
**INTERNATIONAL SESSION SCIENTIFIC COMMUNICATION -
INTERVENTION IN CONSERVATION AND RESTORATION
WALL PAINTING IN THEBAN TOMBS, (EGYPT) (2nd C, B.C)**

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**Sesiunea internațională de comunicări științifice -
Intervenții de conservare și restaurare a picturilor murale din mormintele
tebane (Egipt) (sec. II î. Chr.)**

Rezumat

În cadrul conservării și restaurării patrimoniului, scopul prezentului studiu este analiza picturilor murale din arhitectura funerară, în Teba antică (Egipt). Obiectivul va fi studiul picturilor murale din mormintele tebane. Analiza stării de conservare, a deteriorării și degradărilor, pigmenților și materialelor constitutive, metodele de restaurare și măsurile de conservare.

Cuvinte cheie: *Picturi murale, restaurare, conservare, a XVIII-a Dinastie, Luxore, Egipt.*

Keywords: *Wall paintings, restoration, conservation, XVIII Dynasty, Luxore, Egypt.*

1. Introduction

The painting in ancient Egypt was used for decorative purposes from the first cultural vestiges in the Nile, both for daily use ceramic objects and for animals' representations on walls. Already in Pharaonic times, pigments and glues of animal and vegetable origin have been identified.

Documentation relating to pictorial processes is scarce. Most of the data has been found in Deir el Medina, as it is the artisans' village, with intense activity in the Ramesid period. Texts have occasionally been found in ostraca, which have allowed us to know the painting process, with terms referring to pigments and materials, and the Suemniwet tomb, with references of tombs and temples decoration.

For example, from the Metropolitan Museum of Art, which William Hayes (1942)¹, dates from Senenmut time (1468 BC), where pictorial techniques are described.

During the 18th Dynasty the administration of Egypt was divided between the north and the south of the country, but a large part of the noble classes chose the Theban mountain for their burials. The poor quality of the limestone, being structurally weak, made it impossible to carve the stone, so most of the tombs were painted inside.

* Architect, UNESCO, Spain.

¹ Hayes, William. *Ostraka and Name Stones from the Tomb of Sen-Mut (No. 71) at Thebes*. Publications of the Metropolitan Museum of Art 15. New York: Metropolitan Museum of Art. 1942.

The most significant tombs are located in various necropolis of western Thebes, currently Luxor. They correspond to workers (Deir el Medina), individuals such as nobles and leaders (Dra Abu el-Naga, Asassif, Joja, Sheikh Abd-el-Gurna, Gurnet Murrai and Deir el-Medina), and royal family (Valley of the Kings and Queens).

Although there are tombs belonging to other times, during the 18th Dynasty there was a period of cultural splendor that was evidenced in all the artistic representations of the time; literature, architecture, sculpture and painting.

For many centuries these tombs were abandoned and covered by sand, until at the beginning of the 20th century, began to be excavated by European archaeologists. Currently more than 500 are located. They are in different degrees of conservation and deterioration, due to the poor quality of the material, the inclement weather and the action of man, having been reused as a refuge for shepherds and hermits.

Numerous Egyptologists contributed to documenting both the tombs and the paintings and scenes within them. Many of them once documented, were lost again, being untraceable, while others were deteriorating, were fragmented, looted or taken to museums and private collections, so their work was indispensable.

The works of John Gardner Wilkinson² (1821-1856), as well as those of Nina and Norman de Garies Davies³, were indispensable, when developing a wide catalog of these pictorial representations.

Concept

* There is no Art in Egypt as such, any artistic representation has a religious, liturgical or magical purpose. The painting is a mere work of decoration according to guidelines and models marked by the beliefs and thoughts of each era in the Egypt history.

Religious beliefs were decisive in the development of Egyptian civilization. The resurrection and belief in the afterlife allowed the development of a specific iconographic program, which allowed life to continue after death. For this, the memory of the deceased's life was essential, with his achievements, his affections, family, and daily tasks, as well as the projection of his new life after death, with the magical and ritual processes that would guarantee his eternal life.

Painting was another vehicle to guarantee divine order, seeking beauty and effectiveness.

