



The Getty Conservation Institute



Institut National du Patrimoine

Technician Training for the Maintenance of In Situ Mosaics



Copyright © 2008 J. Paul Getty Trust and Institut National du Patrimoine de Tunisie

Design: Christian de Brer and Elsa Bourguignon

Every effort has been made to contact the copyright holders of the material in this book and to obtain permission to publish. Any omissions will be corrected in future volumes if the publisher is notified in writing.

Getty Conservation Institute
1200 Getty Center Drive, Suite 700
Los Angeles, CA 90049-1684
USA
Telephone: 310 440 7525
Fax: 310 440 7702
E-mail: gciweb@getty.edu
www.getty.edu/conservation

Institut National du Patrimoine
4, Place du Chateau
1008 Tunis
Tunisia
Telephone : 216 71 561 622
Fax : 216 71 562 452
E-mail : dginp@inp.rnrt.tn
www.inp.rnrt.tn

The Getty Conservation Institute works internationally to advance conservation practice in the visual arts – broadly interpreted to include objects, collections, architecture and sites. The Institute serves the conservation community through scientific research, education and training, model field projects, and the dissemination of the results of both its own work and the work of others in the field. In all its endeavors, the GCI focuses on the creation and delivery of knowledge that will benefit the professionals and organizations responsible for the conservation of the world's cultural heritage.

The Institut National du Patrimoine is a governmental and administrative institution with civil and financial autonomy. It works under the aegis of the Ministry of Culture and Protection of Heritage. The Institute's mission is both scientific and technical, and focuses on the inventory, study, protection, and presentation of the cultural, archaeological, historical, human, and artistic heritage of Tunisia.

Front cover photos by Elsa Bourguignon, 2003 and 2004, and Richard Ross, 2002.

ACKNOWLEDGMENTS

The current technician training team would like to recognize the fundamental role that Aïcha Ben Abed had in creating this training project and acknowledge her commitment to the conservation of Tunisia's mosaics.

Several former and current staff members of the Getty Conservation Institute have contributed to developing the training methodology and teaching materials. We are grateful to Kathleen Dardes and Francesca Piqué for their advice. The first versions of this material would not have been produced without the crucial help of Bettina Lucherini, Elsa Bourguignon and Amel Chabbi, former members of the project.

We express our gratitude to Dana Reemes for his illustrations and his sense of humor that help enliven the text.

And, last but not least, to the trainees of the first three courses who have collaborated in this teaching laboratory - we thank them for their patience and response to this work in progress.

Thomas Roby, teacher, conservator

Livia Alberti, consultant teacher, conservator

TABLE OF CONTENTS

Acknowledgments	III
Table of Contents	V
Foreword	VII
Introduction to the Maintenance of In Situ Mosaics	1
Documentation	
Documentation Methodology for the Maintenance of Mosaics	7
Study Phase	8
Planning Phase	22
Intervention Phase	24
Photographic Documentation	28
Archiving	32
Maintenance Cycles	36
The Different Types of Bases and Maps in Graphic Documentation	39
<i>Method : Base Drawing</i>	
Making a Measured Drawing Using a Grid	43
Making a Drawing Traced From a Photographic Montage	46
<i>Method : Base Photograph</i>	
Making a Base Photograph Using a Single Traditional Photograph	53
Making a Base Photograph Using a Single Digital Photograph	55
<i>Method : Making a Map</i>	57
The Use of Photography in Mosaic Maintenance	59
List of Supplies Needed for Documentation	63

Deterioration and Interventions	
Deterioration	67
Levels of Conservation Treatment	74
Cleaning	76
Mortars	79
Stabilization	87
Health and Safety Measures Regarding Lime	92
Reburial	93
List of Materials Needed for an Intervention Campaign	103
A Beginning	105
Illustrated Glossary	109

FOREWORD

Over the course of the last century, archaeological excavations have revealed thousands of mosaic pavements from Classical Antiquity, from the Punic/Hellenistic periods to the Roman and Byzantine periods. Mosaics were an integral part of a wide variety of ancient buildings, from public bathhouses and churches to private houses and villas. Their decorative surfaces of stone and glass tesserae are important artistic evidence that sheds light onto the history, religions, and aesthetics of the ancient world. While excavations have raised public awareness of mosaics, they have also removed the soil and rubble that generally protected them for centuries. Once re-exposed and devoid of the protection provided by ancient walls and roofs, mosaic pavements are subjected to a range of destructive environmental forces and detrimental conditions, such as rain, sun, frost, ground water, pollution and growth of vegetation, as well as human abuse and misuse. Years of exposure to the environment results in the rapid deterioration and eventual loss of the tesserae surfaces, followed by that of the lime mortar foundation layers of the mosaic.

In the past, archaeologists responded to the conservation challenge of excavated mosaics by detaching and lifting the tesserae layer and relaying it on a new support, generally of reinforced concrete. The mosaics were then either exhibited or stored in a museum, or sometimes re-laid in situ or simply left somewhere on site. This was the fate of mosaics or parts of mosaics considered of greater importance or significance, due to their figurative subject or their intricate geometric design. The numerous mosaics of lesser importance and quality were often left in situ without any protection except for occasional cement mortar repairs to fill areas of surface loss. In recent decades, archaeologists and conservators have increasingly addressed the deterioration and loss of in situ mosaics. At the same time, both professions recognized the importance of conserving all these figurative and geometric pavements whole and in their original architectural setting in order to better preserve the integrity of their cultural values and authenticity for the future. Preservation of mosaics in situ, however, requires a new approach to archaeological sites – one that recognizes sites not only as resources for current archaeological research and potentially for museum collections, but also as finite cultural resources whose values

derive from their place within a landscape and that can benefit the public visiting the site and the surrounding community.

In addition to a different approach, better preservation of mosaics in situ and sites in general also requires people trained and employed specifically to manage and maintain a site on a daily basis. In many countries, such as Tunisia, there are not as yet enough people with these skills able to work on sites, whether they are specialized workers or technicians, professionally trained conservators, or trained site managers. The training of technicians for the maintenance of in situ mosaics in Tunisia was undertaken as a first step towards the training of qualified personnel at all levels to maintain archaeological sites. In the future, their work on mosaics will need to be supervised directly by professionally trained INP conservators when they become available. The technicians will be part of a larger team of workers carrying out less specialized maintenance activities on a site as a whole, such as controlling vegetation and visitors. The work of the mosaic maintenance technicians will form an integral part of the prescribed activities of a site management plan to be developed and executed by the trained manager of the site. Such a plan would identify, among other things, which mosaics should be protected by reburial and then maintained, which should be protected by permanent shelters, presented to the public and maintained, which should be covered seasonally and maintained, and which should be left unprotected and maintained most frequently.

Despite the urgent need to address the deterioration and loss of in situ mosaics, many detached mosaics that were re-laid on sites in Tunisia over the past decades are in need of maintenance or new backing. However, the maintenance and treatment of detached mosaics were not part of the current training activities for several reasons. In situ mosaics on their original bedding were considered a priority by the organizers because they generally are more vulnerable to extended environmental exposure. Also, certain site managers believe that lifting mosaics is the only means of preserving them in the long-term on sites, and it is necessary to disprove this belief. In addition, the treatment of detached mosaics involves the use of different materials, tools and techniques because their modern supports are usually made of reinforced concrete, which performs and deteriorates differently from ancient lime mortars. Therefore, it was considered more appropriate to envisage the treatment of detached mosaics as a topic for a separate training program in the future.

The didactic materials presented hereafter were first developed for the training course on the maintenance of in situ mosaics organized in 2001 for workers employed by the Institut National du Patrimoine of Tunisia. They were designed to help them both during training campaigns on site and afterwards, during their future work as maintenance technicians. These didactic materials, which include both summaries of the main topics taught during the course as well as reference documents, provide the trainees with a methodology for creating the documentation and carrying out the technical tasks involved in mosaic maintenance. However, this material was not designed as a self-contained manual. It does not describe, as a manual would, the different operations that are part of mosaic maintenance work, although these were, of course, part of the curriculum taught on site over several months, combining classroom lessons and practical exercises – all essential to a basic training in this field. These teaching materials were designed for the trainees' average level of education, which generally was below or just at high school level, and were revised during the three training courses carried out in Tunisia between 2001 and 2006. These documents are still considered a “work in progress.” They are intended to be tested in the field in other contexts in the future and adapted, if need be, to each situation. Due to the rapid transition to digital photography and the rising number of computer-savvy trainees, this latest version provides a detailed presentation of the use of digital photography for documentation.

INTRODUCTION TO THE MAINTENANCE OF IN SITU MOSAICS

MOSAICS

A mosaic is a decorative surface finishing technique. It is made by inserting elements made of hard materials into a soft layer that holds them in place as it sets.

Mosaics found on archaeological sites are usually made of stone (commonly marble, limestone or sandstone), ceramic or glass elements inserted in a lime-based mortar. They often embellish the floors of a building. For the decoration of a basin or of bathhouses, mosaics could also be used on vertical surfaces of the construction.

Opus tessellatum is the most common type of ancient pavement. It is characterized by the use of small sized elements (usually 5 to 20 mm wide), of regular shape, usually quadrangular, called **tesserae**. The tesserae were prepared prior to designing the mosaic by cutting them to the required shape and size, but they were also cut during the process of making the mosaic, if a tessera needed to be given a particular shape.

The outermost layer of a mosaic containing the tesserae is called **tessellatum**.

A mosaic is made by placing tesserae side by side in more or less regular rows, following an outline or filling a given space.

The tesserae of a mosaic can all be made of the same material and be of only one color, or be made of different materials and several colors. A mosaic made of tesserae of only one color is called **monochrome**; one made of two colors of tesserae is called **bi-chrome** – and these are generally black and white; a mosaic made of tesserae of several colors is called **polychrome**. A surface with different colored tesserae can be decorated with a geometric design or with figures; it is then called a **geometric mosaic** or a **figurative mosaic**. If the tesserae are extremely small – less than 4mm wide – the mosaic can be called *opus vermiculatum*.

The layer into which the tesserae are inserted is called the **bedding layer**. It is made of a mortar very rich in lime so that it stays soft and workable over a long period. In addition,

the bedding layer mortar is laid out a section at a time so that it remains soft during the whole tesserae inserting process.

A more or less simplified outline of the motifs to be created could be incised or painted on the surface of the last preparatory layer or of the bedding layer to guide the mosaicist when inserting the tesserae.

The bedding layer is generally placed on one or two preparatory layers, which are also made of lime-based mortars. The layer immediately below the bedding layer is called the **nucleus**, the layer below that is called the **rudus**. The rudus is normally thicker and made of a coarser mortar than the nucleus.

The foundation of the mosaic is made of an initial layer called **statumen**, used to create a leveled surface and to stabilize the ground to avoid settlement and deformation. The thickness of the statumen can vary and it is often made of large stones pushed into the ground or set with a coarse mortar.

Apart from *opus tessellatum*, there are other types of ancient mosaics with similar preparatory layers. Some of the most common are:

Opus scutulatum or ***lithostroton*** is composed of a usually monochrome *opus tessellatum* background into which stone fragments of different colors and generally irregular shapes are inserted.

Opus sectile is made of stone slabs, most often different colored marble, cut with a saw into regular shapes and placed side by side to create a geometric design.

Opus figlinum is usually made of ceramic tesserae, of the same size and rectangular shape, assembled in groups of a few tesserae and placed side by side to create the impression of a basket weave pattern.

When the tesserae are of different colors and of materials other than ceramic, the pavement is called ***opus pseudo-figlinum***. When the ceramic elements are arranged in a herringbone pattern, it is called ***opus spicatum***.

Opus signinum is made of a lime mortar mixed with ceramic fragments into which a few quadrangular tesserae or small stone fragments are inserted at random or following simple geometric designs.

When this type of pavement does not include inserted elements, it is called ***cocciopesto***.

MAINTENANCE

Mosaics exposed on site can only be preserved through regular maintenance to reduce the impact of destructive environmental forces. Maintenance consists of a series of operations that includes a preliminary study of the mosaic, initial stabilization work, periodic inspection of the mosaic's condition, followed, if needed, by planned interventions to protect and stabilize it.

Periodic inspection begins with collecting data about the mosaic, its condition and the condition of previous interventions. This information is needed to assess how urgently interventions are needed, to estimate the type and amount of work to be done, and to organize the work. Once this planning is done, remedial stabilization measures can be implemented and protective interventions can begin. Each time the condition of a mosaic is inspected a new maintenance cycle begins. It is essential to refer to the documentation of the last inspection to study the behavior of deterioration processes and the performance of the previous interventions.

The entire maintenance process, but in particular, collecting data about the mosaic, planning work, and archiving the created documentation, requires a close collaboration between the specialized maintenance staff and the site managers who play a central role in the management of the archeological heritage.

Documentation

DOCUMENTATION METHODOLOGY FOR MOSAIC MAINTENANCE

Documentation is an essential component of maintenance work. It provides a better understanding of a mosaic and its condition before work is begun, and makes it possible to record all the work carried out on the mosaic. Documentation carried out during the regular inspection of a mosaic is a means to follow the evolution of its condition through time and to evaluate the efficiency of maintenance work.

Documentation can be generated in different formats:

- written, by filling out *data forms*;
- graphic, by drawing *maps* accompanied by their *legends*;
- photographic, by taking photographs recorded on the *photograph log*.

These three formats can be created by hand and also with a computer.

To produce graphic documentation, a *base* is used from which various *maps* are made. A *base* is a drawing (*base drawing*) or a photograph (*base photograph*) of the mosaic. A *map* is a record of different data pertaining to the mosaic and represented by various symbols and colors. A *map* must always be associated with its *legend* which is an explanatory list of the colors and symbols used on the *map*.

All documentation collected during a maintenance campaign can be divided into three successive phases:

- 1. Study phase**
- 2. Planning phase**
- 3. Intervention phase**

STUDY PHASE

In this first phase, information on the construction of the mosaic during Antiquity, the work done on it in the past and its current condition is collected. This data is recorded in written format on three data forms. Data Forms No. 2 and No. 3 have their maps and legends attached to them:

- *Data Form No. 1 - Identification* (p. 9) with a context photograph and a building plan indicating the location of the room
- *Data Form No. 2 - Previous Interventions* (p. 13) with the *Previous Interventions Map* and its *legend* (pp. 14-15)
- *Data Form No. 3 – Condition Assessment* (p. 17) with the four *Condition Assessment Maps* and their *legends* (pp. 18-21)

Data Form No. 1 - Identification

Information on the mosaic is gathered in Data Form No. 1, such as its location within the archaeological site, building and room, its dimensions, and its original construction technique. Data Form No. 1 also helps to collect and provides references to pre-existing documentation on the mosaic (i.e. past articles, excavation reports, old photographs, plans, drawings, references to the *Corpus des Mosaïques de Tunisie*, etc). This data form is filled out only once for each mosaic – when it is first documented – and this must be done with the site manager.

A unique “name” or identifier can be assigned to each mosaic using the information collected in Data Form No. 1. From then on, this identifier (ID) should be used in all written, graphic and photographic documentation pertaining to the mosaic. The *Mosaic ID* comprises letters and numbers corresponding to the abbreviations of the site, building and room where the mosaic is located. If there already are letters and numbers assigned to the building and room (for example, from the *Corpus des Mosaïques de Tunisie* or from an excavation report), these should be used. If none exist, new ones should be created under the guidance of the site manager.

DATA FORM NO. 1 – IDENTIFICATION

STUDY PHASE

MOSAIC ID _____ / _____ / _____ / _____

This form must be completed with the site manager and supplemented by an overall photograph of the mosaic and a plan of the building indicating the location of the room.

