Maria Pia Nugari. ICR Biological Research Laboratory, Rome (Italy).

43. Ivi.



II.7 Bear hunting scene from the south vault illuminated with tangential light, showing the characteristic pathologies of the leather: deformations, hardening, folds, loss of attachment to the wooden support, darkening and stains caused by the oxidation of adhesives, breakage of stitching and of the leather at the joints of the planking, attachment of the leather using metal pins, addition of new fragments of leather, etc. Amadeo López del Águila, PINTURAS_SRR_BOVEDA1-042, 2012, Alhambra and Generalife Board of Trustees, Archive.

II.8 Characters in the central vault on the gilded background, an image that brings together the main pathologies of the pictorial layer. The ruptures and deformations suffered by the leather have been transmitted to the coloured layers and have caused cracking, lifting, peeling and loss. The image was taken after partial removal of the wax stucco. Eduardo Mendoza, untitled, 2018, Alhambra and Generalife Board of Trustees, Archive.

The pictorial surface is almost completely covered with beeswax, which makes it difficult for the adhesives used to fix the polychromy to penetrate and reduces the clarity and sharpness of the drawings and colours. In some areas, considerable accumulations of wax can be seen, which have retained the imprint of brushes and even fingerprints, along with the mark of the lattice and the remains of protective gauze from old fixing tests.

The superficial and heterogeneous application of adhesives or fixatives, which have been applied throughout the different interventions, have formed a layer that has ended up shrinking and tearing off the original colour layer.

The surface of the painting shows small circular colour faults that seem to be the result of the technique used, caused by the escape of tiny air bubbles that were formed when the paint was applied, and which appear especially in the central vault on the flesh tones and clothing.

Wax stuccos, wax surface applications and repaints

The use of wax stucco in 1962 was not only limited to the replacement of missing paint layers, but was also used to restore missing parts in the leather and even to conceal deformations in the wooden support. Thus, we find stuccoes with generalised craquelure in applications of very variable thicknesses, ranging from

a millimetre to several centimetres, which in most cases exceed the limits of the missing parts, hiding the remains of the original paint. There is a notable separation between the wax stuccos and the leather, due to the poor adaptability of the wax to the movements of these supports. In these movements, the wax drags small fragments of the original paint and takes them with it.

All three vaults have been affected by the application of colour retouching to a greater or lesser degree. Most of the repainting is in more or less well-integrated plain colours that overlap the missing parts and are spread over the original paintwork. They are mostly bound with linseed oil and, among the pigments analysed, some of industrial origin have been identified whose manufacture began from the 19th century onwards. Industrial pigments (barium sulphate or baryte, titanium white, lithopone, Prussian blue, cadmium yellow, chrome yellow or cadmium red) have been identified on some flesh tones, certain clothing, background blues, white glazes, greys and other red elements such as belts or roofs. The date of manufacture of these pigments and their marketing can provide information on when they may have been used on the vaults⁴⁴. According to this, most of the repainting analysed is the result of 20th-century interventions, which probably correspond to the work of Gudiol Ricart in the 1960s or later (II.9). Some of this repainting has disappeared as a result of the application of organic solvents in subsequent restoration processes.

INTERVENTION CRITERIA

The modification of the roofs and the placement of the canal on the west side caused serious alterations both to the wooden support and to the pictorial ensemble. The marked degree of deterioration of this side contrasts with the relatively good state of conservation of the east side of the vaults, which fortunately remained protected from water leaking in as a result of the repairs of 1855.

44. Barium sulphate was known as early as the 16th century, but there is now no evidence of its use as a pigment until 1782, as a substitute for lead white. Although titanium oxides were produced in the laboratory after the discovery of the element at the end of the 18th century, it was not until the 20th century that it was actually used as a pigment. After the first world war it was incorporated into the formulation of prefabricated paints. Lithopone was discovered around 1850 and was produced on a large scale from 1874 onwards. Prussian blue was discovered between 1704 and 1710, cadmium yellow was produced as an artificial pigment in 1819 and became commercially available in 1840. Cadmium red was commercialised in 1910. Chromium yellow was first manufactured in 1809. EASTAUGH, Nicholas; WALSH, Valentine; CHAPLIN, Tracey; SIDDAL, Ruth. *The Pigment Compendium. A Dictionary of Historical Pigments*. Elsevier Butterworth-Heinemann, 2004.

