

## State of Conservation

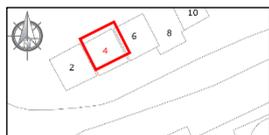
Tomb Nr. PN\_EN\_04

Date: October 2018

Persons in charge:

Marta Ehbreo. Clelia Sbrilli

Position:



South, west, north and east wall of the tomb PN\_EN\_04.

### Dangers and Risks for Visitors

The cornice of the tomb is one of the most fragile areas due to different kind of detached plaster layers, lying on top of each other. Plaster detachment from the masonry are also visible. Due to the high weight of the mortar layers, the cornice is in danger of falling down.

### Masonry - cornice

#### Static Problems

Possible subsidence of the ground

Large Cracks in Masonry (Reason?)

Deformation of Wall

Other

#### Damages

Unfunctional / defect Rain Tubes

Material loss

Loss structural Elements

Missing Mortar (Joints, Cornices)

Lacuna of Stone/Brick

Cracks

# POMPEII SUSTAINABLE PRESERVATION PROJECT

## State of Conservation

Tomb Nr. PN\_EN\_04

	<input checked="" type="checkbox"/>	Detachment (originals + overlapped layers of the cornice)	
		Erosion	
	<input checked="" type="checkbox"/>	Powdering/Sanding	<input checked="" type="checkbox"/> Mortar
			Stone/Brick
		Scaling	
	<input checked="" type="checkbox"/>	Deposit (Dust + soil)	
<b>Collapsing Areas</b>	<input checked="" type="checkbox"/>	Loose Stone/Brick	
	<input checked="" type="checkbox"/>	Other(overlapped layers)	
<b>Salts</b>			
<b>Biological Colonization</b>	<input checked="" type="checkbox"/>	Biodeteroration	
	<input checked="" type="checkbox"/>	Plants/Roots	
<b>Plaster/Stucco</b>			
<b>Structural Damages</b>	<input checked="" type="checkbox"/>	Lacuna	<input checked="" type="checkbox"/> Total Loss of Render / Masonry visible
			<input checked="" type="checkbox"/> Loss of Intonaco / Preparatory Layer visible
			<input checked="" type="checkbox"/> Partial Loss of Intonaco / Eroded Surface
	<input checked="" type="checkbox"/>	Cracks	<input checked="" type="checkbox"/> Surface Cracks
			<input checked="" type="checkbox"/> Deep Cracks
	<input checked="" type="checkbox"/>	Detachments	<input checked="" type="checkbox"/> Intonaco
			<input checked="" type="checkbox"/> Preparatory Layer
			<input checked="" type="checkbox"/> Intonaco & missing Preparatory Layer
			Detachment from Structure
	<input checked="" type="checkbox"/>	Flaking	<input checked="" type="checkbox"/> Intonaco
			<input checked="" type="checkbox"/> Preparatory Layer
	<input checked="" type="checkbox"/>	Powdering/Sanding	<input checked="" type="checkbox"/> Intonaco

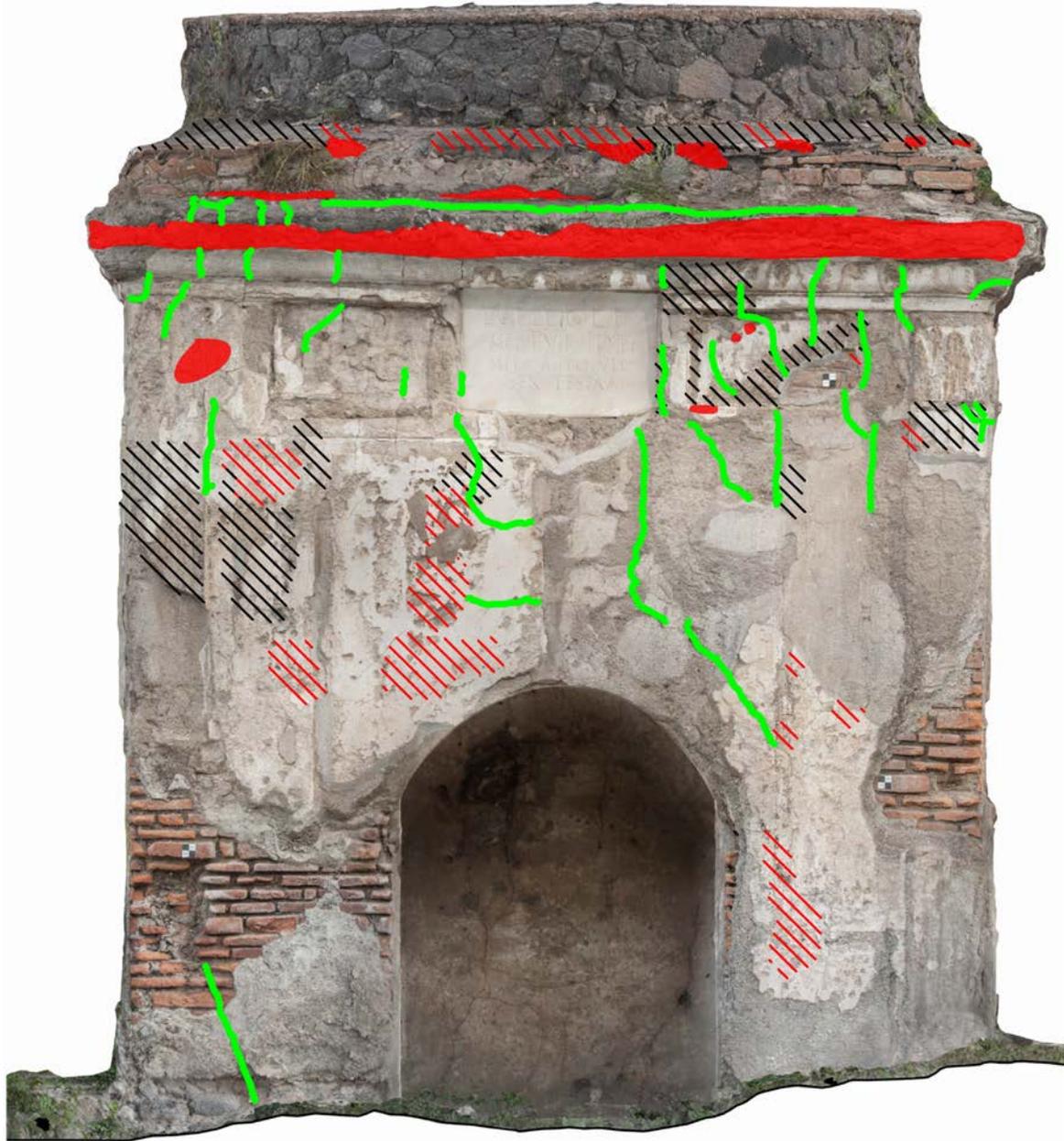
# POMPEII SUSTAINABLE PRESERVATION PROJECT

## State of Conservation

Tomb Nr. PN\_EN\_04

	X	Preparatory Layer
		Deformation
<b>Salts</b>	X	
<b>Biological Colonization</b>	X	Biodeterioration
	X	Plants/Roots

Persons in charge: Evgeniia Nasledova, Ivan Martinovic, Roberta Mirabella  
Digitalization: Lea Oetinger, Kire Stavrov  
Date: Sept. 2018

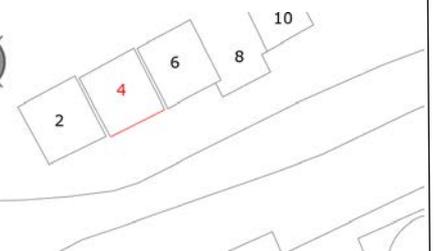


Emergency mapping:  
State of conservation

Tomb no. PN\_EN\_04 south

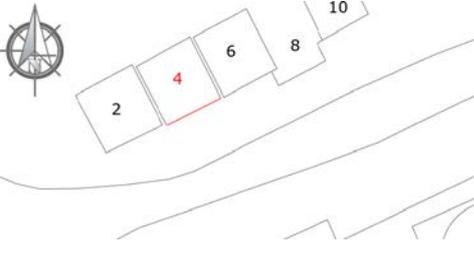
Titel: Priority damages

-  Collapsing elements (Structure)
-  Movable detachment
-  Non movable detachment
-  Cracks

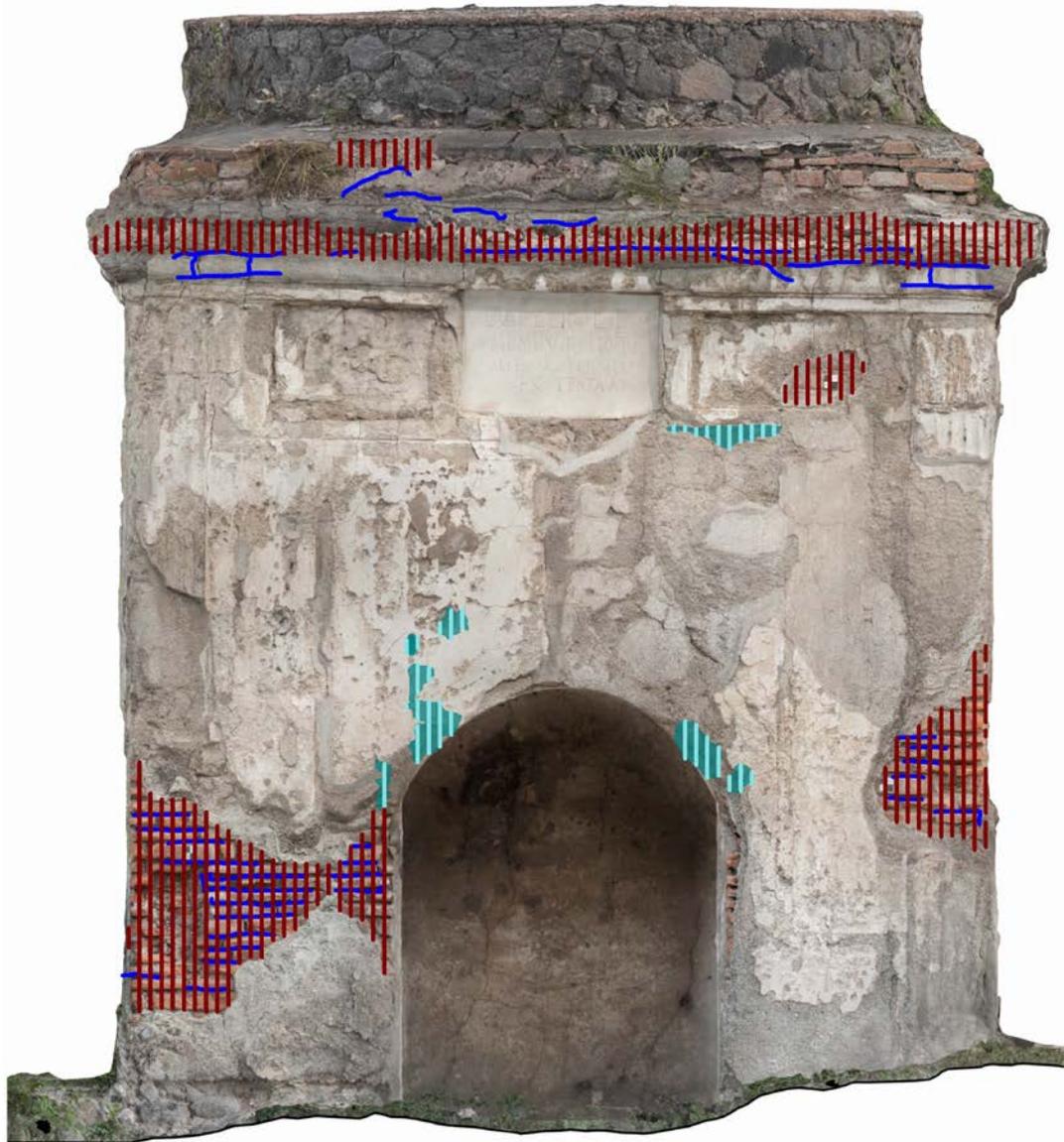


Persons in charge: Evgeniia Nasledova, Ivan Martinovic, Roberta Mirabella  
Digitalization: Lea Oetinger, Kire Stavrov  
Date: Sept. 2018



Emergency mapping: State of conservation	 Loss of cohesion	 
Tomb no. PN_EN_04 south	 Erosion	
Titel: Superficial layer damages	 Flaking	
	 Scaling	

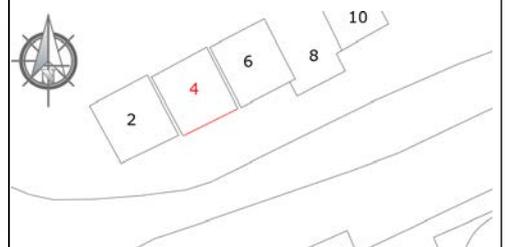
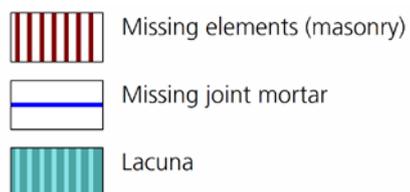
Persons in charge: Evgeniia Nasledova, Ivan Martinovic, Roberta Mirabella  
Digitalization: Lea Oetinger, Kire Stavrov  
Date: Sept. 2018



Emergency mapping:  
State of conservation

Tomb no. PN\_EN\_04 south

Titel: Missing elements



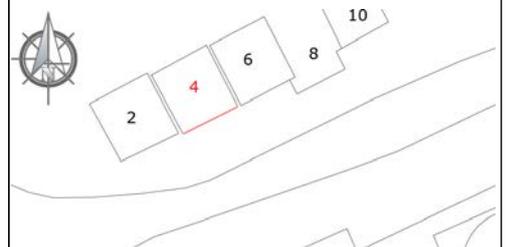
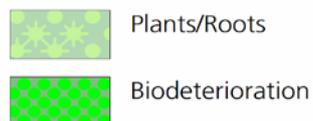
Persons in charge: Evgeniia Nasledova, Ivan Martinovic, Roberta Mirabella  
Digitalization: Lea Oetinger, Kire Stavrov  
Date: Sept. 2018