SITE

BUILDING

ROOM

SECTIONS, FRAGMENTS OR LEVELS

(Use Arabic numerals for sections, letters for fragments, Roman numerals for levels)

MOSAIC ID

_____ / _____ / _____ / _____
(Abbreviation of the site / building / room / sections or fragments or levels)

EXISTING DOCUMENTATION ABOUT THE MOSAIC AND ITS CONSERVATION *(References of publications, plans, photographs, drawings and other documents)*

DATE OF MOSAIC EXCAVATION:

DIMENSIONS AND NUMBERING OF FRAGMENTS, SECTIONS OR LEVELS

(Use an existing drawing or make a sketch of the mosaic indicating the north and the walls of the room)

GENERAL OBSERVATIONS ON THE CONSTRUCTION TECHNIQUE OF EACH LEVEL

(Type of pavement, decoration, materials, colors, tesserae size, etc.)

PREPARED BY

DATE

If need be, one can add to the abbreviations of the site/building/room:

- an Arabic numeral (1, 2, 3, 4...) for each section, when it is necessary to divide a mosaic to document it graphically;
- a letter (A, B, C, D...) for each fragment of a mosaic that is in several pieces;
- a Roman numeral (I, II, III, IV...) for each level if there are several mosaics one on top of another; the first being the more ancient.

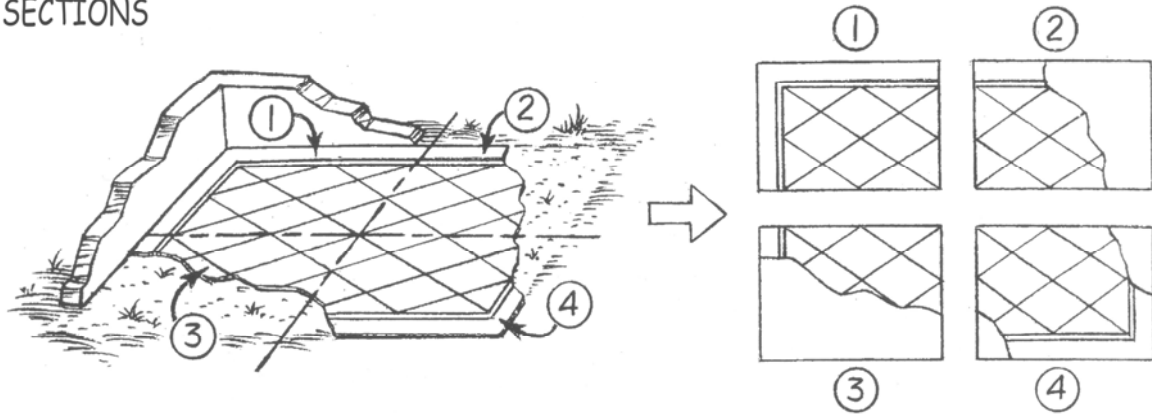
Figure 1 illustrates the different ways of labeling the different sections, fragments and levels of mosaics.

An example of how a *Mosaic ID* is composed: for a mosaic on the site of Utica (UT), in the building of the Maison de la Cascade (MC), in room XXIII (XXIII), and for the third section of the mosaic (3), the *Mosaic ID* will be UT/MC/XXIII/3.

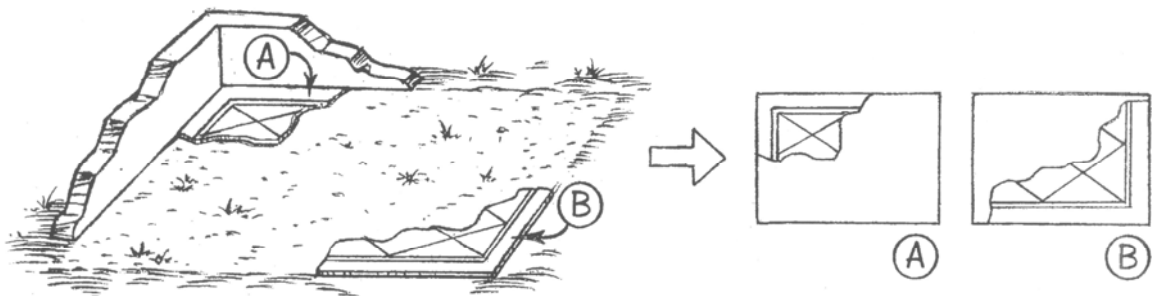
Data Form No. 1 contains a sketch locating the mosaic in relation to the walls of the room and to the other rooms of the building. This data form also comes with an overall photograph of the mosaic and a plan of the building showing the location of the room.

WAYS OF LABELING THE DIFFERENT SECTIONS, FRAGMENTS AND LEVELS OF MOSAICS

SECTIONS



FRAGMENTS



LEVELS

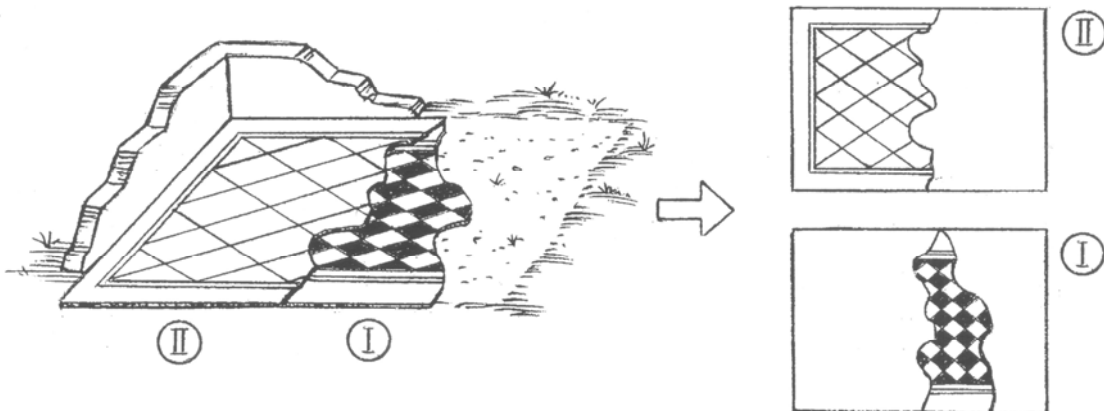


Figure 1

Data Form No. 2 – Previous Interventions

Data Form No. 2 contains information related to maintenance, restoration and protection operations carried out on and around the mosaic in the past. These previous interventions can date from Antiquity or can be modern.

Data Form No. 2 is accompanied by separate graphic documentation in the form of a map with its legend.

Previous Interventions Map

Areas where different interventions were completed in the past on or around the mosaic are indicated on this map using different colors or symbols. On the *Previous Interventions Map* (see page 14) legend, the different types of interventions will be described in greater detail, such as the material composition and the color of mortar used for a type of fill. If there is not enough room on the legend sheet to describe all the existing previous interventions, an *Additional Sheet* should be used (page 15).

Data Form No. 2 - Previous Interventions and the *Previous Interventions Map* are generally completed once during the initial intervention. After a number of years, it may be necessary to make a new map to indicate the numerous interventions, which have been carried out on the mosaic since the beginning of the maintenance program.

DATA FORM NO. 2 – PREVIOUS INTERVENTIONS

STUDY PHASE

MOSAIC ID ____/____/____/____

PREVIOUS INTERVENTIONS ON THE MOSAIC

- Mortar repairs
 - Infilling of lacunae
 - Edging repair
 - Filling of interstices between tesserae
 - Grouting of voids between preparatory layers
- Reintegration of lacunae
 - with tesserae
 - with pieces of stone, brick or other material inserted into the mortar
- Lifting and relaying in situ
 - on reinforced concrete/cement
 - Other: _____
- Surface treatment
 - Mechanical or chemical cleaning
 - Application of a surface product (resin, etc.)
 - Mechanical sanding
 - Other: _____
- Part lifted and stored elsewhere
- Reburial (*Starting from the surface of the mosaic and moving up, describe the fill materials and separation membranes used and provide the total thickness and that of each layer*)

PREVIOUS INTERVENTIONS AROUND THE MOSAIC

- Drainage
- Open shelter
- Wall stabilization
- Removable cover
- Closed shelter
- Other: _____
- Access restricted by: _____

DATES OF PREVIOUS INTERVENTIONS CARRIED OUT AND INFORMATION SOURCES

PREPARED BY

DATE

LEGEND – PREVIOUS INTERVENTIONS MAP

MOSAIC ID _____ / _____ / _____ / _____

Mortar repairs (lacunae fills, edging repairs, fills between tesserae)

Describe each mortar type used: *color, probable binder and aggregates, particle size, surface aspect, hardness, level in relation to the mosaic, and repair date if known.*

Mortar repairs:

Reintegration of lacunae

Describe each type of reintegration carried out and the materials used: *with tesserae, stone or brick pieces, type of mortar used and date of reintegration if known.*

Reintegration of lacunae:

Surface treatment:

Overlapping between mortar layers (new → old)

Lifted and relayed in situ

Part lifted and stored elsewhere

Reburial

Drainage openings

PREPARED BY _____

DATE _____

ADDITIONAL SHEET

LEGEND - **MAP**

MOSAIC ID ____ / ____ / ____ / ____



PREPARED BY _____

DATE _____

Data Form No. 3 – Condition Assessment

Data Form No. 3 is used to record the different types of deterioration presently observed on the mosaic, as well as the condition of past interventions carried out on or around the mosaic. Current exposure conditions of the mosaic are also recorded. This information serves to assess the general condition of the mosaic and the degree of urgency of any intervention.

Data Form No. 3 is accompanied by separate graphic documentation in the form of four location maps and their legends.

Condition Assessment Maps - No. 1, No. 2, No. 3 and No. 4

The location of different types of deterioration is mapped on each of these maps. The four *Condition Assessment Maps* are:

Map No. 1 - Structural Deterioration

Map No. 2 - Surface Deterioration

Map No. 3 - Biological Deterioration

Map No. 4 - Deterioration of Interventions

Maps No. 1, No. 2 and No. 3 are used to record the condition of the mosaic itself, whereas map No. 4 is used to record the deterioration of past interventions (see legends pp. 18-21).

The condition of a mosaic should be regularly monitored through time. At each new inspection, a new *Data Form No. 3 - Condition Assessment* should be filled out, and new *Condition Assessment Maps No. 1, No. 2, No. 3 and No. 4* should be created.

DATA FORM NO. 3 – CONDITION ASSESSMENT

STUDY PHASE

MOSAIC ID ____ / ____ / ____ / ____

PRESENT EXPOSURE CONDITIONS

- In open air
- Reburied
- Under an open shelter
- Walked on
- Under a removable cover
- Under a closed shelter

During the initial intervention, check the boxes of all the conditions that are present. During maintenance cycles, only indicate new phenomena that have occurred since the last inspection or last intervention.

STRUCTURAL DETERIORATION

(Condition Assessment Map No. 1)

- Lacunae
- Cracks
- Bulges
- Depressions
- Detachments between mosaic layers

SURFACE DETERIORATION

(Condition Assessment Map No. 2)

- Detached tesserae
- Deteriorated tesserae
- Deteriorated mortar between tesserae
- Stains
- Incrustations
- Efflorescence

BIOLOGICAL DETERIORATION

(Condition Assessment Map No. 3)

- Micro-organisms
- Vegetation
- Damage caused by insects and other animals

DETERIORATION OF INTERVENTIONS

(Condition Assessment Map No. 4)

- Deteriorated lacunae fills
- Deteriorated edging repairs
- Deteriorated mortar between tesserae
- Deteriorated supports of a detached and re-laid mosaic

- Reburial:
- Vegetation
 - Loss of fill materials
 - Deteriorated separation membranes

DETERIORATION OF INTERVENTIONS AROUND THE MOSAIC

- Inefficient drainage
- Inefficient wall stabilization
- Deteriorated removable cover / open shelter / closed shelter
- Damaged access barriers
- Other: _____

OBSERVATIONS ON THE CONDITION ASSESSMENT

GENERAL CONDITION OF THE MOSAIC

- Good**
- Fair**
- Bad**
- Date recommended for next inspection:
(No intervention required)
- Date recommended for intervention:
(Intervention required - fill out Data Form No. 4)

PREPARED BY

DATE

LEGEND - CONDITION ASSESSMENT MAP NO. 1
STRUCTURAL DETERIORATION

MOSAIC ID ____/____/____/____

Lacunae

Cracks

Bulges

Depressions

Detachments between mosaic layers

PREPARED BY

DATE

LEGEND - CONDITION ASSESSMENT MAP NO. 2
SURFACE DETERIORATION

MOSAIC ID ____ / ____ / ____ / ____

- Detached tesserae
- Deteriorated tesserae
- Deteriorated mortar between tesserae
- Stains
- Incrustations
- Efflorescence
-
-
-
-

PREPARED BY

DATE

LEGEND - CONDITION ASSESSMENT MAP NO. 3
BIOLOGICAL DETERIORATION

MOSAIC ID ____ / ____ / ____ / ____

Micro-organisms

Vegetation

Damage caused by insects and other animals

PREPARED BY

DATE

**LEGEND - CONDITION ASSESSMENT MAP NO. 4
DETERIORATION OF INTERVENTIONS**

MOSAIC ID ____ / ____ / ____ / ____

- Deteriorated lacunae infills
- Deteriorated edging repairs
- Deteriorated mortar fills between tesserae
- Deteriorated supports of a detached and re-laid mosaic
- Deteriorated metal reinforcements in the support panel
-
-
-
-

PREPARED BY

DATE

PLANNING PHASE

Work to be done will be planned on the basis of the data collected during the study phase. The only time the planning phase is recorded in writing is when completing:

- *Data Form No. 4 – Intervention Program* (page 23)

Data Form No. 4 – Intervention Program

Data Form No. 4 serves to evaluate the extent of each intervention to be carried out, estimating the time and personnel needed. A first estimate of the number of work days per technician will be calculated for each operation. This will help in assessing the number of days of work necessary for a group of technicians to completely stabilize a mosaic, while accounting for time to organize labor and any other circumstance that might affect the process. In addition, Data Form No. 4 serves to select and quantify the necessary materials.

During this phase, the need for a conservator to intervene on the mosaic will be determined. Other types of work on site that may be needed should also be noted, such as the construction of a shelter or the creation of a visitors' path, which requires the intervention of a specialist, such as an architect or an engineer. This data form must be filled out under the guidance of the site manager.

A new Data Form No. 4 should be filled out during each new maintenance campaign if stabilization interventions are needed.

DATA FORM NO. 4 – INTERVENTION PROGRAM PLANNING PHASE

MOSAIC ID ____ / ____ / ____ / ____

This form must be filled out with the site manager.

Mark with one to five crosses (small to large) the extent of each treatment to be carried out on the mosaic and give a first estimate of the corresponding number of working days per technician.

TREATMENTS ON THE MOSAIC

- Vegetation removal _____ Work days for 1 technician
Notes :
- Cleaning _____ Work days for 1 technician
Notes:
- Removal of modern repair mortars _____ Work days for 1 technician
Notes:
- Resetting tesserae _____ Work days for 1 technician
Notes:
- Filling interstices between tesserae _____ Work days for 1 technician
Notes:
- Grouting voids between preparatory layers _____ Work days for 1 technician
Notes:
- Infilling lacunae _____ Work days for 1 technician
Notes:
- Edging repairs _____ Work days for 1 technician
Notes:
- Reburial _____ Work days for 1 technician
Notes:

INTERVENTIONS AROUND THE MOSAIC

- Drainage _____ Work days for 1 technician
Notes:
- Wall stabilization _____ Work days for 1 technician
Notes:
- Removable cover or shelter _____ Work days for 1 technician
Notes:
- Other: _____ _____ Work days for 1 technician
Notes:

TIME REQUIRED FOR WORK ORGANIZATION AND EXECUTION

Days of work _____ Number of technicians _____

TYPE AND QUANTITY OF MATERIALS NEEDED:

- INTERVENTION BY A SPECIALIST NEEDED ON THE MOSAIC OR ON SITE
Notes:

PREPARED BY _____

DATE _____

INTERVENTION PHASE

The programmed work is carried out during the intervention phase. All interventions on the mosaic are documented in written and graphic formats by completing:

- *Data Form No. 5 – Current Interventions* accompanied by the *Current Interventions Map* and its legend (pp. 25-26)

Data Form No. 5 – Current Interventions

This data form records the operations carried out on and around the mosaic. The dates of the last intervention and last inspection (if known), as well as the date of the current work and the date recommended for the next inspection, are also recorded on this form.