* The decoration in the tombs helped the deceased in the transformation for the afterlife. The iconographic programs varied according to the social stratum. The tombs were painted to achieve a dynamic cabin with texts and images on the walls, which would guarantee their passage to the next world, in order to protect their body. Ritually the tomb had to be the healing scene, to achieve magical effectiveness of paintings and papyri. The purpose of the decoration was to annihilate evil and disease.

* The symbology was complex and full of allegories. Things are not what they represent but what they mean. The hippopotamus hunt was a reference to

² John Gardner Wilkinson, *Manners and Customs of the Ancient Egyptians*, John Murray, London, 1847.

³ Nina M. Davies, *Ancient Egyptian Paintings*, The Oriental Institute, The University of Chicago, 1936.

evil, the launching of the boomerang against birds was an attempt to control disorder, or the fishing of 2 tilapia, symbolized the 2 forms of the dead.



TT 218. Amenemhat Tomb, Deir el Medina (1295 - 1186 B.C.). God Anubis over the deceased⁴.

Applications and uses

* Painting was also used as a complement to sculpture and relief, everything was colored. In more humble contexts, the support was a simple board of wood, ceramic or limestone, and if more resources were available, it was worked on noble stones, walls of temples or tombs and even obelisks.



Dendera Temple (1500 B.C). Hypostyle hall colored⁵.

* The Egyptian perspective was with the front trunk, legs and faces in profile. The canon was strict, the figures were arranged by juxtaposition, and there

⁴ TT-218. Amenemhat Tomb, artisan Deir el Medina artisan, XIX Dynasty, Ramses II period (1295–1186 B.C).

⁵ Dendera Temple. Dedicated to the goddess Hathor, the initial construction is from the 18th Dynasty (1500 B.C), but the most recent construction is the Mammissi of Nectanebo I (381-364 B.C).

was no perspective. The size was used for the hierarchy, as a plastic conceptualization. The most important figures were represented on a larger scale than the secondary ones, as an expressive resource.

The painters carried out their work according to formal, metric and determined rules that left no scope for creativity. There was no individualized form of representations, since the work had a magical and ritual purpose, not an artistic one.

Thematic

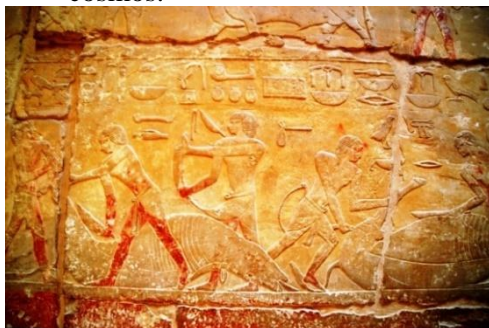
*It varied according to time and period. Also by the social category; whether the tomb was for someone of royalty, a noble or lower class workers. For example, the hunting scenes disappeared in the time of Thutmosis IV, the representations of Osiris, were implanted in the XVIII Dynasty, and the royal kiosk, where the pharaoh was seated, disappears at the end of that dynasty. With the Amarnian period the most expressionist representations began, outside the established canons.

*The main themes are countryside, offerings to the deceased and divinities, funeral banquet, hunting scenes, fishing, boats, and scenes of war or battles in temples to celebrate political victories.

*The location of the type of scene within the tomb also responded to a specific program, and changed according to the architectural distribution of the spaces.

Some of the most frequent are:

- Daily routine scenes. The activities carried out by the deceased, family, social, labor, agricultural or livestock are represented.
- Burial Where the ceremony is represented, with the preparation rituals.
- Offerings to the deceased and funeral banquets.
- Opening of the mouth ceremony, with the ritual for the return to life.
- Pilgrimage to Abydos.
- Hunting in swamps.
- Mythological scenes with references to chaos and order in the cosmos.



Mehu Tomb, Saqqara (2300 B.C.). Funeral scenes.

2. Paintings

Support

* Support materials varied; from wooden slats, ceramics, carved stones, and limestone walls and more noble and better quality stones. The use of papyrus was limited to other purposes, such as narrative and accounting.

* The most compact rock strata were chosen, with successive cutting, carving and polishing. As the rock was very poor, when it was cut frequently large pieces were detached.

