FINAL REPORT

“Conservation Training Field School, Draa Abu el Naga-TT 159”

Abdel Ghafour El Sayed Motawe Ali

Season 2015-2016

Cultural Heritage Tourism Project in Egypt (APS)
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American Research Center
In Egypt – Luxor
Conservation Field School
Season 2015-2016

Conservation Training Field School
Dra Abu El Naga TT 159

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HISTORICAL INTRODUCTION AND PROJECT BACKGROUND:

TT159 tomb is attributed to Rāya, the fourth prophet of Amun and his wife, Mutemwia. Nineteen Dyn: (XIX)

The tomb is T-shaped and consists of a forecourt leading to the main entrance, which then leads to the transverse hall. This hall contains a shaft in the western side and at the center of the hall, another entrance can be found alongside the former entrance. This entrance leads to the longitudinal hall containing a “shrine”. This shrine consists of two statues of the tomb owner and his wife in a seated position. Previously surveyed by Kampp, the tomb was resurveyed by the ARCE crew to obtain the dimensions. For more information, consult these references (Porter & Moss, 1960: El Shahawy, A., 2005).

SEASONAL SCOPE OF WORK (2015-2016) AND PROJECT GOALS:

The Dra Abu el-Naga TT159 Project aims to rehabilitate the tomb and protect it. The project has two goals; first, to carry out conservation of the tomb as a practical goal. Second, to teach trainees as an educational goal. The project carries out documentation, evaluation of the current condition, and selection of the suitable treatment methods for application. Educating the trainees involved provides them with much knowledge and experience in the conservation of antiquities, which makes them equipped to carry out the preservation of our cultural heritage.

CONDITION ASSESSMENT OR SURVEY:

- CLASSIFICATION OF THE DETERIORATION ASPECTS OF THE TOMB

---

The tomb suffered from several decay phases for many reasons. These reasons vary from defects in materials selection to decay due to the surrounding environment. There is also a human element that must be considered. People show a lack of awareness to the importance and value of archaeological tombs during previous periods in history. Deterioration aspects can be classified as follows:

**Decay Walls**

1. **Superficial Decay**
   
   - **Intentional mechanical damage:**
     
     Many of the tomb scenes suffered from cutting for the purpose of theft. Some scenes have also been scratched as an act of vandalism.

   ![Intentional mechanical damage](image1)

   ![Intentional mechanical damage](image2)

   - **Soiling**
     
     **Soot**
     
     The soot is visible in some places, which may have been caused by the use of the tombs by the people of Dra Abu el Naga during some period of time. The use of fire and cooking would have caused soot and damage.

   ![Soot accumulated on the surface](image3)
• Surface Deposits

Wasp nests

Wasp nests can cause severe damage as their saliva is mixed with mud. This poses a severe material cohesion and solid attachment to the walls and ceilings of the tomb walls and ceilings that obstructs the scenery and distorts its form. The collection of mud in order to build the nest causes damage to the plaster and paint layers.

Acid rain drops mixed with dust.

A water and sand mix appears to be as a result of precipitation during previous flooding event. This led to a distortion of the surface of the paint layers and made them susceptible to microbiological growth.

Bird deposits

Bird and bat droppings appear on the surfaces due to the species living inside the tomb within the gaps and large cracks. These spots were very detrimental to the surface and result in a bad visual effect.
• **Microbiological spots**

This pattern appears due to the acid rain drops and bird/bat droppings deposits.

![Hall, South W. -microbiological spots](image1) ![Shrine Ceiling - Insecticide Damage form](image2)

**Insecticide Damage**

The presence of insect holes is usually as a result of the presence of the straw ingredient with the installation of the mud layer. As the insects feed, they burrow throughout the layer, forming holes and gaps that leads to further damage.

• **Previous Intervention**

Some signs indicate there was a limited form of intervention during a period of time to preserve the tomb. Work was done to repair the cracked ceiling of the transverse hall on the inner left side, possibly dating to the end of the last century. Lime mortar was also found to be applied to a small section of painted scenery on the southern wall that could also date back to that same time period.