Current Interventions Map

The locations of the different types of executed interventions are marked on this map. The composition of different mortars used for each intervention should be recorded on the legend of the *Current Interventions Map*. If there is not enough room on the legend sheet to describe all the interventions, an *Additional Sheet* should be used (page 27).

During each new intervention campaign, a new *Data Form No. 5 – Current Interventions* should be filled out and a new *Current Interventions Map* drawn up.

At the end of the initial intervention, a context photograph of the mosaic should be taken and corrections should be made to the base drawing if the profile of the mosaic has changed. This corrected base should be dated and used as a new base for documentation produced during subsequent maintenance cycles. If the mosaic undergoes further substantial changes in the future, a new base will need to be drawn.

DATA FORM NO. 5 – CURRENT INTERVENTIONS INTERVENTION PHASE

MOSAIC ID _____ / _____ / _____ / _____

DATE OF PREVIOUS INTERVENTION

DATE OF PREVIOUS INSPECTION

DATE AND LENGTH OF CURRENT WORK

DATE RECOMMENDED FOR THE NEXT INSPECTION

TREATMENTS CARRIED OUT ON THE MOSAIC

- Vegetation removal
- Cleaning
- Removal of modern repair mortars
- Resetting tesserae
- Filling interstices between tesserae
- Grouting voids between preparatory layers
- Lacunae fills
- Edging repairs
- Reburial (*From the mosaic surface up, describe the fill materials and separation membranes used, and provide the total thickness and that of each layer*)

INTERVENTIONS CARRIED OUT AROUND THE MOSAIC

- Drainage
Notes:
- Wall stabilization
Notes:
- Removable cover or shelter
Notes:
- Other: _____
Notes:

NAMES OF THE TECHNICIANS WHO CARRIED OUT THE WORK

PREPARED BY

DATE

LEGEND – CURRENT INTERVENTIONS MAP

MOSAIC ID _____ / _____ / _____ / _____

- Vegetation removal
- Cleaning
- Removal of modern repair mortars
- Resetting tesserae
Mortar composition:

- Filling interstices between tesserae
Mortar composition:

- Grouting between preparatory layers
Mortar composition:

- Infilling of lacunae
Mortar composition:

- Infilling of lacunae
Mortar composition:

- Infilling of lacunae
Mortar composition:

- Edging repair
Mortar composition:

- Reburial
- Drainage openings
-

PREPARED BY

DATE

ADDITIONAL SHEET

LEGEND - MAP

MOSAIC ID ____/____/____/____



PREPARED BY

DATE

PHOTOGRAPHIC DOCUMENTATION

During the study and intervention phases, photographic documentation is carried out to record the condition of the mosaic before and after the work and to illustrate certain details. Photographic documentation can be created using a traditional camera (i.e. a film camera) or a digital camera.

The photographic records should be organized using a *Photograph Log* (page 31) and a *Photograph Map*.

To be able to identify photographs, their subject and location, each image should include a small chalkboard on which is written the ID of the mosaic, the date, the number of the photograph, the number of the *Photograph Log* and the direction North.

Photograph Log

The *Photograph Log* is a list of the photographs taken during the maintenance process. Traditional photographs and digital photographs should be listed on different log sheets, and filed separately in the photographic archive binder of the site. The log sheets for digital photographs should be numbered sequentially. Log sheets for traditional photographs should be numbered according to the film number.

The Photo Number listed on the log sheet should match the number on the chalkboard placed within the frame of the photograph. When using a digital camera, photographs with the same framing should only be listed once on the log next to the same Photo Number. After uploading the photographs from the digital camera to the computer and adjusting their quality, only the photographs with the same framing will be kept.

For each photograph taken, the ID of the photographed mosaic, the date, the photograph category and a note on its subject should also be recorded in the *Photograph Log*.

The photograph category indicates the general theme of the photo and should be annotated with one of the following abbreviations:

- ID for photographs of the general context included with *Data Form No. 1- Identification* or for photographs used to create a base photograph as well as any photographs of details illustrating the execution technique of the mosaic;
- PI for photographs of Previous Interventions;
- CA for photographs recording deterioration noted during the Condition Assessment;

- CI for photographs taken after and/or during Current Interventions;
- WA for all photographs that will be used as Working Aids, that is, as visual references to assist in carrying out a treatment.

A short descriptive note should briefly explain the subject of the photo and the reason for which it was taken.

Once traditional photographs have been developed, the number of the negative should be noted on the log sheet and each log sheet should be kept with the corresponding negatives in the site's photographic archive binder.

Once uploaded to the computer, each digital photo file should be renamed using the information written on the log sheet. The process of renaming images also applies to all electronic files created while documenting a mosaic such as photomontages of digital photos (see method pp. 50-52) or layouts (see method pp. 55-56).

As with the *Photograph Log*, a **filename** comprises 5 parts and should be no longer than 32 characters. Underscores () should be used between each part. The following model should be used so that all files may be automatically organized in alphabetical and chronological order.

The **Mosaic ID** used in all written documentation comes first. Dashes (-) rather than forward slashes (/) should be used between the different parts of the ID because the computer does not recognize (/) in filenames. For example: HE-H2P-24.

Then comes the **date** when the photo was taken or when the document was created. The date should be written starting with the year, followed by the month and the day, using dashes between each part. For example: May 15, 2006 will be written as 2006-05-15.

After that, one of the abbreviations for the **categories** described above should be added.

A short descriptive **note** should describe the subject of the file. This note should be written with the help of the technical vocabulary found in the map legends and the illustrated glossary. If the description consists of several words, the note should not contain any spaces but rather the first letter of each word will be capitalized. For example: BeforeResettingTesserae. The note should also serve to indicate whether a file is used as a base photograph.

The file should be numbered if several files of similar format have the same ID, date, category and note starting with 01, 02, 03, etc.

A file extension indicates the file format and is found at the end of a filename. It is normally dictated by the program. One will need to **add the extension** manually when a file is renamed from its icon. A photo usually has .jpg as its file extension. A document created in Microsoft Word will have .doc as its file extension.

Thus, a filename should comply with the following model:

Mosaic ID	Date	Subject		Number	File Extension
		Category	Note		
Site-Building-Room-Section	yyyy-mm-dd	<ul style="list-style-type: none"> • ID (IDentification) • PI (Previous Interventions) • CA (Condition Assessment) • CI (Current Interventions) • WA (Work Aid) 		(if several photos share the same ID, date and subject matter)	.jpg .doc

Example:

HE-H2P-24	2006-05-10	WA	BeforeResettingTesser rae	04	.doc
-----------	------------	----	------------------------------	----	------

HE-H2P-24_2006-05-10_WA_BeforeResettingTesserae_04.doc

After placing and formatting the digital image on a blank page to be printed, the filename of the photograph should be copied and pasted under the image. The formatted image with its filename is called a layout. For traditional photographs, the mosaic ID, film and negative number, and the date will be written on the back of the print. If the photograph is glued onto a blank page, this information should be copied underneath the photograph.

Photograph Map

During photographic recording, the location of each detailed photograph frame should be marked on the *Photograph Map* by drawing a corresponding rectangle. For traditional photographs, the corresponding film (F) and photo (ph) numbers should be noted in the rectangle, e.g. F3/ph20. For each digital photo, the corresponding log sheet (L) and photo (ph) numbers will be noted, e.g. L2/ph12.

Paper prints and printed layouts of digital photographs will be kept with the *Photograph Map* in the documentation folder of the corresponding mosaic.

PHOTOGRAPH LOG

SITE NAME : _____

digital photos

traditional photos

LOG SHEET NUMBER : _____

FILM NUMBER : _____

Nég. N°	Photo N°	Mosaic ID	Date	Category and note on the subject
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
	10			
	11			
	12			
	13			
	14			
	15			
	16			
	17			
	18			
	19			
	20			
	21			
	22			
	23			
	24			
	25			
	26			
	27			
	28			
	29			
	30			
	31			
	32			
	33			
	34			
	35			
	36			
	37			

Categories:

ID: IDentification

CI : Current Interventions

PI: Previous Interventions

WA: Work Aid

CA: Condition Assessment

ARCHIVING

All data forms, base drawings or photographs, maps with their legends and photographs pertaining to a mosaic must be placed in the same folder or binder. All the documentation components for a given mosaic (data forms, maps and photographs) must be listed on the *Archiving Data Form*.

Archiving Data Form

This data form is a list of the documentation components contained in the folder pertaining to a mosaic. After creating each document during the first campaign, the date it was created should be recorded on the corresponding line in the first column. New documents created during each subsequent maintenance cycle are added to the folder and grouped together with similar data forms and maps produced during previous campaigns. Their date of creation should be written in a new column of the *Archiving Data Form*. Thus, there is only one *Archiving Data Form* per mosaic.

In summary, the documents to be archived during the maintenance of a mosaic are the following:

- Base drawing or photograph
- Data Form No. 1 – Identification with an overall photograph and building plan
- Data Form No. 2 – Previous Interventions and Map with its legend
- Data Form No. 3 – Condition Assessment and Maps No. 1, No. 2, No. 3 and No. 4 with their legends
- Data Form No. 4 – Intervention Program
- Data Form No. 5 – Current Interventions and Map with its legend
- Photograph map with traditional photograph prints and/or printed digital photograph layouts
- Revised base drawing or photograph

Technician Training for the Maintenance of In Situ Mosaics. INP - GCI
ARCHIVING DATA FORM

MOSAIC ID _____/_____/_____/_____

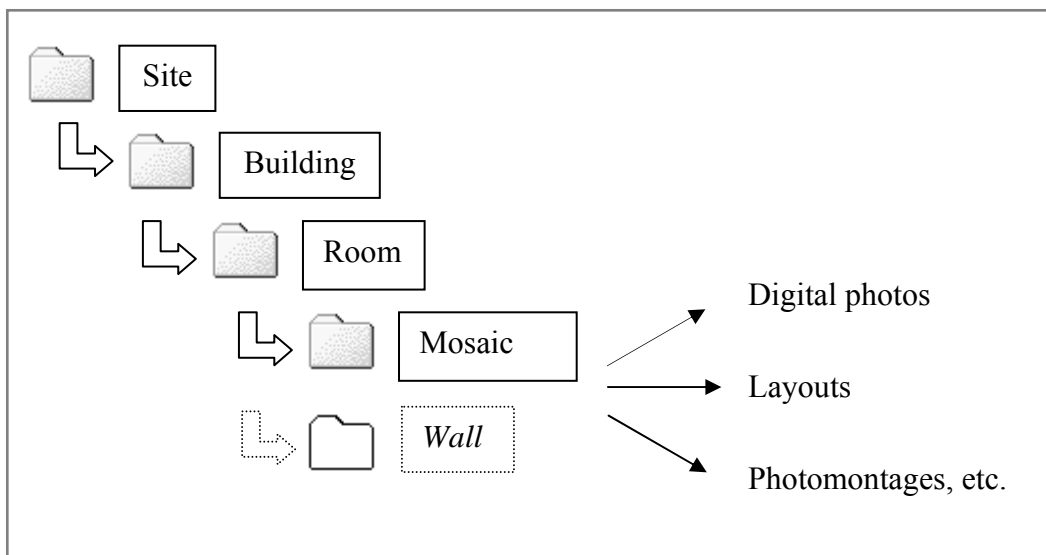
	DATES OF COMPLETION (month and year)				
	INITIAL CAMPAIGN	MAINTENANCE CYCLES			
Base drawing/photograph					
Data Form No.1 - Identification					
Building Plan					
Data Form No. 2 – Previous Interventions					
Map and Legend – Previous Interventions					
Data Form No. 3 – Condition Assessment					
Map and Legend – Condition Assessment Map No. 1					
Map and Legend – Condition Assessment Map No. 2					
Map and Legend – Condition Assessment Map No. 3					
Map and Legend – Condition Assessment Map No. 4					
Data Form No. 4 – Intervention Program					
Data Form No. 5 – Current Interventions					
Map and Legend – Current Interventions					
Photographs					
Photograph Maps					
Revised base drawing/photograph					

All the documentation for a site should be arranged by building. Folders for mosaics within the same building should be filed together in the same archive box. Copies of existing documentation that may have been found (i.e. old photos from the excavation, published articles, etc.) and a site plan showing the location of the building in question should also be placed in a building's archive box.

All the site documentation should be left on site in the care of the site manager and must be stored in a dry, cool area away from sunlight. A second copy of this documentation can be stored in the INP's national archives.

Archiving Digital Files

All digital files should be organized on the computer so that they can be easily located. It will be necessary to create a filing system with folders. Each "Site" folder should comprise a folder for each building, and within each "Building" folder there should be a folder for each room. In the "Room" folder, a "Mosaic" folder should be created to contain all the digital files (photos, layouts, photomontages, etc.) pertaining to the mosaic. If maintenance is carried out on the walls of this room, a "Wall" folder should be created to contain all the documentation produced during inspections and interventions carried out on each wall.



At the end of each maintenance campaign or possibly more often, the digital files should be backed-up onto compact discs (CD). The data pertaining to each room should be burned on a CD, or several if necessary, and include all the electronic files created during the campaign and all previous campaigns. The full Mosaic ID and the dates of the maintenance campaigns during which the files were created should be written on the CD itself using an archival marking pen. Each CD should be stored in its individual box or in a CD envelope affording long-term protection. The CD(s) should be filed in the folder of the corresponding room. If a newly created CD contains all the files also found on an older CD, only the newer CD should be kept.

It is important to create at least one back-up copy of the archive in the event that the computer loses data. A second CD can be left in the national archives at the INP.

MAINTENANCE CYCLES

Maintenance cycles should follow the first intervention and should include the periodic inspection of the condition of the mosaic and of past interventions, as well as the execution of newly needed interventions. It is important to inspect the mosaic regularly, at least once a year.