Emergency mapping:  
State of conservation

Tomb no. PN\_EN\_04 south

Titel: Biological colonization



**Conservation Treatment**

**Tomb Nr. PN\_EN\_04**  
P XXIV 245

<p><b>Treatment Number:</b> PN_EN_4 south (1/1)</p>	<p><b>Period of Treatment:</b> October 2018</p>	
<p><b>Persons in charge:</b> Marta Ebbreo, Clelia Sbrolli</p>		
<p>Type of Object: facade of the PN_EN_04 tomb - <i>Cornice + stucco</i> decorations of the right upper side – upper part of the lesene and its capital on the right side - superficial plaster layer of the lower left side</p>	<p>Position: South wall - right upper side</p>	
<p>Damage:</p> <ol style="list-style-type: none"> <li>1. Collapsing elements and missing parts of the cornice</li> <li>2. Biological growth</li> <li>3. Powdering</li> <li>4. Flaking, scaling, erosion</li> <li>5. Detached plaster and arriccio layers</li> <li>6. Lacunae (at all levels)</li> <li>7. Previous integrations and fillings (stable and collapsing)</li> </ol>	<p>Kind of Treatment:</p> <ol style="list-style-type: none"> <li>1. Removal of overlapping collapsing and detached concrete layers; substitution of the missing joint mortar; fixing of stones, fillings and grouting, reconstruction of the missing parts of the cornice (to avoid the water percolation)- insertion of fiberglasses to sustain the big reconstructions</li> <li>2. Consolidation of the powdering surfaces (if necessary) with Calosil E 25</li> <li>3. Filling and micro-filling of lacunae and missing layers</li> <li>4. Micro- filling are used also for fixing micro -flaking and scaling areas</li> <li>5. Injection with PLM_AL for very thin detachments</li> </ol>	
<p><b>Used Materials</b></p>		
<p><b>Picture:</b></p>  <p>Figure 1 PN_EN_04 south Working area</p>		<p>Used Materials</p>
	<p>Mortar for the cornice</p>	<p>Not sieved, grey river sand + HL Marienstein (3:1) Fiberglass</p>
	<p>Mortar for the arriccio layer of the cornice (mask)</p>	<p>3 grey river sand &lt;0,4 + HL Marienstein (3:1)</p>
	<p>Fillings of the arriccio layer of the capital</p>	<p>1 slaked lime - 0,25 hydraulic lime (Lafarge) 1 yellow river sand &lt;1 1,5 yellow river sand &lt;0,5 0,5 bardolino marble s11</p>
	<p>Fillings of the intonaco layer</p>	<p>1 yellow river sand &lt;0,5 1 yellow river sand &lt;1 1 grey river sand &lt; 0,1 0,75 slaked lime - 0,25 hydraulic lime (Lafarge) Intonaco 4</p>
<p>Micro-filling of the intonaco layer</p>	<p>1 lime (3/4 Slaked lime- 1/4 Marienstein) 2 yellow river sand &lt;0,5 1 yellow river sand &lt; 0,1</p>	

			Consolidation	Nano-lime Calosil E 25
			Injection	PLM-AL
<b>Sampling</b>	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	<b>Pre-Treatment Analysis</b>	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
<b>Sample-Number:</b>			<b>Analysis-Number:</b>	
<b>Photos:</b> PN_EN_04_CS_IMG_0003, PN_EN_04_CS_IMG_1858, PN_EN_04_CS_IMG_1847, PN_EN_04_S_DSCN1730, PN_EN_04_S_DSCN1917, PN_EN_04_S_DSCN1974, PN_EN_04_S_DSCN1973				

The main part of the work is limited to the right upper part of the tomb. The cornice of the tomb is one of the most fragile areas due to the partially loose mortar layers lying on top of each other (Figure 2). Due to the high weight of the mortar layers, the cornice is in danger of falling down. The stucco decoration underneath showed deterioration phenomena linked to the water flowing from the cornice and percolation. Consolidation, reattachments, fillings and micro-fillings were used to preserve the remaining of the original decorations. Lacune and cracks were filled to preserve the original decorations.

**Cornice**

The overlapped and detached cement layers of the cornice were removed piece by piece and cleared of soil and plants (Figure 3). New restoration mortar (1:3 Hydraulic lime and river sand) was used to fix the original stones. Fibreglasses were used to reconstruct big missing part, that were creating water flowing on the stucco decorations (Figure 4).

**Consolidation**

For consolidating the powdering/sanding surfaces has been used nano-lime. It has to be applied two or three time for a good effect (low cohesive powder) but the penetration is quite good. The impossibility of removal of the residue by sponge (because of the extreme powdering of the surfaces) leaves in some areas a white veil. It would be better to pre-consolidate these kind of powdering layers through Ethyl Silicate, waiting for an eventual desalination of the most superficial layers

**Fillings**

The microfilling helped us, in some cases, to solve the problem of micro-fragments heavily detached and fragmented (Figure 5 -10). Filling of lacunae to different layers (arriccio and intonaco) has been done both for conservative and for aesthetic reasons. From a conservative point of view, the filling of cracks, holes, lacunae in the different layers can avoid further deterioration. From an aesthetic point of view, the fillings enabled us to see and perceive the valuable stucco decorations. A test has been done also on the flat superficial plaster layer.



Figure 2 Different layers of detached mortar on the cornice (PN\_EN\_04\_CS\_IMG\_0003).



Figure 3 Removing of the detached mortar and reinforcement with fiber glas (PN\_EN\_04\_CS\_IMG\_1858). PN\_EN\_04\_CS\_DSCN1815).



Figure 4 Removed detached mortar layers and new filling (PN\_EN\_04\_CS\_IMG\_1847).



Figure 5 - 6 Fillings of lacunas and cracks (PN\_EN\_04\_S\_DSCN1917).



Figure 7 Micro fillings of lacunas and cracks (PN\_EN\_04\_S\_DSCN1974).



Figure 8 Micro fillings of lacunas (PN\_EN\_04\_S\_DSCN1973).



Figure 9  
The oblique lighting picture shows serious deterioration phenomena pitting, erosion, cracks and lacuna (PN\_EN\_04\_S\_DSCN1730).



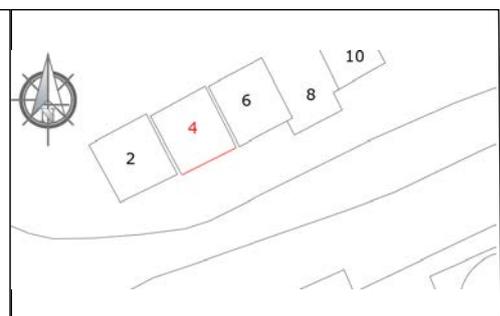
Figure 10 Lacune and cracks were filled to preserve the original decorations.

Persons in charge: Marta Ebbreo, Clelia Sbrolli, Kire Stavrov  
 Digitalization: Lea Oetinger, Kire Stavrov  
 Date: Oct. 2018



Mapping: Treatment  
 Tomb no. PN\_EN\_04 south

-  Fixation dowels/ Fibre glas
-  Consolidation CL: CaloSIL E 25
-  Fix loose elements
-  Filling/ Filling cracks
-  Edging repair



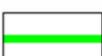
Person in charge: Roberta Mirabella, Clelia Sbrolli  
Digitalization: Lea Oetinger, Kire Stavrov  
Date: Sept. 2018

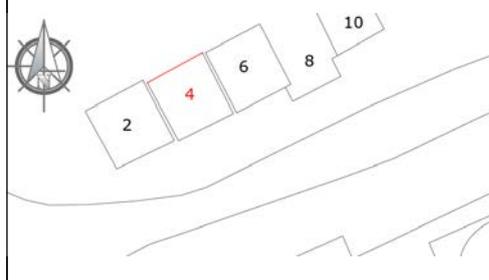


Emergency mapping:  
State of conservation

Tomb no. PN\_EN\_04 north

Titel: Priority damages

-  Collapsing elements (Structure)
-  Movable detachment
-  Non movable detachment
-  Cracks



Person in charge: Roberta Mirabella, Clelia Sbrolli  
Digitalization: Lea Oetinger, Kire Stavrov  
Date: Sept. 2018

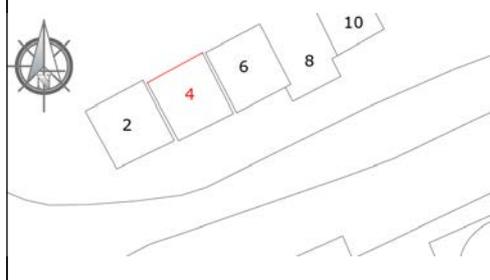


Emergency mapping:  
State of conservation

Tomb no. PN\_EN\_04 north

Titel: Superficial layer damages

-  Loss of cohesion
-  Flaking
-  Scaling



Person in charge: Roberta Mirabella, Clelia Sbrolli  
Digitalization: Lea Oetinger, Kire Stavrov  
Date: Sept. 2018

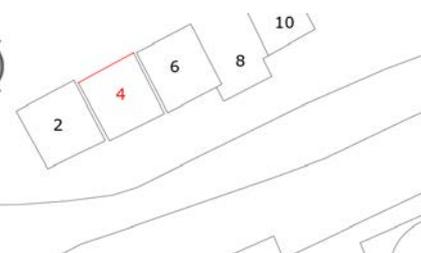


Emergency mapping:  
State of conservation

Tomb no. PN\_EN\_04 north

Titel: Missing elements

-  Missing part
-  Missing mortar
-  Lacuna (Arriccio layer)



Person in charge: Roberta Mirabella, Clelia Sbrolli  
Digitalization: Lea Oetinger, Kire Stavrov  
Date: Sept. 2018

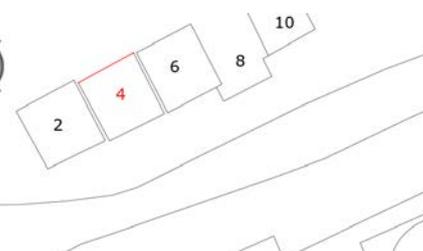


Emergency mapping:  
State of conservation

Tomb no. PN\_EN\_04 north

Titel: Biological colonization

-  Plants/Roots
-  Biodeterioration



**Conservation Treatment**

**Tomb Nr. EN\_04 North**  
P XXIV 24N

<b>Treatment Number:</b> PN_EN_04 north (1/2)	<b>Period of Treatment:</b> 15.10. - 19.10.2018
<b>Persons in charge:</b> Lea Puglisi, Lea Oetinger, Henrieke Drengemann, Giulia Russo, Clelia Sbrolli, Evgenia Nasledova	

<b>Type of Object:</b> Different layer of ancient plaster on volcanic stone masonry	<b>Position:</b> North Wall
<b>Damage:</b> <ol style="list-style-type: none"> <li>1. Detachment of the plaster layers from the masonry structure</li> <li>2. Detachment of Intonaco</li> <li>3. Detachment of several layers of Arriccio plaster</li> <li>4. Deep cracks in the Intonaco and Arriccio layer</li> <li>5. Lacuna in Intonaco and Arriccio</li> <li>6. Open edges on the borders of plaster pieces</li> </ol>	<b>Kind of Treatment:</b> <ol style="list-style-type: none"> <li>1. Facing to secure the detached plaster layers</li> <li>2. Grouting of detached plaster layers</li> <li>3. Filling deep and small cracks, lacunae</li> <li>4. Edging repairs of detached plaster pieces</li> <li>5. Consolidation of plaster</li> <li>6. Taking off the facings</li> </ol>

Used Materials			
	Used Materials	Quantity	
 <p>Figure 1 Orthophoto of the north wall.</p>	Facing	Tylose (1,5 % in 1:1 Iso-propanol and dest. Water) 2-5 ml	
	Cleaning	Dest. Water + Isopropanol-Solution (40:60) 1800 ml	
	Fillings	Mortar Dark Arriccio 10	6 Cups
		Mortar Light Arriccio 12	7 Cups
		Mortar Intonacco 4	9 Cups
		Mortar Intonacco 4 a	10 Cups
Injection	Foam Mortar CaLoSil® E 25	12 Liters	
Filling (dark coarse mortar)	RS yellow < 1 mm – 2 parts RS grey < 0,5 mm – 3 parts RS yellow < 0,5 mm – 1 part Basalt NS6 < 0,25 – 1 part RS grey ≈ 3 mm – 1 part RS grey < 2 mm – 1 part RS yellow < 2 mm – 1 part Basalt < 1 mm – 2 parts Pozzolana S2 - 0,5 part Slaked lime – 4 parts		
<b>Sampling</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	<b>Pre-Treatment Analysis</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		
<b>Sample-Number:</b>	<b>Analysis-Number:</b>		

Photos:

PN\_EN\_04\_N\_DSCN1605, PN\_EN\_04\_N\_DSCN1608, PN\_EN\_04\_N\_DSCN1794, PN\_EN\_04\_N\_IMG\_2362H, PN\_EN\_04\_N\_IMG\_0140, PN\_EN\_04\_N\_DSCN1792, PN\_EN\_04\_N\_IMG\_2346H, PN\_EN\_04\_N\_DSCN1603, PN\_EN\_04\_N\_DSCN1602, PN\_EN\_04\_N\_IMG\_2350H, PN\_EN\_04\_N\_IMG\_0002, PN\_EN\_04\_N\_DSCN1807, PN\_EN\_04\_N\_IMG\_2070, PN\_EN\_04\_N\_IMG\_4727, PN\_EN\_04\_N\_IMG\_4293, PN\_EN\_04\_N\_IMG\_4741

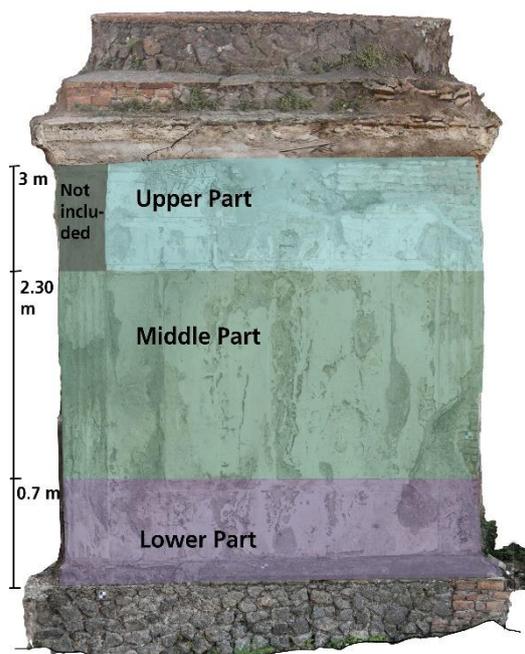
## Conservation Treatment

## Tomb Nr. EN\_04 North

The north wall of the EN\_04 showed several damage phenomena. The main part of the work concentrated on the upper part of the wall due to the big, collapsing fragments. In general, the first step was to secure these collapsing fragments and then concentrate on the rest of the wall. In addition, the middle as well as the lower part of the wall was treated with the aim to reduce the water entry into the structure and to reattach extremely fragile plaster layer. The individual layers of plaster had separated from each other so that voids could form. In brief, the following main damage phenomena can be identified:

- big open voids especially in the upper part of the wall
- deep lacunae
- deep cracks
- detached plaster layers

The cause of these damage phenomena can be mainly found in the presence of water, in combination with salts and microbiological growth underneath the individual plaster layers. Since no roof is present, the water can penetrate the structure. Before the intervention was started, extensive material tests for facing, mortar as well as foam mortar were carried out with the aim of adapting the new materials to the existing ones as well as to stay in a lime-based system during the whole treatment. Especially the different colours of the arricio layer as well as the intonaco layer made it difficult to produce a uniform mortar for these two layers. Because of this, the mortar recipe had to be adapted to the surroundings in some cases



Because of the complexity of the intervention the following description is divided in three parts. Fig. 2 shows the chosen division in upper, middle and lower part. Not included in this description is the work on the capital. The cleaning of the areas involves the entire wall.

