

METHODOLOGY FOR THE CONSERVATION OF THE FAÇADES IN PETRA

by

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Introduction

Within the scope of the Petra Stone Preservation project, which is jointly implemented by the Department of Antiquities and GTZ (German Technical Cooperation), Tomb 825 (Tomb of Fourteen Graves) was the first rock-hewn façade chosen to undergo conservation measures, since it is representative of the Petra façades in its construction techniques and weathering forms.

The methodology implemented in the conservation of Tomb 825 includes investigative steps that are necessary for the understanding of the monument in terms of its architecture, history and condition, in order to arrive at the appropriate execution measures. Investigation can be effectively achieved by incorporating it in the recording process. The pre-execution conservation steps include recording the existing condition, architectural analysis, condition assessment and preparation of the execution plans. In this article the recording methodology and the condition assessment will be discussed.

Recording of Monuments in Petra

Article 16 of the Venice Charter refers to the importance of recording (ICOMOS 1964). However, it is important to understand that the purpose of recording and documentation is not simply pertained to the drawing, photograph or record which emerges, but also to the meaning or understanding it provides.

Although documentation on archaeological excavations of traditional architecture and monuments in Petra has often been conducted, a well defined methodology for the selection of the appropriate scope, level and

recording methods has not been established. As part of the main objectives of the ongoing preservation project in Petra, developing such a methodology for recording and documenting the monuments is at the heart of the conservation process.

Both traditional and digital recording tools and techniques are used in Petra. In fact, different methods can be combined based on the required scope of recording, and, vector and raster heritage records are produced accordingly. Table 1 illustrates these methods.

Condition Assessment

The weathering forms found on Tomb 825 are representative of the general condition of the Petra façades and monuments (Figs. 1 and 2). The mapping scheme of the weathering forms of the façade shows that about one third of the stone surface can be considered intact, and original stone surfaces can be found in protected areas where masons' toolmarks can still be clearly seen. Moreover, the overall state of this monument typically consists of the main weathering forms which vary in type, intensity, location and distribution.

Taking into consideration the above mentioned weathering forms, three major groups of stone decay can be identified. These include the detachment of stone material, the loss of stone material and the formation of deposits on stone surfaces. Two other categories might be added: one of these is the cracking process that occurs in the rock and includes different forms that differ in size and geological formation, while the other category constitutes the decay of mortars and

Table 1.

Recording level \ Results	A Reconnaissance record	B Preliminary record	C Detailed record
Purpose of recording	<ul style="list-style-type: none"> initial inventory initial planning reference data 	<ul style="list-style-type: none"> planning initial condition investigation stabilization reference data 	<ul style="list-style-type: none"> "as found" condition restoration/intervention monitoring posterity
"Traditional" tools used	<ul style="list-style-type: none"> 35 mm photography sketches 	<ul style="list-style-type: none"> hand recording 35 mm rectified photography 	<ul style="list-style-type: none"> hand recording large format rectified photography stereo-photogrammetry
"Digital" tools used	CAD	<ul style="list-style-type: none"> digitization of images 	<ul style="list-style-type: none"> digital photogrammetry "Total Station" surveys
	images	<ul style="list-style-type: none"> scanning rectification 	<ul style="list-style-type: none"> vectorization of images
Results	<ul style="list-style-type: none"> photographic report photo key plan initial condition - description sketches 	<ul style="list-style-type: none"> measured drawings description - condition observations photographic report 	<ul style="list-style-type: none"> measured detailed drawing description - condition assessment
	<ul style="list-style-type: none"> low-cost electronic product (text, image, drawing) 	<ul style="list-style-type: none"> electronic product (text, image, drawing) 	<ul style="list-style-type: none"> desktop product (text, image, drawing)

plasters. The classification scheme was developed to include weathering types peculiar to Petra, and will be used for future investigations that will be conducted on the monuments. Furthermore, the detailed mapping requires direct accessibility to the whole structure which can be provided by scaffolding construction. The investigation should also include measurements of the salt content and water uptake rates that would be useful in giving additional information concerning the state of deterioration.

Classification Scheme of the Weathering Forms

A) Detachment of Stone Material

1. Granular Disintegration Sanding: Existence of granular or powdery particles in




























the stone.

2. Flaking: Detachment of small, flat, thin pieces of the outer layers of the masonry surface.
3. Scaling: Detachment of large flat layers of uniform thickness which follow the profile of the masonry surface.
4. Exfoliation: Is the detachment of the outer surface of masonry into thin layers which occurs parallel to the masonry beds, sometimes referred to as the "bedding problem".