* Imperfections were concealed with top layers of coating;

- Garnished: Calcium sulfate mortar, mud and straw.
- Plaster: Plaster, to create a flat surface.

The rendering of the surfaces to be painted was made with a base of clay-straw and gypsum. The plastering procedure was to smooth the surface of the rock with this mixture of clay and chopped straw, and apply a layer of plaster on top, which it was painted. In some cases that required a quality improvement, silt from the Nile was used instead of clay, named Hib.

Painting Process

* **Analysis.** The work area that was to serve as base was studied.

* **Preparation.** If it was good, the stone was sculpted. If it was bad, was covered with plaster (white or yellowish tone).

* **Drawing.** Grid tracing with rope dipped in red paint. Ostrakon in red / black, on which it was sculpted and later painted. Canon and measures according to decorative program. The proportions tabulated according to module and canon (Lepsius⁶, whose studies were expanded by Iversen⁷), according to proportions of hand and arm, cubit and royal cubit.

The outlines of the scenes were drawn, and the background was whitewashed with a certain transparency, to be able to complete the drawing later. The free areas between the pictorial motifs were filled with a second coat of paint to give the background opacity.

The Suemniwet Tomb (TT92), from the time of Amenhotep II, is one of the unfinished tombs that allow us to see the entire pictorial process of the walls.

The use of the modulation by squares, varied according to the period. In the times of Thutmose IV and Amenhotep III, its use declined, limiting itself to the large, more important figures corresponding to the owner of the tomb, while the secondary figures were drawn freehand or with simple guide lines. Examples of this are the tombs of Menna, Nakht (TT52), and the unfinished tomb of Neferrenpet (TT43).

* **Painting.** The technique was tempera painting or gouache, with the application of several layers. The pigment was prepared in small cakes or bricks, and dissolved in water and blinder, or vegetable gum, to adhere to the

⁶ K.R. Lepsius, *Die Langenmasse der Alten*, W. Hertz, Berlín, 1884.

⁷ E. Iversen, *Canon and proportions in Egyptian Art*, 1^a ed., Londres, 1955.

base. The arabic gum presented a problem, which was the loss of viscosity at high temperatures ($> 30^{\circ}\text{C}$). The components of the paint were 3; pigment, binder and diluent.

- Pigment: Varied according to color, the majority of mineral origin.
- Binder: Vegetable (acacia nilotica), arabic gum or animal (cartilage, collagen by hydrolysis) animal glue.
- Diluent: Water.

* **Finishing.** The varnish, consisting of resins initially, and egg white in later times, was applied. Vegetable varnishes could be imported conifers, cedar or mastic, and animal varnishes made with the eggs of different birds, mainly geese.

In the following images we can see the painting process, both of images and hieroglyphics, with the initial strokes of the ocher and black sketch.



KV 17 Seti I Tomb, King's Valley (1289 B.C.). Different phases of walls decorations⁸.

⁸ KV17, Seti I Tomb. Founder of 19th Dynasty, and the Ramesida royal house (1305 - 1289 B.C.)



KV-14 Tauseret Tomb, Queen's Valley (1190 B.C.). Figure sketches⁹.

The color

* **Simbology.** Colors were not used arbitrarily. The tonality of each stone, amulet or hieroglyph gave it its magical properties, so the tones used had to be appropriate to ensure the effectiveness of the magic.

They use flat color, without gradation.

- Female skin (pink, light yellow)
- Male skin (red, brown)
- Backgrounds (white, yellow)

Shades.

- Yellow. Used for representations of sun and life.
- Red. It represents the red earth, the desert and the God Seth.
- White. Used as the basis for the scenes, it was also associated with cleanliness and pure.

- Black. It symbolizes the black and fertile earth, soaked by the floods of the river.

- Blue. It represents the Nile, and when is dark the sky, as an allusion to the navigable of the other world. Used on grapes, it invoked wine and fertility.

- Green. Associated with the idea of vegetation, fertility, the resurrection and the Osirian cult.

* **Pigments.** The colors were natural, of mineral or vegetable origin, later ground and dissolved in the binders. The binders were vegetable gum, rabbit glue, and even egg white, and beeswax have been dated.