In earlier periods, the vaults must have reached a 'state of equilibrium' with the environment, in which the alterations must have been caused by the intrinsic ageing of the constituent materials and their different mechanical behaviour in relation to the thermo-hygrometric environmental conditions. This adaptation of the work to its surroundings was altered by the appearance of occasional leaks or other localised external aggressions, but they do not seem to have had such a negative impact on its conservation as those that occurred from the 19th century onwards.

Over the last two centuries, there have been repeated attempts at material recovery through the use of various products and methodologies (organic glues, waxes, synthetic resins, etc.), which over time have only amplified the differences in behaviour between the various components, whether original or restoration components, and accelerated the processes of deterioration and loss of the original.

The intervention criteria have been adapted to current legislation and international recommendations. Both the materials used and the methodologies followed have been compatible with the building tradition of the property, have followed reversibility criteria and offer sufficiently proven behaviour and results.

However, the limitations of some theoretical assumptions in the material reality of the work must be accepted. Concepts such as reversibility are not always fully applicable during the processes, as the total elimination of adhesives, used as consolidating compounds for a substrate or as fixatives for colour layers, is often not feasible. The same applies to the products used to hydrate the leather.

Consequently, the intervention has been approached from the point of view of minimum intervention: eliminating as far as possible everything that is damaging it, and carrying out actions aimed at stabilising the whole through products and methodologies that will always allow us to re-treat the paintings with any type of material.

At this point, it is essential to assume the need for a periodic plan for maintenance and control of the condition of the vaults, which facilitates the early detection of changes in condition and their correction. This plan would cover not only the revision of the installations and maintenance of the roofs, but also include actions such as the revision of the mechanical anchoring of the leather, actions to control the fixation of the pictorial layers and the control and evaluation of the materials used in the reintegration.