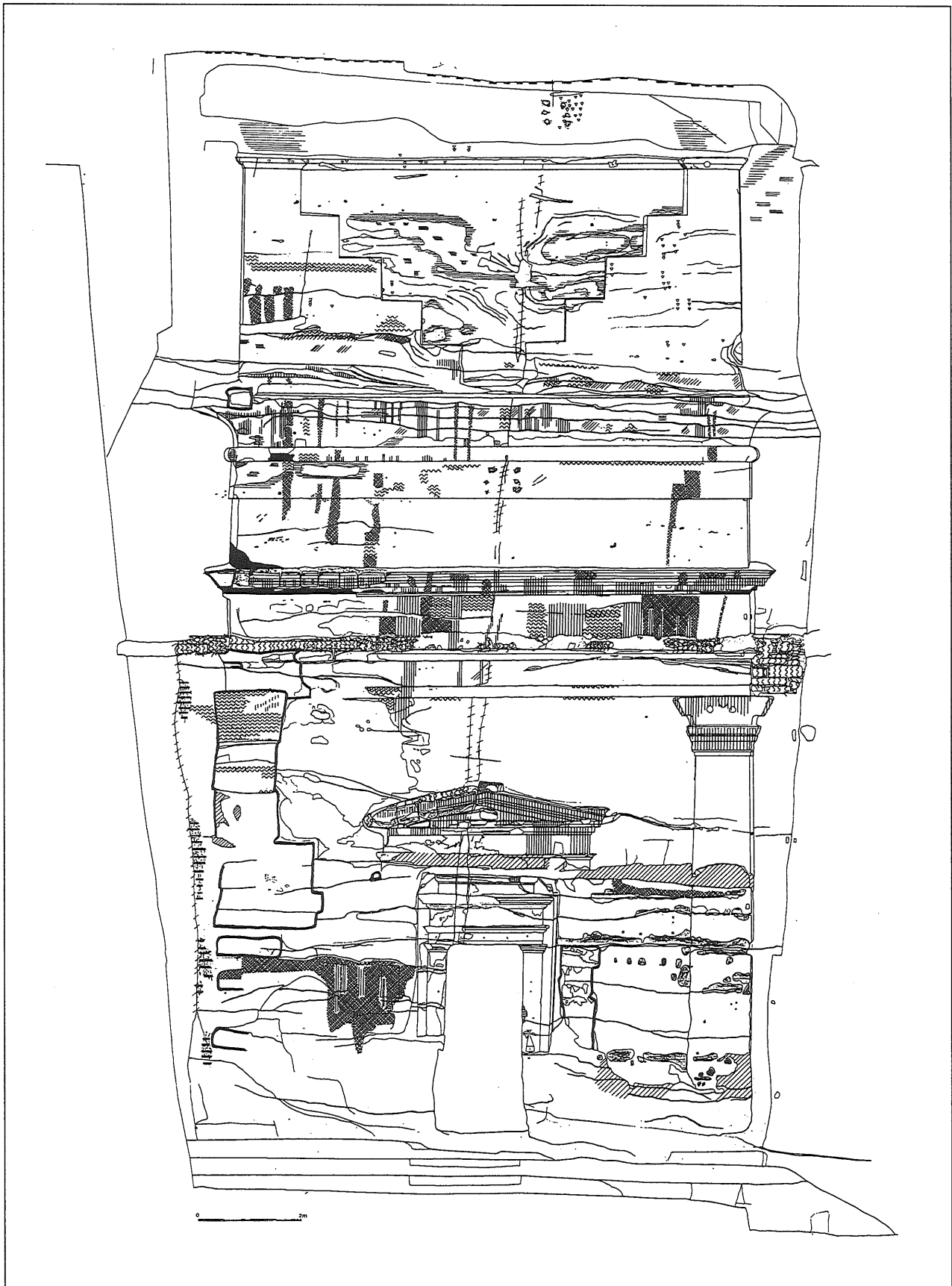
B) Loss of Stone Material

1. Pitting: Presence of small cavities in the non-homogeneous stone surface, which is a result of different rates of erosion of single particles of stone.