⁹ KV14, Tauseret Tomb, suffered successive modifications in its design. Tauseret was a queen-pharaoh with whom the 19th Dynasty ends, was co-regent of Siptah (1188 - 1186 B.C.)

Varnishes were used in the late New Kingdom, adding a layer of protection to colors.

The pictorial palette was mainly made up; white, black, red, yellow, blue, and green as primary colors, and a series of mixed colors such as gray, pink, orange, and brown as secondary colors.

Except for black, which was made from soot, almost all the pigments used were of mineral origin.

The main pigments were found in Egypt, but rarer ones were imported from the East.

Orpiment (As_2S_3), is an arsenic trisulfide, it is a monoclinic mineral composed of arsenic and sulfur, lemon yellow in color, which intensified the golden tone. (yellow arsenic sulfide). Its origin dates to the Red Sea, Turkey or Iran.

Realgar (As_4S_4) is a natural arsenic sulfide, although rare; forms well-molded grains and crystals, which are red to orange with a resinous luster.

Huntite ($\text{CaMg}_3(\text{CO}_3)_4$) white pigment, is a mineral of the carbonate class, an anhydrous calcium and magnesium carbonate, which was widely used, alternated with calcium carbonate and calcium sulfate to provide shine in the colors and make them lighter.

- Ocher, natural from the desert, yellow. Arsenic sulfide was used to give it a golden hue. Goethite is the mineral form of iron oxyhydroxide, whose formula is $\alpha\text{-Fe}^{3+}\text{O(OH)}$, it appeared in small grains that appeared to be gold dust.

- Reddish, red ocher from yellow ocher anhydrate that turns reddish when heated, or hematites (iron oxide).

- White, obtained by crushing the local stone, lime (calcium carbonate) or gypsum (calcium sulfate). Occasionally contribution of huntite.

- Black, smoke, soot or burning materials. Pyrolusite powder, (manganese dioxide) was used sporadically

- Blue, popularized as "Egyptian blue", from a vitreous substance such as a frit composed of silica, copper, and calcite or gypsum and an alkali such as natron. Malachite filings could also be added with the copper. Less frequently it was made with azurite, from Sinai.

- Green, cobalt-based (malachite, copper carbonate dihydroxide, and azurite). It could also be a frit combining carbon, and calcium carbonate or calcium sulfate.

To color pigments, in later period paintings, even white inert pigments were added to give them more shine, or increase their volume.

The associations between painting and magical medicine have been reflected in numerous documents, such as ostracas or papyri. Certain pigments or compounds were used for medical purposes.

The yellow and red ocher were used in recipes for eye ailments, yellow for throat pain and orpiment for cough. Red ocher for diseases of the feet, hands and

ears. The white for snake bites and insect pests. For the eyes, blue (lapis lazuli), green (malachite) and black were used.

3. Restoration and Conservation

In wall painting interventions, it is essential to know the behavior of the materials to the treatments to be applied. Determining the reversibility of the applications is important, and for this it must start from the identification of the materials on which we are going to act, from a successful analytical. A thorough knowledge of the materials, the execution techniques and their reactions to external agents is required.

The poor quality of the limestone in the area made it difficult to build and decorate the tombs, making direct carving or painting on the rock impossible. To do this, it was necessary to apply plasters to serve as a base for the paintings, in one or more layers prior to decoration.

In the case of the Theban Tombs, it must be considered that the geological formation of the area has produced a limestone with a high content of salts. The presence of water or humidity in the material causes their precipitation, affecting first the structural capacity of the stone, and then the coating and decoration materials that exist on it.

The main cause of the deterioration of wall paintings is the crystallization of salts, both in the base rock, as in the plaster and paint. Although the pigments are chemically stable to external actions, it must be considered that the binding of the mixture is water, so it could be affected by being soluble. The migration of salts and their crystallization on the walls form small rinds, which fragment the materials, until they are detached.

It should also be taken into account that the walls are affected when exposed to excess light by the actions of ultraviolet rays.

The main states analyzed and most frequent in the injuries of the area, respond to a deterioration process, and are the following;

- * Cracks or fissures in the rock, and extrusion of part of it.
- * Stratification of the plaster applied as a base coat for paints.
- * Separation of the plaster from the rock, as the adhesion layer disappears.
- * Chipping and disintegration of the plaster layer, with loss of material on the surface.
- * Spraying pigments on the paint layer.
- * Flacking and shedding.
- *
- * Mechanical damage and discoloration.