RESTORATION TREATMENTS

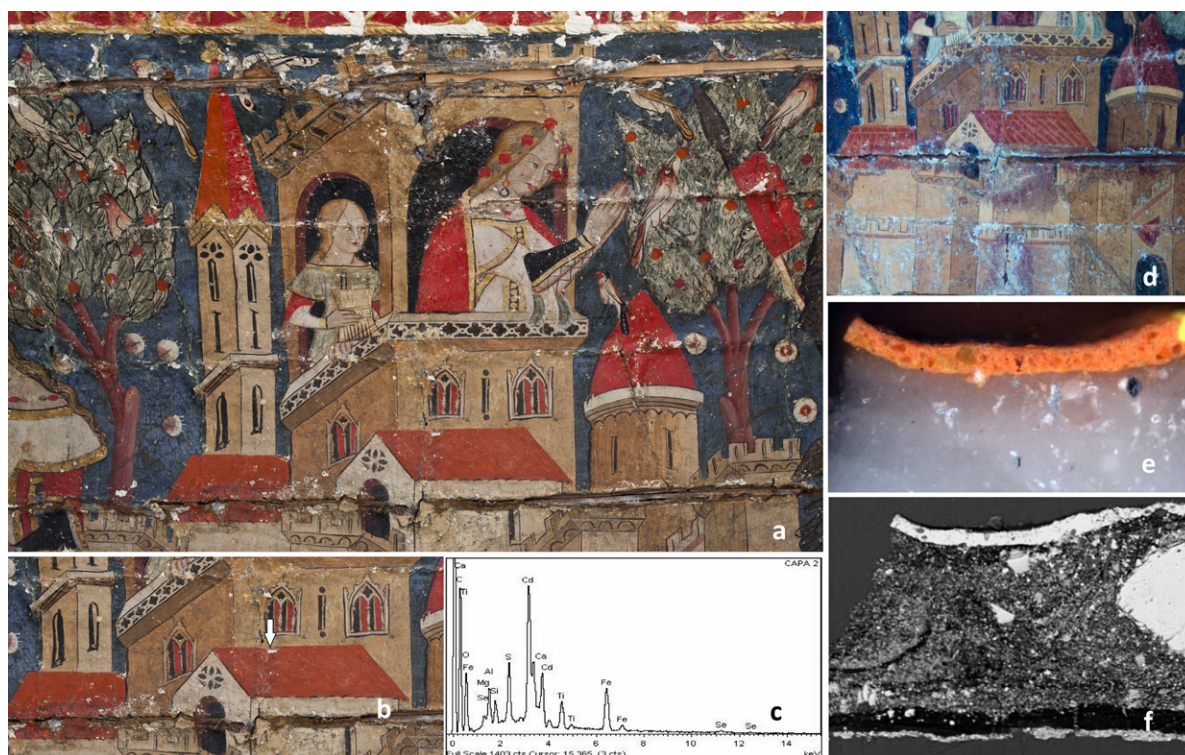
Restoration of pictorial layers

After the removal of superficial dirt deposits, it was necessary to fix the pictorial layers prior to any other procedure. During this process, the use of a thermoplastic polymer (2-ethyl-2-oxazalin) was alternated with the application of non-inionic hydroxypropyl cellulose, depending on the degree to which the colour layer had been lifted. This action made it possible to remove the surface wax layer, which reduced the sharpness and saturation of the original colours, by combining chemical means with moderate heat.

As for wax and repainting, those in good condition which did not interfere negatively with the paintings and which were

considered part of their material history were maintained. Therefore, only altered additions, those that were detrimental to the conservation of the paintings and those that concealed part of the original pictorial layer have been removed. The older, larger wax stuccoes were removed after they had been numbered and located in the planimetric and photographic documentation. Their heavy weight and irregular backs, clogged with sand and dust from the roofing materials, made their preservation in situ infeasible. The same treatment was given to leather replacements that were in a good state of conservation and did not damage the work.

Once the paint surface had been freed from the wax layer, which partly prevented the penetration of the adhesive fixing



II.9. a: Scene belonging to the south vault with red repainting on the lower roofs; b: point of extraction of the samples; c: result of the EDX microanalysis of layer 2; d: illumination with ultraviolet light of the scene in which the pattern of the tiles can be made out, barely perceptible when illuminated with visible light. The study of paintings with fluorescence induced by ultraviolet light can provide information on the technique and state of alterations and interventions not inherent to the work. The fluorescence of the paints is determined by the type of binder, the pigment and the combination of both. Most of the pigments have a very slight fluorescence, except for zinc white, cadmium yellow and cadmium red, among others, characterised by strong fluorescence; e: 200X petrographic microscope image of the stratigraphic section showing layer 1 of whitish preparation thicker than 475 μm , composed of calcium carbonate, dolomite, silicates and silica grains, and layer 2 of a thickness of between 30 and 50 μm of orange-red colour formed by cadmium red, cadmium yellow, ochre earth and titanium white; f: scanning electron microscope image (with BSE detector) of the cross-section. a and b: Amadeo López del Águila, PINTURAS_SRR_BOVEDA1-205, 2012, Alhambra and Generalife Board of Trustees, Archive; c: Eugenio Fernández Ruiz, 14PROY-01-P1-003, 2012, Alhambra and Generalife Board of Trustees, Archive.

the paint, a general colour was re-applied using the same type of resins and moderate heat (Il. 10).

Restoration of the leather

The results of studies and tests carried out to control biodeterioration in the wood and leather structure caused by fungi and insects advised against the use of biocidal products because of their unknown effect on the leather and paint layer. Since the identification of fungi had occurred only in a small area and since the attacks by xylophagous insects had been isolated and they were not active, it was decided not to apply biocidal products in favour of monitoring the humidity content of the wood by installing sensors and carrying out periodic inspections.

