

Final Report

Conservation and Study Campaign 2015 and Summer Academy for Young Conservators

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1 Introduction

The first International Summer Academy for Young Conservators of the PSPP at the necropolis of Porta Nocera took place at Pompeii from Sept 7th to Oct 30th 2015. Effective restoration measures were carried out on seven funerary monuments in the necropolis of Porta Nocera. Ten young restorers from five different countries and eight different restoration schools have participated in the Summer Academy and had the chance to learn new emergency techniques to preserve ancient wall-surfaces. In this context, seven of the most endangered funerary monuments in the necropolis of Porta Nocera could be secured.

The other important results of the campaign can be summarized as follows:

- Repair interventions on seven protective roofs located in the eastern portion of the Necropolis that had been in use for more than 22 years and could no longer do their duty.
- Enhancement and improvement of the virtual 3D model of the necropolis and integration in the GIS system of the Soprintendenza of Pompeii on the part of the CNR IBAM directed by Professor D. Malfitana.
- Drawing and planning of a prototype of a modular roof by Arch. Roberta Fornti, TUM. The roof is characterized by being anti-seismic, it is simple to build, made of durable material (steel beams, terracotta on an aluminum frame) and will need no maintenance for many years.
- First use of an innovative type of grouting foam mortar to fill hollow plastered surfaces. This type of grouting was developed in Bavaria during the restoration of baroque ceiling frescos and has been used for the first time on ancient walls in Pompeii, after experimenting it in loco. This grouting is particularly suited to the task because the thin strata of plaster of the ancient grouting are often detached over large surfaces from the body of the monument and among themselves. By using foaming agents bigger pores develop in the mortar structure that reduce greatly the weight of the filling material and thus allow filling also large gaps and detachments.
- The University of Oxford has tested a new datalogger and a miniature weather-station to measure climate on the funerary monuments.

We would also like to thank the Soprintendenza Archeologia di Pompei for the exceptional collaboration. A special thank you goes to the Superintendent Prof. M. Osanna and his team (especially Dr. Annalisa Capurso, Dr. Grete Stefani and Dr. Stefania Giudice) who have supported the summer academy in every possible way thus contributing greatly to its success. A thank you goes also to the instructors of the Summer Academy, Dr. Pia Kastenmeier, Prof. Monica Martelli-Castaldi, Klaus Klarner, Dr. hc. Jürgen Pursche, Prof. Erwin Emmerling, to the participants and speakers of the workshop, to the team of the Herculaneum Conservation Project (especially Dr. Jane Thompson und Dr. Paola Pesaresi) and to the untiring participants of the first PSPP Conservation Summer Academy.

2 Timeline of the first PSPP Conservation Summer School, Campaign 2015

September 2015

Monday	Tuesday	Wednesday	Thursday	Friday	Sat.	Sun.
	1	2	3	4	5	6
7	8	9 First Workshop	10 First Workshop	11 First Workshop	12	13
14 Survey of the necropolis Discussion about how to handle a world heritage site and the values of the Necropolis Development of site-mapping (issues and legend)	15 Survey of the necropolis Mapping of the site and mapping with focus on tombs in two groups. Development of a list about needed preparatory work and possible treatments on site	16 Survey of the necropolis and prioritization Evaluation and comparison of the actual site-mapping with the site-mapping of 2014 Discussion about different damages, conservation materials/techniques Prioritization	17 Workshop with Klaus Klarner: material tests, mortars in general, introduction and practical training in foam mortar production Development of a system to collect and inventory fragments	18 Workshop with Klaus Klarner: temporary fixation methods, consolidation materials and emergency conservation technique	19	20
21 Preparatory work and documentation Collecting fragments	22 Preparatory work Discussion about damages, conservation and restoration materials and techniques Tour over necropolis linked to the previous discussion Collect Fragments Tour over necropolis with scaffolding firm	23 Tests for conservation materials and techniques: mortars, consolidation materials	24 Tests for conservation materials and techniques: mortars, consolidation materials Purchase of materials Excursion to ancient Pompeii with Pia Kastenmeier (afternoon)	25 Tests for conservation materials and techniques: mortars, consolidation materials Previous organization of work and worksite Order of scaffolding and organization of the depot Development of emergency conservation mapping	26	27
28 Preparatory work and documentation Photographical documentation of the tombs Preparation of the worksite Building of scaffolding by firm Collecting fragments Tests for conservation materials and techniques: mortars	29 Preparatory work and documentation Preparation of the documentation sheets Purchase of materials Tests for conservation materials and techniques: edging repair Excursion to Herculaneum (in the morning)	30 Preparatory work and documentation Photographical documentation Preparation of sheets and legend for mapping Collecting fragments Tests for conservation materials and techniques: edging repair Decision about the conservation materials and techniques to be used				

October 2015

Monday	Tuesday	Wednesday	Thursday	Friday	Sat.	Sun.
			1 (Rain) Preparatory work Discussion about mapping in general Mapping on tombs: state of conservation Tests for conservation materials and techniques: injection with foam mortar	2 (Rain half day) Documentation Photographical documentation Mapping: state of conservation Tests for conservation materials and techniques: injection with foam mortar ⇒ Start of emergency work on Porta Nocera Necropolis Preparatory work: killing plants	3	4
5 (Rain half day) Emergency conservation on site Discussion about first experience with consolidation materials on site	6 Emergency conservation on site	7 Emergency conservation on site	8 Emergency conservation on site Excursion to Oplontis (afternoon)	9 Documentation	10	11
12 Emergency conservation on site ⇒ Start of emergency conservation on Via Nucerina Necropolis	13 Emergency conservation on site	14 Emergency conservation on site	15 Documentation Purchase of materials	16 Emergency conservation on site	17	18
19 Emergency conservation on site	20 (Rain) Documentation (But two participants also worked on site)	21 (Half Rain day) Emergency conservation on site	22 (Rain) Documentation (But two participants also worked on site)	23 Emergency conservation on site	24 E. C. (Half day)	25
26 Emergency conservation on site	27 Emergency conservation on site	28 Emergency conservation on site	29 Documentation	30 Cleaning Cleaning worksite and Depot Loading equipment into the car	31	

Survey, Tests, Preparatory Work, Documentation
 Emergency Conservation on Site

3 Survey of the Porta Nocera Necropolis and Via Nucerina Necropolis

The first week a **survey of the Porta Nocera and Via Nucerina Necropolis** has been conducted by the young professionals to address specific issues. Since this was the first time at the Porta Nocera and Via Nucerina Necropolis for most of the participants, it was important to become familiar with the area and to gain an impression of the necropolis as an overall system linked to the archaeological

park of Pompeii. During the survey the special values of the necropolis were discussed as well as the main problems and needs of the entire site and of the tombs in particular with the aim to get an overview of the different kind of damages and to come to a prioritization for emergency conservation work. Both, on which tombs to work and what kind of interventions can be realized.

In a first step, a **group discussion** should point out the specific **values of the necropolis** to clarify the importance for the preservation of the area. As a funerary place the necropolis is a treasure for archeologists in order to explore the burial rites of the ancient romans. But since the necropolis is also an extension arm of the ancient Pompeii and its inhabitants, it also serves as historical source of the city public life. Due to its position along the connecting street to the city of Nuceria the tombs were also used as a platform of representation, communication, election and other advertising manifestations – the few remaining dipinti, paintings and graffiti on the plasters/stucco are the last witnesses for this fact. Since the necropolis was not only a place for the dead but also a vivid place to meet, the area should be considered and preserved as part of the overall picture of the ancient city although it is outside the city walls. This position additionally sets a connection point between the archeological park and the modern city of Pompeii. Next to the »amphitheatre entrance« and directly located at the boarder with the modern street Via Plinio the Porta Nocera necropolis is visible from outside the excavated site and can be either a starting or an ending point of touristic tours. For this reason the above mentioned values and the condition of the necropolis is also important both for the tourism business in the streets (like hotel and souvenir shops) and for the tourism of the archaeological park itself since the necropolis can be the first or the last impression they get from the cultural heritage site.