Figure 2 Characterization of the different parts of the north wall.

## Cleaning

Especially in the upper part of the north wall a lot of plants and roots had to be removed. The roots of the plants had already formed branches below the plaster. These were very carefully removed mechanically. Furthermore, in some parts a solution of water and ethyl alcohol (1:1) was sprayed to kill them. Loose plants remains and dust were removed with a brush. All voids were first prepared, before filling them, by cleaning them dry by using a brush and if it was necessary wet with a water and ethyl alcohol (1:1) solution.

## Upper part

### Facing

Especially on the Intonaco level of the plaster there were several parts of detached plaster pieces and partial loss of mortar substance in different phases. These plaster pieces were going to fall down immediately. After performing a facing material test, Tylose (1,5 % 1:1 in Isopropanol, dest. Water) were chosen and applied with Japanese paper on the surface.

### Grouting

The big voids of the detached plaster were injected with foam mortar (Figure 3 - 4). Therefore, the first step was to stabilize the piece for the grouting by performing edging repairs. So that none of the foam mortar could leak from the void. While performing the edging repair a space was left open, so that the foam mortar could stay in contact with the air for the circulation and be able to set with the plaster layers (Figure 5). The foam mortar was injected step by step by using big syringes with tubes to get deep inside the void.

This procedure guaranteed that the foam mortar could set in the whole void. Particularly the big voids were filled in more than two steps, so that the amount of foam mortar could set and react properly with the plaster. After 1-2 days, the open borders of the voids were closed with mortar (Figure 6 - 9). The detached pieces of the smaller voids could be reattached to the arriccio layer by creating edging repairs.

### Mortar Filling

To handle the different color of the arriccio and the intonaco layer the recipe had to change to achieve a better optical connection to the surroundings. The challenge of the Deep lacunae and open borders in the arriccio layer were faced by filling first with the ready-made mortar (compositions of the participants). Unfortunately, the color was too light and too greyish for dark- grey-brown arriccio of the original plaster. The participants changed the mixtures to better manage the color.

Lacuna in the Intonaco layer were filled with mortar Intonaco 4 (fine) up to the surface-level. This step needed to be done, otherwise with the water flow running down on the surface on rainy days could have caused more loss to the substance. Two conservation mortars (Arriccio 10, Arriccio 12) were used to fill lacuna in the Arriccio layer.

**Middle part:****Removal of old repairs mortar**

Detached old edging repairs were carefully, mechanically removed. Afterwards the areas were cleaned dry with brushes.

**Mortar fillings**

Cracks in the surface of the *intonaco* were closed by conservation mortar (Intonaco 4) (Figure 13-14). For very small lacunae and cracks a conservation mortar was used, which has a finer grain size distribution. The mortar was applied up to the surface-level.

**Consolidation/ Grouting**

Especially in the right part of the tomb some scaling damages as well as powdering mortar layer are visible, which were consolidate with Calosil E25. Afterward foam mortar was used to fill the holes by using the before mentioned steps (check upper part) (Figure 10- 12).

**Lower part:****Consolidation**

At the beginning of the intervention the intonaco showed minimum cohesion in the mortar (Figure 15). CaLoSil® E25 was chosen as consolidant in relation to the results of the material tests. The consolidant was applied from the back side of the detachment in order to prevent the building of white haze on the surface of the plaster. The application proceeded with a syringe until the complete saturation of the material. On the next day, after full evaporation of solvent, the treatment was repeated. After the first application some green stains appeared on the surface, probably as a result of microbiological contamination. They became less visible after drying the plaster. On the third day, as the treated areas were completely dry, the bonding within the consolidated mortar was significant better as before.

**Grouting**

On the day after the second consolidation with CaLoSil® E25, as the intonaco plaster became strong enough to be touched, the detachment gaps were backfilled with a fine-grained lime mortar. The inner surface of the detachment gap was pre-wetted with distilled water with the help of a syringe, then a mortar was applied using a small spatula. This method was preferred to injection, as the detachment gaps were mainly too wide for injection of suspension without aggregates (PLM-AL was considered), but still too narrow for a mortar injection. Lime-based mortar 1:3 without hydraulic components was considered to be less hard and aptest for a frail original substance.

**Filling**

For the fillings of cracks and small lacunae two kinds of mortar were prepared using recipes described above. The darker coarse-grained mortar was used for fillings on arriccio layer, the lighter and finer one was supposed to imitate the character of original intonaco. The fillings were applied after pre-wetting of the surface with distilled water (spray). To make the aggregates visible and to reduce the bright color of the new conservation mortar few minutes after applying the surface was sprayed with water. The excess water was removed with a sponge.

**Edging repair**

For the edging repair the same light fine-grained mortar imitating the original intonaco was used. Mortar was applied after pre-wetting of the surface with distilled water (spray). To make the aggregates visible and to get a better adjust the color of the edging repairs which can become too bright from the calcitic binder, a few minutes after applying the surface was sprayed with water (Figure 16 – 18). The excess water was removed with a sponge. In some cases, “acqua sporca” was used to achieve a darker color and applied wet-on-wet with a brush.

**Notes**

The colour of the mortar wasn't fitting properly with the original surface. The main problem was that the lime mortar was setting too fast due to the higher temperatures and the dry climatic circumstances. Also the different techniques how to fill with mortar, were hindering and weren't closing aesthetically the surface.

Upper part:

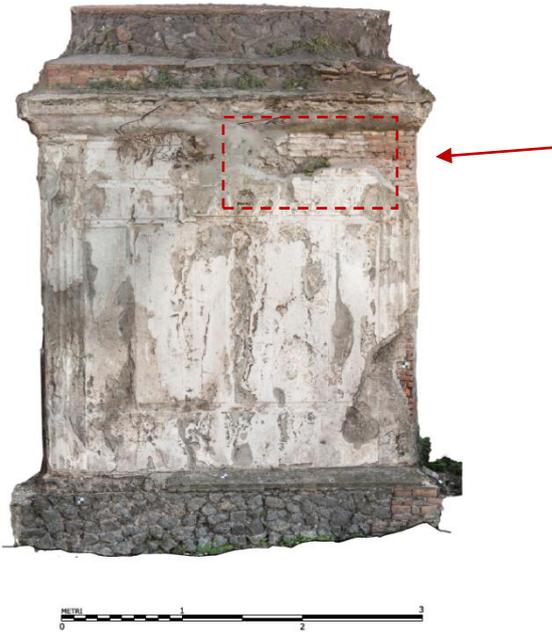


Figure 3 Detached plaster layers and plants on the upper part of the wall (PN\_EN\_04\_N\_DSCN1605).



Figure 4 Void of the detached plaster layers (PN\_EN\_04\_N\_DSCN1608).



Figure 5 During the intervention, the open void were selected to fill the foam mortar (PN\_EN\_04\_N\_DSCN1794).



Figure 6 Final result with new edging repairs (PN\_EN\_04\_N\_IMG\_2362H).

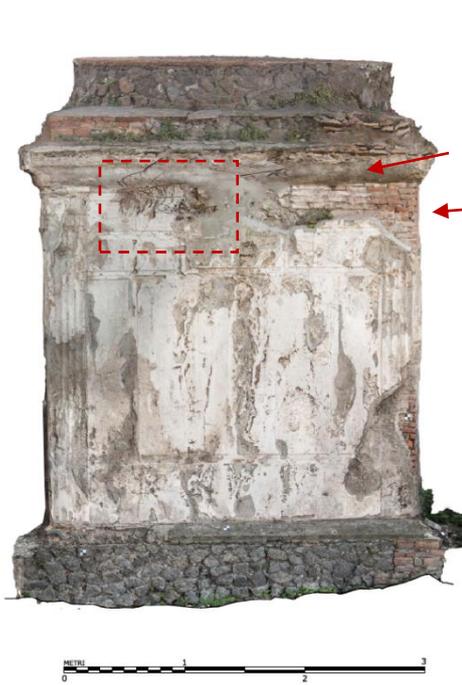


Figure 7 Plants, cracks and detached plaster in the upper part (PN\_EN\_04\_N\_IMG\_0140).



Figure 8 Plaster was removed and new edging repairs were made (PN\_EN\_04\_N\_DSCN1792).



Figure 9 Final result with new edging repairs (PN\_EN\_04\_N\_IMG\_2346H).

Middle part

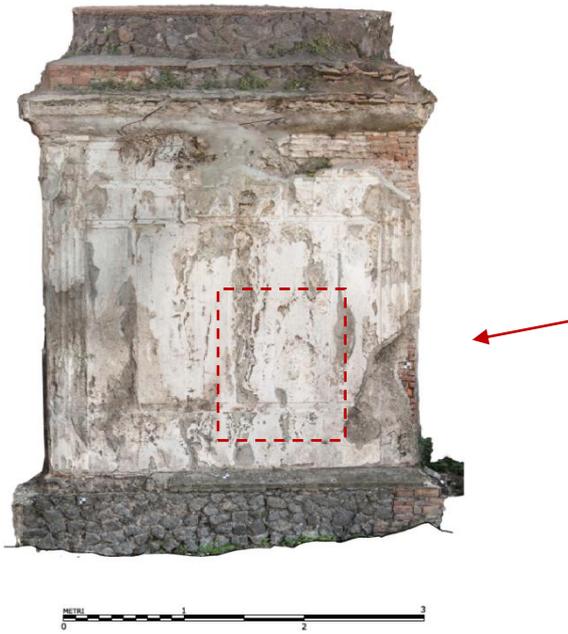


Figure 13 Different kind of detached plaster layers and lacunae (PN\_EN\_04\_N\_IMG\_0002).



Figure 14 Final result after grouting and filling the lacunae (PN\_EN\_04\_N\_DSCN1807).

Lower part

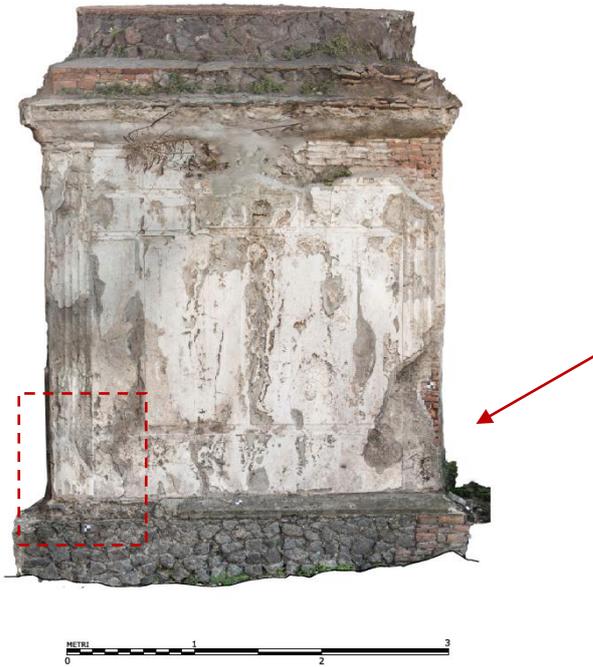


Figure 15 Detached plaster layers as well as loose of surface cohesion (PN\_EN\_04\_N\_IMG\_2070).

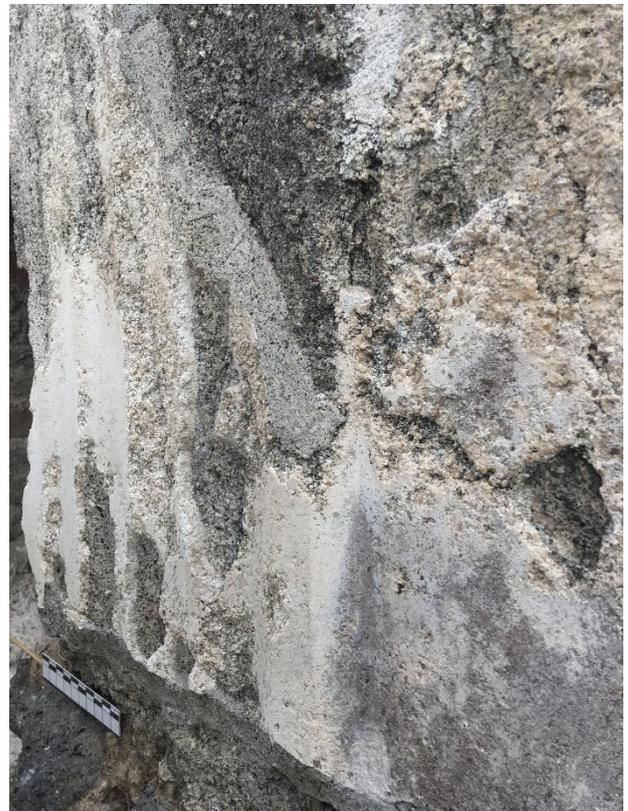


Figure 16 Final result, after consolidation of the surface and creating new edging repair (PN\_EN\_04\_N\_IMG\_4727).