![Hall, ceiling - previous intervention](image3) ![Hall, South W - previous intervention](image4)

**2- A - Paint layer decay**

- **Loss of paint area**

There was areas where loss of the paint, pictorial and preparatory layer was evident.
- **Scaling**

This pattern displays a loss of color over areas that were painted over the white wash layer.

![Hall, Ceiling - loss of paint area](image1)

![Hall, south - scaling of color](image2)

**Flaking**

Flaking is loss of the adhesive between two layers. Flaking occurs mainly on the color layer. This phenomenon can appear as voids between paint and plaster layer with some cracking evident.

- **Spots**

This is a change of surface color due to water drops or other material effects.

![Hall, South - flaking of color](image3)

![Shrine, ceiling - superficial spots](image4)

2-B- **Preparatory layer decay**

- **Cracks**

This pattern appears as separation in the layers as lines. It is deep and fine.

- **Loss area**

This aspect means loss of the preparatory and pictorial layer without loss of support.
- **Loss of thickness**

  This aspect means there is a loss of some parts of the preparatory and pictorial layer, but not a complete loss of the support layer.

- **Pictorial and preparatory layer detachment**

  Any separation between the paint layer and pictorial layer, or between the preparatory layer and support layer.
3- Support decay

- Discoloration of support

This is a result of any accumulation of any material, such as soot or dirt that causes a change to the base color of support.

![Hall, West - discoloration of support](image)

- Fault at support

This is generally caused by geological factors in the shifting of the bed rock, causing the wall painting to separate.

![Hall, Ceiling, fault at support](image)

• STRATIGRAPHIC STUDY FOR ORIGINAL TECHNIQUE

The tomb is carved in limestone base rock. The craftsmen then began to even its surface with a layer of mud mortar. In some cases, aggregate of limestone and sandstone were used to thicken the surface. The craftsmen used mud mixed with straw then placed a layer of lime or gypsum mortar on top until the surface was ready for painting. An application of lime wash was immediately used prior to color.
The thickness of preparatory layers differs depending on how coarse the surface of support is. However, the thickness of mud generally is about 1-15cm. This contributed to the separation and decay of many of the mud sheets. Regarding the paint layer, the artist used red, yellow, black, white, blue, and green colors. An outline of the inscriptions and figures was made using the red color, then filled in the spaces using selected colors.

**DOCUMENTATION**

The documentation stages have included:
- Photographing all the sections of the tomb before treatment.
- Drawing the scene details using transparent sheets.
- Copying with mylar to create the layer maps.
- Writing the condition report and deterioration aspects on condition mapping.
- Writing the proposal and treatment reports.

Trainees recording decay  

Trainees recording treatment activities
Archiving

- Photo before conservation
- Base drawing
- Identification, evaluation and ID code
- Superficial decay
- Mapping of superficial decay (layer1)
- Key of superficial decay
- Paint and Pigment Layer
- Mapping of Paint and Pigment Layer (layer2)
- Key of Paint and Pigment Layer
- Support decay
- Mapping of Support decay (Layer3)
- Key of Support decay
- Treatment proposal
- Treatment condition report
- Mapping of treatment report (layer4)
- Key of Treatment layer
- Photo after conservation

Base photo

Draa Abu el-Naga TT159_Hall_Ceiling-D1-Before Conservation

Base drawing
Identification Evaluation & ID

Superficial Decay

Superficial Decay mapping
### Condition Mapping Key

1. **Superficial Decay**
   - Intentional Mechanical Damage
   - Efflorescence
   - Salt Blossoming
   - Salt Crust
   - Sediment
   - Fungus and Mold
   - Biological Growth
   - Insect and Mite Damage
   - Previous Intervention Margin

### Paint & Pictorial Layer

![Paint & Pictorial Layer mapping](image)

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Paint & Pictorial Layer Mapping key