In a second step **mapping** has been used as a tool to achieve the above mentioned aims of the survey as well as to obtain an instrument for communication. To enable a good readability of possible connections between the single influencing factors, floor plans are intended to be used as basis for mapping. Two kinds of maps have been created, a site-map and a map with a focus on the individual tombs. Thus the comparison between those may point out »hot spots« of problems and causes. Issues and legend of the maps have been developed in the group as a whole, mapping itself has been performed in two groups of each of four young professionals by hand drawings.

The issues of the **site-map** resulting from the previous site research included the main influencing factors climate and weather, biota, human factors, the terrain and the presence and condition of roofs and protective devises.

Site-Map Issues	
Climate and Weather	
Water	Way of rainwater
	Collecting points
	Water regulation devices (collectors, pipes, drains)
Sun	Sun position during the day
	Radiation intensity
Wind	Wind direction

	Dust exposure
Temperature	°C
Biota	
Vegetation	Bushes
	Trees
	Roots
	Grass
Biodeterioration	Presence
Animals	Kind of animal
	Do they cause problems
Human influences	
Tourists	Tourist movement
	Collecting points
	Hot spots of interest
	Risks for tourists
	Damages due to tourists
Terrain	
Land levels	Relief of the terrain
	Tomb on two levels in contact with ground
Roofing and protective devices	
Ancient roofs	Condition
Reconstructed roofs	Presence and condition
Temporary protective roofs	Presence and condition
Protective devices (glass, fences, grid)	Presence and condition

The issues of the **tomb-map** resulting from the previous site research included the archaeological importance due to the decoration of the tombs, the main damages and the difficulty level of needed preparatory work for further emergency conservation interventions.

Tomb-Map Issues	
Historical importance	
Decoration	Graffito, painting, dipinti, plaster, stucco, stonemason work, sculptures
Damages and risks	
Masonry in bad condition	Lack of stones, tiles, bricks, joints
	Defect cornices
	Sanding/powdering building materials
	Water infiltration
	Cracks
	Static problems
	Danger for tourists
Plaster in bad condition	Detachment
	Cracks
	Sanding/powdering plaster
	Fragments on the ground
Preparatory Work needed	
	Questions to Soprintendenza

	Collecting fragment
	Killing and removing biological growth
	Scaffolding needed

The **evaluation** of the mapping has been done by comparing the maps among themselves as well as with the maps of autumn 2014. As result the main problems of the necropolis and its tombs have been pointed out to be the same like one year before with sometimes small changes in dimension. As an example the crack in masonry of tomb PN_EN_28 is enlarged to a size that causes visible static problems. The consultation of an engineer would be important in this case.

The **main problems** of the necropolis (for detailed information see report and maps of MONICA MARTELLI CASTALDI, 2014) in the context of preservation result from the fact, that it is an excavated archaeological area which has been treated by previous structural and surface interventions, is exposed to environmental factors (weather, sun etc.), is visited by many tourists and is difficult to maintain because of dimension and less attention besides the area inside the ancient city walls.

Since the excavation the necropolis is, as well as the entire archaeological park of Pompeii, exposed to the weather which causes many damages. With its position at the lowest part of the excavation the necropolis is a collecting point for **rainwater** not only out of the ancient city but also from modern Pompeii. A working water regulation does not exist. A major part of the damages can be linked to water penetration from the wet soil into masonries and plasters but also to direct rainwater infiltration. Many of the cornices, wall copings, roofs and protective coverings are in bad condition and therefore not-functional. The overhangs of temporary or permanent roofs are too short to protect the tombs against driving rain. The rainwater pipes and drains that are located are wrongly structured and / or blocked. Humid walls and plasters involve further **biological growth** that can be observed throughout the necropolis. Plants, roots and biodeterioration spread into the masonries and plaster and lead to water retention and damages like e. g. cracks and detachments. The **lack of continuous maintenance** allow decay going on with the result of several damages that lead to more and more material and information loss. Also **tourist behavior** is sometimes a risk to the tombs and their decoration. They climb on walls and inside small gaps between the monuments, scratch surfaces with their bags and immortalize themselves by notching signs into plasters. **Previous interventions** and therefore used material also cause several problems and damages. The different kind of damages and their genesis, which have been detected on the tombs of the necropolis are described in detail in the chapter 5 State of Conservation.

As a result of the survey of the necropolis, the following **lists for main damages and suggested interventions** have been created by the young professionals.

Main Damages	
Masonry	Loose stones and tiles / bricks
	Missing stones and tiles / bricks
	Powdering / sanding stones and tiles / bricks
	Scaling stones and tiles / bricks
	Powdering / sanding joints

	Missing joints
	Cracks
	Biological growth (plants, roots, biodeterioration)
	Damaged wall copings and roofs
	Damaged cornices
	Static problems
Plasters / Stucco	Detachment
	Broken off plaster fragments (fragments on the ground)
	Powdering / Sanding plaster / stucco
	Scaling plaster / stucco
	Cracks
	Lacunae
	Biological growth (plants, roots, biodeterioration)
	Deposit (dust, sand, organic material)
	Conservation and restoration materials of previous interventions
List of needed and suggested interventions	
Needed conservation treatments	Consolidation
	Fixing of scaling
	Facing
	Temporary fixation
	Injection
	Filling
	Edging repair
Needed preparatory work that can be done by the young professionals	Collecting the plaster fragments on the ground
	Ask Soprintendenza for boxes for the storage of fragments
	Clean the surrounding of the tombs for work and scaffolding
	Killing off and remove plants (ask Soprintendenza for biocide)
	Combat of biodeterioration
	Create a list for tombs where scaffolding or platform is needed
	Plan scaffolding and contact firm
	Create a list for prioritization
	Worksite planning (also barriers for tourists)
	Development of documentation sheets and mapping legend
General needed preparatory work that can not be done by young professionals during this campaign	Control water regulation
	Control and clean all water outflows
	Change the system of water outflows
	Control and repair all roofs, wall copings, cornices, covers
	Repair old protective roofs
	Control all epigraphy
	Fix all slopes which are endangered for landslides (western end of Porta Nocera Necropolis, western and eastern end of Via Nucerna Necropolis)
	Build barriers for tourist around tombs with risks for visitors (e. g. tomb PN_EN_28)
	Consulting of a structural engineer because of static problems
	Development of a new system for protective glass
	Maintenance of necropolis (training for custodians)

4. Prioritization

Finding the tombs, with which we wanted to begin the emergency conservation work, has been one of the important first steps of the campaign. For that a few steps were decisive: the survey over the necropolis in order to get an overview about the main damages and their possible causes, the definition of the criteria for the prioritization, the creation of the priority list of tombs and at last the final choice of the tombs for beginning the conservation work.