LEGEND - Weathering Forms

Granular Disintegration/Sanding		Salt Crust	
Flaking		Vegetation	
Scaling		Insectile Colonization	
Exfoliation		Soot	
Pitting		Bird Droppings	
Alveolar Weathering		Paint	
Outbreaks		Soiling	
Spalling		Slight Crack	
Backweathering		Severe Crack	
Washouts		Joint	
Missing Insets		Fault	
Salt Efflorescence		Plaster Detachment	
Surface Crust		Mortar Disintegration	
		Mortar Infestation	

1. Weathering Forms.



2. Mapping of the weathering forms of tomb 825.

2. Alveolar Weathering: Existence of alveoli (cavities) which are created in a honeycomb pattern.
3. Outbreaks: Breaking away of stone pieces or compact fragments in different sizes. They occur due to mechanical causes, vandalism, gunshots, etc.
4. Spalling: Is the breaking away of stone pieces or chunks in the masonry surface due to natural weathering in a localized area.
5. Backweathering: Loss of stone material parallel to the stone surface or profile, and sometimes following the limonite veins.
6. Washouts: Eroded parts of masonry surface of soft sandstone material or sand pockets which are regularly washed and etched by rain.
7. Missing Insets: Original stone insets of the carved façade that have been lost leaving a cavity.

C) *Formation of Deposits on the Stone Surface*

1. Salt Efflorescence: Existence of whitish deposits of loosely attached soluble salts on masonry surface.
2. Surface Crust: Formation of a hard thin skin which is strongly attached to the masonry surface due to the leaching out of the internal components of the stone (cementing material, salts or other substances within the stone).
3. Salt Crust: Is a type of a surface crust in the form of a solid layer of colorless or white salt.
4. Vegetation: Growth of plants in joints or cracks of masonry due to a high moisture content.
5. Insectile Colonization: Formation of small nests by insects formed on stone corners or infestations in the sandstone.
6. Soot: Compact black colored layer

1. Preservation: Retention of an existing form, material and integrity of a structure; Restoration: Recovery of an earlier form, material and in-

caused by pollutants.

7. Bird Droppings.
8. Paint: Non-original paint or graffiti caused by vandalism or modern reuse.
9. Soiling: Accumulation of dust and mud.

D) *Cracking*

1. Crack: Identifiable fracture in the stone material which occurs as a result of weathering action such as temperature changes within the stone. There are two types of cracks:
 - a) Slight Cracks: Identifiable narrow slight lines (less than 1.5 mm) of fractures at the stone surface.
 - b) Severe Cracks: are cracks that are more than 1.5 mm wide.
2. Joint: A rather plane surface of parting produced by strains imposed on the rock. In a joint there is no displacement of the sides of the fracture. Joints can form under tension or compression produced by the bending or folding of strata strains that are released along fractures.
3. Fault: A fractured surface or zone in the rock, in which one wall of the fracture is displaced relative to the other wall. Faults are produced by stresses in the earth's crust that either compress or extend rocks and cause them to shear.

E) *Deterioration in mortar / plaster*

1. Plaster detachment.
2. Mortar disintegration.
3. Mortar infestation due to biogenic growth.

Intervention Approach on Façade 825

Three levels of intervention can be implemented according to the priorities of each case. These levels include preservation, restoration and reconstruction.¹ Considering the concept of minimal intervention on the archaeological remains of Petra, major execution work will only be conducted

integrity of a structure; Reconstruction: Recreation of vanished or irreversible deteriorated resources.

on deteriorated areas of the upper half of the façade to assure the necessary protection. Moreover, the lower part would be preserved in its "as found" condition without the addition of new elements; this is partly due to the lack of evidence and is an attempt to avoid reconstruction when it does not provide further protection. On the other hand, along the upper parts of the Tomb 825 façade, it would be necessary to introduce new compatible materials in order to be able to repair the deteriorated protective architectural elements and cornices. The treatment of such details would provide protection for the plane surfaces underneath. In particular, the upper cornice should preferably be completed and "reconstructed" in its original form.

The new material which will be introduced would consist of natural raw materials available in the area. Sand, therefore, will be used for compatibility reasons with a silica-based binding material (silica sol). Mortars are being tested in the field to decide on the suitability of their components and proportions, and to observe the long term impact on their appearance and color.

On the other hand, consolidants will only be used when architectural details become very friable. Therefore, consolidation techniques are also being tested in the field and include commercially available formulas of ethyl silicates [Wacker (OH) and Remmer (OH)]. The testing of consolidants considers the application mode, as well as their application prior and after introducing the new mortar. A silica sol based wash is also being considered for stabilizing areas where sanding and flaking take place on the stone material.

Additionally, samples from the monument were used in the laboratory investigations for the determination of stone characteristics that are relevant to weathering. The laboratory investigations targeted the determination of mineral components, compressive strength and porosity characteristics.

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