Support Decay

Support Decay Mapping
Support Decay Mapping Key

Treatment Proposal

Treatment Report
**TREATMENT TRIALS AND PRELIMINARY TESTING:**

We performed tests for choosing the most suitable material and methods for conservation applications. The tests included:

1- **Cleaning Tests**
   A- **Mechanical Cleaning Tests**

<table>
<thead>
<tr>
<th>Sa.No.</th>
<th>Tools</th>
<th>Location and Time</th>
<th>Applying System</th>
<th>Photo Before</th>
<th>Photo After</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Soot sponge</td>
<td>Hall-North wall-Plat.B2</td>
<td>First: soot sponge</td>
<td></td>
<td></td>
<td>Removed accumulated dirt from surface without decay</td>
</tr>
<tr>
<td></td>
<td>Yellow wishab</td>
<td>25-1-2016</td>
<td>Second: wishab</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Soot sponge</td>
<td>Hall-North wall-plat.B7</td>
<td>First: soot sponge</td>
<td></td>
<td></td>
<td>Removed accumulated dirt from surface without decay</td>
</tr>
<tr>
<td></td>
<td>Yellow wishab</td>
<td>25-1-2016</td>
<td>Second: wishab</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Soft Erasers</td>
<td>For 10 Minute</td>
<td>Three: Soft Erasers</td>
<td></td>
<td></td>
<td>This result was chosen for cleaning most of the dirty painted areas.</td>
</tr>
</tbody>
</table>
## B- Chemical Cleaning Tests

<table>
<thead>
<tr>
<th>S.No</th>
<th>Component</th>
<th>Location and Time</th>
<th>Applying System</th>
<th>Photo Before</th>
<th>Photo After</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Distilled Water, Cotton swabs</td>
<td>Hall-North wall- Plat. B1 Di.1.5x2 Cm 20-10-2015</td>
<td>Cotton Swabs</td>
<td></td>
<td>Safe test for removing soot But some soot remained on the details</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Carbopol 934 2G, 100 ml D. water Tissue paper</td>
<td>Hall-West wall- Plat.B2 5-1-2016 For 30 Minute</td>
<td>Gel Poultice, tissue paper, Brush, and cotton swabs</td>
<td></td>
<td>Cleaning took a long time due to increasing the poultice setting time. - Dust remained on the surface - Continue to find a solution</td>
<td></td>
</tr>
</tbody>
</table>

## 2- Re-adhesion

<table>
<thead>
<tr>
<th>Sa.No.</th>
<th>Material type</th>
<th>Location and Time</th>
<th>Applying System</th>
<th>Photo Before</th>
<th>Photo After</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Klucel G 3g, D. Water 50 ml Ethyl Alcohol 50 ml</td>
<td>Hall_ South Wall_ C3 12-11-2015</td>
<td>Small syringe with silicon sheet</td>
<td></td>
<td>• Secured the edges well • Wetting the flaked edges resulted in good re-adhesion • Penetration was slow</td>
<td></td>
</tr>
</tbody>
</table>
3- Consolidation tests

- Mud sheet layer consolidation

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Material type</th>
<th>Location and Time</th>
<th>Applying System</th>
<th>Photo Before</th>
<th>Photo After</th>
<th>Comment</th>
</tr>
</thead>
</table>
| 3      | ESTEL 1000    | Hall-North wall- Plat.B7 25-11-2015 | Fine brushes, Semi Saturation | ![Photo Before](image1) | ![Photo After](image2) | • Color: Very good
• Did not darkening
• Penetration: Full |

- Pictorial layer consolidation

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Material type</th>
<th>Location and Time</th>
<th>Applying System</th>
<th>Photo Before</th>
<th>Photo After</th>
<th>Comment</th>
</tr>
</thead>
</table>
| 1      | Lime water    | Shrine _north wall under the remains statues 4-12-2015 | Removing the dust and using small brushes for applying the solution | ![Photo Before](image3) | ![Photo After](image4) | • Color: Very good appearance
• Contact separated grains: good |
## 4- Joint mortar tests