Based on the quick survey of the site to get an overview by repeating the mapping of the Preliminary Campaign 2014 the young professionals discussed the results in order to define the criteria for the prioritization and to select priority tombs. For the determination of the tombs the results of the survey and the personal opinion of each participant has been decisive. Since there are a lot of endangered tombs in both necropoleis, in total 29 tombs have been selected as priority tombs as the result of this first assessment. In the next step the participants defined the criteria for the list of tombs of the first survey in order to select priority tombs and to minimize the amount of tombs, where the young professionals actually could work during the campaign. For creating a priority list of tombs not only the state of conservation, the quantity of endangered surfaces and the urgency of emergency measures have been decisive. In fact logistic questions as the accessibility, the possibility of building scaffoldings and the proximity to the depot have been important criteria, which should influence the decision. The criteria have been defined as follows:

- Danger for tourists (collapsing elements, holes in the ground etc.)
- Decorative elements (dipinto, graffito, stucco, painting, sculpture etc.)
- State of conservation of plaster/stucco (detachment, powdering / sanding)
- State of conservation of masonry (cracks, sanding stones/bricks etc.)
- Assumed static problems
- Preparatory work needed (treatments as killing off and removing plants, consolidation of powdering plaster/stucco, collecting fragments)
- Scaffolding needed (mobile scaffolding, specifically constructed scaffolding, platforms, ladders)
- Existing protective roofs and glass
- Relative archaeological / historical / artistic importance

Based on these criteria, priority lists have been made out. The young professionals decided to establish two lists depending on the complexity and quantity of emergency interventions. By doing a second survey the lists have been created as a "Tomb List" (19 tombs) with the necessity of several treatments combined to a complex organized worksite and a "Spot List" (10 tombs) with more punctual emergency intervention per tomb, which can be probably done by a team of two conservators (see priority lists below).

With the mapping of the priority lists on the site map combined with the mapping of scaffolding possibilities, the participants were able to decide where to start the conservation work (see appendix). The decision has ultimately been influenced by the logistical criteria, since mainly all the selected tombs were endangered especially in the areas of decorative elements. The final decision depended on several aspects: the group of tombs at the western end of Porta Nocera Necropolis

(PN_OS_27 and PN_OS_29) and the Via Nucerina Necropolis haven't been sufficiently accessible due to the current excavation. Single standing tombs (PN_OS_3, PN_EN_30) have not been considered as complex worksites from a practical point of view because they would have required separating the groups and working on several tombs. Tombs with protective glass dropped out (PN_OS_9, PN_ES_11, PN_ES_19, VN_N_D) – although some had a high priority due to their endangered painted surfaces – since it was not possible to get the permission for dismantling the glass in time before the ending of the campaign. Some single standing tombs required specifically constructed scaffoldings for a low amount of emergency conservation work (PN_ES_3, PN_ES_7).

The selection of the tombs PN_EN_4, 6, 10, 12 and 14 was not mainly done by the procedure of exclusion. This group of tombs has been chosen for starting the work from a practical and logistical point of view (flat area, flexibility because of the possibility of movable scaffoldings, proximity to the depot, possibility to set a complex worksite integrating several tombs) and due to the amount of endangered stucco on each tomb. In comparison to the state of conservation of 2014 the urgency of emergency measures on these tombs was obvious, as big parts of the Intonaco have already fallen down during one year (PN_EN_6, PN_EN_14, figg. 1, 2, 3, 4). A further reason was the continuation of the Preliminary Campaign, since the tomb PN_EN_14 has already been documented very detailed in year 2014.

Furthermore after excavation stop in Via Nucerina Necropolis and reorganization of groups the participants selected two more tombs. The tombs VN_N_A and VN_N_F have been chosen because of their endangered plaster surfaces with Dipinti, the huge loss of plaster since 2014 (VN_N_A, figg. 5, 6) and the urgency of interventions to prevent damages during following excavations (VN_N_F). The work in Via Nucerina Necropolis could be started soon after excavation stop, since there has been no need of scaffoldings.

fig. 1: PN_EN_6_S State of Conservation 2015

fig. 2: PN_EN_6_S State of Conservation 2014



fig. 3: PN_EN_14_S State of Conservation 2015

fig. 4: PN_EN_14_S: State of Conservation 2014



fig. 5: VN_N_A_S State of Conservation 2015

fig. 6: VN_N_A_S State of Conservation 2014



Priority Tomb-List

Tomb	Danger for Tourists	Decorative Elements	State of Cons. Plaster: Detachment	Static Problem	State of Cons. Masonry	Preparatory Work needed	Scaffolding	Observations, Suggestions	Archaeological, historical, artistic importance
PN_OS_29	cornice instable	stucco	X	-----	maybe top	kill plants biodeterioration Between 29-27 and 29-31; before building the scaffolding collect fragments	X differeents levels, 2 scaffoldings at front (40 cm) and backside (70 cm)	-----	-----
PN_OS_27	static	stucco	X	X	X Consolidation of bricks needed; Lack of mortar	Consolidation of bricks Collect fragments	X Same as at 29	Archeological excavation (protect surface)	
PN_EN_2	Hole at backside	Wall painting in Chamber	Cannot see inside	-----	X Lack of bricks	Permission needed to go in the chamber	Scaffolding longer than 4 m	Craftsmen's work	
PN_EN_4	-----	Dipinti Stucco	X	-----	X Consolidation of bricks, Cracks above the inscription	Kill plants Consolidation of bricks Collect Fragments	X 40 cm between tombs	Craftsmen's work	X
PN_EN_6	-----	Stucco Dipinti Graffito	X	-----	X	Kill plants Consolidate bricks Collect fragments	X 40 cm between tombs	-----	X
PN_EN_10	-----	Stucco Dipinti	X	-----	X	Consolidate bricks Collect Fragments	X 40 cm between tombs		X
PN_EN_12	-----	Stucco Dipinti	X	-----	X Lack of mortar	Collect Fragments	X 20-40 cm between tombs	Fragments are falling down, Cornice bricks fall?	X
PN_EN_14	-----	Stucco Graffito	X Piece of plaster behind another	-----	X Lack of mortar	Kill plants Consolidation of bricks Collect fragments	X 20 cm between tombs		X
PN_EN_30	-----	Stucco Graffito	X	X		Kill Plants	X Maybe platform with movable Scaffolding	Re-attach collected fragments	X
PN_ES_3	-----	Stucco Dipinto	X	-----	X Cornice	Kill plants Collect Fragments	X Round tomb	Check epigraphy	X
PN_ES_7	-----	Painting Stucco	X	-----	X Cocciopesto damaged Roof damaged Architrave damaged	Kill plants, Biodeterioration Collect Fragments	X For the top of the roof		X
PN_ES_9 PN_ES_11	-----	Stucco Dipinto Painting	X Dangerous cracks urgent	modern tiles		Kill plants	X	Proposal to change the system of the glass protection and roof, glass protection damaged	X
PN_ES_13	X Plaster falling down on the street;	Stucco	X	-----	-----	Check the travertine pieces on the top; Collect fragments	X	-----	X

Tomb	Danger for Tourists	Decorative Elements	State of Cons. Plaster: Detachment	Static Problem	State of Cons. Masonry	Preparatory Work needed	Scaffolding	Observations, Suggestions	Archaeological, historical, artistic importance
	Travertine on top?								
PN_ES_17		Stone Capitals Painting	X		X Bricks (arch, columns)	Kill plants, check roof, check capitals and consoles	Ladder		X Bricks, no tiles
PN_ES_19		Stucco Painting	X			Kill plants	X	Proposal to change the system of the glass protection and roof, Glass damaged, corrosion of the metal construction on the plaster	X
VN_N_A		Dipinti	X				X Platform Maybe complete	Problem with old protecting roofs	
VN_N_D		Dipinti	X				X Platform	Problem with old protecting roofs	
VN_N_F			X				Maybe not needed	Problem with old protecting roofs	