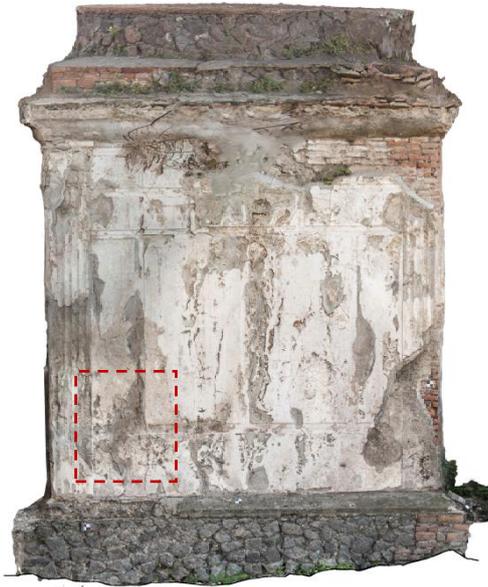


Figure 17 Plaster cracks (PN\_EN\_04\_N\_IMG\_4293).

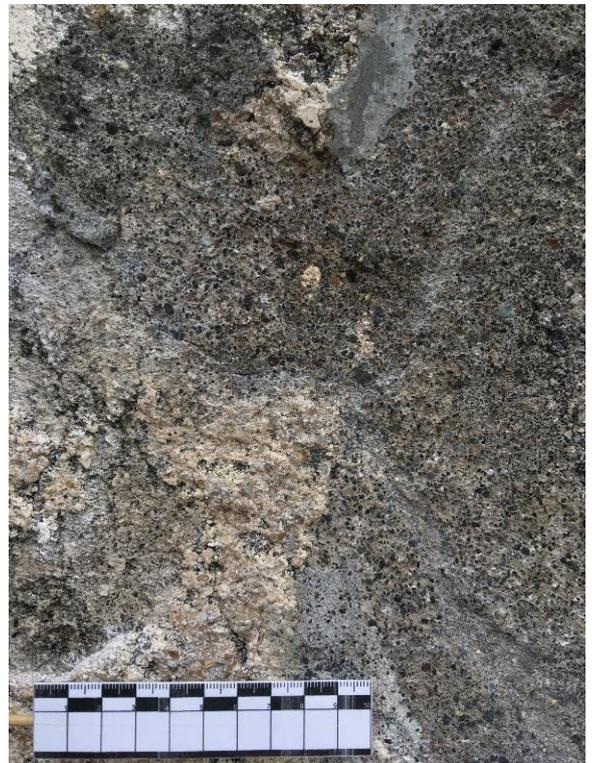


Figure 18 Final result after filling the cracks with moratr (PN\_EN\_04\_N\_IMG\_4741).

Conservation Treatment

Tomb Nr. PN\_EN\_04

P XXIV 2 4 N-E

Treatment number: PN_EN_04 N_E (2/2)		Period of Treatment: 1.10.2018 – 19.10.2018	
Persons in charge: Ivan Martinovic, Roberta Mirabella			
Type of Object: Stucco decoration (preparatory layers, intonaco)		Position: Upper part of the Corner North-East	
<b>Damage:</b> <ol style="list-style-type: none"> <li>1. Detachment of intonaco and stucco from preparatory layer</li> <li>2. Detachments between preparatory layers</li> <li>3. Detachments from the structure (masonry)</li> <li>4. Cracks</li> <li>5. Lacunae</li> <li>6. Powdering surface of preparatory layer and arriccio</li> </ol>		<b>Kind of Treatment:</b> <ol style="list-style-type: none"> <li>1. Facing</li> <li>2. Consolidation</li> <li>3. Block of collapsing fragment with mortar</li> <li>4. Injection of PLM-AL</li> <li>5. Injection of Foam mortar</li> <li>6. Filling</li> <li>7. Edging repair</li> </ol>	
<b>Used Materials</b>			
 <p>Figure 1 3D Model of the tomb, the marked section shows the working area</p>		<b>Used Materials</b>	<b>Quantity</b>
	<b>Facing</b>	Tylose 1,5% in water and iso-propanol 1:1, japanese paper	
	<b>Consolidation</b>	Calosil E25	
	<b>Injection</b>	PLM-AL in water 1:1 (w/w) foam mortar	900 ml
	<b>Filling</b>	Arriccio 12 Arriccio (yellow) Intonaco 4 Intonaco 4 (fine)	
<b>Edging repair</b>	Intonaco 4 Arriccio 12		
<b>Sampling</b>	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	<b>Pre-Treatment Analysis</b>	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
<b>Sample-Number:</b>		<b>Analysis-Number:</b>	
<b>Photos:</b> PN_EN_04_N_IMG_2005, PN_EN_04_N_IMG_2023, PN_EN_04_N_IMG_1854, PN_EN_04_N_IMG_2056, PN_EN_04_N_IMG_4754, PN_EN_04_N_IMG_4755, PN_EN_04_N_IMG_4756, PN_EN_04_N_IMG_4757, PN_EN_04_N_IMG_4758, PN_EN_04_N_IMG_4759, PN_EN_04_N_IMG_4760, PN_EN_04_N_IMG_4761			

**Conservation Treatment****Tomb Nr. PN\_EN\_04**

The work was concentrated on the capital, which is placed on the corner to the north and the east side of the tomb. As an emergency intervention dowels and wood supports were applied, to secure the fragile stucco decoration (Figure 2 - 3). Mortar bridges were created to block the collapsing fragment (Figure 6). The aim of the treatment is to secure the detached plaster layers as well as to supplement the lacuna in order to reduce the water entry.

**Cleaning**

The surface was cleaned by using a brush and metal wire, tweezers and perete, in order to remove dust and loose materials (aggregates of the original ancient mortars, small fragments of original mortars and mortars of the previous interventions) (Figure 4).

**Facing**

A facing with Tylose 1,5% in water and isopropanol (1:1), and japanese paper were applied in collapsing and detached areas in two layers (Figure 5).

**Consolidation**

The consolidation of powdering surface was performed with Calosil E25, applied with a brush, two times after a pre-wetting with ethyl alcohol.

**Injection of PLM-AL**

To prepare the injection the edges of the detachment were closed. Each area were pre-treated with a mixture of ethanol and water (1:1) before the injection. PLM-AL was prepared in water in concentration 1:1 and injected with a syringe in the detached areas and cracks (Figure 6 -7).

**Injection of foam mortar**

Bridges of mortar were created to fix some movable fragments and improve the stability of the area (Figure 8). Edging repairs were created to close the detachment. The surface was pre-wetted with demineralized water. The capital shows different kind of detachments, in some areas the Intonacco had detached from the preparatory layer as well as a detachment between the preparatory layers were visible (Figure 3). Injection of the big and wide detachments was performed with syringes and big plastic tubes, narrow detachments with smaller plastic tubes and cannula. The foam mortar was injected step by step, with the lowest possible pressure (Figure 9).

**Filling**

Lacunae and some cracks and detached areas were filled to avoid the water flowing or penetration inside these areas. Were used different kinds of mortars (Arriccio 5, Arriccio 12, Arriccio (yellow), Intonaco 4, Intonaco 4 (fine)) depending on the different features of the areas and the original mortars (color and grain size distribution).

First the surface was wetted with demineralized water by spraying and syringe, then the mortars were applied with spatulas of different sizes. The detached areas were filled below original level. The lacunae were filled lower than the surface of the finishing layer (Figure 10 -11). \* The surfaces of the applied mortars were sprayed with water in order to make the different aggregates visible; in some cases "dirty water" was applied on the fresh mortar with a brush to make the surface darker and more similar to the original one: it's a mixture of washed soil of the necropolis and water (M.Martelli Castaldi's recipe).

\* In November the 2018, after the Summer Academy conclusion, the level of the fillings on the North-East corner of the capital, were modified, to have a slighter under-level, compared to the finishing layer level, in order to avoid the water percolation inside cracks and lacuna (M. Ebbreo)

**Edging repair**

Two different kinds of mortars were used (Intonaco 4, Arriccio 12) depending on the different features of the areas and the original mortars. After pre-wetting the surface, the edging repair was done with an angulation that the water can run down. The surfaces of the applied mortars were sprayed with water in order to make the different aggregates visible (Figure 12 -13).

Emergency intervention



Figure 2 Securing the most dangerous parts with dowels and foamed material (PN\_EN\_04\_N\_IMG\_2005).



Figure 3 Detail of a mortar detachment (PN\_EN\_04\_N\_IMG\_2023).

Cleaning and Facing



Figure 4 Removing dust and loose particles from the capital by using a perette (PN\_EN\_04\_N\_IMG\_1854).



Figure 5 Facing from detached plaster layers (PN\_EN\_04\_N\_IMG\_2056).

Injection of PLM-AL



Figure 6 Injection of PLM-AL, new edging were already performed (PN\_EN\_04\_N\_IMG\_4754).



Figure 7 Final result after the treatment (PN\_EN\_04\_N\_IMG\_4755).

Injection of foam mortar



Figure 8 Bridges of mortar to fix some movable fragments (PN\_EN\_04\_N\_IMG\_4756).



Figure 9 Injection of foam mortar (PN\_EN\_04\_N\_IMG\_4757).

Filling



Figure 10 Detached plaster and lacuna on the east side (PN\_EN\_04\_N\_IMG\_4758).



Figure 11 Filling of the lacuna and performed edging repairs (PN\_EN\_04\_N\_IMG\_4759).

Edging repair



Figure 12 Performing edging repairs (PN\_EN\_04\_N\_IMG\_4760).



Figure 13 Finished edging repairs (PN\_EN\_04\_N\_IMG\_4761).

**In November 2018 some additional works have been done on this stucco decoration. In particular: filling of holes, cracks and dips, that could have been easy ways for the water to penetrate and damage the original layers (by Marta Ebbreo)**

Persons in charge: Lea Puglisi, Lea Oetinger, Henrieke Drengemann, Giulia Russo,  
Clelia Sbrolli, Evgenia Nasledova

Digitalization: Lea Oetinger, Kire Stavrov

Date: Oct. 2018

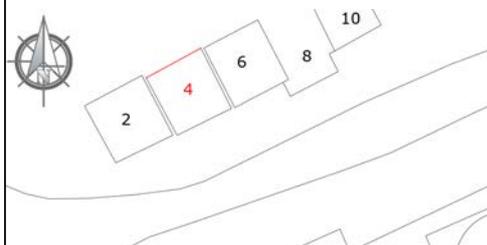


Mapping Treatment

Tomb no. PN\_EN\_04 north

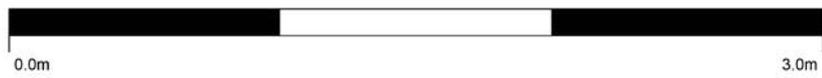
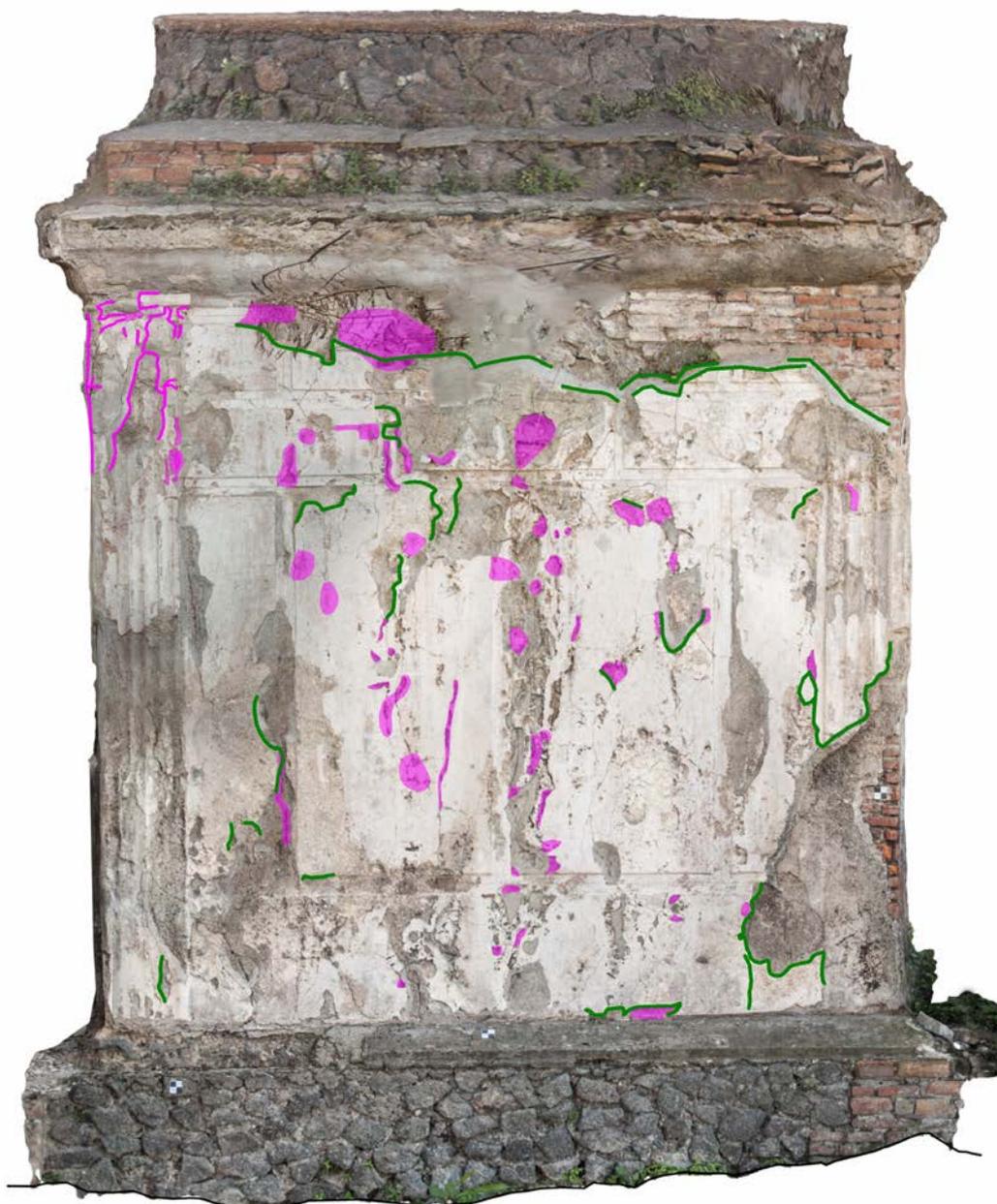
Emergency securing

-  Temporary fixation (Dowls/ Fibre glas)
-  Temporary fixation (Wood panels & Sticks)
-  Facing



Persons in charge: Lea Puglisi, Lea Oetinger, Henrieke Drengemann, Giulia Russo,  
Clelia Sbrolli, Evgenia Nasledova