The iron or brass nails introduced in the 19th century that did not fulfil their function of fastening and whose removal did not imply any kind of alteration were partially eliminated. They were removed in parallel with the correction of deformations and the recovery of the anchorage points of the leather to the wood.

Regarding the need for leather hydration treatment or not, the use of traditional materials designed to regenerate dryness such as ethanol, glycerine, lanolin or polyethylene glycol were ruled out because of the risk of oily patches due to oxidation or the stiffness experienced by the leathers years after treatment⁴⁵. Likewise, neither the short- nor long-term effects on the pictorial layers could be anticipated.

On the other hand, this type of process requires an even application, prevented by the presence of the remains of the paint layer on the reverse side.

Other hydration systems, such as the supply of hydration through polyester membranes, did not guarantee the safety of the paints, as the scope of the treatment would only partially reach the protean support.

In this situation, it was decided to take advantage of the natural hydration of the leather during the months with higher relative humidity to reduce major deformations.

The action has made it possible to recover the correct position of bent leathers, edges, or small fragments without a pictorial layer, introducing a new system of mechanical fastening to the wooden structure.

The new mechanical fastening of the leather to the ligneous support allows dimensional variations of the leather

without increasing stress levels. The holes left by the removed nails have been used to insert stainless steel screws or flat-head nylon screws and washers made of plastic conservation material that provide a flexible hold on the leather, respecting its movement and allowing it to adapt to climatic variations. A layer of fluorescent pigment bonded with acrylic resin has been applied to the washers to maintain their transparency, so that they blend in with the surrounding colour and become visible and therefore traceable when illuminated with ultra-violet light (Il. 11).

Volumetric reintegration

Various materials and products were tested to replace the missing leather and paint layer. Finally, the idea of introducing different materials that could result in different mechanical behaviour was rejected, and a single composite with a behaviour similar to the originals was used to reintegrate all the missing parts in the leather, the priming and the coloured layers.



Il.10 Colour application process in the north vault "The Fountain of Youth". The adhesive was applied by injection under the scales or through Japanese paper. Moderate heat was applied to achieve greater penetration. Azuche 88, untitled, 2014, Alhambra and Generalife Board of Trustees, Archive.

45. CRESPO ARCÁ, Luis. Reflecting on the past: improvements in the conservation of documents on parchment using traditional manufacture and restoration techniques. In: *Unicum Versión Castellano*, 2011, p. 218.

This new material consists of cellulose pulp and hydroxypropyl cellulose dissolved in ethanol to form a lattice of fibres of different lengths to which a small amount of fluorescent pigment is added. The addition of this pigment makes it visible when illuminated with ultraviolet light, a feature that allows the exact location of the added parts and facilitates their complete removal if necessary.

The entire reintegration work is thus unified with other elements in the Hall of the Kings, in which this same pigment has been applied to distinguish and locate the reintegrations of the plaster decorations and the coloured stucco plinths that imitate ceramic tiling.

Prior to its use, the cellulose stucco was subjected to a behavioural study together with the other constituent materials, by means of fatigue tests and their subsequent evaluation through observation and analysis methods. For this purpose, various combinations of wood, leather, paint layer and wax stucco samples were used with the cellulose stucco and aspects such as weight variations, morphological changes, appearance and development of damage both on the surface and in section, as well as objective colour changes, were measured. Laboratory results confirmed that the material is stable and compatible with the other elements present. In terms of workability, it is a material that is easy and quick to apply, safe for the work and for the restorer and, above all, easily reversible.