The intervention process on the damaged parts is based on the cleaning and consolidation of the plaster layers, with injection of grout or mortars, filling and restitution of the detached parts, repositioning of the pictorial part and consolidation chromatic pigment

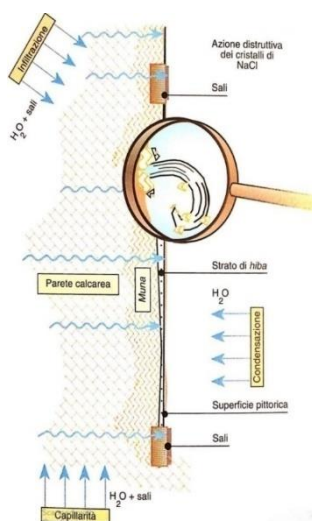
Pathological states and degradation

* Degradation of paintings and decorations due to material, hydrography, and lack of heritage conservation.

* Dirt on the surface due to accumulation of dust, sediment, and insect nests.

* Stratigraphic analysis reveals that the Theban mountains belong to the Eocene, with sediments that are of marine origin. The presence of salts and their precipitation in the presence of humidity, alter the paintings and the walls decoration.

The salts can materialize among others, as macroscopic subflorescence, crystallization on the surface or efflorescence, and crystallization in the painted area.



Nefertari Tomb, Queens Valley (1255 B.C.). Salt formation process¹⁰.

Causes

* Due to humidity and presence of salts.

* By degradation of materials; varnishes and pigments used that alter the original color.

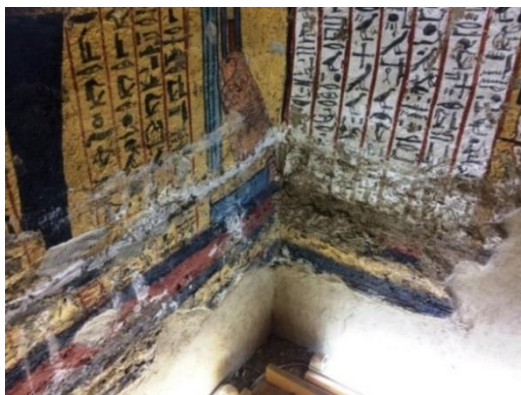
* Presence of smoke and fire inside the tombs, which dirty the walls.

Analysis

- * Structural. Cracks and fissures that affect the walls.
- * Geological, hydrological, climatological, and biological state.
- * Chemical, spectrographic and X-ray diffraction tests on plasters, pigments and salts.

¹⁰ Christian Leblanc, Alberto Siliotti, *Nefertari e la Valle delle Regine*, Giunti Gruppo Editoriale, Firenze, 2002.

- * Electron micrographs. Analysis of the plaster with a microscope; typologies, composition;
 - Crushed rock
 - Sand
- * Smoke-blackened surface.
- * Measurement and color calibrator.



TT 218 Amenemhat Tomb, Deir el Medina (1295 - 1186 B.C.)¹¹.

Actions

* Cleaning of the action area; dust on walls, ceilings and rooms. With brushes, and air guns, or low-pressure air guns.

* Preventive clamping of paintings so that there are no collapses during the works, nor loose fragments come off. For this we can use Japanese paper strips, slightly adhered to the wall, with acrylic resin (20% Paraloid B72 in trichloroethane). In areas with fragments detachment, they can be fixed with a specific application of acrylic resin emulsion (Primal AC-33), with protective silicone sheets.

* Structural consolidation and fixation of the rock.

* Specific actions on walls and injection of consolidants. Location of visible and non-visible detachment areas, due to hollow sound. Use of acrylic emulsions based on resins (Primal SF-016), being able to be used dissolved in Water + Polyvinyl Acetate PVA.

First inject water and alcohol so that the consolidant penetrates better. Sealing cracks with sand mortar and lime paste (50%). Pigment can be added to the mortar to give visual continuity to the surface on which it is applied.

- * Preparation and protection of walls and ceilings.
- * Elimination of salts.