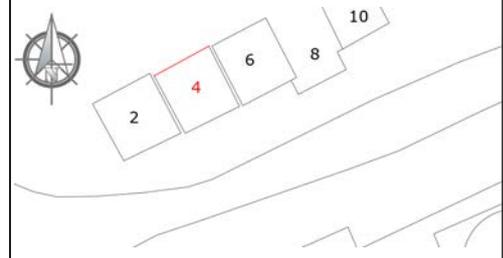
Digitalization: Lea Oetinger, Kire Stavrov  
Date: Oct. 2018



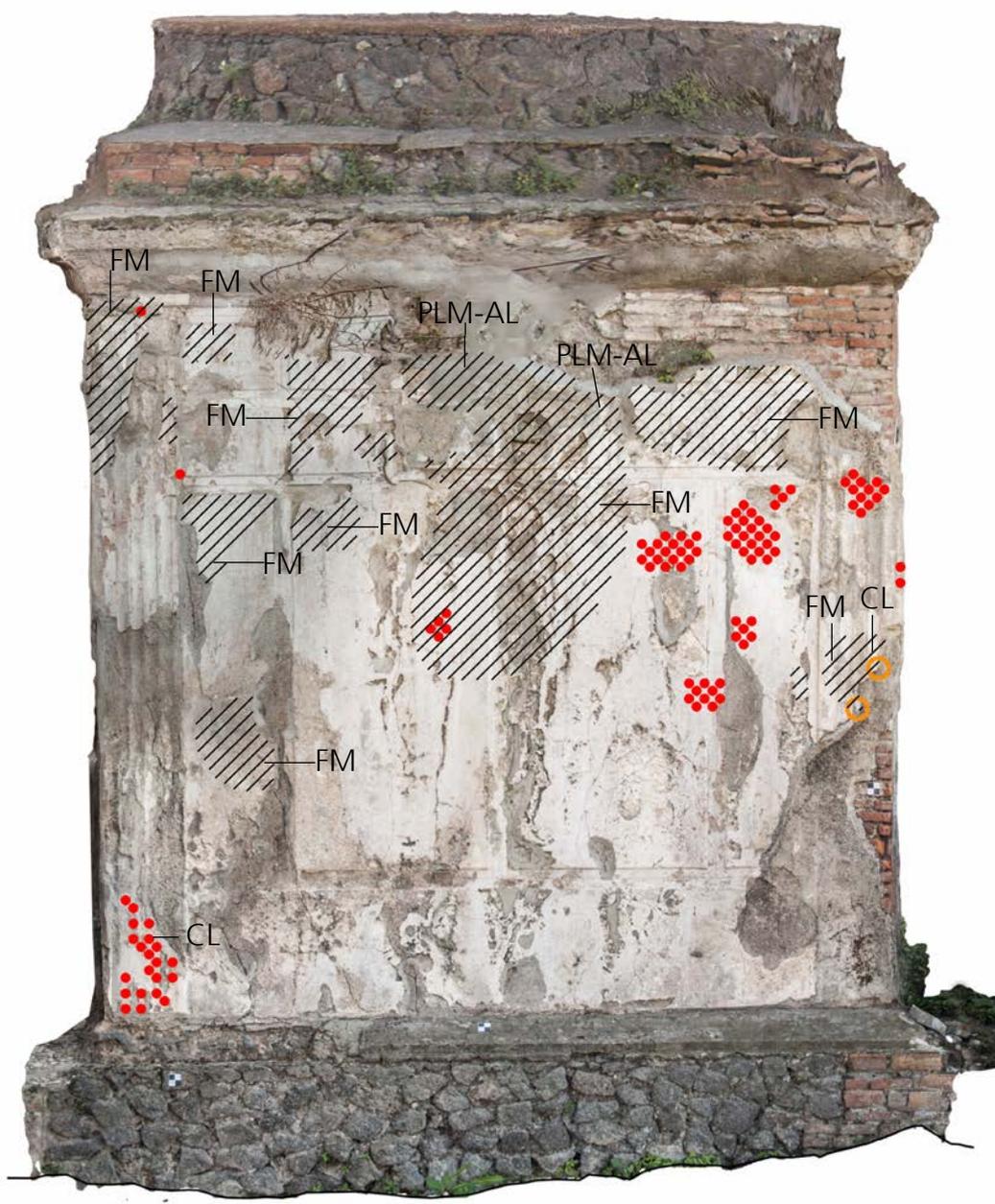
Mapping: Treatment

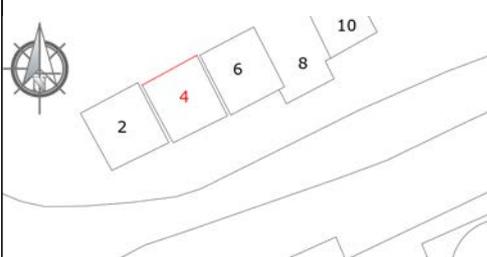
Tomb no. PN\_EN\_04 north

-  Filling/ Filling Cracks
-  Edging repair

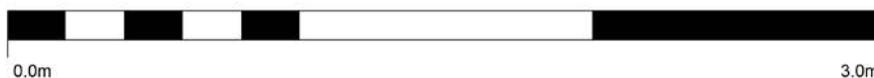
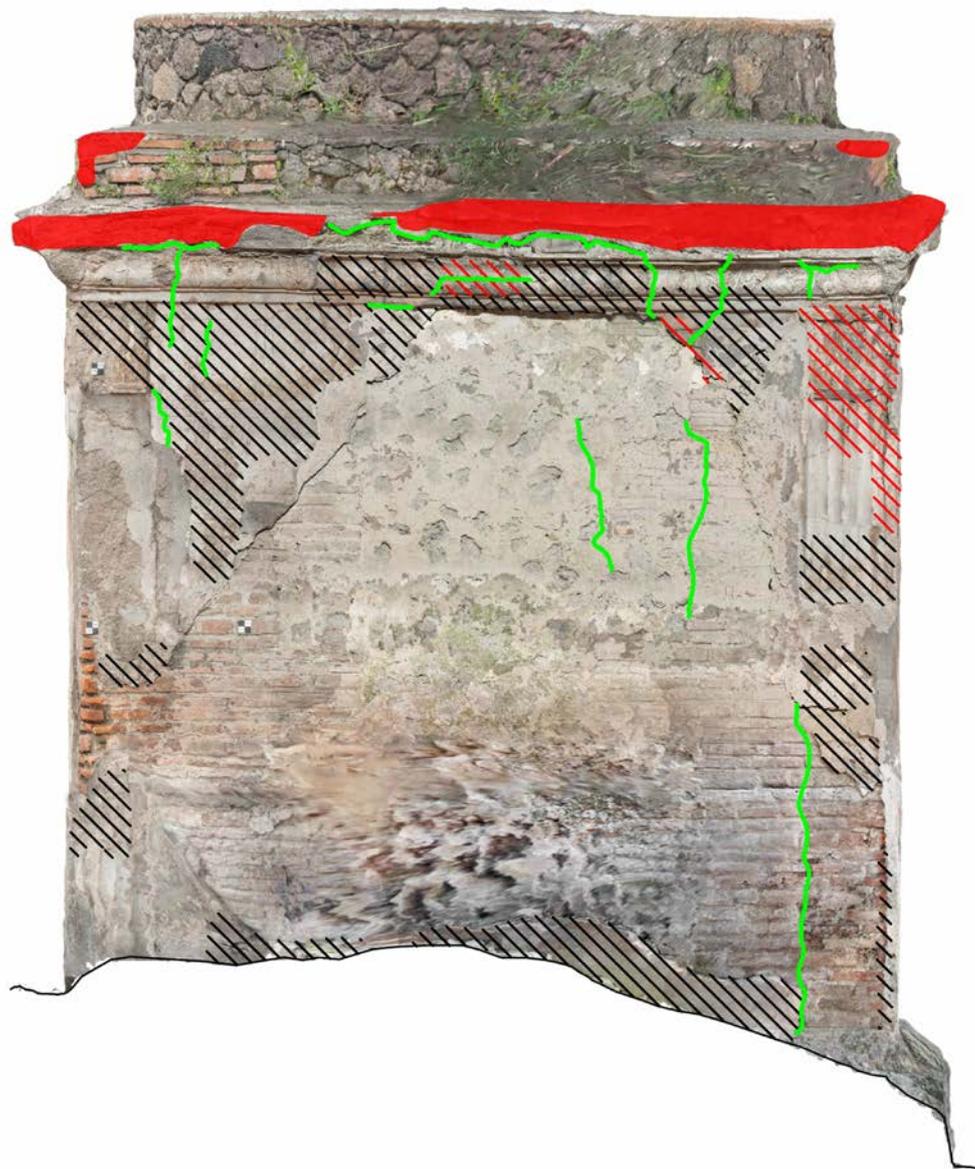


Persons in charge: Lea Puglisi, Lea Oetinger, Henrieke Drengemann, Giulia Russo,  
 Clelia Sbrolli, Evgenia Nasledova  
 Digitalization: Lea Oetinger, Kire Stavrov  
 Date: Oct. 2018



<p>Mapping: Treatment</p> <p>Tomb no. PN_EN_04 north</p>	<table border="0"> <tr> <td></td> <td>Injection</td> </tr> <tr> <td></td> <td>Consolidation</td> </tr> <tr> <td></td> <td>Fixation fibre glas</td> </tr> </table> <p>FM : Foam mortar              CL: CaLoSiL E25 / PLM-AL</p>		Injection		Consolidation		Fixation fibre glas	
	Injection							
	Consolidation							
	Fixation fibre glas							

Persons in charge: Roberta Mirabella, Ivan Martinovic, Evgeniia Nasledova  
Digitalization: Lea Oetinger, Kire Stavrov  
Date: Sept. 2018

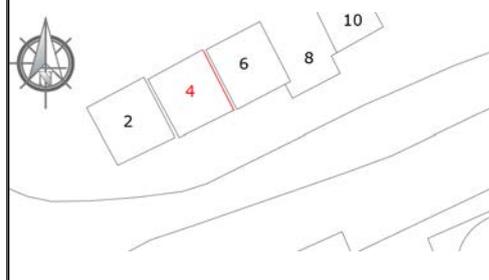


Emergency mapping:  
State of conservation

Tomb no. PN\_EN\_04 east

Titel: Priority damages

-  Collapsing elements (Structure)
-  Movable detachment
-  Non movable detachment
-  Cracks



Persons in charge: Roberta Mirabella, Ivan Martinovic, Evgeniia Nasledova  
Digitalization: Lea Oetinger, Kire Stavrov  
Date: Sept. 2018

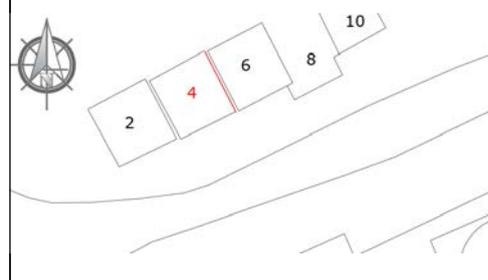


Emergency mapping:  
State of conservation

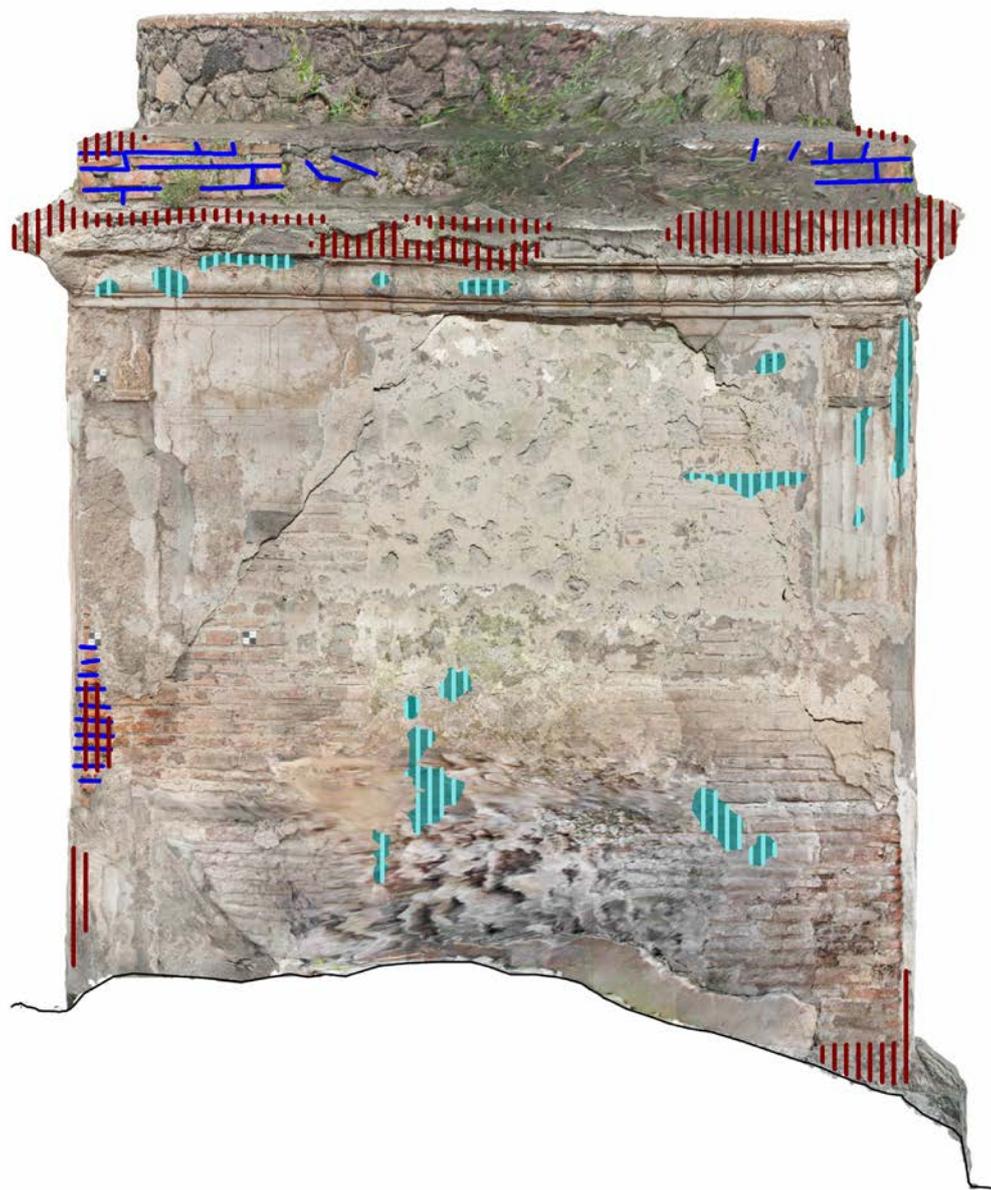
Tomb no. PN\_EN\_04 east

Titel: Superficial layer damages

-  Loss of cohesion
-  Erosion
-  Flaking
-  Blistering
-  Scaling



Persons in charge: Roberta Mirabella, Ivan Martinovic, Evgeniia Nasledova  
Digitalization: Lea Oetinger, Kire Stavrov  
Date: Sept. 2018