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Components</th>
<th>Applying System</th>
<th>Result</th>
<th>Comment</th>
</tr>
</thead>
</table>
| 1      | 50 ml yellow Sand rough "2  
50 ml Mud powder light "1  
50 ml Mud powder orang "5  
50 ml Lime water       | Applying with spatula  
Finishing with wishab backside  | ![Result Image] | Color: medium  
Cracks: No  
Visual strength: Very good |
PRACTICAL /INTERVENTION CONSERVATION TREATMENTS ON WALLS:

• Pre-consolidation for unstable parts

After completing the documentation process, we started the pre-consolidation for the unstable parts of the edges of mud plaster, which needed intervention. The work included:

- Cleaning the selected area with air pumps and soft brushes before placing strips.
- Selecting the parts which needed intervention and fixed them with strips.
- Using strips from tissue paper, 3 sheets with a width of 2cm and a length related to the case. However, we used Klucel G 3% on the strips with small brushes for fixing the edges of the mud plaster with the surface of support stone.

First aid strips to contact the edges of mud sheet with stone support

• Mechanical cleaning activities

Mechanical cleaning stages for support and paint areas have been included:

1. Using soft brushes and rubber blower for removing superficial dust from paint layer.

2. Using scalpels and fine spatulas for removing wasp nests.

3. Using hard brushes and fiber road for removing accumulated soot on stone surfaces.

4. Cleaning paint areas with soot sponges, wishab and erasers for removing soot and thin deposits on the paint layer.
Hall N. W. and ceiling - stages of mechanical cleaning by rubber blower, fine brushes, and scalpels

Shrine, W.W
Before soot removal from the bed rock

Shrine, W.W - during soot removal from the bed rock by fiber road

Shrine, W.W - after soot removal from the bed rock

Hall, N.W. - Cleaning painted areas by mechanicals methods
• **Consolidation Activities**
  1. **Consolidation of the micro fragment parts from bed rock**

    Connecting the small separated parts of stone using Acrill C33 (5-10%) related to size of separated pieces. The applied system uses injection utilizing small syringes.

    Hall, N.W. - Injecting the fragmentation of support with Acrill C33 (5-10%)

2. **Consolidation of Mud sheet layer**

    ESTEL 1000 was used for consolidation of the mud sheet edges which showed powdering. Moreover, this was related to the results of tests which had been tried before. However, the ESTEL 1000 gave the best suitable result. The solution was applied using brushes.

    Hall, N. W. - Mechanical cleaning results before and after cleaning
3. Consolidation of pictorial layer

The consolidation process was conducted in two stages:

1- Cleaning the surface with an air pump with care, because the plaster was very weak.
2- Applying lime water solution by spray
3- Applying wood support to protect the consolidated plaster

Shrine - under statues - mechanical cleaning for the decayed plaster and consolidation by lime

Shrine - under statues - before and after consolidation by lime water

4. Consolidation and isolation of pictorial edges

Consolidating fine pictorial edges were carried out with Paraloid B44 3.5% in Xylene + Acetone 1:1. This process was applied with very fine brushes. Care was taken during the application of this process so as not to damage remnants of the paint layer.
Fixing stone fragments and separated plaster pieces

We removed some voided pieces of stone and mud parts. After removing the pieces, we cleaned them and removed the remaining dust and straw from the wall. The adhesion process was completed using Acrill C33. Application of the re-adhesion material was carried out with a small syringe. The separated pieces were pressed on by hand for re-adhesion. After finishing, the voids and cracks were filled using a suitable joint mortar.

Hall, S.W. - Consolidation of fine pictorial edges by Paraloid B44 percent 3.5%

Hall, N.W. - Stages of Re-adhesion on some separated stone blocks

Hall, N.W. - Before and after fixing separated stone and mud blocks
Supporting the statue fragments

A plastic grid was used to isolate the sheet between fragments and new mortar. The grid was used on a portion of the area that was isolated before the application of the mortar. We used mortar consisting of: 1 sand + 1 lime + 1 sandstone powder + 1 lime stone powder.