Priority Spot-List

Tomb	Danger for Tourists	Decorative Elements	State of Cons. Plaster: Detachment	Static Problem	State of Cons. Masonry	Preparatory Work needed	Scaffolding	Observations, Suggestions	Archaeological, historical, artistic importance
PN_OS_31					Stone detachment		X	Remove bird excrement from lion	
PN_OS_23			X		X Lack of mortar			Maybe in other campaign	
PN_OS_13		X Stucco, the only rest of whole monument	X			Check cornice	Ladder		
PN_OS_1	Material collapsing, tourists stay here because of shadow		X		X On the Top (Craftsmen's work)	Check cornice Put a barrier for Tourists	X Territory is not high	Craftsmen's work	
PN_OS_3						Check cornice, especially the south-east side			
PN_OS_29						Check epigraphy			
PN_OS_9	X Concrete of Reconstruction		X			Create a barrier for Tourists	We don't know yet		
PN_EN_20	?	X	X Consolidate	?					
PN_EN_38			X Consolidate	?			Ladder?		
PN_ES_5	X			X Left corner of facade			Ladder	Inside we can test methods and materials	

5 State of Conservation

In the 2015 campaign, the state of conservation was acquired for the tombs no. PN_EN_4/6/10/12/14 and VN_N_A/F considering only damages on the façade. Our work is based on the report by M. Martelli Castaldi. Former research about the state of conservation was done by Monica Martelli Castaldi (report 22 September - 16 November 2014), where she gave a general overview about condition of the tombs, damage genesis and an analysis about the water situation. Christina Elsässer (Report 2014) did a research about the state of conservation on the tombs PN_EN_14 and PN_ES_7. She did a mapping to following damages on the tomb PN_EN_14 and built a short conclusion:

Damages mapped by Christina Elsässer
Damage of Masonry
cracks in masonry (<i>attention: no cracks in masonry, therefore no maps!</i>)
eroded brick (round flushed out)
eroded lava (round flushed out)
missing mortar
powdering mortar
presumably powdering mortar
scaling (exfoliating) brick
scaling (exfoliating) lava
Damages of Plaster
Cracks staying at the surface
Deep Cracks (presumably reaching through all plaster layers)
Delamination (detachment) from structure
Delamination (detachment) Intonaco from preparatory layers
Delamination (detachment) preparatory layers from each other's
Intonaco flaking
Intonaco powdering
Intonaco scaling
Preparatory layers flaking
Preparatory layers powdering
Preparatory layers scaling
Collapsing areas
Loose plaster fragments, collapsing
Lacunae, collapsing
Loose stones, brick and architectural elements
Biological Overgrowth
microbiological overgrowth
mosses
plants

General state of conservation

“At a first superficial view, the general conditions of the Necropolis appear healthy. The area is kept clean and in order, as a careful cut of the vegetation is carried out regularly. In reality, looking at the monuments with major attention and detail, the state of conservation of some structures gives a different impression and the conditions of the surfaces appear definitively bad, with a very high risk of losing the remains of decorations.” (Monica Martelli Castaldi, report 2014, p.49).



Fig. 7: South side of the tombs PN_EN_10, PN_EN_12, PN_EN_14

PN_EN_DSC_0307

Structure: the structure seems to be stable, as there are no static cracks visible on these tombs. “But the difficulty in Pompeii’s archaeological sites is that structures and surfaces don’t give clear sign of alert for a possible weakness, they simply suddenly collapse.” M. Martelli Castaldi P.51. Generally the structure is in a bad condition. The cornices of the tombs have many big cracks, detachments and architectural elements in danger to collapse. Mostly on the roof and cornices, but also on masonry of the walls, are growing plants. The water cannot run off probably from the roof (fig. 8). In a height of 1.50- 2m you can find a lot of sanding bricks and stones which have been already eroded partly. Also, the join mortar is missing in these areas (fig. 7 PN_EN_10).



Fig. 8: damaged cornice PN_EN_4_6_DSC_0426

PN_EN_10_E_IMG_4006

PN_EN_6_W_IMG_0110

Plaster: the general condition of plaster on the tombs is, as MONICA MARTELLI CASTALDI already described, in a really bad condition. On the main parts of the tombs the masonry is visible, so there are big lacunae of plaster or islands of plaster inside the lacuna.

Main damage is detachment / delamination of plaster layers (from structure or from each other). Nearly all plaster is detached and therefore unstable. Fragments on the ground in front of the tombs show the high risk of collapsing plaster. In addition to the detachments there are often big cracks up

to 4 mm wide, which are building the border of the detachment. They can appear vertical from the cornice down through every plaster layer. These cracks are visible on every tomb. The damage potential lies not only within the instability for plaster but also within the possibility of water penetration. Furthermore the preparatory layer is very weak and big parts are sanding / powdering. This loss of binder causes a missing adhesion to the structure.



Fig. 9: damaged plaster PN_EN_12_S_IMG_4230

PN_EN_12_S_DSC_0521

VN_N_A_S_DSC_0133

Surface: the very flat and polished surface of the Intonaco is interrupted by scaling. Layer internal, parts of the surface stick out in different forms; concave, roof shaped, little blister or pustule, bigger blister and bubbles, flaking with a lot of fine cracks, little explosions. The result of scaling is a loss of the polished surface (lacuna, original Intonaco surface is missing). These damaged areas of Intonaco are rough, often sanding and buffer humidity for biodeterioration.



Fig. 10: damaged surfaces

PN_EN_6_S_DSC_0366

PN_EN_6_E_IMG_4046

Damages and phenomena

Following damages and phenomena were registered:

Damages & Phenomena	Comment
Lacunae → eroded brick & stone → missing join mortar → preparatory layer + Intonaco is missing → preparatory layer surface + Intonaco is missing → Intonaco is missing → Intonaco surface is missing	Not mapped in situ
Movable detachment Not movable detachment → a) detachment of preparatory layer from structure → b) detachment of preparatory layer from each other → c) detachment of Intonaco from preparatory layer → d) detachment of Intonaco with missing preparatory layer	Mapped in situ
Sanding / powdering plaster → preparatory layer → Intonaco Sanding / powdering masonry → brick → stone → joint mortar	Mapped in situ Mapped in situ
Scaling → preparatory layer → Intonaco <ul style="list-style-type: none"> ➤ concave, roof shaped ➤ little blister or pustule ➤ bigger blister and bubbles ➤ flaking with a lot of fine cracks ➤ little explosions 	Mapped in situ but not detailed
Cracks → big cracks 2-4 mm → Middle Cracks 0,5-2 mm → Fine cracks <0,5 mm → Cracks inside structure	Only big cracks mapped in situ

Biological growth	Not mapped in detail
Salts	Not mapped

Damage genesis

Humidity (Rising damp, condensation, rain water): moisture carries soluble substances. This can be soluble salts transported to the regions near the surface. In different phases moisture can ingress into the plaster and structure and can proceed the process. That's why humidity is a part of the damage genesis of salts. → salts and resulting deterioration

Furthermore moisture can take out binder from the plaster or/ and concentrate it. Rain water can dissolve/ flush out binder from the surface or from the uncovered edge (plaster particles as sands are visible). This causes a loss of adhesion and cohesion. → Detachments, sanding and powdering plaster and masonry

Materials inside the plaster, such as clay minerals, can undergo hygroscopic expansion while the wetting and drying cycles. The change of volume can blow up the plaster thus cause damage. → Scaling, sanding powdering plaster and masonry