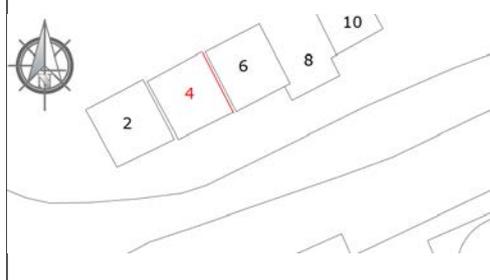


Emergency mapping:  
State of conservation

Tomb no. PN\_EN\_04 east

Titel: Missing elements

-  Missing elements (masonry)
-  Missing joint mortar
-  Lacuna



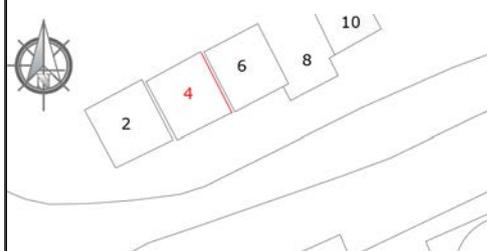
Persons in charge: Roberta Mirabella, Ivan Martinovic, Evgeniia Nasledova  
Digitalization: Lea Oetinger, Kire Stavrov  
Date: Sept. 2018



Emergency mapping:  
State of conservation

Tomb no. PN\_EN\_04 east

Titel: Biological colonization



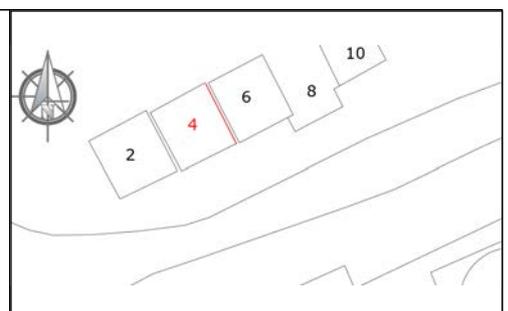
Person in charge: Evgeniia Nasledova  
Digitalization: Lea Oetinger, Kire Stavrov  
Date: Sept. 2018



Emergency mapping:  
State of conservation

Tomb no. PN\_EN\_04 east

-  Collapsing elements (Struct)
-  Movable detachment
-  Non movable detachment
-  Cracks
-  Lacuna



Conservation Treatment

Tomb Nr. PN\_EN\_04\_E  
P XXIV 2 4 E

<b>Treatment Number:</b> PN_EN_04 East (1/4)		<b>Period of Treatment:</b> 02.10.2018-09.10.2018			
<b>Persons in charge:</b> Leo Borgatta, Ayman Yaghi					
<b>Type of Object:</b> Structural upper part of the cornice		<b>Position:</b> East wall			
<b>Damage:</b> 1. Collapsing of previous reconstruction mortar of the cornice 2. Collapsing and detachments of original masonry elements (stones, mortar) below the reconstruction mortar.		<b>Kind of Treatment:</b> 1. Removing reconstruction mortar 2. Cleaning and removing plants and soils 3. Filling, consolidation of the detached elements 4. Filling the detachment of the cornice's plaster			
<b>Used Materials</b>					
 <p>Figure 1 Working area, east side.</p>		<b>Used Materials</b>	<b>Quantity</b>		
	<b>Consolidation</b>	PLM-AL in H <sub>2</sub> O (1:1)			
	<b>Filling</b>	River sand < 1mm Hydraulic lime HL5 (3:1)			
	<b>Injection</b>	Foam mortar	12 L		
<b>Sampling</b>	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	<b>Pre-Treatment Analysis</b>	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No
<b>Sample-Number:</b>			<b>Analysis-Number:</b>		

**Photos:**

PN\_EN\_04\_CE\_IMG\_5566, PN\_EN\_04\_CE\_IMG\_5569, PN\_EN\_04\_CE\_IMG\_5614, PN\_EN\_04\_CE\_IMG\_5604, PN\_EN\_04\_CE\_IMG\_5623, PN\_EN\_04\_CE\_IMG\_5628, PN\_EN\_04\_CE\_IMG\_5672, PN\_EN\_04\_CE\_IMG\_5736, PN\_EN\_04\_CE\_IMG\_7967

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**Conservation Treatment****Tomb Nr. PN\_EN\_04\_S**

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The intervention was conducted on the east wall, included the area above the cornice (Figure 2 – 4). The work to stabilize the cornice was carried out from this area.

**Cleaning**

As the mortar is completely detached from the original masonry, it is easily removed with hands. After removing the mortar's layer, the original masonry was cleaned with soft brushes. The upper part of the cornice was gradually removed from the already detached mortar. Through the soil, the joint mortar has lost its cohesion to the masonry. In order to create a good bond for the new mortar, the areas are carefully removed from the soil. Furthermore, the roots of the plants that grew in the masonry are stocked deep into it. They are killed with alcohol and water and removed gently. The soils are removed until the stable masonry was reached. By removing the soils, original fragments (mortar and stones) are also removed (Figure 5 -7).

**Re-fixing of fragments**

Bigger fragments are re-fixed with hydraulic lime mortar to the masonry. The mortar was applied after pre-wetting with distilled water (spray). As they were completely detached before cleaning, it is not possible to put them back exactly in their original places (Figure 9).

**Consolidation**

The loose elements of the masonry (not detached) are consolidate with PLM-AL. The aim is to regain the cohesion of the fragments as one "block" (Figure 8).

**Grouting**

The detachment of the cornice's arriccio plaster is filled with foam mortar from the top. The already existing holes in the masonry are used to inject the foam mortar (Figure 10 - 11).

Working area

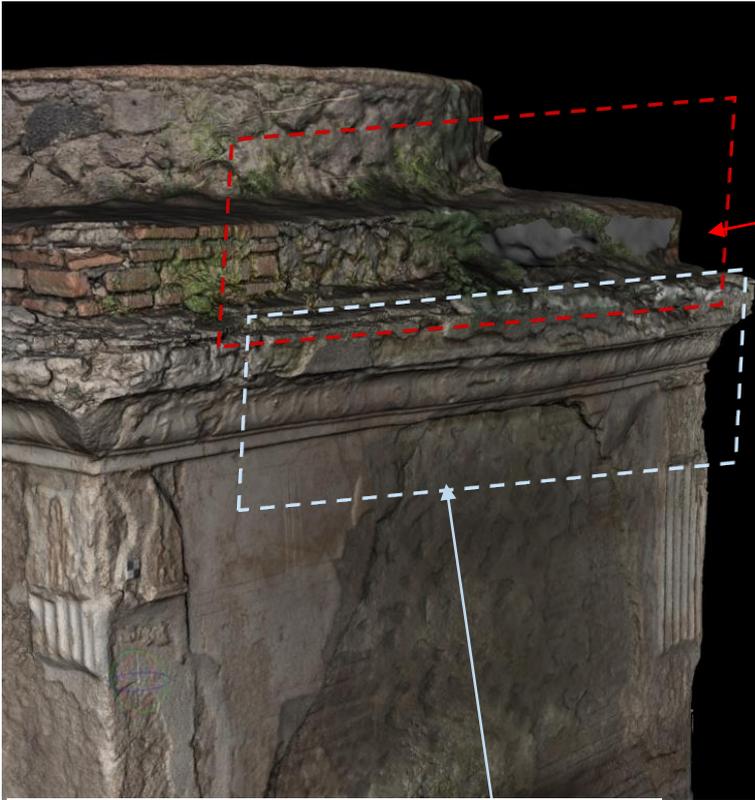


Figure 2 Detail 3D model, working area, east side.



Figure 3 State of conservation, Structural upper part of the cornice (PN\_EN\_04\_CE\_IMG\_5566).



Figure 4 State of conservation, cornice with reinforcement (PN\_EN\_04\_CE\_IMG\_5569).

Cleaning of the structural part of the cornice



Figure 5 Detail of the structural part of the cornice, with detached mortar layers (PN\_EN\_04\_CE\_IMG\_5604).



Figure 6 Soil and plants (PN\_EN\_04\_CE\_IMG\_5614).



Figure 7 Cleaned working area (PN\_EN\_04\_CE\_IMG\_5623).

Consolidation and re-fixing of mortar fragments



Figure 8 Consolidation with PLMA (PN\_EN\_04\_CE\_IMG\_5628).



Figure 9 Re-fixing of fragments with mortar (PN\_EN\_04\_CE\_IMG\_5672).

Injection of foam mortar



Figure 10 Injection of foam mortar with a mortar pipe (PN\_EN\_04\_CE\_IMG\_5736).

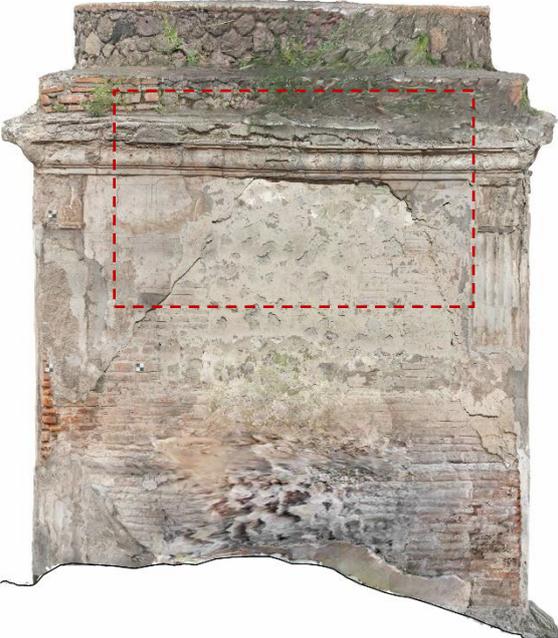


Figure 11 Injection of foam mortar (PN\_EN\_04\_CE\_IMG\_7967).

Conservation Treatment

Tomb Nr. PN\_EN\_04\_E

P XX IV 24 E

Treatment Number: PN_EN_04 east (2/4)		Period of Treatment: 02.10.2018-09.10.2018	
Persons in charge: Leo Borgatta, Ayman Yaghi			
Type of Object: cornice		Position: East wall	
Damage: 1. Detachment of all the plaster layers from the masonry (Structural damages) 2. Movable and not movable detachments between 1,2 or 3 layers of plaster (Superficial damages) 3. Lacuna 4. Scaling 5. Deformation		Kind of Treatment: 1. Facing 2. Temporary bracing 3. Closing of detachment 4. Filling 5. Grouting 6. Edging repairs 7. Consolidation	
			
Figure 2 , Marked working area, east wall.			
		Used Materials	Quantity
	Emergency securing	Wooden panel, dowel Foam rubber for temporary closing of the cornice's detachment	
	Securing	Fiber glass bars Ø8 mm (~10cm)	8 pieces
	Consolidation	PLM-AL in H <sub>2</sub> O (50g for 63ml water) CaLosiL IP 25	300 ml 20 ml
	Fillings	Arricio mortar 5 Arricio dark Intonaco mortar 4 (lime ratio: 70% slake lime, 30% NHL 3,5)	
	Injection	Foam mortar	120 ml
Sampling	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	
Sample-Number:	-		
		Pre-Treatment Analysis	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
		Analysis-Number:-	

**Photos:**

PN\_EN\_04\_CE\_DSCN1282, PN\_EN\_04\_CE\_DSCN1305, PN\_EN\_04\_CE\_DSCN1305, PN\_EN\_04\_CE\_IMG\_5568, PN\_EN\_04\_CE\_IMG\_5681, PN\_EN\_04\_CE\_IMG\_5697, PN\_EN\_04\_CE\_IMG\_5717, PN\_EN\_04\_CE\_IMG\_5738, PN\_EN\_04\_CE\_IMG\_5686, PN\_EN\_04\_CE\_IMG\_5859, PN\_EN\_04\_CE\_IMG\_5926, PN\_EN\_04\_CE\_IMG\_5990

**Conservation Treatment****Tomb Nr. PN\_EN\_04\_S**

The cornice of the east side shows various types of damage. In general a detachment of all plaster layer from the masonry is visible (structural damages). These plaster layers are also separated from each other (Figure 2 - 4). Furthermore lacunae and cracks are visible. Due to this very dangerous situation, the first step was to secure the entire cornice.

**Facing**

Facing of the detachments of the intonaco layer from the cornice to avoid any detachments or losing of collapsing elements while proceeding of bracing and reinforcing works.

**Reinforcement**

Reinforcement of the lower part of the cornice with dowels and fiber glass bars: this is an emergency intervention to stabilize the heavy detached and deformed cornice by creating a form of support for it. The fiber glass bars fixed with hydraulic mortar in the masonry in a depth of 5 - 6 cm each ~ 15 cm should support the vertical pressure force of the collapsing cornice. The fiber glass ( $\varnothing 8$  mm, length ~ 10 cm) bars should be permanent and hide by the future edging repair (Figure 5).

**Temporary bracing**

As the previous fiberglass reinforcements, the bracing of the cornice is also made in emergency to stop the collapsing. The bracing is made of wood beams. The opposite wall permits the bracing. The beams are placed in an angle of 30°, in order to support "diagonal" pressure forces. Only a tiny pressure is made to keep the beams in place without "pushing" the cornice (risk of cracks). In between the wood and the cornice's surface is placed a soft material (foam) (Figure 6).

**Filling of structural and superficial detachment**

Closing the empty space of the detachment between the *arriccio* and the masonry structure with lime mortar. The detachments are closed in both the upper and the lower sides of the detached areas of the cornice (see pictures). Before performing edging repairs the area are pre-wetted with demineralized water. Holes are left for future grouting fillings of the detachments (Figure 7 - 8).