As for its use to cover up the lack of stucco, its application was adapted to the existing deformations of the leather, in such a way that it maintains the prescriptive character of the passage of time. The missing parts were not covered in their entirety, but only in areas where there was a pronounced unevenness between the original polychrome and the leather support. The differential deterioration of the ensembles was also taken into account, in which areas in very poor condition coexisted with others that were better conserved, so that the stucco had to act as a gradual union between these parts.⁴⁶

Recovering the image

The chromatic reintegration was based on all the graphic documentation available (engravings, tracings made in the 20th century, photographs and X-rays), which made it possible to recover the general forms. The image of the vaults documented in 1976 by the photographer Oronoz, when they are consid-

ered to be in their most complete state, has been sought, always checking it against all the previous graphic documentation in order to correct possible mistakes and erroneous interpretations by the restorers. Owen Jones's drawings have been extremely useful in this respect, as they show the scenes depicted with great precision and respect for the original; the X-rays, in which the limits of the original painting can be clearly distinguished, together with the tracings of the paintings on canvas paper, commissioned to Manuel Gómez Moreno in 1871 by the Provincial Commission of Historic-Artistic Monuments of Granada, in case they suffered further deterioration during Rafael Contreras's restoration. We have retained the reproductions of the images of the main figures, which correspond to the reintegration work by Gudiol in the 1960s, specifically the faces and hands of the central vault, as they are now of documentary and historical value, especially as the previous documentation shows a significant lack of information in these areas, which would make their reconstruction extremely difficult ⁴⁷(II.12) and (II.13).

The general reading of the image has been recovered by adding as little material as possible and subtly recomposing the missing parts, so that the viewer is able to interpret all the scenes, even if they have not been reintegrated in detail.

Technically, watercolour has been applied to the lines, and for the gilding, pigments of mica coated with titanium oxide and iron oxide bound with gum arabic. With regard to the chromatic palette, a reduced tonal range has been used, while at the same time trying to keep the vibration of the reintegrations lower than the original in order to maintain the essence of authenticity of each piece, considering the very high percentage of losses to be recovered.⁴⁸

7. OTHER CONTRIBUTIONS

The restoration of the vaults has managed to stabilise their state of conservation and restore the material consistency of both the wooden structure and the pictorial ensemble. It has also made their aesthetic reading possible by recovering the lost image through volumetric and chromatic reintegration. Previous studies and analyses carried out before and during the restoration have revealed other aspects such as the construction technique of the support, the type of leather and tanning,

46. 2018. Final Report. Volumetric and chromatic reintegration of the paintings on leather in the Hall of the Kings of the Alhambra. Granada. September 2018. Memory made by Tracer. Alhambra and Generalife Board of Trustees.

47. 2013. The paintings in the Hall of the Kings. Conservation-restoration work on the front... Op. cit (n.2).

48. 2018. Final Report. Volumetric and chromatic reintegration of the paintings on leather in the Hall of the Kings of the Alhambra... Op. cit (n39).



II.11 Mechanical anchorage points of the leather to the wooden structure in a central-vault character illuminated with normal and ultraviolet light. The ultraviolet light or black light reveals all the anchorage points used. Eduardo Mendoza, untitled, 2018, Alhambra and Generalife Board of Trustees, Archive.

the cutting of the leather, the type of stitching and joining to the wooden frame, the characterisation and identification of the pictorial technique, etc.

Beyond these obvious questions, we would like to point out other data that are relevant to the thorny issue of authorship and which may help to further our knowledge of the manufacturing process of the paintings. The data presented below is the result of a detailed study of the reading of the materials used, and these studies are even more enriching when they can be compared with others carried out on the same monument.

With regard to its manufacture, the wooden vault that serves as a structure for the pictorial support is constructively parallel to the hemispherical and coffered frames of the east and west temples of the Palace of the Lions, attributed to the reign of Muhammed V (1362/1391), the restoration of which was completed in 2018 by the Wood Restoration Workshop.