- **Mortars application**
  1. **Mud mortar**

Through the obtained result from the joint mortar tests, the best mixture consisted of:

- 50 ml Sand rough yellow "2
- 50 ml Mud powder light "1
- 50 ml Mud powder orange "5
- 50 ml Lime

This mortar mixture creates a suitable harmony with the current original materials, as well as providing strength, durability, and a lack of shrinkage after the drying. We used the selected mortar for closing cracks and gap filling prior to the grouting process.
Closing cracks and joints

The mortars was applied using fine spatulas with the surface roughened to increase porosity. The following figures show the appearance and homogeny of the selected mixes of mortar in different portions of the mud sheet from the tomb and its location, in addition to commentary regarding the results.

Filling gaps

After finishing the grouting process and recording the grouting points, we filled gaps and holes with mud mortar. We isolated the pictorial edges with Paraloid B44 3.5% solute in acetone and xylene before applying the mortar in order to avoid yellowish spots. We used stone fragments during the filling of gaps to avoid cracks. The mortar was applied and finished with fine spatulas.

Treatment mud sheet edges with liquid mortar

We used liquid mud mortar to connect separated pieces from the edges of mud sheet. The application system was applied with brushes and the pieces were compressed to affix them. The components of mortar were as follows:

- 50 ml mud (3 light mud+ 2 dark mud)
- 10 ml P.L.M.
- 5 ml Acrill C33
- 20 ml Distilled water
Mortar for protecting pictorial edges

We used mortar consisting of:

60 ml washed fine sand
32.5 ml slaked lime
1.5 gm red brick powder
0.5 gm black pigment
2.5 gm gypsum

The mortar was applied with a fine spatula to protect decaying parts from the edges of pictorial layer.
• **Grouting detachment between the mud sheet and support**

This process is an important phase for connecting the separated areas together to form an internal network utilizing grout material. The grouting material is P.L.M. and distilled water and are not intended to fill the gap. The injection process was distributed as follows:

- Identify tube holes, so that the grouting material can cover the largest possible area.
- Ensure any holes or cracks are filled which may cause leakage from the next point of grouting.
- The holes are then arranged by size according to the required depth, then all holes are arranged into a fixed sequence of filling in the tomb.
- Before application, each grout receives 1 syringe of alcohol substance in order to clean the dust and prepare the hole for the injection of the grouting material.
- During the process of applying the liquid mortar, the team carefully monitors adjacent gaps to avoid any damage that may occur.
- The grouting process starts from lower level to higher level.
- Application of 1 syringed area each day and record the amount that was applied on a table sheet.
- After completion of the grouting process, we removed the plastic tubes from the holes. We then closed the hole space with a suitable mortar.

<table>
<thead>
<tr>
<th>Location</th>
<th>Point No.</th>
<th>Material</th>
<th>Date</th>
<th>Quantity ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dra Abu el-Naga TT159_ transverse hall (total quantity of grouting materials)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East side of North wall</td>
<td>1-47</td>
<td>P.L.M. + D water</td>
<td>10 Jan. to 14 Feb. 2016</td>
<td>14210</td>
</tr>
<tr>
<td>West side of South wall</td>
<td>136-222</td>
<td>P.L.M. + D water Lime stone powder with some point</td>
<td>17 Jan. to 16 March 2016</td>
<td>18370</td>
</tr>
<tr>
<td>West Wall</td>
<td>223-272</td>
<td>P.L.M. + D water Lime stone powder with some point</td>
<td>6 March to 21 March 2016</td>
<td>5180</td>
</tr>
<tr>
<td>West side of North wall</td>
<td>273-315</td>
<td>P.L.M. + D water Lime stone powder with some point</td>
<td>22 March to 28 March 2016</td>
<td>7180</td>
</tr>
<tr>
<td>Location</td>
<td>Point No.</td>
<td>Material</td>
<td>Date</td>
<td>Quantity ml</td>
</tr>
<tr>
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</tr>
<tr>
<td>Dra Abu el-Naga TT159_ Main Entrance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Point No.</td>
<td>Material</td>
<td>Date</td>
<td>Quantity ml</td>
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<tr>
<td>Dra Abu el-Naga TT159_ Shrine</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Shrine east wall</td>
<td>316-320</td>
<td>P.L.M. + D water</td>
<td>6 Mar. to 10 Mar. 2016</td>
<td>200</td>
</tr>
<tr>
<td>Shrine west wall</td>
<td>320-325</td>
<td>P.L.M. + D water</td>
<td>6 Mar. to 10 Mar. 2016</td>
<td>150</td>
</tr>
</tbody>
</table>
South wall total and signature the grouting point's numbers as a sample
• Replace the previous mortar intervention by repair mortar