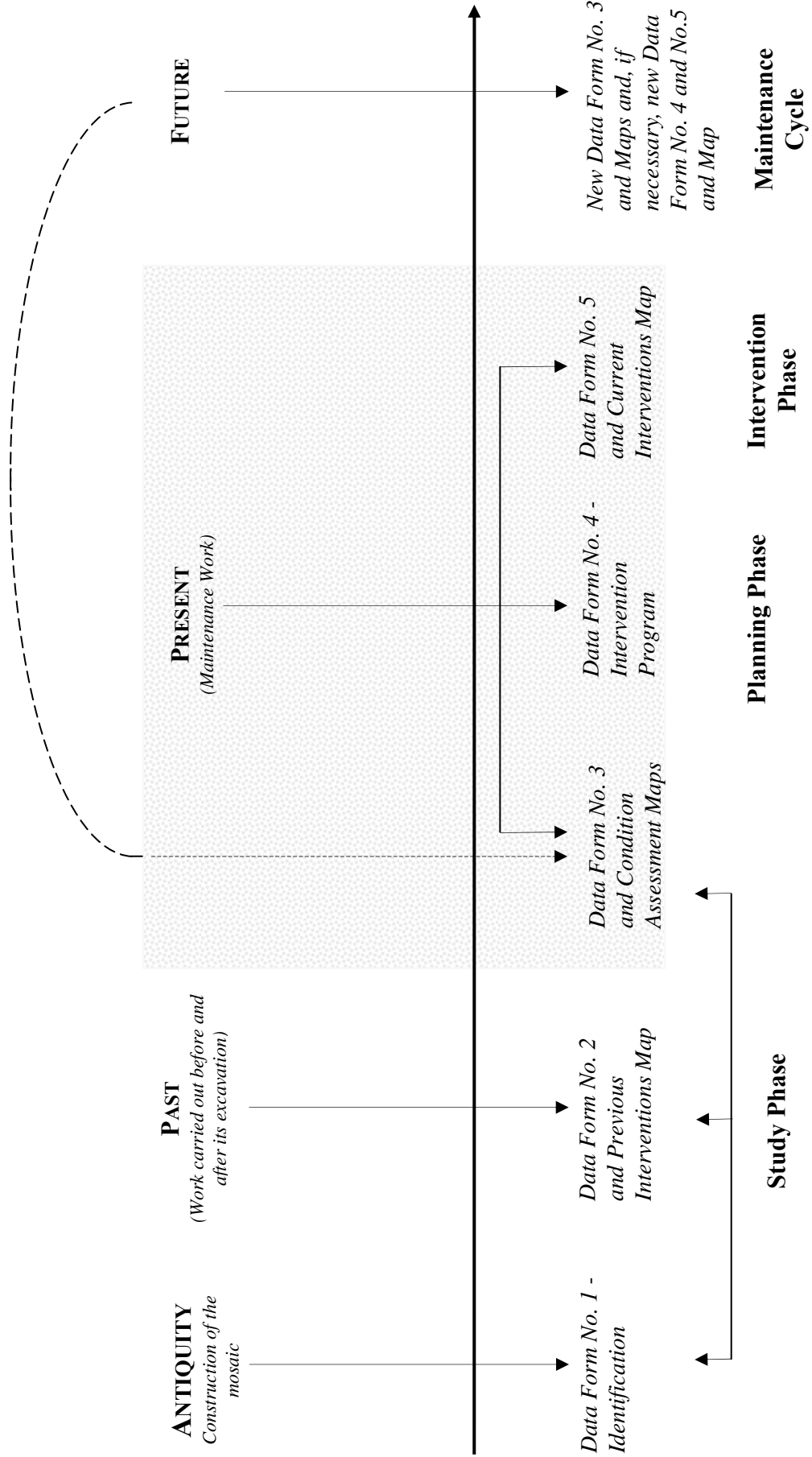
At this time, new *Condition Assessment Maps No. 1, No. 2, No. 3 and No. 4* should be drawn on the corrected base drawing or on the overall photograph taken at the end of the initial campaign. The *Condition Assessment Map No. 4* will serve to evaluate the deterioration of implemented interventions. It is important to compare the *Condition Assessment Maps* with those produced during previous campaigns as well as the initial campaign. The occurrence of recent on-going or recurrent deterioration processes should be indicated using a graphic symbol (a box or an arrow for example). The symbols used will have to be drawn on the map itself with their meaning indicated beside them.

When filling out a new *Data Form No. 3 – Condition Assessment*, only the deterioration processes that occurred since the last inspection or intervention should be recorded. If these phenomena seem to persist from one intervention campaign to the next, these observations should be noted in the space reserved for comments on the data form. The site manager will be informed of these findings and an attempt will be made to understand the underlying causes and to find the means of preventing their re-occurrence.

Inspecting the condition of the mosaic provides the opportunity for assessing the need and the urgency of a new intervention campaign. If the general condition is good, another inspection will be scheduled at a later date. If new deterioration mechanisms have appeared, it will be necessary to program new interventions. A new *Data Form No. 4 – Intervention Program* will then be filled out and, as the work is carried out, a new *Data Form No. 5 – Current Interventions* will be completed and its corresponding map drawn.

All new maps should use the same legends as those used for earlier maps. All newly created documentation material (data forms, maps and photos) must be placed in the same mosaic archive folder as the previous documentation. New data forms and maps should be grouped together with the same type of data forms and maps created during preceding campaigns.

THE MAINTENANCE PROCESS AND ITS DOCUMENTATION THROUGH TIME



THE DIFFERENT TYPES OF BASES AND MAPS IN GRAPHIC DOCUMENTATION

Graphic documentation enables the accurate mapping of different types of deterioration on the surface of the mosaic and makes it possible to rapidly assess their extension and to pinpoint the location of interventions.

BASES

Creating a base is the first step in graphic documentation. Copies of the base or transparent sheets superimposed onto the base are used to make all the maps.

There are two types of bases:

- Base drawing
- Base photograph

A base drawing is a drawing of the mosaic. A base photograph is a photograph of the mosaic. Each type of base can be obtained through different techniques.

Base drawing

- *Measured drawing* (see method pp. 43-45)

A base drawing can be obtained by placing a regular grid of strings onto the mosaic and by drawing the mosaic directly to scale using graph paper based on measurements taken using the grid.

- *Traced drawing* (see method pp. 46-52)

A base drawing can be made from a montage of photographs or a single photograph. To make a montage, the mosaic is photographed sector by sector and these photographs are assembled to create a single image. The mosaic is traced from this photographic montage or from a single photo, producing a drawing.

- *Existing drawing*

An existing drawing of the mosaic, found in a book, in archives or given by

the archaeologist or the site director, can also be used. An existing drawing might have to be modified if it is outdated and no longer exactly corresponds to the mosaic's current condition due to larger lacunae for example. It is also important to note the provenance and date of the drawing.

Base photograph

- *Single photograph* (see method pp. 53-56)

A base photograph can be obtained by taking a photograph of the mosaic. The entire area of the mosaic being documented must be visible in a single photo. If a single digital photo is taken, the image can be rectified on the computer using image-processing software such as Adobe Photoshop or Corel PaintShop Pro.

- *Digital photomontage* (see method pp. 50-52)

A montage of digital photographs rectified with image-processing software such as Adobe Photoshop or Corel PaintShop Pro can be assembled. Putting together photographs taken sector by sector will produce a complete single image of the entire mosaic.

- *Existing photograph*

An existing photograph from a book (*Corpus des Mosaïques de Tunisie*, etc.), archives, or given by the archaeologist or the site director can also be used. An existing photograph that may be old and no longer corresponding exactly to the mosaic's current condition due to more extensive lacunae, for example, may have to be modified. It is also important to note where the photograph comes from and its date.

Choosing between the two types of bases depends on the work environment and the characteristics of the mosaic. A base drawing may be more appropriate because it does not require much equipment. Only a pencil, paper and measuring tapes are necessary. It may be easier to draw a very large mosaic rather than photograph it in several sections to create a photomontage. Moreover, a drawing remains better conserved over time than a photograph.

A base photograph is easier and faster to obtain for a smaller surface or for a mosaic with an intricate design. A photo provides a better view of surface detail than a drawing.

MAPS

Once a base drawing or photograph has been created for the mosaic, it is used to make several maps. Each map records with colors and symbols the position of various types of information related to the mosaic such as previous interventions, condition and current interventions (see method pp. 57-58).

Whatever type of base is used, the maps can be drawn in two different ways:

- *Drawing directly on a photocopied base*

The information about the mosaic is directly recorded on a photocopy of the base drawing or photograph.

- *Drawing on a transparent sheet overlaid onto the base*

The information about the mosaic is recorded on transparency film or on a sheet of tracing paper placed over the base.

Legends

To be read, each map must have a legend. A legend is a list of the colors and graphic symbols used to record the data recorded on the map. For example, the color red can be used to represent detached tesserae, while green hatching can be used to record the presence of micro-organisms. Without a legend, it is impossible for others to understand what information has been recorded on the map. A legend is established prior to recording data on the map. If the legend is on a separate sheet, it must always be attached to the map as a reference in the future. The legend can also be placed on the edges of the map itself if there is enough space available to list all the information recorded on the map.

It is advisable to always use the same legend to facilitate the comparison of various mosaic maps from the same site or between different sites.

STEPS IN THE GRAPHIC DOCUMENTATION PROCESS

Type of base	Method to produce a base	Media on which the maps are drawn	Type of maps
Drawing (base drawing)	Draw the mosaic to scale using graph paper and a grid of strings placed on the mosaic	Photocopies of the base or Sheets of tracing paper or a transparency film overlaid on the base	Previous Interventions maps Condition Assessment maps Current Interventions maps
	Photograph the mosaic in a single frame or by sectors and draw the mosaic using the photograph or a photomontage		
	Duplicate a drawing of the mosaic taken from a book or an archive		
	Take a single photograph of the mosaic		
Photograph (base photograph)	Photograph the mosaic by sectors with a digital camera and make a photomontage on the computer		
	Duplicate a photograph of the mosaic taken from a book or an archive		

METHOD: BASE DRAWING

Making a measured drawing using a grid

Equipment

- String
- Equipment to keep the strings taut (nails, wooden planks, stones, etc.)
- Folding ruler, retractable measuring tape, reel measuring tape
- Large wooden framing squares (to check right angles when building the grid)
- Small triangle (to draw)
- Drawing board
- Graph paper
- Tracing paper
- Masking tape
- Pencil and eraser
- 0.1 or 0.2 ultra fine point pen
- Razor blade
- Compass
- Colored sticker dots

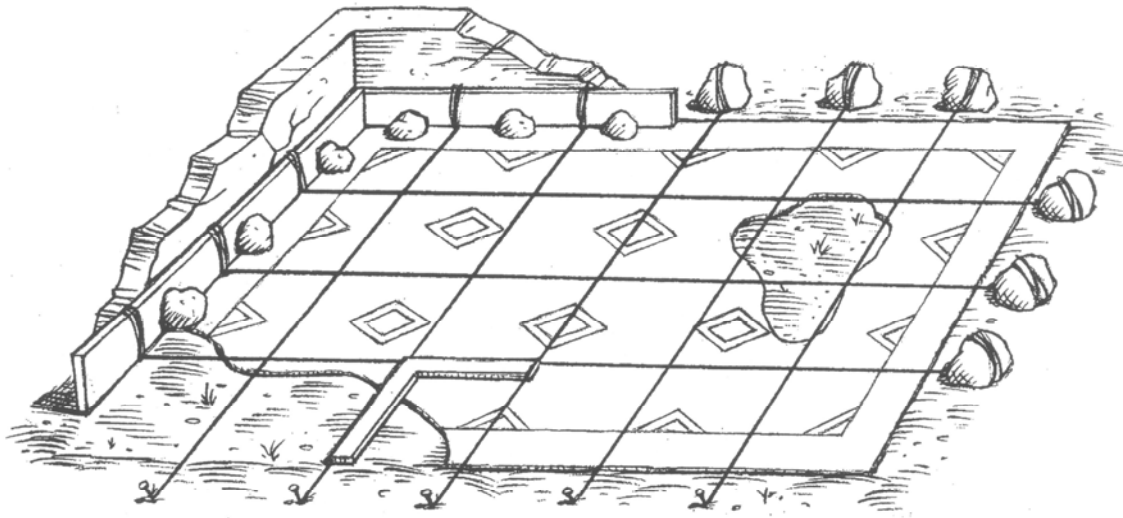
Steps (Figure 2, p. 44)

Remove dirt and sand from the mosaic surface with a soft brush, if it is possible to do so without damaging it.

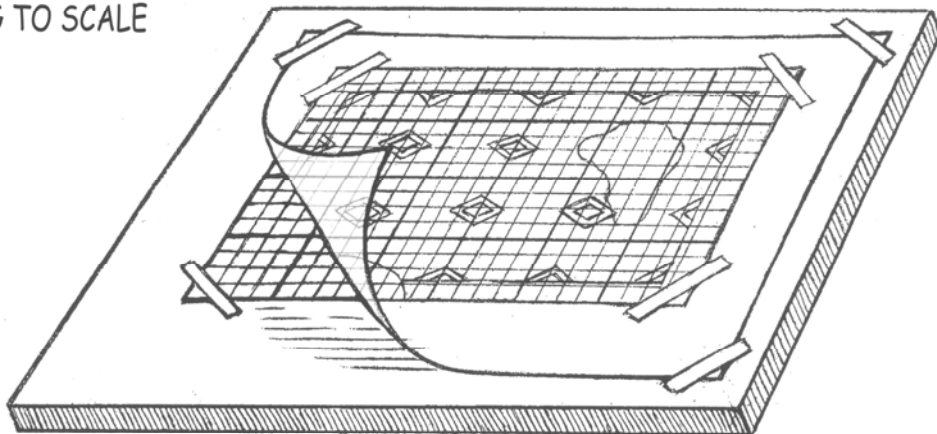
Build a grid over the mosaic by stretching strings across it at regular intervals (for example, 50 cm) to create squares. The grid squares must always have 90° angles (right angles) and therefore, the strings must be placed using a large wooden framing square. The strings can be fixed to the ground with nails in areas devoid of tesserae or original mortar; otherwise they must be attached to stones, wooden planks or by other means that do not damage the mosaic.

MEASURED DRAWING USING A GRID

SETTING UP THE GRID



DRAWING TO SCALE



BASE DRAWING

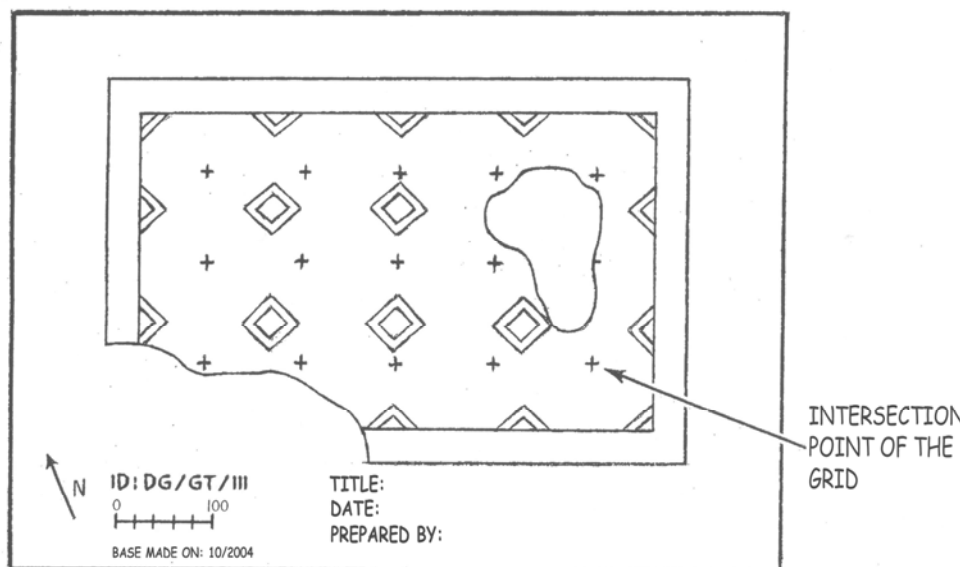


Figure 2

Attach a sheet of graph paper to the drawing board with masking tape and put a sheet of tracing paper over it. Choose a scale for the drawing (usually 1:10 or 1:20) according to the mosaic size and the paper format used (A3 or A4). With a pencil, **draw** on the tracing paper **the outline of the mosaic, its simplified design and the walls of the room**, if they are close by. The mosaic must be drawn square by square, by taking measurements using the mosaic grid and transferring them onto the tracing paper using the graph paper grid.

If the mosaic is large, it can be **divided into sections**. Each section of the base is then drawn on a separate sheet. These sections and their dimensions will be noted on the sketch of the mosaic on *Data Form No. 1 – Identification*. Each section will be numbered in succession (1, 2, 3, 4...).