Moisture is necessary for biological growth. → plants, biodeterioration

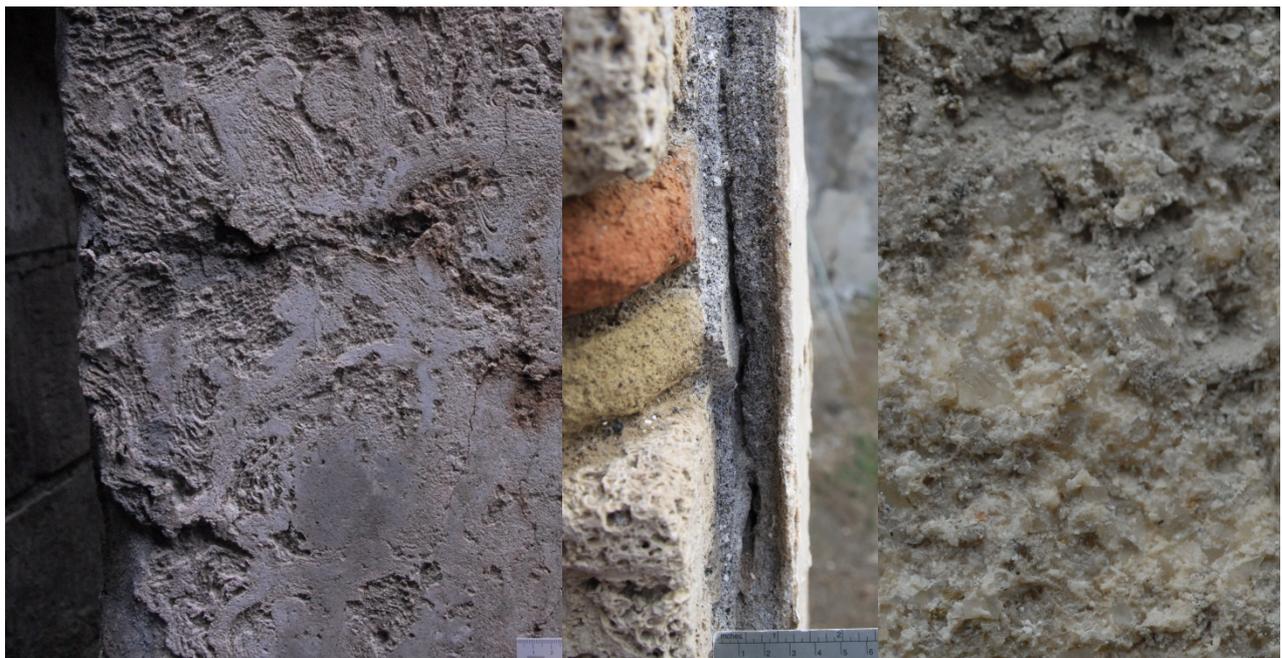


Fig. 11: Deterioration by humidity & salts Pn_OS_29_S_DSC_0351 PN_EN_12_S_IMG_4229 PN_EN_12_S_DSC_0254

Salt loading: the soil, construction materials and depots for salts which can be carried by water. Up to a height of 2 m from the ground salts are concentrated. Permanent wet masonry and plaster (at least in autumn) carry salts to zones near the surface and accumulated them there. Both efflorescence and subflorescence can occur. Changes in volume due to dissolution and recrystallization of salt minerals lead to a reduction of cohesion and hence a detachment of plaster and destabilization of the masonry. The attrition causes a fine granular disintegration and this determines a slow loss of fabric. → scaling, deformation, detachment, sanding plaster and masonry, cracks

Biological growth: biodeterioration can intensify the damages. All biological growth buffers the humidity and the surface is for a longer term wet. The roots of the plants can destroy the structure by mechanical exposure. → scaling, sanding plaster, cracks

Construction technique: the original construction technique can also cause some damages. The Intonaco (denser) and preparatory layer (weak) probably cause big tension between the plaster layers. Also movement in the structure can cause detachments and cracks. → cracks, detachment

Previous conservation materials: techniques or materials applied in the past which can lead to additional or accelerated deterioration of original materials. Probably a brownish yellow coating (polymer layer of a former conservation treatment) causes a strong surface tension on the plaster (e.g. it impedes vapor diffusion and/or tends to expand). This coating/ resins can be a possible nutrient media for the biodeterioration. Former fillings and edges with a strong material (like cement) can damage the very weak original plaster. Also cement plaster can contain salts. → scaling, cracks

Missing/ Perpetuated research

Structure: it is missing a research about the condition of the structure together with an engineer or architect, to have a base for the conception of the interventions together with an archaeologist. The cornices of the tombs have a lot of big cracks, detachments and architectural elements in danger to collapse, so maybe there are constructive and/ or reconstructive methods necessary. The research should figure out, if there are “dangerous” movements of the masonry.

Humidity: a research to water moving inside the Necropolis has been already done, but it is missing a research of moisture transport (especially rain water) on the tombs with a dedicate view on salt movability. This is important for the conception of the interventions (idea of reconstructed the roof). Measurements about humidity content + Temperature for all the layers would be good to understand the process of drying and salt crystallization.

Salts: research/ documentation about salt horizons (with height? On every wall?), to get a better idea of the genesis, is missing. Main questions are:

Which kind of salts? → To see possible reactions with new consolidation materials (Nano Estel®, Nanorestore®)

Quantity of salts? → To understand the situation for new consolidation/grouting

Origin of the salts? → to possibly minimize the contribution of salts

“A third study, which could be of immense help for the conservation community, and absolutely essential for the conservation in archaeological sites, is a new approach to salt presence and decay mechanisms (useful both for the decorative features, and for the mobile artifacts found during the excavation). A necessary and not really existing way of considering the problem, as this subject has been generally approached as a “battle against a very dangerous enemy (...)” (MARTELLI CASTALDI 2014, p.71).

Biodeterioration: which kind of biodeterioration is on the tombs?

It is necessary to know, to see, if there are possible reactions with new consolidation materials.?

Research about the damages genesis is missing. Possible question: is the coating a nutrient media?

Former conservation materials: what kind of "coating/consolidant" is on the tombs?

This is necessary to understand the reactions and ageing and if the coating causes (or contribute) to surface scaling. The research is also good to improve the new consolidant.

How deep was the penetration of the material? If it causes damages, it is also necessary to find a proper solvent and methods to extract them.

Need of treatment

The most important need of treatment is to stabilize the collapsing areas (mostly detached plaster and some structural elements). Therefor it is necessary to some preliminary works (like consolidate sanding plaster etc.). After that it is very important to avoid, that water can run inside the plaster (edging repair).

Immediately

- Movable detachments: The damage potential is very high. There is a risk of losing plaster because of missing adhesion.
- Sanding plaster: To build a proper ground for following conservation treatment, a structural consolidation is necessary
- Big Cracks: high damage potential, because penetration of water is given and cracks are making the plaster unstable
- Salts, need of treatment after research is high, because is one of the main damages causes
- Biological growth, need of treatment is high, to build a proper ground for following conservation treatment and to avoid an expansion

For the other damages is also a need of treatment given, but the damage potential is not so high or there is more research necessary before acting. For example, develop a conception for the structural problems.

Not immediately, but monitoring and future intervention

- Sanding bricks and stones: can become eroded (round flushed out).
- Scaling (but need of research is high!!!)
- Middle cracks
- Structural problems, cornices, cracks etc. (but need of research is high!!!)