Some areas previously filled with mortar, were in need of repair and did not match the current conservation work. We removed this mortar carefully using a spatula. Upon completion, we grouted the void using P.L.M. + Acrill C33 + distilled water for attaching the parts on the support layer. Finally, the voids were filled with the selected joint mortar number 9 shown above.

After this application, we carried out re-adhesion of the paint layer flaking with Klucel G 1.5 -3% utilizing a small syringe.

• Fault treatments

Phase1. Filling the faults by polyurethane foam

This procedure includes closing the deep cracks before applying the mortar finish. One advantage of this process is that the material is very light. Polyurethane foam is for filling gaps below the exposed face of the wall. The foam provides a stopping point within the deep gaps to allow a secure tight fill finish.

Phase2. Applied final rough surface

The fault walls are the same geological material as the carved lime stone wall. Occasional installation of small limestone blocks with lime mortar forms a homogeneous configuration with the surrounding color of the natural stone.

After applying the polyurethane foam and preparing the fault for application of the final filling with mortar, we started final filling in the faults on the south wall. We also used fragments of
limestone as needed that had the same characteristics as the original rough surface. The lime mortar consisted of:

- 50 ml lime stone powder
- 50 ml sand stone powder
- 50 ml rough sand
- 50 ml slaked lime

After fixing the fragments with mortar, we started grouting with the same mortar but in liquid form. This is so the mortar will be in contact with the original surface and the back side of the fragments.

Hall, S. W. - fixing the fragments of stone at the faults with lime mortar
Hall, S. W. - Grouting with liquid mortar after fixing the fragments of stone

Hall, S. W. - the fault before treatment
Hall, S. W. - After filling the fault with polyurethane foam
Hall, S. W. - After applying final form stone fragments
Re-adhesion of flaking in paint areas

This process is considered one of the most important procedures in the treatment of wall paintings. We worked on a very small scale using very fine tools because the consolidation material was applied in the small voids between the paint color and fine pictorial layer or between pictorial and preparatory layer. The consolidation material used was Klucel G 1.5-3% diluted by distilled water + Ethyl Alcohol 1:1. The application system requires very small syringes and silicon sheets. By alternating between consolidations and cleaning, we used white wishab and erasers for cleaning the surface mechanically.

![Hall, S. W. - injecting the flaking of color using a small syringe](image1)

![Hall, S. W. – Before (L) and after (R) re-adhesion of the flaking](image2)

- **Chemical cleaning activities**

  **Gel Poultries**

  Some painted areas suffered from an accumulation of bird deposits during previous periods. These deposits often caused decay of the paint. Furthermore, the mechanical cleaning was not successful with this type of deposit, so we decided to use a few chemical materials related to previous tests. We used a poultice of Carbopol 20 2g + 100 ml. D. water + 3g Arbocell, for 10 minutes at a time, after that we used cotton swabs with distilled water to remove the poultice remains and continued the cleaning process.
Distilled water

We used a continuous cleaning process using distilled water and cotton swabs to remove the hard deposits. This system was applied to the South West, West and North West side of the hall.