Material used: Edging mortar 4 with changing ratio of lime: 70% slake lime: 30% Hydraulic lime NHL 3,5 (ratio 2:1). For detachments that are bigger than 2 cm, the detached areas more than 2 cm of detachment the ratio of sand should be changed by adding 1 part of river sand < 2mm. Furthermore the different plaster layer detachments were closed with mortar, following the same steps.

**Temporary closing**

The detachment of the lower part of the cornice is too wide (more than 3 cm) to be closed with mortar. (it is not impossible but hard and it is probably a waste of time to try to close it this way) Due to this a temporary closing were performed with foam rubber to block this area, the foam mortar cannot leak during the subsequent injection (Figure 9 - 10).

**Consolidation**

Consolidation and filling of movable detachments of the cornice and wall plaster layers (*arriccio* and *intonaco*): This step should be made in order to avoid collapsing of the detached areas. The movable detachments are treated first. Depending on the degradation and the depth of the detachments, different techniques and

materials are used. Small detachments of arriccio or intonaco layers are filled with PLM-AL. Detachments that are deeper than 1 cm are filled with foam mortar. Detachments that are not deeply detached are only closed with lime mortar (edging repairs made at the same time). Scaling areas (only small areas) are consolidated with lime-based consolidant product CalosiL IP25.

### **Grouting**

To reattach the cornice to the masonry foam mortar were used. The injection is made from the top of the cornice using two holes left on the original masonry and from the lower part, on both corners of the detached cornice (Figure 11).

The lower detached areas which are thinner than 1 cm are filled with PLM-AL. Detachments wider than 1 cm are filled with foam mortar.

### **Filling Intonaco**

The filling of the intonaco's lacunae of the cornice are made with the intonaco mortar 4. The concept for the fillings dictates that they are made as discreet as possible by suggesting the shapes of the original decorations. Suggesting does not mean reconstructing. The new fillings have to be discreet but should be recognizable. To achieve this the surface of the new filling is scratched.

### **Edging repair**

After the injection the gap between the plaster layers and the masonry were closed by performing edging repairs. Due to the fact of the wide detachment of more than 4cm, the detachment is filled with 3 layers of mortar (1<sup>st</sup> layer mortar 4 with 1 part river sand <2mm. 2<sup>nd</sup> and 3<sup>rd</sup> layer: arriccio dark). On the lower part of the cornice, the edging repair cover the fibreglasses that are left in place as a structural support. The surface of the last applied mortar layer is sprayed in order to gain the right color and surface aspect (Figure 11 - 15).

After the Summer Academy further interventions will be done to secure the re-attached cornice through a net and metal hook.

State of conservation



Figure 2 State of conservation, structural damages (PN\_EN\_04\_CE\_DSCN1282).



Figure 3 State of conservation, superficial damages (PN\_EN\_04\_CE\_DSCN1305).



Figure 4 State of conservation, cracks, and superficial damages (PN\_EN\_04\_CE\_DSCN1305).

Temporary bracing and Reinforcement with dowels and fiber glass bars



Figure 5 Temporary bracing with wooden panel and foam rubber (PN\_EN\_04\_CE\_IMG\_5568).



Figure 6 Reinforcement with dowel and glass bars (PN\_EN\_04\_CE\_IMG\_5681).

Filling of structural and superficial detachment

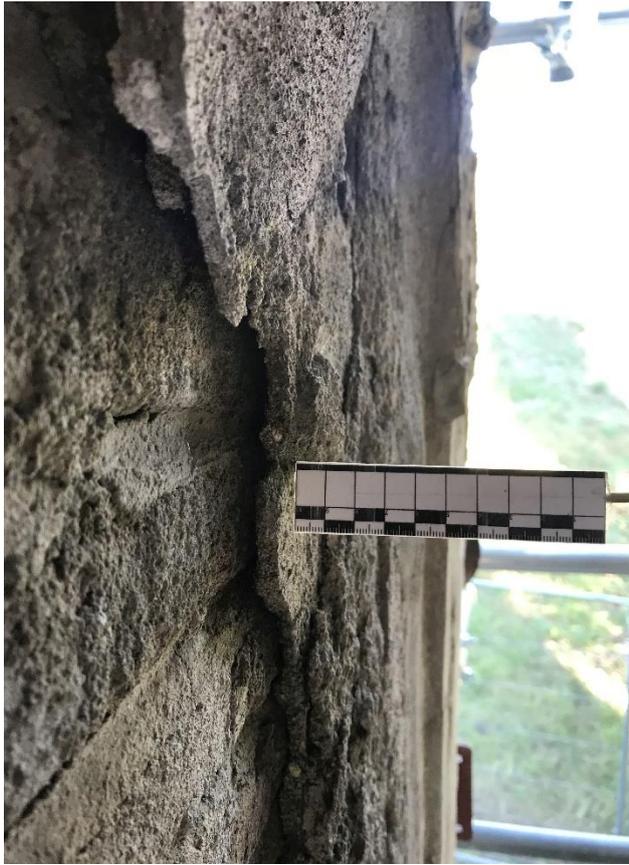


Figure 7 Mortar layer detachment (PN\_EN\_04\_CE\_IMG\_5697).



Figure 8 Filling the mortar layer detachment (PN\_EN\_04\_CE\_IMG\_5717).

Temporary closing



Figure 9 Structural detachment from the masonry (PN\_EN\_04\_CE\_IMG\_5686).



Figure 10 Temporary closing for the injection of foam mortar (PN\_EN\_04\_CE\_IMG\_5738).

Edging repair



Figure 11 After the injection of the foam mortar (PN\_EN\_04\_CE\_IMG\_5859).

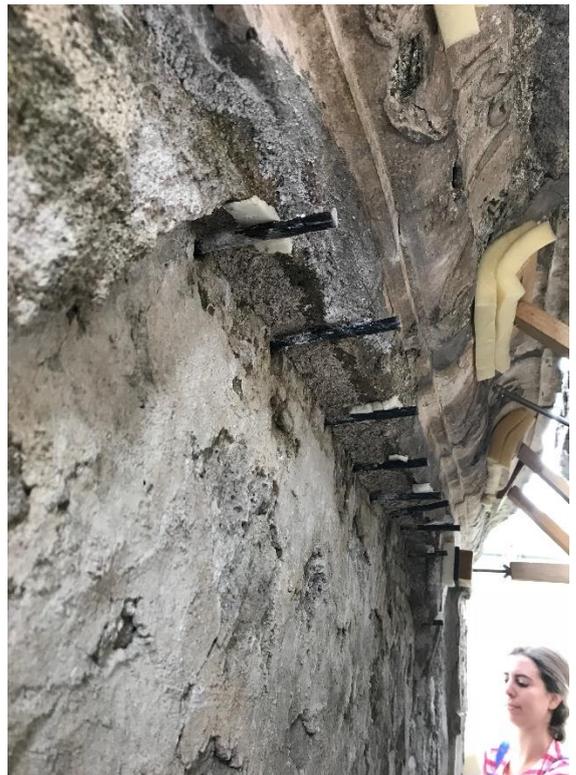


Figure 12 First layer of the edging repair (PN\_EN\_04\_CE\_IMG\_5926).



Figure 13 In the front part finished edging repair (PN\_EN\_04\_CE\_IMG\_5985).

Edging repair



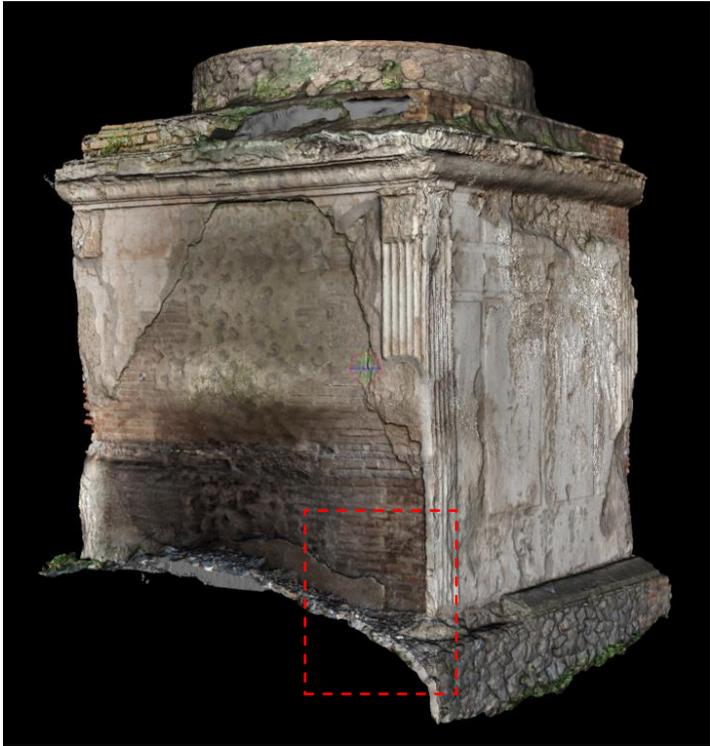
Figure 14 Detached plaster state of conservation (PN\_EN\_04\_CE\_IMG\_5697).



Figure 15 Final result of the intervention (PN\_EN\_04\_CE\_IMG\_5990).

Conservation Treatment

Tomb Nr. EN\_04 East  
P XXIV 2 4 E

<b>Treatment Number:</b> PN_EN_04 east (3/4)		<b>Period of Treatment:</b> 08.10.18 – 12.10.18	
<b>Persons in charge:</b> Evgeniia Nasledova			
<b>Type of Object:</b> plaster layers (aricchio, intonaco) on brick and stone masonry		<b>Position:</b> East wall, lower part	
<b>Damage:</b> 1. Detachment of preparatory layer from structure 2. Loose material and dust in the detachment gap		<b>Kind of Treatment:</b> 1. Cleaning 2. Emergency securing with mortar bridges 3. Foam mortar injection 4. Edging repair	
<b>Used Materials</b>			
		<b>Used Materials</b>	<b>Quantity</b>
	Fixation	Mortar A12	
	Injection	<b>Foam mortar</b> Mariensteiner HL5 – 500 ml Distilled water - 300 ml Drahlon® fiber – 0,2 g Sika® Lightcrete 400 – 25 ml per 1 l of distilled water Foam in mortar – 500 ml Foam dencity -45 g/l	1 l
Edging re- pair	Mortar A12 „Acqua sporca“		
<i>Figure 1 3D Model of the tomb, the red square shows the working area.</i>			
<b>Sampling</b>	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	
	<b>Pre-Treatment Analysis</b>		<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
<b>Sample-Number:</b>			<b>Analysis-Number:</b>

## Photos:

PN\_EN\_04\_Co\_DSCN1274, PN\_EN\_04\_Co\_IMG\_0056, PN\_EN\_04\_Co\_IMG\_0088, PN\_EN\_04\_Co\_IMG\_3460, PN\_EN\_04\_Co\_IMG\_3453, PN\_EN\_04\_Co\_IMG\_4175

**Conservation Treatment****Tomb Nr. EN\_04 East**

Before starting the treatment, the first step was the collection of the collapsed fragments between the tombs PN\_EN\_04 and PN\_EN\_06 (Figure 2).

**Cleaning**

The loose material has been removed from the detachment with a spatula, metal wire, brush and perete.

**Fixation with mortar bridges**

Parallel to the removal of material from the detachment gap, as the space was cleaned, five mortar bridges were created in order to secure the plaster layer and to prevent it from moving (Figure 3 - 5). This step was especially necessary for the following mortar injection. Mortar A12 was used for the bridges. All surfaces were pre-wetted with distilled water before applying the mortar.

As the cleaning operation was finished, the side of the detachment gap was closed with the same mortar composition.

**Injection of the foam mortar**

The next day, as the mortar bridges were hard enough to provide the necessary support, the detachment gap was filled with foam mortar (Figure 6). The surface was pre-wetted with water-isopropanol solution (2:1). For the injection the plastic tube Ø 5 mm was inserted from the upper part of the detachment and located on the bottom of the gap. The position of the tube was changed a few times in the south-north direction. 1 l. of foam mortar was used to fill the gap to the top.

**Edging repair**

Three different ways to close the edges were tested and discussed (Figure 7 - 8). In spite of the better aesthetical appearance of the edging N3, which allowed the original stratigraphy to stay readable while being itself „invisible“, the edging N1 were preferred because of its better properties in terms of conservation of the original structure. The complete covering of the edge and creating a slope were considered the necessary protection from water penetration and a fixation of plaster to the wall as well.

Before applying a mortar the surface was pre-wetted with water. Mortar A12 was used. As all of the pre-tested mortar compositions had a very light appearance, the „acqua-sporca“ method was used to achieve a suitable color of the edging (Figure 9). For this a small amount of the original loose material, which was collected with a plaster fragments from a corridor between the tombs EN\_04 and EN\_06 was used. The used material was sieved to 0,25 mm, washed few times in distilled water and applied wet-on-wet.

State of conservation



Figure 2 State of conservation (PN\_EN\_04\_Co\_DSCN1274).



Figure 3 Detached plaster from the masonry (PN\_EN\_04\_Co\_IMG\_0056).

Fixation with mortar bridges

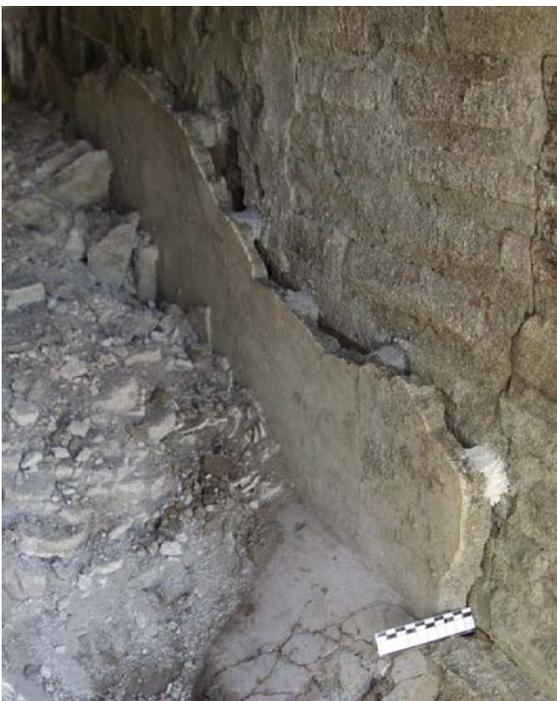


Figure 4 Mortar bridges to secure the detachment (PN\_EN\_04\_Co\_IMG\_0088).