Overlay a second sheet of tracing paper onto the first one with the original pencil drawing and, with a 0.1 or 0.2 ultra fine point pen transfer the drawing **onto the second sheet** by retracing the outline. If a second sheet of tracing paper is not available, turn over the first sheet, and retrace the original drawing with a pen on the reverse side, and then erase the pencil drawing on the front of the tracing paper sheet.

During the study phase, the grid can be left in place to help draw the maps. If one wishes to remove the grid, it is advisable beforehand to **place color sticker dots** on the mosaic surface where the strings intersect and to mark the same points on the drawing base to create reference points.

Complete the base drawing (see Figure 2, p. 44) with:

- The full mosaic ID and the date when the base was made
- The scale of the drawing and the North arrow
- The following headings: Title:
Date:
Prepared by:

METHOD: BASE DRAWING

Making a drawing traced from a photographic montage

PHOTOGRAPHIC SURVEY

Equipment

- Folding ruler, retractable measuring tape, reel measuring tape
- Large wooden framing squares (to check right angles when building the grid)
- Colored sticker dots
- Traditional or digital camera
- Print film
- Stepladder, short ladder or other prop to take pictures from above
- 2-meter stick
- Metric scale
- Small chalkboard and white chalk
- Compass
- *Photograph Log*
- Pencil and eraser

Steps (Figure 3, page 48)

The photographic survey method to create a photomontage is similar for traditional and digital photographs.

Remove dirt and sand from the mosaic surface with a soft brush, if it is possible to do so without damaging it.

Divide the mosaic in rectangular sectors of identical size using the measuring tape and the wooden framing square, marking the sector angles with colored sticker dots on the surface of the mosaic. Sectors measuring 70 cm x 100 cm are appropriate if the photographs are taken from a 2-meter height with a 35 mm camera lens.

Make a schematic drawing of the room and mosaic. Divide the drawing according to the sectors created with sticker dots. Assign a letter (A to Z) to each vertical column and a number to each horizontal row. Each picture will be identified by a letter-number code corresponding to the photographed sector. For example: The photo of the sector located at the top of the first column and in the first row to the left will be referred to as A1. Directly underneath will be photo A2; to the right of A1 will be photo B1, etc.

For each sector, **place** within the photo frame but outside the sector being photographed **the metric scale and the chalkboard** on which the mosaic ID and the sector letter-number code are written. **Indicate North** on the chalkboard or with an arrow.

Set the camera if the camera is a traditional one. The camera settings and the zoom – if present – must be adjusted for the first photo and must remain the same throughout the entire survey of a mosaic. On the other hand, the aperture must be adjusted before taking each picture (see pp. 59-60).

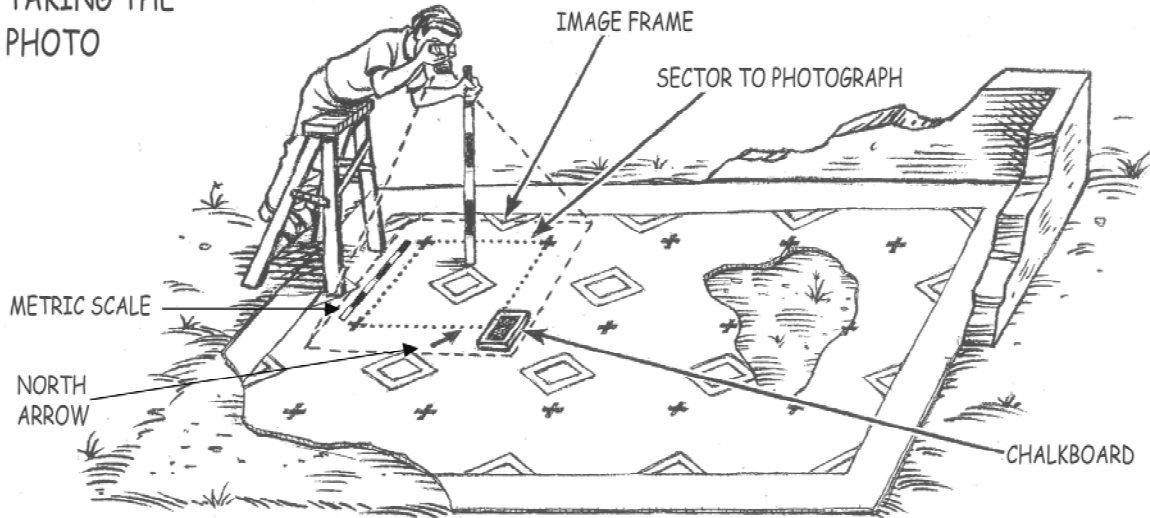
Photograph the mosaic, one sector after another, following the previously established divisions by placing the camera vertical to the mosaic surface and as close to the center of the rectangle to be photographed as possible. For the photos to be at the same scale, the camera must always be placed at the same distance from the mosaic for each photo. A rigid metric scale or a stick can be used to insure the same distance between the mosaic and the camera.

Each photo must contain the entire sector to be photographed marked by the sticker dots and also include a part of each adjacent sector where the chalkboard and the metric scale are placed.

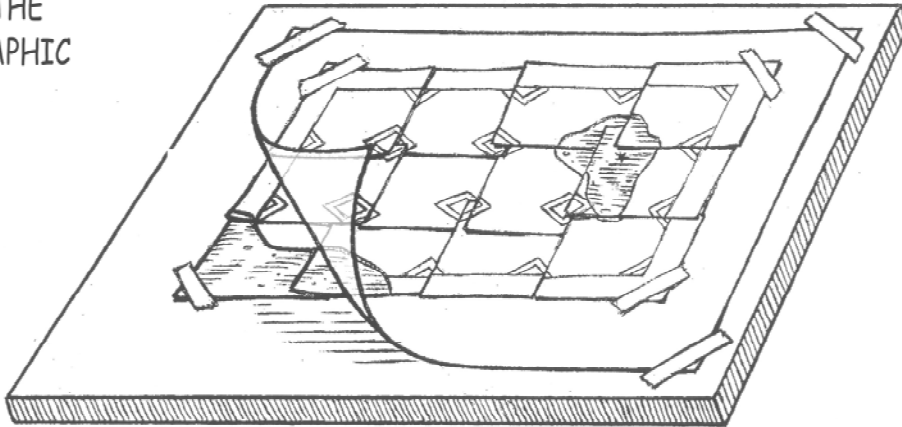
List the photos on the *Photograph Log* as they are taken and also note the letter-number sector code.

TRACED DRAWING FROM A PHOTOGRAPHIC MONTAGE

TAKING THE PHOTO



TRACING THE PHOTOGRAPHIC MONTAGE



BASE DRAWING

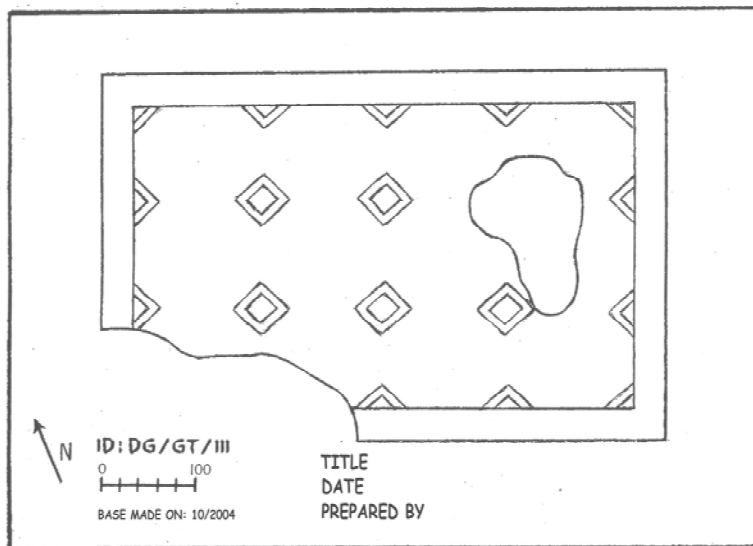


Figure 3

PHOTOGRAPHIC MONTAGE OF TRADITIONAL PHOTOGRAPHS AND TRACING A DRAWING FOR THE BASE DRAWING

Equipment

- Scissors
- Long ruler and framing square
- Adhesive tape
- Tracing paper
- Pencil and eraser
- 0.1 or 0.2 ultra fine point pen
- Razor blade

Steps (Figure 3, page 48)

Put the photographs in order on a table following the division of the photographed sectors previously recorded on the schematic drawing of the room.

Cut the photograph edges, keeping a large enough margin outside each sector marked by the colored sticker dots, to be able to put one sector on top of another.

Make the montage by **overlapping the photographs**, row by row, putting the colored sticker dots seen in the photos one above the other and trying to keep the mosaic design continuous. Then, using a ruler and a framing square, check that the colored sticker dots are aligned.

During the montage, the photographs should be temporarily attached one to the other with little pieces of tape stuck to the front of the photos. When the photographic montage is finished, **fix it permanently with Scotch tape on the back of the photos**. Then remove the pieces of tape that were fixed to the front.

On a sheet of tracing paper placed on top of the photographic montage, **trace the outline of the mosaic** and its simplified design with a pencil.

Overlay a second sheet of tracing paper onto the first one and, with a 0.1 or 0.2 ultra fine point pen, **trace on the second sheet the original pencil drawing** made on the first

tracing paper sheet. If a second tracing paper sheet is not available, turn the first sheet over, and retrace the original drawing with a pen on the reverse, then erase the pencil drawing made on the front of the tracing paper sheet.

Complete the base drawing (see Figure 3, p. 48) with:

- The full mosaic ID and the date when the base was made
- The scale of the drawing and the North arrow
- The following headings: Title:

Date:

Prepared by:

PHOTOGRAPHIC MONTAGE OF DIGITAL PHOTOGRAPHS AND TRACING A DRAWING FOR THE BASE DRAWING

Equipment

- Digital Camera
- Computer
- Adobe Photoshop (image processing software)
- Printer

Steps

Start by **uploading the digital photographs from the camera to the computer**. The photos taken for the photomontage will be archived in a new folder called Montage 1 in the folder corresponding to the documented mosaic. Each image should be renamed with the letter-number sector code referring to the photographed sector on the schematic drawing of the room and the mosaic. A folder called Montage 2 should also be created and should contain all the modified and rectified images as well as the result of the photomontage.

After launching the Adobe Photoshop software, open photo A1 and create a new layer to **correct its color**. To reduce contrasts between images and even the color hues, use the

“Levels” function. The black “Eyedropper” tool will serve to match the darkest part of the image with the color black (one can use the black squares on the North arrow or metric scale). Do the same with the white “Eyedropper” tool to tweak the lightest area of the image. It is important to save this process to be able to apply it to the following images (the file extension corresponding to this process is .alv). Thus, the color of all the photos will be adjusted to the same levels.

Enlarge the canvas size before proceeding. **Establish the proper proportions for the photo.** To do so, drag two guides from the ruler so that they pass as close as possible through the colored sticker dots on the longer side of the sector. Use the on-screen ruler to measure the distance between these two guides. Since the real measurements of the sector are known, it is possible to calculate the proper width of the sector on the screen. Drag two other guides to complete the rectangle that corresponds to the frame of the photographed sector and is true to the proportions of the frame. Note that the four colored sticker dots do not necessarily align with the intersection of the guides. This is because the photo is deformed.

Rectify the photo by using the tools “Skew” and/or “Rotate” in the “Transform” function. These tools will stretch the photo in order to line up the colored sticker dots with the corners of the rectangle formed by the guides. The photo will be straight and correctly proportioned.

Save the rectified image in the Montage 2 folder as a .psd file before closing the file.

Repeat the same process with the subsequent photos. Correct the color of the subsequent photos by running the “Levels” function file that was saved earlier. For each photo, enlarge the canvas and, by using the guides, create a rectangle that will have the correct dimensions calculated for the first photo. Rectify each photo using the tools in the “Transform” function and save each rectified image in the Montage 2 folder.

Once all the pictures have been rectified, open photo A1.psd from Montage 2 folder. Enlarge the canvas so that all the photos of the mosaic will be able to fit together and **use the guides to create a grid.** Each of the grid boxes will correspond to each of the photographed sectors. The size of the boxes will match the size of the rectified frames.

Open the next image proceeding row by row. **Place the image in the grid box corresponding to its real location.** Use the “Move” tool and drag the image into the window of the first image (it will then appear as a new layer). Try to line up the colored sticker dots one on top of the other so that the overall image of the mosaic is seamless. The opacity of one layer relative to another can be changed from the “Layer” toolbar. If the dots do not match up, use the tools in the “Transform” function to line them up. If the colors are too different, adjust the levels of the images.

Save the document as “MosaicID.Photomontage.psd” in the Montage 2 Folder. Open the next image and repeat the same steps. Save the work regularly.

Once all the photographs have been inserted, aligned and overlaid, **delete the areas with too much overlap** with the “Rectangular Marquee” tool. Adjust the feathering to 15 pixels to make the photomontage seem seamless, i.e. without apparent sections revealing the different grid boxes or layers.

When all the final adjustments are completed, **flatten and crop the image** with the “Crop” tool. Save the final image as:

Mosaic_Date (Year-Month-Day)_Photomontage.tif

Create a layout of the photomontage and **print** (see method pp. 55-56). **Create a drawing** for a base drawing by tracing it from this digital photomontage (see pp. 49-50).

METHOD: BASE PHOTOGRAPH

Making a base photograph using a single traditional photograph

Equipment

- Traditional camera
- Print film
- Stepladder, short ladder or other prop to take pictures from above
- Metric scale
- Small chalkboard and white chalk
- Compass
- *Photograph Log*
- Pen
- A4 sheet of paper
- Glue

The base photograph can be a photograph of the mosaic taken during the study phase or an existing photograph of the mosaic from a book or an archive.

Steps

To take a photograph to use as a base photograph, the entire mosaic section to be documented must be visible in a single photograph (see pp. 59-60 on how to use a manual camera). To minimize subject deformation, the photo should be taken as vertically as possible from an elevated position at the center of the mosaic.

The metric scale and the chalkboard indicating mosaic ID, date and photo number should be placed within the image frame of the photograph. **Indicate North** on the chalkboard or with an arrow.

Take the photograph and list it on the *Photograph Log*.

If possible, **develop the photograph** in a large format (13x18 cm or 15x21 cm) print and glue it to an A4 sheet of paper. If the photo is small (10x15 cm or less), it should first be glued on an A4 sheet and then enlarged.

Complete the base photograph with:

- The full mosaic ID and the date when the base was made
- The scale of the drawing and the North arrow (if not present in the photo)
- The following headings: Title:

Date:

Prepared by:

If the photo is small, this information should be written in small print, very close to the photo, as the whole base will be enlarged.

If the photograph comes from a book or an archive, its photocopy, in color if possible, should be glued on an A4 sheet of paper and the information listed above should be added. The provenance of the photograph (title of the book, name of the archive, etc.) and, above all, the date the photo was taken should be noted on the sheet of paper for the condition of the mosaic may have changed since the time it was originally photographed.

METHOD: BASE PHOTOGRAPH

Making a base photograph using a single digital photograph

Equipment

- Digital camera
- Computer
- Stepladder, short ladder or other prop to take pictures from above
- Metric scale
- Small chalkboard and white chalk
- Compass
- *Photograph Log*
- Pen
- Sheet of A4 paper

Steps

Taking a digital photographic survey follows a similar process as for traditional photos (see pp. 59-60).

Upload the photographs from the digital camera to the computer. **Check** the quality of each photograph and rotate it so that it is in the proper direction, and, if possible, rectify it (see method pp. 50-51). **Rename** the file according to the information written on the *Photograph Log* (see pp. 28-30). **File** the image in the folder corresponding to the mosaic photographed following the digital file archiving method (see page 34).

Run the Microsoft Word application and **insert the digital image** in a new document.