PRACTICAL /INTERVENTION CONSERVATION TREATMENTS ON CEILING:

- Removing the previous intervention mortar

We discovered lime mortar had been previously applied on the ceiling. This mortar was probably applied for adhesion of a mud sheet detachment. We removed the old mortar and installed a grouting point and applied mud mortar.
• Grouting activities

1- Grouting detachment

The grouting process carried out on the ceiling of the transverse hall and shrine was done using the same technique used on the walls. The ceiling grouting points from the transverse hall are arranged as follows in the next table. The points of the shrine ceiling were started at numbers 48 to 60. The same grouting material of P.L.M. + distilled water was used. Note: in all of the grouting mixes, we added insecticide (TOPSEN) to prevent further insect damage. In some areas we also applied the re-adhesion technique after grouting.
2- **Grouting and re-adhesion of the separated parts**

This process was applied to the fault on the ceiling. We used P.L.M. and Acrill C33 to connect the separated mud sheet. This phenomena probably occurred due to faults from the support layer. We started grouting the gaps, then we used wooden support, silicon sheet, foam sheet, plastic cylinder support, and metal pressuring. This process took one to three days. We grouted the void with P.L.M. + D. water for fixing this part of the support.
1. Consolidate the decayed plaster using lime water before Re-adhesion process, to connect the grains.

2. Fill large gaps in order to avoid any leakage of mortar injection liquid during injection.

3. Grout the detachment using liquid suitable mortar and fast re-adhesion. The mortar contained the following components:
   - 30 ml P.L.M.
   - 10 ml mud
   - Distilled water as case

4. Fill the edges and joint with suitable mortar after finishing the grouting process. Mortar edges consist of:
   - 1 P.L.M. + 1 mud + Distilled water

Shrine, ceiling - the stages of re-adhesion of plaster detachment

Shrine, ceiling - the difference in appearance before and after re-adhesion
Fault treatment

Phase 1. Grouting with polyurethane foam

This fault was considered the deepest fault crack in the tomb. It measured greater than 50cm in depth. We filled most of the fault utilizing polyurethane foam, so as not to cause stress or load on the bed rock. Upon completing this, we applied the final form of stone fragments and mortar.

Phase 2. Applying final rough surface

This process included applying fragments of stone which are harmonious with the materials of the bed rock. The fragments were attached with mortar consisting of:
100ml lime stone powder
100ml sand stone powder
100ml sand
100ml slaked lime

**Mortar Application**

1- Gap treatment using mud mortar

We filled gaps and holes with mud mortar. However, before filling gaps, isolation of the pictorial edges with Paraloid B44 3.5% solute in acetone and xylene had to be done before applying the mortar, so as to avoid the appearance of yellowish spots. We added insecticide to the mortar to prevent damage by insects. The mortar was applied and finished using fine spatulas. In some cases, we grouted the voids with P.L.M. and carried out re-adhesion.
2- Pictorial edges and cracks treatment

This phase was carried out after finishing the grouting process and applying mud mortar. It consisted of the same material as the pictorial mortar, but used rough sand instead of fine sand.
Re-adhesion

We fixed a separated part of the pictorial layer at the ceiling of hall on the west side which was in need for urgent repair. We used Klucel G 3%, by syringe. After application of the Klucel a silicon sheet and compression techniques were used to re-adhere the separated parts.

The Klucel G 1.5-3% was diluted with distilled water + Ethyl Alcohol 1:1. The application system consisted of very small syringes and a silicon sheet, also fine brushes were often used.
PRACTICAL /INTERVENTION CONSERVATION TREATMENTS ON FACADE:

- **Removing cement mortar intervention**

  We encountered stone jambs and header at the front door coated with cement mortar that consisted mainly of cement and sand. The mortar was used to cover the stone and joints. Cracking was observed on the surface due probably to expansion and contraction of the stone blocks. Also, the appearance of the surfaces did not blend in with the surrounding natural stone. We installed castings of the surrounding roughness of the natural stone to blend in better with the landscape.