Figure 5 Detail of a mortar bridge (PN\_EN\_04\_Co\_IMG\_3460).

Injection of foam mortar and testing edging repair



Figure 6 Injection with foam mortar (PN\_EN\_04\_Co\_IMG\_3453).



Figure 7 Different kind to close the edges (PN\_EN\_04\_C\_IMG\_3644).

Injection of foam mortar and edging repair



Figure 8 Detail of the edging repair (PN\_EN\_04\_C\_IMG\_2043).



Figure 9 Final result of the intervention after creating edging repairs Injection with foam mortar (PN\_EN\_04\_Co\_IMG\_4175).

Conservation Treatment

Tomb Nr. EN\_04 East

P XXIV 2 4 E

<b>Treatment Number:</b> PN_EN_04 east (4/4)		<b>Period of Treatment:</b> 28.09.2018 – 11.10.2018	
<b>Persons in charge:</b> Evgeniia Nasledova			
<b>Type of Object:</b> stucco - plaster (arriccio, intonaco) on a stone masonry, area between tombs EN_04 and EN_06		<b>Position:</b> East side, basement - area between tombs EN_04 and EN_06	
<b>Damage:</b> <ol style="list-style-type: none"> <li>1. Plants rooting in the original structure</li> <li>2. Loss of cohesive properties of mortar</li> <li>3. Detachments</li> <li>4. Fragmentation of plaster and cracks caused by mechanical damage</li> <li>5. Small separated plaster fragments in soil</li> <li>6. Separated fragments beneath the original surface</li> <li>7. Lacuna</li> <li>8. Missing parts</li> </ol>		<b>Kind of Treatment:</b> <ol style="list-style-type: none"> <li>1. Uncovering from material collapsed from adjacent walls</li> <li>2. Collecting fragments</li> <li>3. Facing and emergency secure</li> <li>4. Removal of plants and roots</li> <li>5. Dry Cleaning</li> <li>6. Consolidation</li> <li>7. Grout injection</li> <li>8. Filling, of cracjks and lacuna</li> <li>9. Edging repair</li> </ol>	
<b>Used Materials</b>			
		<b>Used Materials</b>	<b>Quantity</b>
	<b>Plants removal</b>	Ethanol	ca. 7 ml
	<b>Consolidation</b>	CaLoSil® E25	ca. 50 ml
	<b>Injection: voids</b>	PLM-AI with 100% dist. water	ca. 30 ml
	<b>Injection: cracks</b>	PLM-AI with 140% dist. water	ca. 20 ml
	<b>Facing</b>	Cotton gauze Tylose® MH 300 1,5% in distilled water/isopropanol	3 cm <sup>2</sup>
	<b>Edging 1: emergency secure</b>	Mortar A5, the bigger grains in composition (≈3 mm) were replaced with RS arev ≤2 mm. Mortar A 12	
	<b>Filling: cracks</b>	RS yellow < 0,5 mm - 2 parts RS yellow < 0,25 mm - 1 part Slaked lime/aggregate ratio 1:2 NHL 3,5 – 5 % „acqua-	

Figure 1 Area of the intervention.

			<b>Filling lacuna</b>	RS grey < 1 mm – 1 part RS yellow < 1 mm – 2 parts RS yellow < 0,5 mm – 2 parts T13 washed < 3 mm – 1 part Slaked lime/aggregate ratio 1:3 NHL 3,5 – 5%		
<b>Sampling</b>	Yes	No		<b>Pre-Treatment Analysis</b>	Yes	No
<b>Sample-Number:</b>				<b>Analysis-Number:</b>		
<p><b>Photos:</b>                  PN_EN_04_C_DSCN1563, PN_EN_04_C_DSCN1593, PN_EN_04_Co_IMG_2856, PN_EN_04_Co_IMG_2716, PN_EN_04_Co_DSCN1632,                  PN_EN_04_Co_IMG_4172, PN_EN_04_Co_IMG_1988, PN_EN_04_Co_IMG_2094, PN_EN_04_Co_IMG_2119</p>						

**Conservation Treatment**

**Tomb Nr. EN\_04 East**

The first step included the freeing of the area from collapsed material from the adjacent walls and cleaned with soft brush and perete (Figure 2-3). This intervention is described separately.

**Consolidation**

Consolidation with a weak mortar was used to consolidate the area, but also to stabilize the soil (Figure 5). CaLoSil® E25 was applied with a syringe, after the pre-cleaning of the surface with a soft brush and perete. The consolidant was injected until saturation of the material, this operation was repeated on the next day after full evaporation of the solvent. CaloSil® was preferred to silica-based consolidants in order to stay in lime-based system during the entire conservation treatments.

**Grout injections**

PLM-AI with 100% distilled water to its weight was used for injection of small voids. For injection of cracks the proportions were changed to 140% distilled water to the weight of binder in order to achieve a better fluidity of the grout. For the pre-wetting was used water-ethanol solution 2:1. The cracks were filled leaving some place for closing it with a fine mortar.

**Facing**

Two small fragments of plaster were detached and situated in a void beneath the original surface level. The cotton gauze facing was glued with Tylose® to make possible to pull the fragments out to the surface level. After the fixation of fragments (Edging 1) the facing was wetted with distilled water and removed and the surface cleaned with a moist cotton wool swab.

**Re-attachments - Edging 1 (emergency secure)**

As the collection of the material from the corridor had to be continued, the first treatments on the uncovered area were restricted to emergency securing of detached and moving parts. This should have made possible to go ahead in removal plaster fragments from the space between two tombs and to uncover the next section.

The mortar was applied after pre-wetting of the surface with distilled water (spray). In order to create the necessary conditions for a hydraulic reaction and to prevent a too fast drying, the edges were sprayed with water few times after applying in an interval of few hours (Figure 6).

**Removing plants**

To prevent further growing ethanol was injected with a syringe into the lower external part of the plants (Figure 4). Ca. 5 minutes later the overgrown part of plants was cut off with a scalpel.

**Filling cracks**

For the filling of cracks was created a fine yellowish mortar, imitating the original intonaco. Mortar was applied after pre-wetting with distilled water (spray). A few minutes later, the surface was treated with a moist sponge. To obtain a darker tone „acqua-sporca“ was applied (M. Martelli Castaldi's recipe: a small amount of the original crashed material, which was collected with a plaster fragments from a corridor between the tombs EN\_04 and EN\_06 was used. The material was sieved to 0,25 mm, washed few times in distilled water and applied wet-on-wet with a brush) (Figure 7).

**Filling lacuna**

A big lacuna on a light coarse-grained layer with unregular surface was filled with an especially prepared mortar described above. The filling was treated with a spatula to imitate the surface of the surrounding area. As a darker mortar was used A12. The fillings were applied after pre-wetting with distilled water (spray). To make the aggregates visible and to reduce the brightness of filling, a few minutes after the application, the surface was sprayed with water. The water in excess was removed with a sponge. To make a color darker was used „acqua-sporca“ in wet-on-wet technique (Figure 7-9).

**Edging repair**

The mortar A12 was applied after pre-wetting. To make the aggregates visible and to reduce the brightness of filling mortar the surface was sprayed with water few minutes after applying. The exceding water was removed with a sponge. To make a color darker was also used "acqua-sporca". Edging was formed with a slight slope (Figure 10).

State of conservation and removing the collapsed fragments



Figure 2 State of conservation before the intervention (PN\_EN\_04\_C\_DSCN1563).



Figure 3 Removed collapsed fragments and cleaned area (PN\_EN\_04\_C\_DSCN1593).

Removing plants



Figure 4 Removed collapsed fragments and cleaned area (PN\_EN\_04\_Co\_IMG\_2856 ).

Consolidation, filling cracks and lacunas and performing edging repair



Figure 5 Cleaned and consolidated area (PN\_EN\_04\_Co\_IMG\_2716).



Figure 6 Securing the edges with mortar (PN\_EN\_04\_Co\_DSCN1632)



Figure 7 Finised result of the inervention (PN\_EN\_04\_Co\_IMG\_4172).

Consolidation, filling cracks and lacunas and performing edging repair



Figure 8 Cleaned area of the second area (PN\_EN\_04\_Co\_IMG\_1988).



Figure 9 Finised result of the inervention (PN\_EN\_04\_Co\_IMG\_2094).

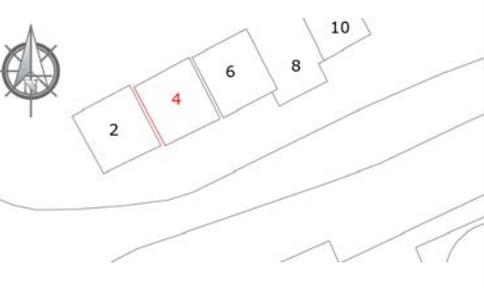
Final result of the treatment



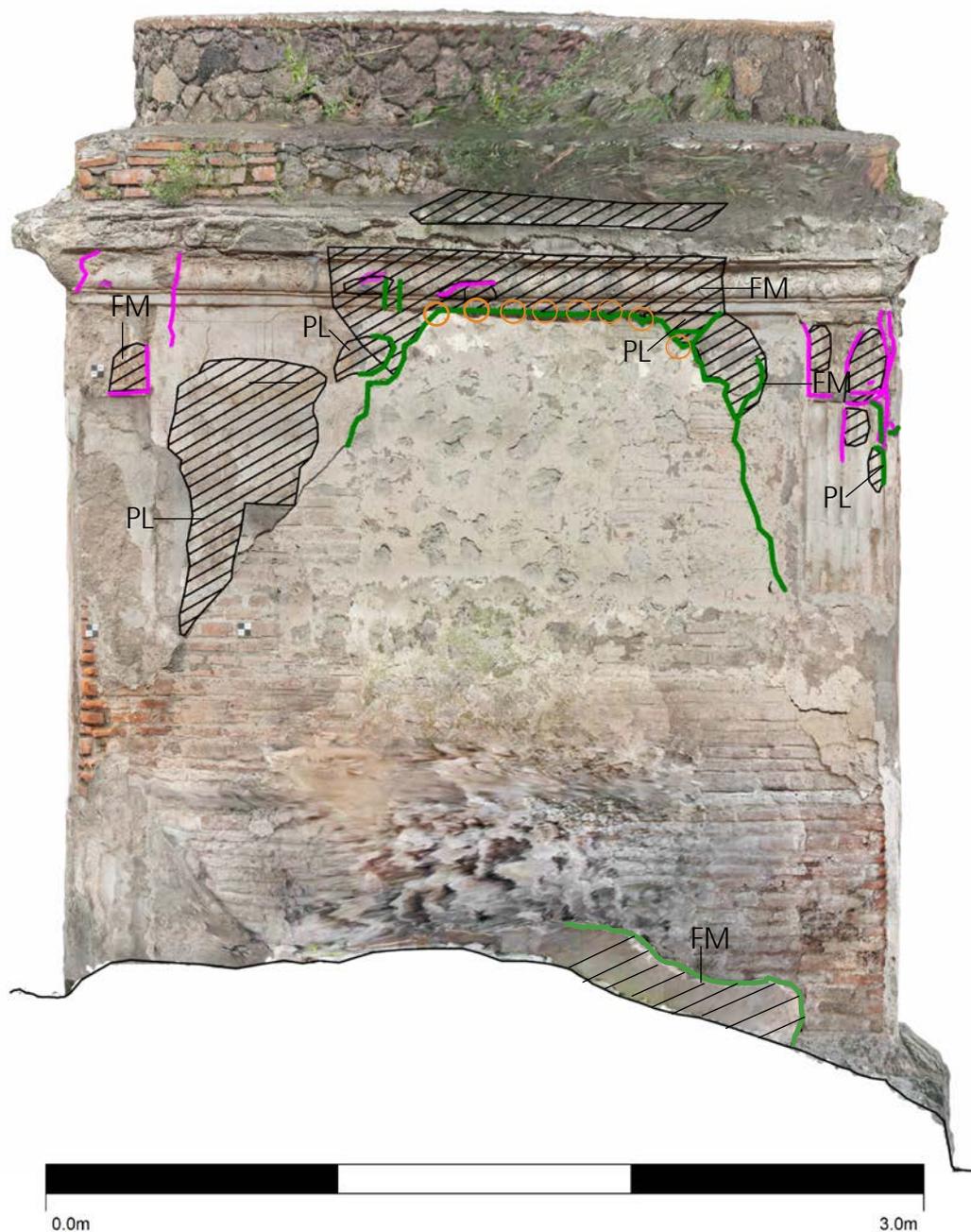
Figure 10 Final result of the inervention (PN\_EN\_04\_Co\_IMG\_2119).

Persons in charge: Leó Borgatta, Ayman Yaghi, Roberta Mirabella, Ivan Martinovic  
Digitalization: Lea Oetinger, Kire Stavrov  
Date: Oct. 2018



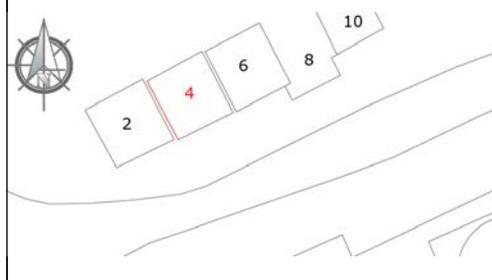
<p>Mapping Treatment</p> <p>Tomb no. PN_EN_04 east</p>	<table border="0"><tr><td></td><td>Temporary fixation (Wood panels)</td></tr><tr><td></td><td>Consolidation</td></tr><tr><td></td><td>Fix loose elements</td></tr></table>		Temporary fixation (Wood panels)		Consolidation		Fix loose elements	
	Temporary fixation (Wood panels)							
	Consolidation							
	Fix loose elements							

Persons in charge: Leó Borgatta, Ayman Yaghi, Roberta Mirabella, Ivan Martinovic  
 Digitalization: Lea Oetinger, Kire Stavrov  
 Date: Oct. 2018



Mapping: Treatment  
 Tomb no. PN\_EN\_04 east

-  Filling/ Filling cracks
-  Edging repair
-  Fixation dowels/ Fibre glas
-  Injection FM : Foam mortar  
 PL: PLM-AL



Persons in charge: Leó Borgatta, Ayman Yaghi, Roberta Mirabella, Ivan Martinovic  
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Date: Oct. 2018



Mapping Treatment

Tomb no. PN\_EN\_04 east

-  Consolidation
-  Filling/ Filling Cracks
-  Edging repair
-  Injection PL: PLM-AL