6 Material Tests

BINDERS

SLAKED LIME			
NAME	TYPE	ORIGIN/MANUFACTURE	COLOUR
B1	Slaked lime 3 years old	Cimmino Calce, Casoria (NA), Italy	White
B2	Slaked lime 1 year old	Cimmino Calce, Casoria (NA), Italy	White
HYDRAULIC LIME			
NAME	TYPE	ORIGIN/MANUFACTURE	COLOUR
B3	Calce romana	Brigliadori Fornace, Santarcangelo di Romagna (RM), Italy	Pale reddish-pinkish
B4	Mariensteiner HL5	Rohrdorfer Zement, Munich, Germany	Grey

REACTIVE LIME (WITH SOME QUANTITIES OF NOT HYDRATED OXIDS)			
NAME	TYPE	ORIGIN/MANUFACTURE	COLOUR
B5	Burnt limestone	Weimar 2005 For information ask Klaus Klarner	White
B6	Burnt limestone	Ballenberg 2005 For information ask Klaus Klarner	White

MORTAR FOR INJECTION ALREADY PREPARED			
NAME	TYPE	ORIGIN/MANUFACTURE	COLOUR
B1.1	Malta da iniezioni e riempimento	For information ask Monica Martelli Castelli	Pinkish, brownish
---	PLM-AL	CTS Europe, Naples, Italy	

SANDS

HYDRAULIC			
NAME	TYPE	ORIGIN/MANUFACTURE	COLOUR
S1	Biopozzolana	Cimmino Calce, Casoria (NA), Italy	Brownish
S2	Pozzolana "fine powder, ventilate".	For information ask Monica Martelli Castelli	Grey
S3	Pozzolana	From building supplies store	Brownish. It does not give much colour to the mortar.
S4	Brick powder	For information ask Monica Martelli Castelli	Red
NOT HYDRAULIC			
NAME	TYPE	ORIGIN/MANUFACTURE	COLOUR
S5	Limestone sand	For information ask Monica Martelli Castelli	Grey
S6	Siliquarzite with fibres	For information ask Monica Martelli Castelli	Yellowish

S7	River sand	Local sand For information ask Monica Martelli Castelli	Brown, red, yellow, black
S8	Local limestone	Cava dei Tirreni (SA), Italy For information ask Monica Martelli Castelli	Beige
S9	Red stone	For information ask Monica Martelli Castelli	Red
S10	Basalt	For information ask Monica Martelli Castelli	Black
S11	Marble	For information ask Monica Martelli Castelli	White
S12	Marble	For information ask Monica Martelli Castelli	White

MORTAR TESTS

PREPARATORY LAYER

NAME	PROPORTIONS	BINDER	SAND A	SAND B	SAND C	SAND D	SAND E	OBSERVATIONS
P 1	1:3	(1) B1	(1 ½) 0.8 mm ≤ S7 < 2 mm	(1 ½) S7 < 0.8 mm				
P 1.2	1:2	(1) B1	(1) 0.8 mm ≤ S7 < 2 mm	(1) S7 < 0.8 mm				
P 2	1:3	(1) B2	(1 ½) 0.8 mm ≤ S7 < 2 mm	(1 ½) S7 < 0.8 mm				
P 2.2	1:2	(1) B2	(1) 0.8 mm ≤ S7 < 2 mm	(1) S7 < 0.8 mm				
P 3	1:2	(½) B3 + (½) B2	(1) 0.8 mm ≤ S7 < 2 mm	(1) S7 < 0.8 mm				
P 4	1:2	(½) B4 + (1) B1	(1 ½) 0.8 mm ≤ S7 < 2 mm	(1 ½) S7 < 0.8 mm				
P 5	1:3	(1) B1	(1 ½) 0.8 mm ≤ S7 < 2 mm	(1) S7 < 0.8 mm	(½) 0.8 mm ≤ S10 < 2 mm			
P 6	1:3	(1) B1	(½) 0.8 mm ≤ S7 < 2 mm	(½) S7 < 0.8 mm	(1) S10 < 0.8 mm	(1) 0.8 mm ≤ S8 < 2 mm		¼ of B1 was added because the mortar was too dry
P 6.2	1:2	(1 ½) B1	(½) S7 ≥ 0.8	(½) S7 < 0.8 mm	(1) S10 < 0.8 mm	(1) 0.8 mm ≤ S8 < 2 mm		
P 6.2 new Mainly	1:3	(1) B2	(½) S7 < 0.8 mm	(½) 0.8 mm ≤ S7	(¼) S10 < 0.8	(½) 0.8 mm ≤	(1) 0.8 mm ≤ S8	

used Version				< 2 mm	mm	S10 < 2 mm	< 2 mm	
P 6.4	1:3	(1) B2	(1 ½) S7 < 0.8 mm	(½) S8 < 0.8 mm	(1) S10 < 0.8 mm			
P 7	1:2	(1 ½) B1	(1) S7 < 0.8 mm	(1) S8 < 0.8 mm	(1) S8 ≥ 0.8 mm			
P 8	1:3	(1) B1	(1 ½) 0.8 mm ≤ S7 < 2 mm	(1) S7 < 0.8 mm	(½) 0.8 mm ≤ S10 < 2 mm			0.05 volume of B1 was added because the mortar was too dry
P 9	1:3	(1) B1	(2) S5 < 0.8 mm	(1) S6				S6 is not sieved
P 10	1:3	(1) B1	(3) Sand taken in between the tombs					
P 11	1:3	(½) B1 + (½) B4	(1) S5 < 0.8 mm	(1) S10 < 0.8 mm	(1) S7 < 0.8 mm	(⅓) S10 ≈ 2 mm		
P 16	1:3	(1) B1 with fibres	(2) S7 < 2 mm	(½) 0.8 mm ≤ S8 < 2 mm	(½) 0.8 mm ≤ S10 < 2 mm			Add a little bit of pozzolana (ca. 2%) when it has to be used.
P 16 Mainly used Version	1:3	(1) B1 with fibres (hemp)	(1) 0.8 mm ≤ S7 < 2 mm	(1) S7 < 0.8 mm	(½) 0.8 mm ≤ S10 < 2 mm	(½) 0.8 mm ≤ S8 < 2 mm		Add a little bit of pozzolana when it has to be used.
P 18	1:3	(1) B1	(2) 0.8 mm ≤ S7 < 2 mm	(1) S7 < 0.8 mm				
P 19.1	1:3	(1) B2	(2) Lapillo	(0.25) S3 < 0.8 mm	(0.5) 0.8 mm ≤ S3 < 2 mm			Lapillo taken from the ground of Via Nucarina Necropolis
P 19.2	1:4	(1) B2	(2) Lapillo	(0.25) S3 < 0.8 mm	(0.5) 0.8 mm ≤ S3 < 2 mm			Lapillo taken from the ground of Via Nucarina Necropolis
P 19.3	1:5	(1) B2	(2) Lapillo	(0.25) S3 < 0.8 mm	(0.5) 0.8 mm ≤ S3 < 2 mm			Lapillo taken from the ground of Via Nucarina Necropolis

INTONACO

NAME	PROPORTIONS	BINDER	SAND A	SAND B	SAND C	SAND D	SAND E	OBSERVATIONS
P 12	2:3	(2) B1	(1) S8 < 0.8 mm	(½) S8 ≥ 0.8 mm	(1) S6	(½) S5 < 0.8 mm		S6 is not sieved

P 12.2	1:2	(1.5) B1	(∅) S8 < 0.8 mm	(∅) 0.8 mm ≤ S8 < 2 mm	(1) S6	(∅) S5 < 0.8 mm	(∅) Marble powder	S6 is not sieved
P.13	1:3	(1) B1	(1 ½) S8 < 0.8 mm	(∅) S8 ≥ 0.8 mm	(1) S5 < 0.8 mm			
P 13.2	1:2	(1 ½) B1	(1) S8 < 0.8 mm	(∅) S8 ≥ 0.8 mm	(1) S5 < 0.8 mm	(∅) Marble powder		
P 14 Mainly used Version	1:3	(1) B2	(1) S7 < 0.8 mm	(2) S6 < 0.8 mm				
P 14.2 Mainly used Version	1:3	(1) B2	(∅) S7 < 0.8 mm	(∅) 0.8 mm ≤ S7 < 2 mm	(1) S6 < 0.8 mm	(1) 0.8 mm ≤ S6 < 2 mm		
P 15	1:3	(1) B2	(1) S8 < 0.8 mm	(1 ½) S6 < 0.8 mm	(∅) Marble powder			
P 17	1:3	(1) B1	(∅) S3 < 0.8 mm	(∅) S3 ≥ 0.8 mm	(1) S7 < 0.8 mm	(1) 0.8 mm ≤ S7 < 2 mm		

CONCLUSIONS

First general conclusion regarding the binders:

It would be better to use the binder B2 (one year old) instead of B1 (three years old). Binder B1 becomes quite dry and it is difficult to mix. For this reason it is almost always impossible to prepare a mortar with proportion 1:3, which would be a convenient proportion for a mortar that is not too strong. Binder B2 is better for the preparation of a mortar with proportion 1:3 because it is easy to prepare and the lime is less strong. For this reason binder B2 is more appropriate for the intentions of the conservation treatment.