Use the “Picture” toolbar to modify the appearance of the image on the page. To reduce the image frame of the photo, use the “Crop” tool in the “Image” toolbar. To

change the size, select the “Format picture” tool. In the “Size” tab, the size of the picture can be reduced or increased while respecting its proportions. In the “Layout” tab, choose either “Tight” or “Square” options to adjust how the text wraps around the photograph.

Complete the base photograph with:

- The full mosaic ID and the date when the base was made
- The following headings: Title:

Date:

Prepared by:

Save the file in the folder corresponding to the room where the mosaic is located and **name the file as:**

MosaicID_Date(Year-Month-Day)_ID_BasePhotograph.doc (see method pp. 28-30). After **printing** the layout, **draw the scale and the North arrow** (if not present in the image frame).

In some cases, a photomontage of digital photographs (see pp. 50-52) can be laid out and used as a photographic base. The same method should be applied for the layout of a single photograph and the same additional information should be written below.

To print the laid out base photograph and use it for making maps, the image control options should be modified: the color mode should be changed so that the image is in black and white. Use the tool “Image Control” in the “Picture” toolbox and select “Grayscale.” This can also be achieved using image-processing software. If the image was modified in Adobe Photoshop, go to the “Image” menu, then to “Mode” and select “Grayscale.”

METHOD:

Making a map

Equipment

- Photocopies of the base or base and sheets of tracing paper (or transparency films)
- Drawing board
- Pencil and eraser
- Felt pens
- Colored pencils
- Permanent markers for transparencies
- White corrector fluid

Steps

If the maps are to be drawn directly on photocopies of the base drawing or photograph, **photocopy the base** on A4 or A3 paper, reducing it or enlarging it as needed. To make copies of the base photograph, make the **photocopy as light as possible** so that the colored mapping is legible on the photocopy.

If the map is to be drawn on a separate transparent sheet of paper, **overlay a sheet of tracing paper** or transparency film **onto the base**.

The following information should be written on each photocopy or each sheet of tracing paper:

- The title of the map (e.g. Current Interventions Map)
- The date (e.g. May, 2004)
- The name of the people who made the map
- In the case of transparency film, copy the full mosaic ID

Using different colors and graphic symbols already defined in the legend, **draw the map** on a photocopied base or trace it on a sheet of tracing paper or transparency film

placed over the base. Draw one type of data for the entire mosaic surface before proceeding to the next type of data when creating the study phase maps (*Previous Interventions Map* and *Condition Assessment Maps*). For the *Current Interventions Map*, it is recommended to record on the map all work as soon as it is completed.

A legend must always be kept with its corresponding map or be drawn beside the map, as a map cannot be understood without a legend.

THE USE OF PHOTOGRAPHY IN MOSAIC MAINTENANCE

Photography enables a mosaic to be documented in a more direct and realistic way during the phases of maintenance work. Photography is well-suited to illustrating certain conditions, such as the seriousness of some types of damage; however, other types of information can only be represented graphically because they are not visible. For example, the extent to which micro-organisms are present can be documented using a photograph, while detachment between preparatory layers can only be represented using graphic documentation.

Photography is also used at the beginning of the study phase to take an overall image of the mosaic, which will be attached to *Data Form No. 1 – Identification* and may be used to create a base for graphic documentation.

Cameras

A camera consists of a body and a lens. The light emitted from the photographed object enters the camera body through the lens. Inside the body, a light sensitive surface captures light. There are two types of light-sensitive surfaces that comprise the two main types of photography: photographic film for traditional photography or sensors for digital photography.

Among traditional and digital cameras, some models can be adjusted completely manually while others may be automatically adjusted for one or several settings. Either a traditional manual or an automatic digital camera is well suited to documentation needs during mosaic maintenance.

Using a traditional manual camera (Figure 4)

The use of a traditional manual camera is detailed below.

Choose the type of film to be used. There is a choice between slide or print films, and color or black and white and a choice in terms of the sensitivity of the film to light (ASA/ISO). 100 ASA/ISO is recommended for use outdoors on sunny days; 200 ASA/ISO for use outdoors on cloudy days or indoors if there is a lot of light; 400 ASA/ISO for use

indoors, when there is low lighting. Insure that the “use-by” date of the film has not been reached.

After inserting the film, **set the film sensitivity (ASA/ISO)** on the camera body so that it corresponds to that of the film used.

If present, **adjust the zoom** to obtain the desired image frame. For example, the zoom will be set from 50 mm to 80 mm for a image frame for photographs of details, and from 28 mm to 35 mm for the wider framing of overall shots.

Focus the subject to obtain a sharp image using the focus ring, which is located on the part of the lens farthest away from the camera body.

Adjust the shutter speed with the dial located on the top of the camera body. The dial generally bears numbers from 1 to 1000. It is suggested that speeds of 60 or 125 be used. Slower speeds (numbers below 60) should not be used when the camera is not stable, because it would be difficult to obtain a clear image.

Adjust the lens aperture with the ring located on the part of the lens closest to the camera body, generally bearing numbers from 22 to 2.8. This ring controls the quantity of light entering the camera when a photograph is taken. Choose the aperture number recommended by the camera, which can be read inside the viewfinder.

The shutter speed and lens aperture are linked. If the chosen shutter speed does not allow setting the aperture to the one recommended by the camera, the shutter speed must be changed.

When all the adjustments have been made, push the shutter release button to take a photograph.

TRADITIONAL MANUAL CAMERA

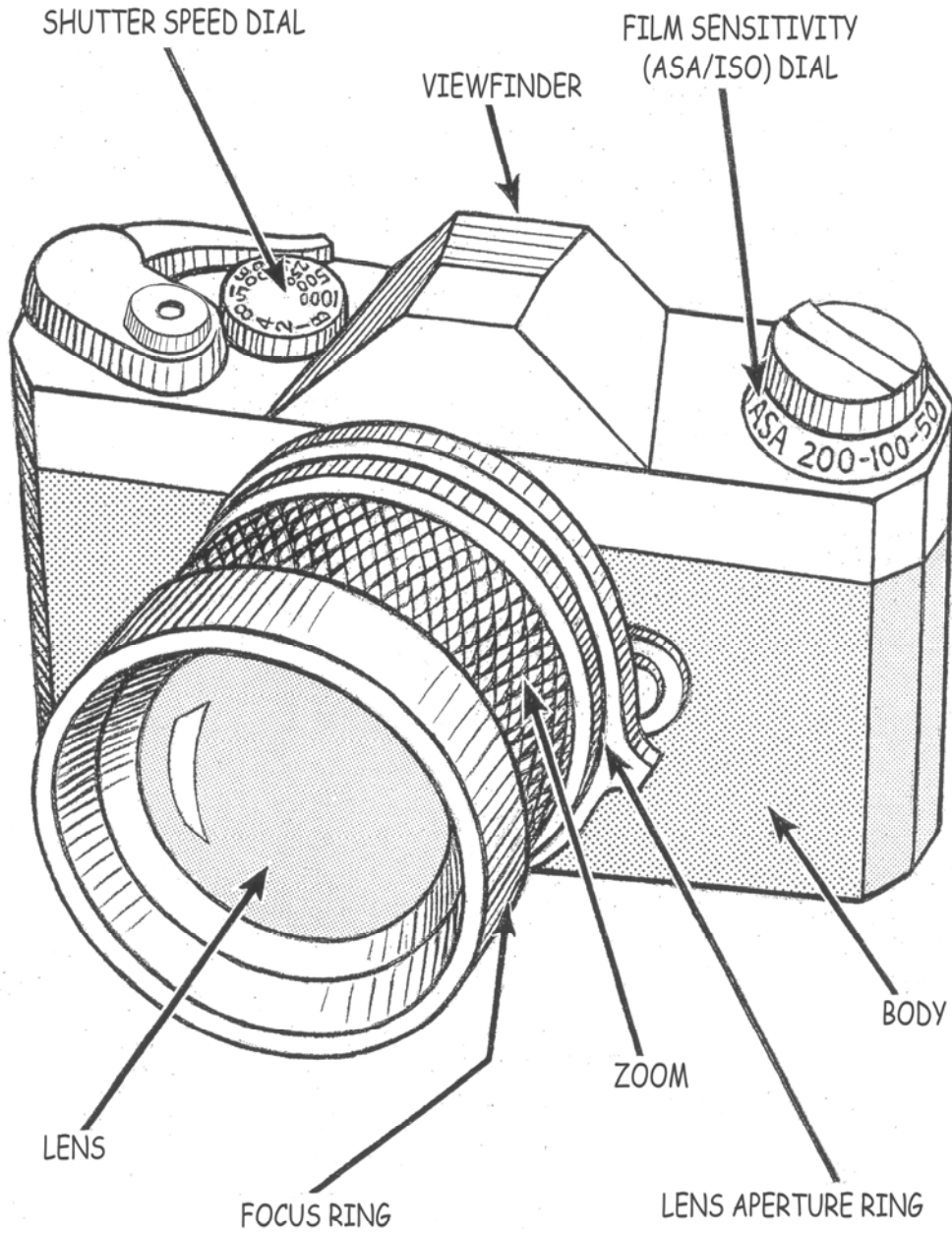


Figure 4

Digital photography

In a digital camera, the light emitted by the subject is captured by sensors that act like the photographic film and electronically translate the light into an image. The image is an electronic file that is saved on the memory card in the digital camera. Images can be uploaded to a computer with a USB cable.

Digital photographs can be kept either on the computer (short-term) or burned to a CD (long-term), or can also be printed on paper.

Like print photos, digital photographs must be filed and archived (see method page 34).

Using a scanner connected to a computer, traditional photographic images (negatives, slides or prints) can also be transformed into digital images, which can then be printed. Scanning may also be used to create a digital copy of traditional photographs to keep them in a digital format.

General advice about photography

To take a good photograph, one should consider a number of practical aspects:

- Avoid taking photographs facing the sun.
- Avoid taking photographs of areas that are partly shaded and partly lit, as too great a difference in lighting will not allow the camera to be correctly adjusted; consequently part of the photo will be too light or too dark.
- Pay attention to how you frame the image. It should be centered exactly on the area of the mosaic to be photographed and should be tightly framed to avoid the inclusion of other objects in the photo.

To care for the camera:

- Avoid touching the lens and/or the plasma screen on the camera body.
- Keep the camera in a closed bag. It is a fragile object, which is sensitive to dust.
- Store the film in a cool and dry place.
- After uploading the pictures to the computer, empty and format the memory card often by following the instructions in the camera user's manual.
- Do not remove the memory card from the digital camera while the images are being uploaded to the computer.
- Remove the batteries and the memory card when the camera is left unused for a long period of time.

DOCUMENTATION EQUIPMENT CHECK-LIST

- _____ Drawing board
- _____ Pencil and eraser
- _____ Pencil sharpener
- _____ Ball-point pens
- _____ 0.1 or 0.2 black ink ultra fine point pen
- _____ Razor blade
- _____ Felt pens and colored pencils
- _____ White liquid paper correction fluid
- _____ Long ruler
- _____ Small triangle
- _____ Masking tape
- _____ A4 and A3 graph paper
- _____ A4 and A3 tracing paper
- _____ Colored sticker dots

- _____ Data Forms
- _____ Photocopies (blank copies) of the base drawing or photograph
- _____ Archive box
- _____ Folders
- _____ Plastic sheet protectors
- _____ Binder
- _____ A3 portfolio
- _____ Paper clips
- _____ Transparent Scotch tape
- _____ Scissors
- _____ Stapler and staples
- _____ Writing pads

- _____ String
- _____ Equipment to keep the string taut (nails, wooden planks, stones, etc.)
- _____ Large wooden framing squares
- _____ 2-meter folding rule
- _____ 5-meter retractable measuring tape
- _____ 20-meter reel measuring tape

- _____ Camera
- _____ Print film or memory card
- _____ Stepladder, short ladder, or other props
- _____ 2-meter stick
- _____ Small chalkboard
- _____ White chalk
- _____ Black and white metric scale
- _____ Arrow to indicate North
- _____ Compass
- _____ Photograph Log

Deterioration and Interventions

DETERIORATION

Causes of deterioration of in situ mosaic are numerous and often combined. Deterioration of a mosaic is generally due to environmental factors, the inherent properties of the materials of which it is composed and to human action.

ENVIRONMENTAL FACTORS

Climate

The climate of a site, i.e. the weather conditions (rain, sun, snow, temperature, etc.) prevailing in that area, is one of the principal environmental factors. In some climates, changing weather conditions lead to significant variations in temperature and humidity during the day and throughout the year. If these changes are significant, sudden and frequent, they will lead to the deterioration of the constituent materials of a mosaic (lime mortar, stone, etc.) through different mechanisms. In a more stable climate, these variations will be less significant, slower and not as frequent; consequently, mosaics will suffer less deterioration.

All archaeological sites do not have the same climate and therefore do not suffer the same type of deterioration. The climate of coastal sites is generally more stable, but they are affected by salty sea winds and salty ground water. Inland sites generally experience more significant temperature variations between seasons, with hot summers and cold winters, and sometimes, snow in the mountains. Sites close to the desert undergo large temperature differences between very hot days and cold nights.

Much of the deterioration caused by environmental factors is linked to the presence of water, which may derive from:

- Atmospheric precipitations (rain, snow, etc.);
- Condensation: water vapor in humid air is transformed into liquid water when it comes in contact with a surface colder than the air, such as the surface of a mosaic (Figure 5);

- Capillary rise: water in the soil rises to the surface of the mosaic where it evaporates in the drier air. This water can come from rain-saturated soil or from a water table close to the surface or from the sea. This water movement also occurs when the mosaic is exposed to the atmosphere after being excavated (Figure 6).

Environmental factors can affect the materials of the mosaic by triggering various deterioration mechanisms. Most of the time, damage happens gradually through recurring aggressive action of the environmental. Below are a few simple explanations on how certain deterioration can occur.

Salt crystallization

Ambient humidity diminishes when the temperature rises, causing water contained in the mosaic to evaporate. If the water contains dissolved salts, these will be transformed into crystals during evaporation. If the salts crystallize within the mosaic, they fracture the materials enclosing them. If they crystallize on the surface of the mosaic, they form efflorescences, generally white powder-like or whisker-like crystals, loosely adhering to the mosaic surface. After a long period of time, salts can also form incrustations or mineral crusts that are often hard and compact, and can strongly adhere to the mosaic surface (Figure 7).

Deformation due to water absorption or temperature

Mosaic materials can increase in volume if they absorb water or if there is a steep temperature rise. This generates compression within the mosaic causing cracks and detachment of the uppermost layers of the mosaic.

Freeze-thaw

When the ambient temperature falls below 0° C, the water contained in the mosaic turns into ice, causing the materials to fracture.