¹¹ TT-218. Amenemhat Tomb, artisan from Deir el Medina, XIX Dynasty, Ramses II period (1295 - 1186 B.C.).

- Soluble, with a pure water-based wash.
- Not soluble, by meticulous mechanical operation.
- * Collection of detached fragments, and subsequent union.
- * Injections of synthetic resins, after a preventive injection of water and alcohol, and replacement of the detached parts (calcium caseate with 10% polyvinyl acetate).
- * In areas where the pigment has disintegrated, the paint may be powdered (become powdery). The binder lost in pigments is consolidated with Toluene, where it dissolves 10% acrylic resin (such as Paraloid B-72, 100% based on Ethyl-methacrylate),

Cleaning of walls

- * Eliminate previous actions.
- * Fresh powder, with a soft brush, and mud with alcohol and water, and if necessary, a scalpel.
- * Fat materials, animal glues or organic deposits.
 - Brush with acetone, water (50%) and thinner.
 - NH_3 diluted 10-20%
- * Waxes, resins and molds.
 - Papeta;
 - Water (H_2O)
 - Ammonium Bicarbonate (NH_4HCO_3)
 - Sodium Bicarbonate (NaHCO_3)
 - Desogen (Ciba-Geigy)
 - Carboxymethylcellulose ($\text{RnOCH}_2\text{-COOH}$)

It is applied with a brush on the surface, and removed with a sponge soaked in distilled and ionized water. The compress is kept from 1h to 1 day.



TT 192 Kheruef Tomb, El-Assasif (1388 - 1350 B.C). Cleaning and restoration work¹².

¹² TT-192, Kheruef Tomb, El-Assasif. Steward of the Great Royal Wife Tiye, during the reign of Amenhotep III. 18th Dynasty (1388 - 1350 B.C.).

*Soot. Physico-chemical method through aqueous solution with modified pH.

– Ethanol, (solvent with pH 7), 80% and deionized water 20%.

Low water content packages with ethanol and with Japanese paper as support and filter are used.

The Japanese paper is applied on the surface with a buffering operation, using a sponge. Then a soft brush sweep to remove loose, loose dirt.



Hatshepsut Temple (chapel). Deir el Bahari (1490 - 1468 B.C). Ceiling details, before and after cleaning works¹³.

*Laser cleaning. It is a non-invasive technique that dissolves particles of soot and dirt from fragile surfaces. Previously a test is done to check the material, and detect color changes, lost material, surface changes.



Dendera Temple (ceiling). Cleaning and restoration work¹⁴.

¹³ Hatshepsut Temple (chapel). Deir el Bahari. 18th Dynasty (1490 - 1468 B.C.).

¹⁴ Dendera Temple. Dedicated to the goddess Hathor, the initial construction is from the 18th Dynasty (1500 B.C.), but the most recent construction is the Mammissi of Nectanebo I (381 - 364 B.C.).

4. Conclusions

Thanks to the dry climate of Egypt, most of the paintings have been preserved. It has been possible because the presence of humidity in the environment has been infrequent in recent centuries.

The durability of these constructions has been affected by the salt content of the rock that serves as support. The presence of humidity causes its precipitation and the appearance of crystals that fragment the rock and its pictorial coating.

In many of the cases under study, of many of the Theban tombs, the pathologies come from ancient times. It was the application of plaster, with a certain moisture content on the walls of the tombs, to create a base on which to apply the paint. The presence of water on the bedrock, favored the precipitation of salts and their crystallization under the plaster layer.

If the heat and dryness of the environment managed to maintain them for a time, the torrential rains, the increase in the ground water level and other atmospheric agents, caused the evaporation of water from the subsoil, which increased the deterioration of the walls.

The diagnosis of the materials used, the characterization of chemical components and deteriorating agents is essential for a correct intervention and conservation work.

The restoration of the paintings requires a subsequent conservation program to guarantee their durability over time. Uncontrolled tourism, pollution from human action and humidity irreversibly accelerate the deterioration of heritage

The correct musealization of the tombs must control the level of humidity in the environment and ventilation to guarantee its maintenance. Control of temperature, relative humidity, and level of carbon dioxide are essential to maintain the heritage.

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