Second general conclusion:

According to the huge variations in textures and colours of the mortars in the necropolis due to the use of different constitutive materials and because of the degradation, it is necessary to make some variations with the chosen mortars (colour and grading curve of the sands) in relation to the context.

Preparatory layers

The tests P 6 and P 6.2 gave good results in colour and texture but the three years old lime (binder B1) was too dry and difficult to mix and strong.

For that reason a new mortar was performed using the same sands but changing the binder (binder B2 was used instead binder B1).

Nevertheless it is necessary to adapt the proportions of the different sands and the grading curve in relation to the context. For example the colour of the ancient mortar in the tomb PN_EN_6 is clearer than the mortar P 6.2 new and it was necessary to reduce the quantity of S10 <0.8 mm.

Edging repair (preparatory layers)

The mortar **P 6.2** was good in different situations but **it is convenient to change the binder and use a proportion of 1:3. Besides the colour and texture** of the mortar have to be adapted as argued above.

If the mortar is not suitable or appropriate because the context is very dark, it has to be changed. It is possible to prepare a new dark mortar using dark sands, for example **S3** or **S10**, or using hydraulic dark binders (as in the case of P 11).

Behind plasters and old mortars (hidden mortar)

For the inside parts of the detachment it is useful to add to the mortar **P 16** a little bit of pozzolana. This allows a better adhesion to the masonry and a better carbonization.

Also **P 18** can be used and it could be appropriate for the fillings in between the preparatory layers (better is to use the binder B2).

Holes: for small holes mortars P 16 and P 18 with binder B2 were used. The same mortars were used also for big holes, adding sands with bigger grading curve and stones.

Intonaco

Mortars P 14 and P 15 were used for fine Intonaco, but it is important to make variations in relation to the context (colour and texture). Mortars P 12, P 13, P 12.2 and P 13.2 could be good if the Intonaco is wrinkled, but it is necessary to make colour variations and use binder B2 (in proportion 1:3). Notice that mortars P 12.2 and P 13.2 are lighter because of the marble powder.

The mainly used mortar was the P 14.2.

7 Preparatory Work

Collecting fragments: the local areas of the tombs are partially covered with broken off plaster fragments. There are several reasons supporting the need of their collection:

- protection against destruction due to tourists, scaffolding building, conservation work on site
- protection against continuing degradation due to environmental influences
- storing and inventory for potentially reattachments in future

As the figures no 12 and 13 south side of tomb PN_EN_14 exemplarily show, especially larger plaster-elements with a remaining Intonaco-layer can be relocated on the tomb. The preservation of the Intonaco-fragments therefore is important to maintain the possibility to reattach them in further restauration-work. It is for this reason that collecting, storing and inventory has to be done in a systematical way that ensures the re-identification of related elements.



Fig. 12 PN_EN_14_S_DSC__0344



Fig. 13 PN_EN_14_S_DSC_0352

Following guideline for the approach of collecting broken-off fragments has been developed by the young professionals:

- Needed equipment: plastic-box, bucket, brush, scale, camera, paper, cardboard, pencil.
- First: get an overview of the area and the fragments and decide which fragments to collect.
- Take an overview photo of the area with scale and tomb number (nomenclature of the PSPP).
- Cleaning the area (be careful of fragments under the grass).
- Write the tomb number and the position (e. g. PN_EN_6_S) with a pencil on a sheet of paper. Use the sheet for photographical documentation and put it into the box with the fragments.
- Take two photos of the area in general: the tomb and the fragments must be visible.
- Take two photos of the fragments in detail: shape and size must be visible (if you consider that the photo in general is detailed enough to identify shape and size, just take this)
- How to take the photos: take the photos from left to right, notice each photo-number and put the note into the box. Take the same photo twice: one with scale and one without because the scale can cover fragments.
- How to put into the box: put the fragments into the box in the same order you located them on the ground. If layering is needed in the box, separate the layers with a cardboard.
- In the case of a big heap of fragments you have to work in several layers according to the order *in situ* (this also includes photography).

The plastic boxes that have been used for collecting and storing the fragments are a temporary solution only. Standardized boxes of the Soprintendenza would have been necessary. The collected fragments have been stored in the depot-building (II,8,1) of the summer-academy. Due to the leaking roof, this storage location is a temporary solution too. It would be the best to store the fragments all together in a general depot of the Soprintendenza. Even if the most endangered fragments have been collected, the huge amount of and the lack of time forced the young professionals to stop the action at the beginning of October. Especially the layers of fragments in between the tombs PN_EN_4 and PN_EN_6, PN_EN_10 and PN_EN_12, PN_EN_12 and PN_EN_14 couldn't be collected due to the slow manner of proceeding that was necessary here (Figg. 14, 15, 16).



Fig. 14

PN_EN_4_and_PN_EN_6_DSC_0063

Fig.

15PN_EN_4_and_PN_EN_6_DSC_017

8_

edited



Fig.16. PN

Buying materials and organizing worksite: Before starting the campaign and starting the work in the necropolis the materials and the worksite had to be organized. Materials, which weren't brought from Munich, have been bought in the beginning and during the campaign in local stores and CTS (lime, sands, special tools, etc.). All the conservation materials, machines and tools have been stored in the depot (Pompeii, II, 8, 1). Since there was no possibility to store the materials next to the tombs, it was necessary to bring the relevant materials and machines every day to the worksite and back to the depot. For the setting of the worksite it was needed to organize scaffoldings and fences as barriers for tourists. On the back of the tombs PN_EN_12 and PN_EN_14 it was possible to place the power generator, the compressor and the foam machine for the preparation of the foam mortar. When two participants began to work at Via Nucерina Necropolis it was necessary to organize a second depot close to the worksite and a second power generator.

Organization of scaffolding: The tombs of the Necropolis are normally very high and for this reason scaffoldings are needed in order to reach the whole surfaces, have a detail overview of that assessment condition and work. Nevertheless a general overview of the state of conservation is possible also without scaffoldings. All the young professionals went around the Necropolis and had a look for this in order to draw up the list of tombs which needed a conservation treatment.

After this they checked where it was possible to use only a ladder and where scaffoldings were needed. Due to the different levels of the ground, to the shapes of the tombs (for example some are round or they have bases and cornices) and to their position (most of them are very close to each other), movable scaffolding or built scaffolding where needed and in some cases also a platform was necessary (see appendix).