Both examples were built on the ground to be later hoisted to their final location. The ribs of the vault caps and the

ribs of the trusses form a continuous framework that cannot be separated into segments. These ribs are made up of several frames assembled with wood and reinforced with forged nails. They are irregularly squared, with marks on the surface left by common tools such as a saw or an adze and missing segments that were probably removed after assembly because they are parts that could lead to problems over time, such as unstable knots. The ribs that reinforce the ends of the leather vaults have a similar arrangement to those observed in the armou-ring of the small temples: they are made up of a main rib that forms the complete arch, another perpendicular to it that divides the caps in two, and two other ribs that are assembled at 45° in the angles formed by the previous ones. Two more ribs per quadrant are inserted in the structures in the courtyard (Il. 14) and (Il. 15). All ribs are inserted into the base ring by means of dowels.

The planks of both the vault caps in the Hall of the Kings and the hemispherical trusses are made of boards of unequal



II.12 Volumetric reintegration of the figure in II. 11 with cellulose stucco. The stucco has been mass-coloured to facilitate the process of chromatic integration, except for the gilding, which has been used without colour. In terms of texture, the surface of the stucco has been left slightly uneven to encourage a certain vibration of the reintegrated areas. For the chromatic reintegration of the gold areas with relief, the cellulose stucco was applied smooth and a template was used for the rigatine tempera, adding shading that imitated the volume. It has also been necessary to colour-correct washers, metal fasteners, old wax stuccoes and replaced leathers. Eduardo Mendoza, untitled, 2018, Alhambra and Generalife Board of Trustees, Archive.

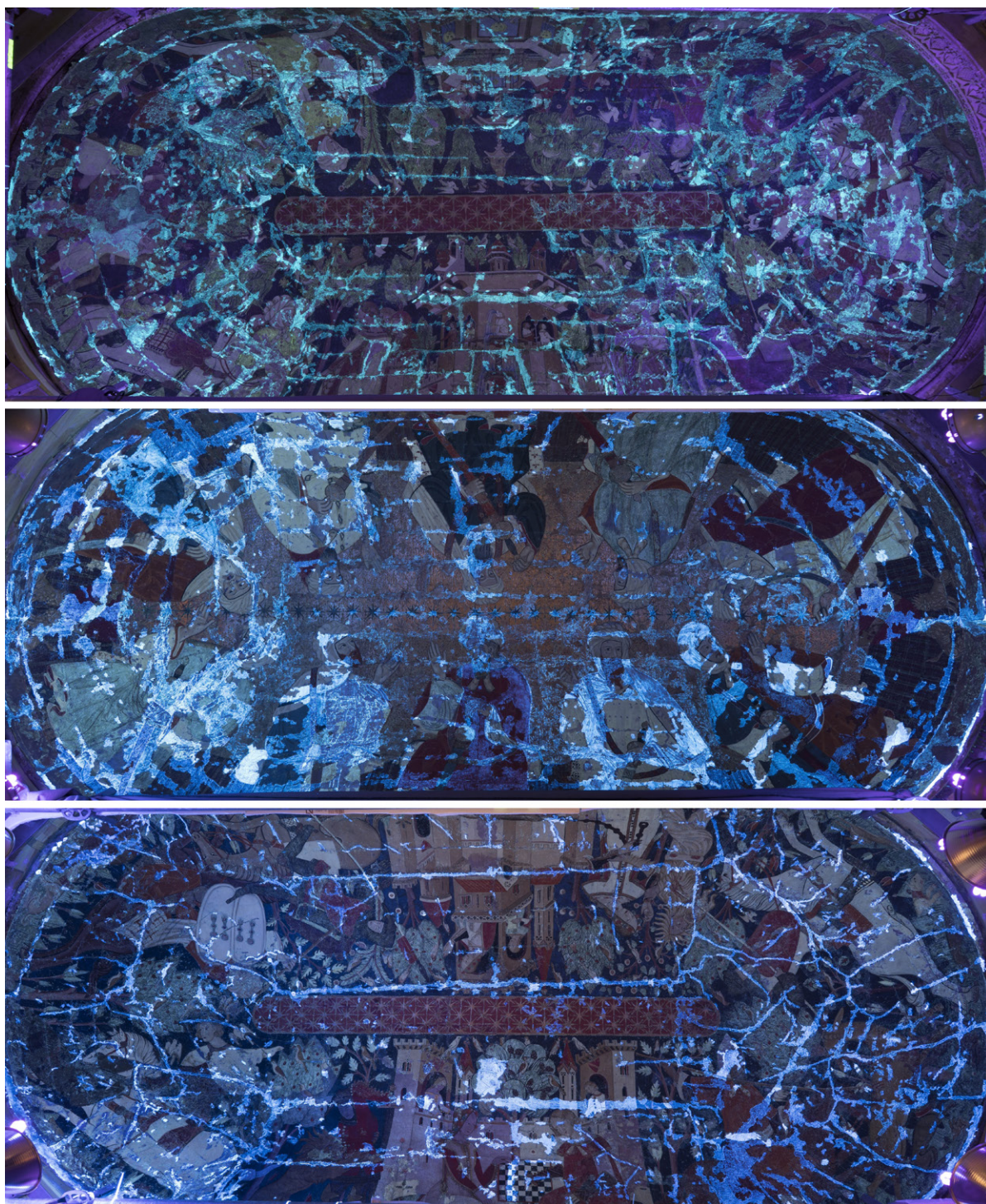
triangular shapes that fit together to form the concave parts, which seems to indicate that they were cut as they were being assembled into the structure. In the less curved parts, more regular and rectangular-shaped boards were used. Between the boards of the vault caps and the trusses, spaces are sometimes created that are filled with small wooden strips in the form of splints and/or vegetable fibre mixed with animal glue in the vaults⁴⁹. This final adjustment may be related to the shrinkage of these pieces during drying, which may have been cut from green wood or steam-wetted to make bending easier.⁵⁰ In the structures in the Palace of the Lions, the use