- **Placing cast tiles on the facades**

  The main reasons for carrying out this process is to form an improved harmony with the form of surrounding area. This process can also covers imperfections within the fabricated stone structures. The stages of installing cast tiles on facades included:

    Drilling small holes on tile and stone wall, and installing carbon fiber for protection

    Fixing the edges and closing gaps with mortar consisting of 2 sand + 1 slaked lime + 1 white cement

    We prepared liquid mortar similar to the hard mortar and filled the distance between tiles and the wall. We also removed old mortar and applied mortar consisting of the same materials as the tiles casting for the closing of joints and voids between the tiles.
Liquid formation internal sides and finishing process

It was at this stage we used mortar casting slabs and silicon molds poured directly on the wall. In addition to finishing joints between the tiles and also covering the flat area beside the front-end to become one stone block. The following figures explain the phases of the direct pouring process.
Treatment of the fault with pieces of stone and mortar

This process included the application of fragments of stone to create harmony with the form of bed rock. The fragments have been attached with mortar consisting of:

- 100ml lime stone powder
- 100ml sand stone powder
- 100ml sand
- 100ml slaked lime

Water as the texture required
Maintenance on the metal door

We removed the old metal mesh and removed corroded layers. We then installed a metal sheet for covering the backside of the door. We then installed a mesh on the outside of the door. After completing the repair, we are used paint in the same color of the landscape.
POTENTIAL FUTURE WORK AND RECOMMENDATIONS:

Potential future work will include: Completing the ongoing rehabilitation of the forecourt and adding lighting, floor and handrails.
Conservation activities before and after treatment

Hall, W. W. - before treatment

Hall, W. W. - after treatment

Hall, N. W. - before treatment

Hall, W. W. - after treatment
Hall, E. W. - before treatment

Hall, E. W. - after treatment

Hall, S. W. - before treatment

Hall, S. W. - after treatment
Ceiling protection

After the interior of the tomb was conserved and restored, we began making the outside of the tomb and its surrounding area safe, accessible, and welcoming to tourists. This type of work is known as ‘site development’.

Filling the Fault above TT 159

We cut and removed debris that was over TT 159, especially over the transverse hall, in cooperation with the on-site archaeologists. We removed about 1 meter of debris from the top of TT 159, so that the bed rock of the mountain was exposed. After we removed the debris, we detected a large crack, which extended horizontally above the transverse hall of TT 159, and then vertically between TT 159 and TT 286. The fault was about three meters long, 15-30 cm wide, and 10-40 cm deep. Filling and closing this crack will prevent any liquids from leaking inside the tomb. The phases of the filling process were as follows:

- Removed the dust and cleaned the fault.
- Applied polyurethane foam into the fault in order to close it. We did not fill the entire fault with foam because we needed to leave some space for other materials.
- Spread fiber glass over the foam in order to isolate it.
- Applied plastic grids to ensure contact between the fiber glass sheet and the mortar. (Small stone fragments were mixed with the mortar.)
- Applied mortar and stone fragments above the plastic grids. During this process, the remaining space in the fault was completely filled. The mortar was made from:
  - 1000 ml sand
  - 1000 ml sandstone powder
  - 1000 ml mountain powder (Hiba)
  - 1000 ml lime
Location of fault between tombs TT 286 and TT 159

Cleaning the fault

After cleaning the fault

Cleaning the fault

After cleaning the fault
Filling fault with polyurethane foam

Applying fiber glass over the foam for isolation

Applying plastic grid to connect the fiber sheet with the mortar

After filling fault with polyurethane foam

Applying fiber glass over the foam for isolation

Applying plastic grid to connect the fiber sheet with the mortar
Applying mortar with stone fragments into the fault (horsetail side)

Applying mortar with stone fragments into the fault (horsetail side)

Applying mortar with stone fragments into the fault (vertical side)

Applying mortar with stone fragments into the fault (vertical side)

Fault after treatment on the horsetail side

Fault after treatment (vertical side)