CONDENSATION

WHEN THE SURFACE IS COOLER THAN THE AIR

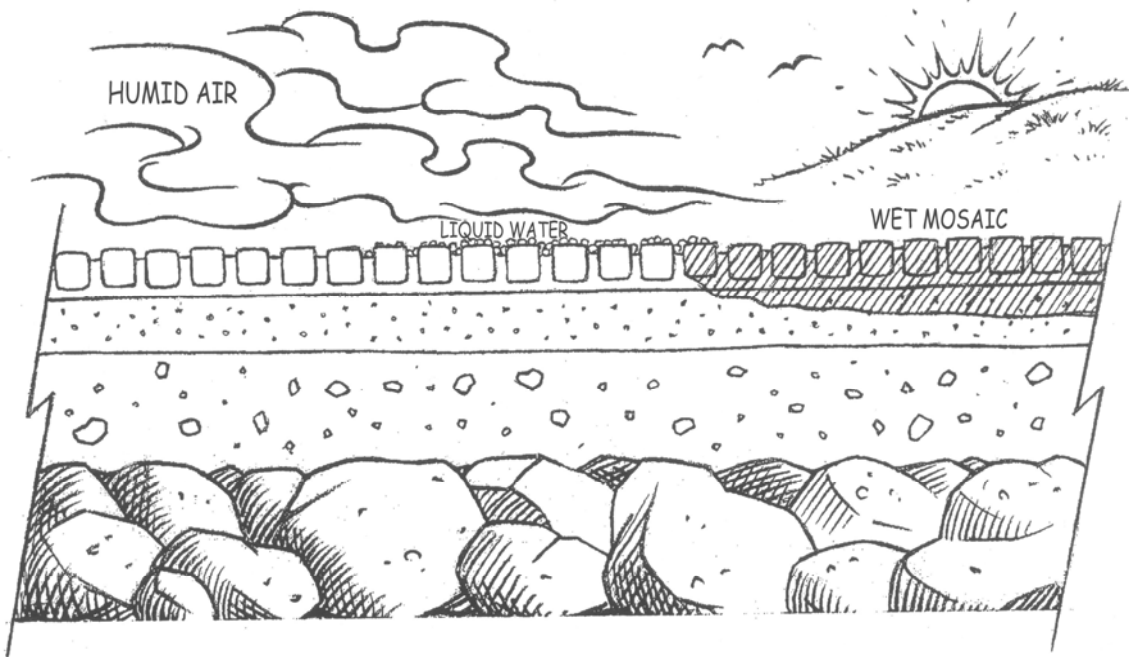


Figure 5

CAPILLARY RISE OF WATER

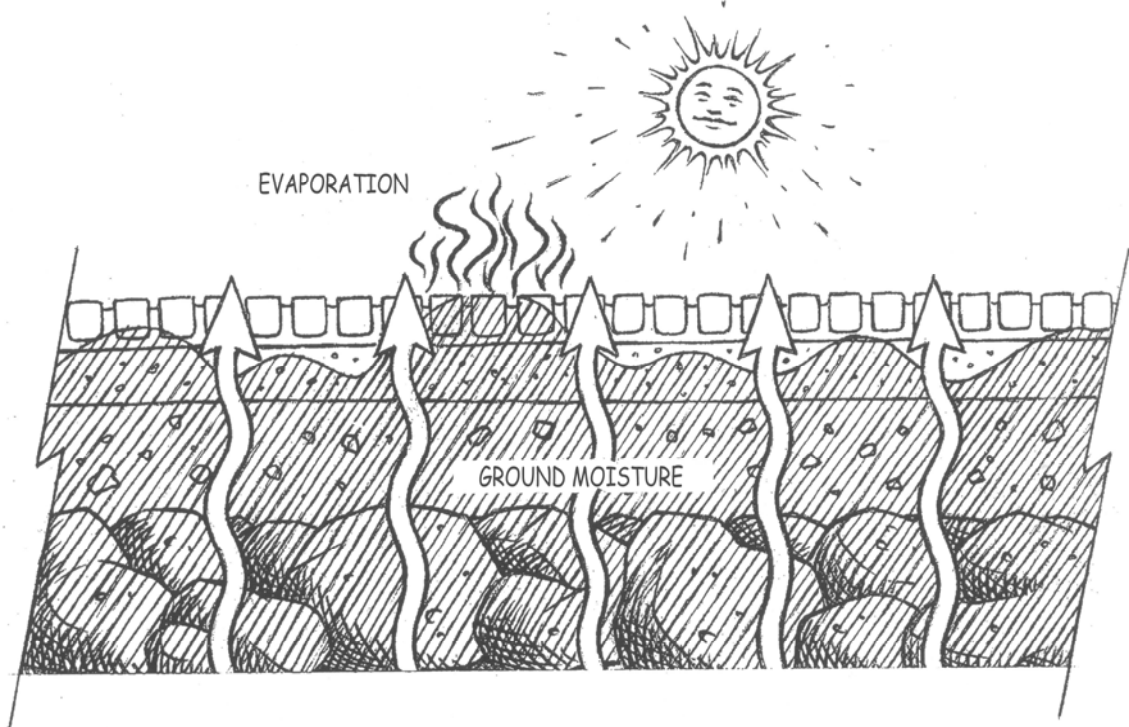


Figure 6

Biological deterioration (Figure 8)

The impact of animals and plants is also a significant cause of mosaic deterioration. Climate influences the type of animals and plants found at a given site and the severity of damages they can cause.

Micro-organisms

Micro-organisms are small living organisms of different colors and shapes. Those most commonly found adhering to mosaic surfaces are algae, lichens, and mosses.

Algae are generally green or black. Algae can grow on the surface of the mosaic and under the tesserae, and even inside the tesserae and the mortars.

Lichens take root directly on the tesserae surface. They form layers of different colors and, in certain cases, can entirely cover a mosaic surface.

Mosses, which are small plants, take root in damp areas where soil is present, for example in the interstices between mosaic tesserae.

These microorganisms often co-exist and their presence contributes to keeping the mosaic damp, thereby causing the deterioration of its materials and promoting the growth of larger plants.

Vegetation

Grass and plants grow in soil present in the interstices between tesserae, cracks and lacunae of a mosaic. Trees, shrubs and bushes grow in the soil around the mosaic. Plant roots can grow under the mosaic or in-between its layers, even if it does not contain soil. They can then crack the layers and also cause their detachment.

Animals

Animals, like large plants, can also provoke structural deterioration. Ants and other insects build their nests; rats, moles and other small animals dig tunnels within or under the mosaic.

Sheep, cows and other large animals deteriorate the mosaic by walking on it and by pulling out plants that are rooted in or close to the mosaic.

SALT CRYSTALLIZATION

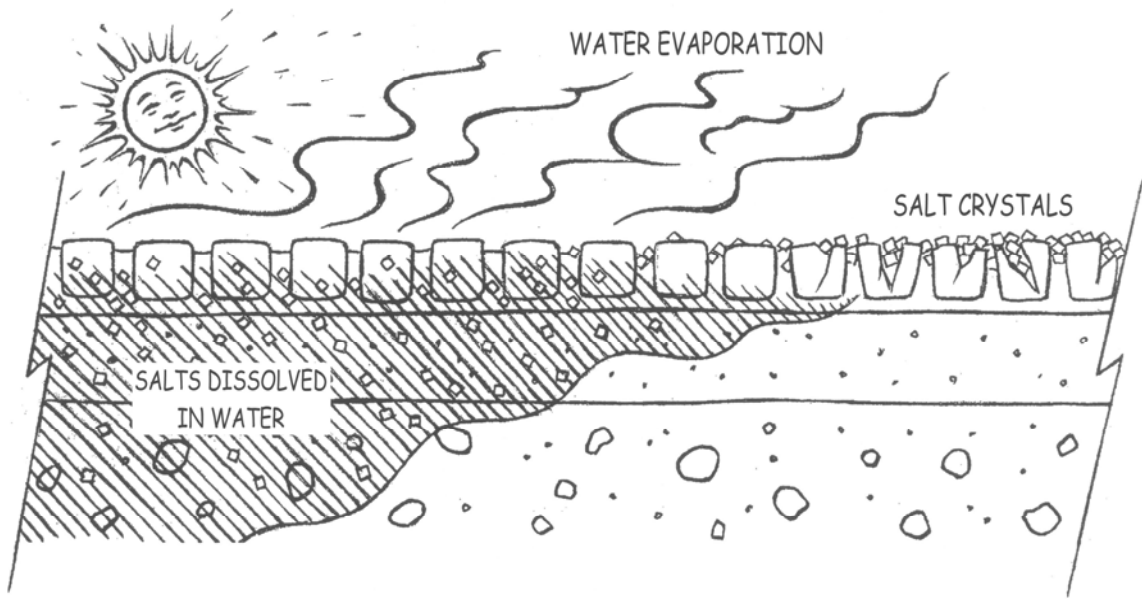


Figure 7

DETERIORATION CAUSED BY ANIMALS AND PLANTS

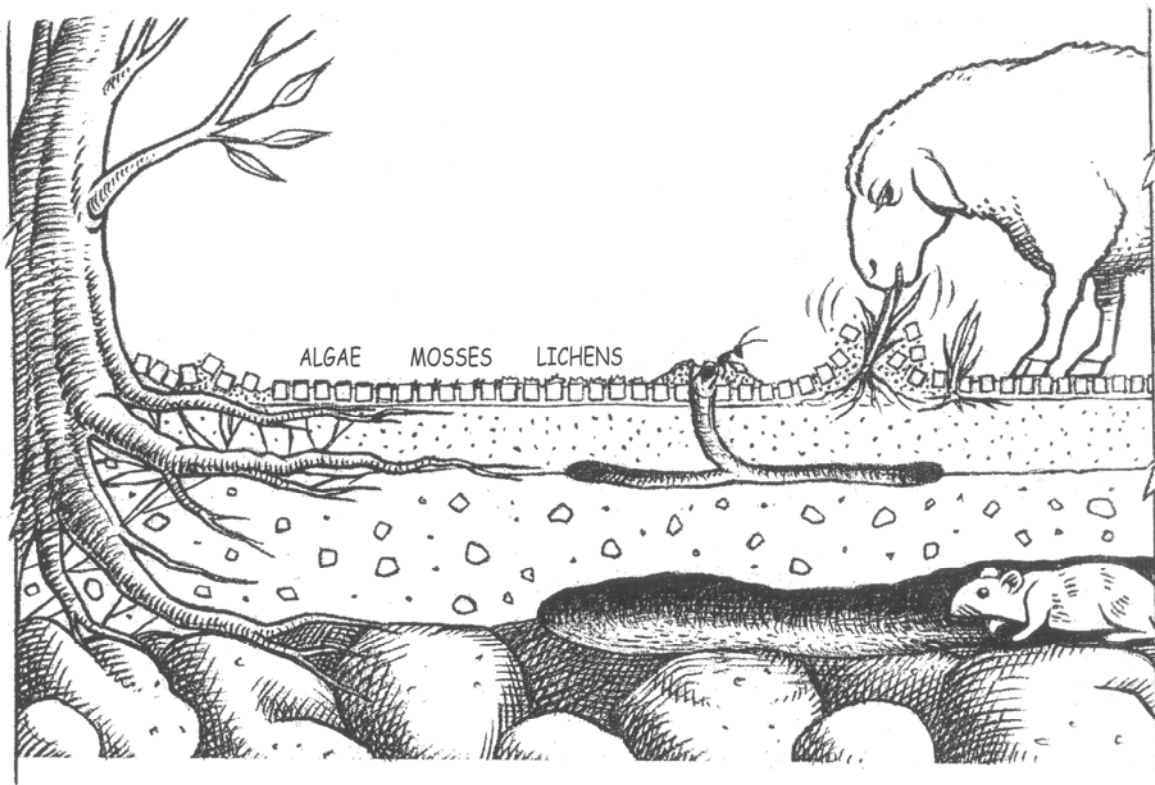


Figure 8

Pollution

Air and water pollution is also an environmental factor affecting the deterioration of mosaics.

Some chemicals from factories or agricultural fertilizers are dissolved in rainwater and soil moisture. These substances may cause deterioration if in contact with the mosaic. Polluting substances can deteriorate or chemically alter calcareous materials (lime mortars, limestone, and marble).

Natural Disasters

Exceptional events such as earthquakes or violent floods can also cause the sudden deterioration and loss of mosaics.

INHERENT PROPERTIES OF THE MATERIALS

Besides the environment, mosaic deterioration is also related to the inherent properties of the materials of a mosaic. All materials in a mosaic are porous, i.e. they can absorb water, but the characteristics of each material are different (porosity, hardness, mineral composition, etc) and thus each material will deteriorate differently when exposed to the same environment.

For example, within the same mosaic pavement, it can often be observed that tesserae of a certain stone type are much more deteriorated than others. Similarly, mortars can be more or less resistant. Within the same building, some mosaics can be made with well-made mortars, which are still in good condition, while other mortars are much more deteriorated.

Human Activities

Human activities are also a significant cause of mosaic deterioration. Among these activities are:

- *Poor management of archaeological sites*: lack of a conservation and maintenance program, poor planning of conservation interventions and documentation during excavations, abandonment of mosaics after their excavation, and poor management of tourist visits where trampling on mosaics is not prohibited.
- *Inappropriate interventions*: poorly executed work and use of potentially damaging materials such as cement, plaster, iron elements and irreversible resins.
- *Destruction*, gratuitous, deliberate, or accidental, due to vandalism, wars, or the removal of a few souvenir fragments, etc.
- *Theft* of mosaic sections for the purpose of selling them.
- *New constructions* (houses, roads, etc.) leading to destruction of part of a site and its mosaics.

Although the possible causes of in situ mosaic deterioration described above are numerous, it is important to identify which ones have the greatest impact on a given mosaic. With this approach, it should be possible, with the site manager's agreement, to take measures to eliminate these causes to the greatest extent possible, thus avoiding future deterioration, rather than carrying out periodic repairs on a mosaic that continues to deteriorate. Because of the frequent inspections they perform, maintenance technicians are perhaps in the best position to identify the primary causes of deterioration, and then develop a protection and stabilization program with the help of others.

LEVELS OF CONSERVATION TREATMENT

Conservation treatments can be divided into three categories according to the aims pursued and the degree of intervention.

The main work of technicians is to carry out mosaic maintenance, but they can also carry out some simple first-aid operations and contribute to the conservation of mosaics under the supervision of a conservator.

First-aid or emergency care

The purpose of first-aid treatments is only to stabilize the areas of the mosaic in danger of immediate loss, pending intervention within the framework of a full treatment program. They generally include operations to temporarily protect the edges of the mosaic as well as localized stabilization work.

They are generally carried out during a short period of time, when the mosaic is exposed for the first time during excavation, construction work, or when an excavated mosaic has suffered sudden damage or prolonged neglect.

Emergency treatments should be documented quickly, but thoroughly.

Conservation

The purpose of conservation treatments is to restore the structural and aesthetic integrity of the whole mosaic. They generally include cleaning, stabilizing, consolidating the materials of the mosaic (stone, brick, mortar, etc.) and operations of aesthetic presentation. They should be based on the condition assessment of the mosaic, on preliminary investigations and on laboratory analyses. A methodology can thus be determined (types of operations and materials to be used) as well as a conservation program (hours and cost of work). Conservation programs must include a future maintenance program for the mosaic.

The whole conservation process should be accurately documented in detail.

In the past, conservation treatments often consisted of lifting mosaics and transferring them onto a new support. However, these operations should only be carried out in exceptional cases where the mosaic would be totally lost if it were not lifted and

transferred. Currently, it is considered much more appropriate to leave mosaics in situ in their architectural context.

Maintenance

The purpose of maintenance interventions is to preserve the structural integrity of the mosaic over a long period of time after its initial conservation treatment or stabilization.

These interventions are planned when necessary and on the basis of regular inspections to check the condition of the mosaic and of the previous interventions.

They include:

- Operations to prevent the progression of mosaic deterioration by controlling its causes, for example, regular weeding of the mosaic surface, elimination of accumulated water, sand and soil, and improvement of drainage in the room containing the mosaic.
- Cleaning and localized stabilization of the mosaic in areas where new deterioration has appeared since the last maintenance campaign.
- Replacement of modern repair mortars that are no longer effective or are damaged.
- Reburial maintenance, repairs of protective shelters and other interventions carried out around the mosaic.

These three categories (i.e. first-aid, maintenance, and conservation) represent the different levels of mosaic treatment, from the minimum to the most complete. Every mosaic can be the subject of each of these different treatment levels at different moments depending on its condition, its exposure and the available resources. However, regular maintenance should normally offset the need for first-aid treatments.

CLEANING

A periodic maintenance program for in situ mosaics includes cleaning operations.