of stanchions has been found,⁵¹ while in the vaults the use of such elements has not been recorded. In all cases the planking is nailed from the front side to the ribs and is mostly composed of poplar wood (*Populus alba* L.). As for the species chosen for the ribs, poplar wood has been the one mainly characterised in the vaults, while it has not been verified whether it is poplar or pine in the structures in the Palace of the Lions owing to the fact that the reverse side cannot be accessed. In any case, both poplar wood and Aleppo pine (*Pinus halapensis*), identified in four boards of the central vault, were the types of indigenous wood most commonly used in Nasrid carpentry.

49. 2010. Paintings in the Hall of the Kings. Alhambra, Granada. Report on the intervention on the reverse of the paintings... Op. cit (1).

50. 2008. Dendrochronology study of the Hall of the Kings of the Alhambra, Dendrochronology Laboratory. Report by Eduardo Rodríguez Trobajo. Forestry Research Centre. INIA.

51. Elongated metal parts with a square cross-section. The central part of the stanchion is thicker and serves as a connection between two wooden planks.



II.13 Images of the vaults after the chromatic reintegration processes and illuminated with ultraviolet light. The fluorescence of the pigment added to the stucco makes it possible to detect and quantify the whole of the intervened pictorial surface. Eduardo Mendoza, untitled, 2018, Alhambra and Generalife Board of Trustees, Archive.

With regard to the protective layers of the wooden backs, it has not been possible to establish a comparison between the hemispherical frames of the Palace of the Lions and the vaults of the Hall of the Kings. Unfortunately, we have not had access to the back of the structure of the east temple and the back of the west structure is currently covered by a layer of plaster from the 1966 restoration by Prieto Moreno. This layer of plaster does not allow us to see if the remains of a layer of pitch similar to that characterising the vaults are preserved underneath. However, covering the back of frames and alfarje wooden ceilings with a layer of plaster was common practice in Nasrid carpentry, as it protected the wood from fire and from attack by xylophagous insects. However, to date, no layers of pitch have been found protecting the backs of other structures or alfarje ceilings in the Alhambra, except for those belonging to the leather vaults. Perhaps this peculiarity can be explained by the need to make them more waterproof, given the fact that leather is very vulnerable to water.