After an internal discussion about the different ideas for the scaffoldings and the priority list of tombs, two young professionals went around the Necropolis with the persons in charge of the scaffoldings'

company in order to show them their ideas and discuss about the possibility of building different kind of scaffoldings, the best solutions and the time needed. During the discussion were also pointed out the problems for the construction of scaffoldings. Indeed there are some places where the space is too narrow, for example the distance in between the tombs PN_EN_12 and PN_EN_14 and in the future it will be needed to find a solution to work also in these areas.

After the discussion with the persons in charge of the scaffoldings' company, the young professionals chose all together the tombs where they wanted to work and the best solution for the scaffoldings.

The choice was to use movable scaffoldings. They cannot be very high (ca. 4 meters) but it was enough for the kind of treatment requested. Besides the young professionals could move them very easily and this point was very important because they could reach different parts of the surface and check and take photos of the treated areas in a very clear way (without the scaffolding's tubes). Nevertheless in between the tombs PN_EN_4 and PN_EN_6 the space was too narrow (ca. 40 cm) and the ground was covered by plaster's fragments. For this reason built scaffolding was needed.

Killing off and removal of plants: the biological growth all over the necropolis cause several problems. One of the most significant is the plant growth inside the masonry of the tombs. Roots and plant shoots spread between the building elements and the plasters by breaking them slowly but steady. This leads to cracks and detachments but also to retention of moisture in the structure. A second issue is the biodeterioration which can be located mostly on the plasters and cause almost the same damages but on a more microscopic level. For this reasons killing and removal of each kind of biological growth has been done as preparatory work before the emergency conservation treatments at the tombs of high priority. The biocide Preventol R180® was used in a dilution of 2 % in demineralized water, like it is recommended in the material data sheet. The actual effectiveness of the biocide must be verified in the next campaign. A steady control of the biological growth all over the necropolis would be of importance for the future preservation of the tomb monuments.



Fig. 17 PN_OS_29_N_DSC_0209

Fig. 18 VN_N_A_IMG_4113_edited



Fig. 19 PN_

Documentation: a further issue of the preparatory work is the development of documentation sheets for recording the tombs in general, their state of conservation and the performed treatments. For this, three kinds of sheets have been designed – general information, state of conservation and treatment sheet (see appendix) – in the shape of tables with a combination of check-, text- and image-boxes. The »general information sheet« has been designed as a survey about the entire tomb including its location, typology, dimensions, dating, historical structure like e.g. construction technique, building materials and surface decoration as well as modern additions like e. g. previous interventions or protective devices. The »state of conservation sheet« gives a review of the different kind of damages of each side of the tomb whereby masonry and plaster/stucco damages have been separated. Designed with check- and textboxes this is also a kind of checklist for the investigation but with the possibility to specify in textual form. The »treatment sheets« has been created to give a summary about all information regarding each intervention that has been performed at a tomb. Besides period of treatment, persons in charge, kind of damage and treatment, it also states the used materials and quantity (if possible). Further a mapping on the treatment sheet provides information about precise location of each single conservation-action and -material. In the last column of the first page all photos are listed that have been taken before, during and after the treatment. On a second page a textbox allows a more detailed description of the approach and special features during intervention.

8 Practical Work on Site

Organization of groups: During the campaign there were eight young professionals daily working in the necropolis. The team building has been a necessary issue to systemize and simplify the working processes. The first idea has been to work in two internationally organized groups of respectively four participants. During the process of prioritization and the precisely planning of the work the conception changed into work in little groups of two to three people for one tomb depending on the kind and quantity of interventions. The idea was to be more flexible in order to jump from tomb to tomb connected to the plan of doing emergency conservation with preferably simple measures.

The participants started the conservation work in teams of two persons at respectively one side of the tombs PN_EN_4, 6, 12 and 14 with all participants. When the work at Via Nucarina Necropolis started, a reorganization of groups was needed. Two main groups have been built with one referent per group as person in charge for communication and for cases of making quick decisions. Six persons formed the big group at the tombs of Porta Nocera Necropolis and two persons as the second small group worked at the Via Nucarina Necropolis. From that moment the organization of materials and tools was decisive in order to manage and enable a running working process. For this reason one participant was responsible for managing the depot and organizing the material for the worksites.

Bigger groups and working at tombs next to each other was necessary due to the possibility to share tools and materials at the worksite. Within these groups working in two person teams has been efficient. Especially in case of working with foam mortar two persons (not more) were necessary for

temporary fixation measures and preparation and injection of mortar. Treatments like edging repair, filling, using biocide could be done by one person.

9 Conservation works

See separate report by Monica-Martelli Castaldi.

10 Conclusions

The work of the first international Conservation Summer Academy of the POMPEII SUSTAINABLE PRESERVATION PROJECT lasted for 8 weeks. During a final workshop with papers, discussions and guided tours speakers presented the effective restoration measures that were carried out on seven funerary monuments in the necropolis of Porta Nocera were presented to the Soprintendenza of Pompeii. Ten young restorers from five different countries and eight different restoration schools have participated in the Summer Academy and had the chance to learn new emergency techniques to preserve ancient wall-surfaces. In this context, seven of the most endangered funerary monuments in the necropolis of Porta Nocera could be secured.

The other important results of the campaign have been summarized in the introduction to this report as:

- Repair interventions on seven protective roofs located in the eastern portion of the Necropolis that had been in use for more than 22 years and could no longer do their duty.
- Enhancement and improvement of the virtual 3D model of the necropolis and integration in the GIS system of the Soprintendenza of Pompeii on the part of the CNR IBAM directed by Professor D. Malfitana.
- Drawing and planning of a prototype of a modular roof by Arch. Roberta Fornti, TUM. The roof is characterized by being anti-seismic, it is simple to build, made of durable material (steel beams, terracotta on an aluminum frame) and will need no maintenance for many years.
- First use of an innovative type of grouting foam mortar to fill hollow plastered surfaces. This type of grouting was developed in Bavaria during the restoration of baroque ceiling frescos and has been used for the first time on ancient walls in Pompeii, after experimenting it in loco. This grouting is particularly suited to the task because the thin strata of plaster of the ancient grouting are often detached over large surfaces from the body of the monument and among themselves. By using foaming agents bigger pores develop in the mortar structure that reduce greatly the weight of the filling material and thus allow filling also large gaps and detachments.
- The University of Oxford has tested a new datalogger and a miniature weather-station to measure climate on the funerary monuments.

We thank again the Soprintendenza Archeologia di Pompei for the exceptional collaboration. A special thank you goes to the Superintendent Prof. M. Osanna and his team (especially Dr. Annalisa Capurso, Dr. Grete Stefani and Dr. Stefania Giudice) who have supported the summer academy in every possible way thus contributing greatly to its success. A thank you goes also to the instructors of the Summer academy, Dr. Pia Kastenmeier, Prof. Monica Martelli-Castaldi, Klaus Klärner, Dr. hc. Jürgen Pursche, Prof. Erwin Emmerling, to the participants and speakers of the workshop, to the team of the Herculaneum Conservation Project (especially Dr. Jane Thompson und Dr. Paola Pesaresi) and to the untiring participants in the Summer academy. With their work, curiosity and enthusiasm they have made this a very successful campaign.

In the coming years this work needs to be continued to preserve the unique site of the Porta Nocera Necropolis.

11 Sampling

See separate report and list of samples.

12 Report on climate measurements

See separate report by Fraunhofer IBP.

13 Report on protective roof development

See separate report by TUM.

14 Report on activities CNR / digital documentation

See separate report by CNR-IBAM.

Appendix / List of all reports

Final Report

Report on the Conservation Work by Monica Martelli Castaldi

Report by J. Pursche (in German with English and Italian Summary)

Report on Climate Measurements (IBP Fraunhofer, S. Bichlmair)

Report on Protective Roof (TUM)

Report by the CNR-IBAM

Sampling