On the other hand, the unit of measurement used in the manufacture of the elements of the wooden structure was the Arabic foot, as was evident during the restoration of the reverse sides⁵².

Another revealing piece of information is provided by the radiographic study of the vaults from one of the radiographic plates: specifically in the central vault, where Arabic calligraphic traces appear under the remains of the pictorial layer and repainted wax stuccoes. The image provided corresponds to a complex image due to the superimposition of the different materials that make up the paintings. The light areas indicate the areas of higher density while the dark areas belong to the areas of lower density or thickness. The calligraphic traces appear upside down on the radiographic plate, which leads us to believe that they must have been made on the reverse side of the leather, on the flesh side, so that it was adhered to the wooden structure at the time of preparation of the protean support. Radiation distinguishes with whiter tones pigments with high atomic weight elements such as lead (minium or white lead) or mercury (cinnabar), all of which are identified in the paint analysis process (II.16).

Reversing the X-ray reveals the Arabic letters, each drawn with a single line with great precision, and with the lower and upper ends of the perfectly straight and parallel stems of the letters *alif* and *lām* of the Arabic article curved to the left below and with a double curvature above, and executing the *lām-alif* composition with a clear and secure loop, with which the letter

mim that appears in the image was also calligraphed. It is clear, therefore, that it is a calligraphic work with artistic or ornamental intent, perhaps a sketch or calligrapher's exercise, but the fact that it is not complete and that the features of some of the other letters are not clearly visible makes a secure reading of the inscription impossible. It is clear that the calligraphic fragment contains no proper name or date, so we cannot establish any significant link with the paintings. And although it recalls the form of the desiderative expression *al-Yumn wal-iqbāl* (Fortune and prosperity), quite widespread in the epigraphy of the Alhambra and in Nasrid art, perhaps with the *waw* barely visible filling the central hollow, the fact is that the absence of the last letters and the lack of clarity of others makes it impossible to conclude that this is the correct reading⁵³.

As a final conclusion, we can conclude that the construction technique of the wooden vaults, their similarities to the hemispherical structures of the Patio of the Lions attributed to the reign of Muhammad V, the unit of measurement used in their execution, as well as the calligraphic traces on the leather, indicate that the construction of the wooden structure and the preparation of the leather support were carried out by Muslim craftsmen. However, the design and execution of the paintings may have been carried out by artists of different origins.

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52. 2010. Paintings in the Hall of the Kings. Alhambra, Granada. Report on the intervention on the reverse of the paintings... Op. cit (1).

53. Observations on the calligraphic traces by the specialist Jose Miguel Puerta Vilchez.



II.14 Extrados of the north vault (The Fountain of Youth) after the restoration of the reverse side. Distinguishing features include the framework formed by the ribs and the triangular shape and arrangement of the planking that makes up the caps. The dark stains correspond to the remains of the originally applied pine pitch coating. The light-coloured coatings are fragments of the plaster mortar that protected the reverse sides. Elena Correa Gómez, untitled, 2009, Alhambra and Generalife Board of Trustees, Archive.



II.15 Extrados of the hemispherical frame of the west temple of the Palace of the Lions in 1966 during the intervention of Prieto Moreno, at the time of the dismantling of the roof and before the restoration of the frame. The architect covered the wood with an orange layer of minium, which was used as a preventive barrier against attack by xylophagous insects due to its lead content, and renewed the plaster cladding. Unknown author, Palace of the Lions. Small temple of the Palace of the Lions. Consolidation works. Phase 1, 1966, Alhambra and Generalife Board of Trustees, Archive, F-020738.



II.16 Arabic lettering appears in the central vault on the reverse of the leather. The state of conservation of the poplar wood, which appears to have been attacked by cubic rot, the superimposition of the deteriorated leather, the remains of the original paint and the wax stuccoes provide a confusing image that makes it difficult to read. Applus, X-ray B2CE2-4, 2010, radiographic plate, Alhambra and Generalife Board of Trustees, Archive.