Within the framework of maintenance activities, the purposes of cleaning operations are:

- to remove substances and materials from the surface of the mosaic that could be responsible for its deterioration;
- to enable a better assessment of the mosaic's condition by making its surface more visible;
- to prepare the mosaic for mortar-based stabilization treatments.

Before beginning to clean, it should be insured that cleaning is compatible with the mosaic's condition; an overly forceful action on a fragile mosaic can lead to the detachment of tesserae. If the mosaic is very damaged, stabilization may be necessary to reinforce the mosaic before cleaning it.

In the course of the cleaning during mosaic maintenance, anything that could potentially undermine the conservation of the mosaic should be removed. For an in situ mosaic, vegetation growing on or around the mosaic, soil and other debris deposited on its surface and particularly in between the tesserae, as well as micro-organisms adhering to it should be removed. Finally, modern repair mortars, especially if they are damaged or are damaging the mosaic, should be removed.

The removal of soil, especially when it is under the tesserae, is a particularly important operation to insure that lime-based treatment mortars adhere to the original materials.

Cleaning should be carried out gradually, starting with the removal of less strongly adhering deposits, like soil, before proceeding to more strongly adhering deposits, such as micro-organisms (lichens, etc.). While cleaning, water should be used in minimal amounts and changed as soon as it becomes dirty. Chemicals should not be used for cleaning as they can damage mosaics.

CLEANING WITHOUT WATER

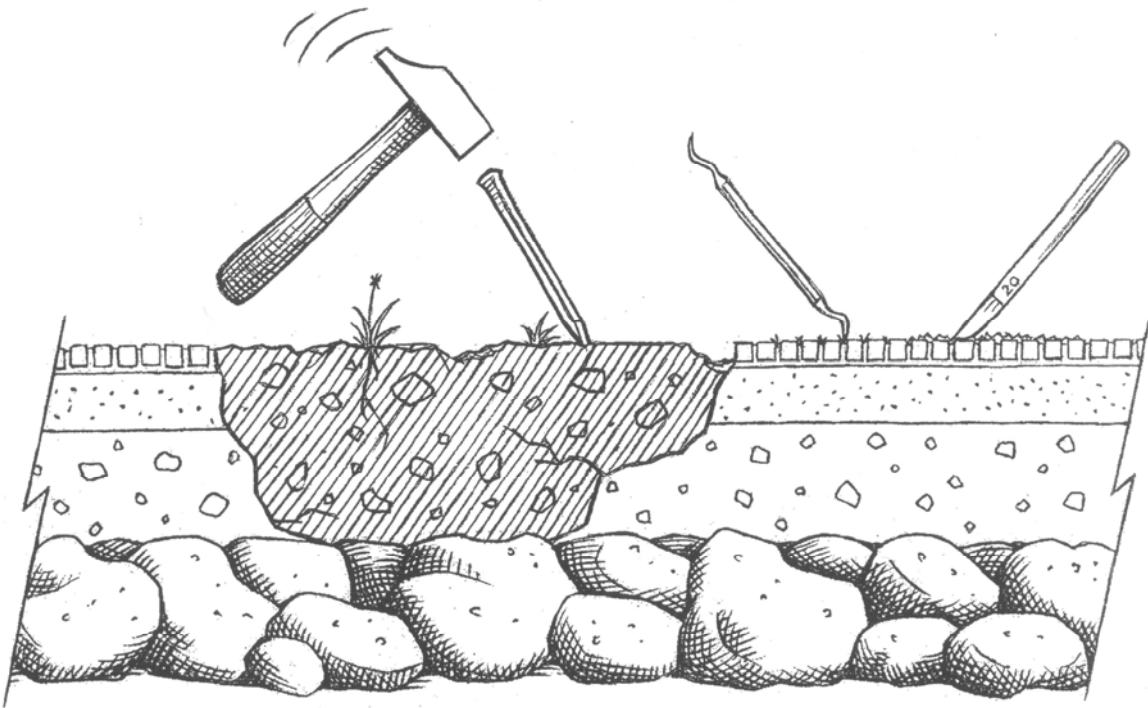


Figure 9

CLEANING WITH WATER

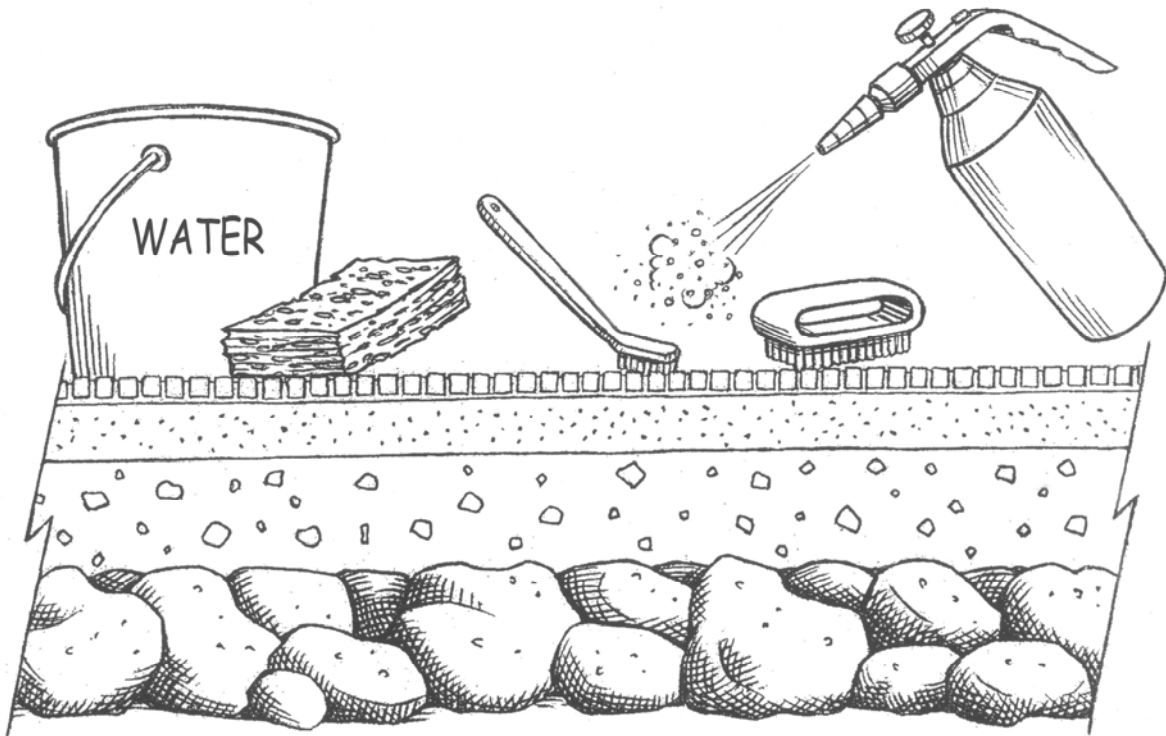


Figure 10

Cleaning can be carried out with or without water (Figures 9 and 10, page 77). The most commonly used cleaning tools are scalpels, dental tools, wooden sticks, chisels, various kinds of brushes (never metal brushes), paintbrushes, manual blower bulbs, vacuum cleaners, sponges and hand held water sprayers. Each tool has specific characteristics and must therefore be used for specific operations. The incorrect use of a tool can damage the mosaic and break the tool.

If specific problems occur during the cleaning process, such as the presence of large tree roots, a specialist should be called who can then select the appropriate chemical (herbicide, etc.) or choose a specialized treatment method and supervise its application.

Cleaning operations carried out only for aesthetic purposes are considered beyond the scope of maintenance activities.

MORTARS

Mortars are used for all mosaic stabilization operations. A mortar is the combination of a binder (lime, etc.), aggregates (sand, gravel, etc.) and the appropriate quantity of water. This mixture is used while still soft and malleable, and fulfills its structural function when it sets and becomes hard.

BINDERS

Binders are materials that bind aggregates together when mortars set and have become hard. Binders can be divided in two categories: non-hydraulic and hydraulic binders. A non-hydraulic binder needs to be in contact with air to set, whereas a hydraulic binder sets predominantly when in contact with water.

Non-hydraulic binders

Lime putty (non-hydraulic lime putty)

Making lime putty starts with burning pure limestone. Limestone is transformed into quicklime by combustion. Quicklime is then transformed into lime putty when water is added. This latter operation is called the slaking of quicklime. Lime putty, which is generally white and thick, is obtained by slaking it with excess water. Lime putty keeps for a very long time and its properties improve with age if kept under water. When lime putty is exposed to air, it hardens and is transformed into a material that has the same composition as the original limestone (Figure 11, page 80).

Hydrated lime (non-hydraulic powdered lime)

Hydrated lime is made the same way as lime putty, i.e. by burning pure limestone. The difference is that only the minimum quantity of water is added to the quicklime to thoroughly transform it without leaving any excess water. This produces slaked lime in

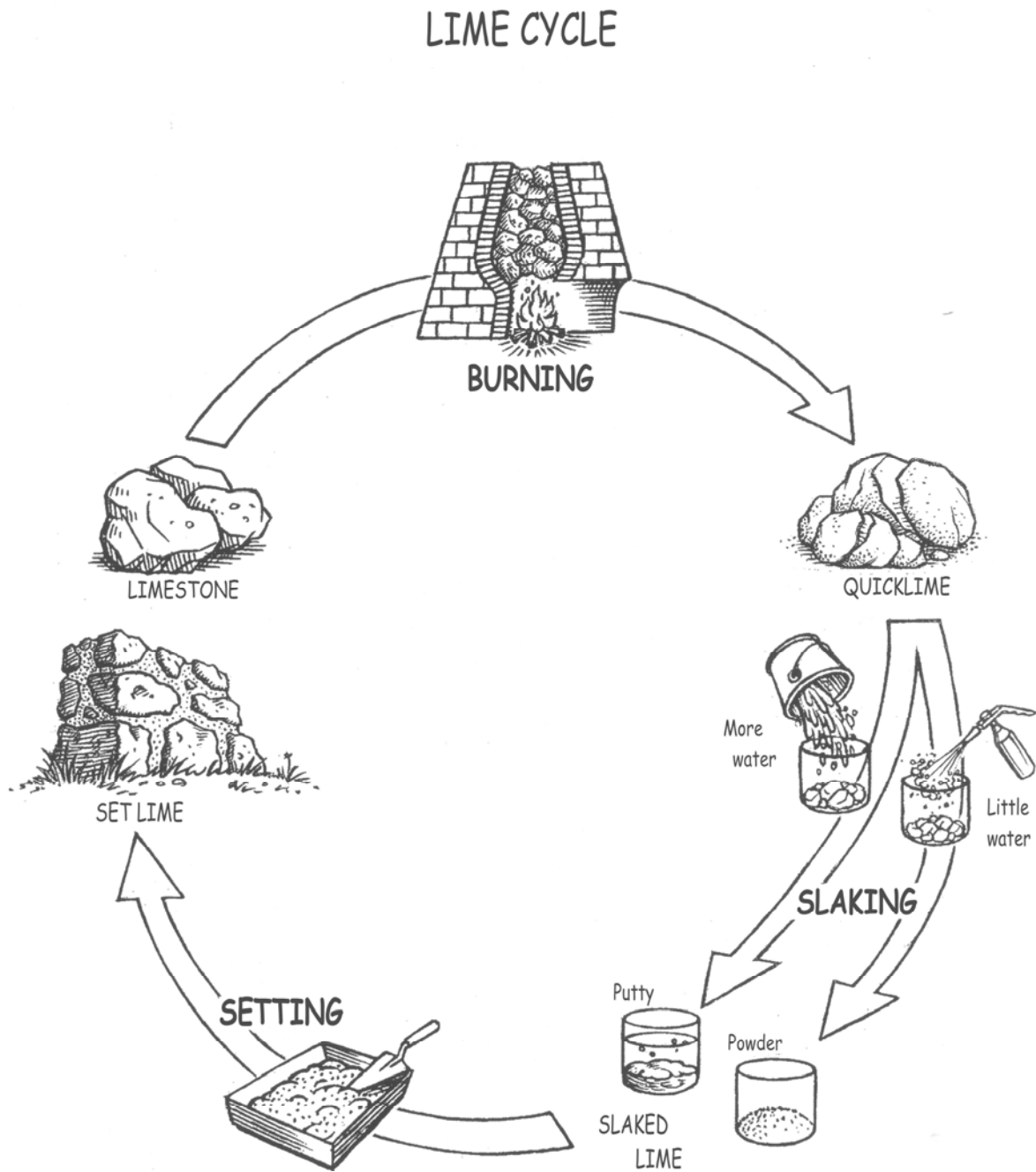


Figure 11

the form of a white powder rather than as putty. Like lime putty, hydrated lime sets in contact with air; it is therefore also non-hydraulic lime (Figure 11).

As a powder, hydrated lime must be stored in a dry place. It can be turned into lime putty by adding water. It can then be kept under water for a very long time.

Hydraulic binders

Natural hydraulic lime (powder)

Natural hydraulic lime comes from impure limestone containing other minerals (silica, alumina, etc.) and it has the capacity to partially set in presence of water and partially in contact with air. The manufacturing process of hydraulic lime is similar to that of non-hydraulic lime, except that the limestone is burned at a higher temperature. Lime gets its hydraulic properties of setting in contact with water from the presence of these impurities that are burned at high temperature. Hydraulic lime can be slightly or strongly hydraulic depending on the type of limestone used and the burning temperature.

Natural hydraulic lime should be stored in a dry place and be used quickly after its manufacturing date.

Artificial hydraulic limes and cements (powder)

To make these materials, additional products are added to the stone during the manufacturing process. The additives give these materials significant hydraulic properties contributing to their great hardness. These materials also contain soluble salts.

Artificial hydraulic limes and cements should be stored in a dry place.

For all conservation and maintenance work on mosaics, **it is strongly advised to use natural lime-based mortars** because their chemical composition and their physical characteristics are similar to those of ancient materials. Artificial hydraulic limes and cements (gray or white) are generally too hard, and also contain soluble salts that can deteriorate mosaics.

AGGREGATES

Aggregates make up the skeleton of the mortar: their hardness contributes to its strength and they help decrease shrinkage during setting. A good aggregate should be clean, that is, should not contain soil, dust, and especially salts. The properties of an aggregate can always be improved by washing it with water.

Aggregates can be divided into two main categories: those that are inert and those that react with the binder to produce hydraulic properties.

Inert aggregates

Sand and gravel

Sands and gravels are inert aggregates because they do not react chemically with binders. Sands can come from a riverbed or a quarry. They have small-size grains. Sand from quarries is generally less clean than river sands, which have been naturally washed. Beach sands should not be used because they contain a lot of salt.

Gravels come from quarries and are crushed pieces of stone.

There are many types of sands and gravels of different sizes with different hardness, color and particle shape.

Aggregates with hydraulic properties

Fired clay, volcanic earths and stones

Bricks, tiles or pottery made of fired clay, crushed and grinded, can be used as aggregates and can give hydraulic properties to lime putty mortars. The reactivity (hydraulicity) of these materials depends on the type of original clay and on its firing temperature. It is generally considered that if the clay firing temperature is very high, the material reactivity will be less significant or even non-existent; this is the case for a lot of modern bricks.

Some volcanic earths and stones, naturally formed at high temperature, such as pozzolana, are able to chemically react with lime in the presence of water and can create a strong hydraulic set.

FACTORS INFLUENCING THE PROPERTIES OF A LIME-BASED MORTAR

Choosing the type and quality of each of the mortar ingredients (binder, aggregates and water) and their respective proportions will determine the characteristics and performance of the mortar during its preparation, application and when it has set.

Non-hydraulic and hydraulic properties

Depending on the type of binder and aggregates mixed together, a mortar can be non-hydraulic, i.e. it needs to be in contact with air to set, or hydraulic, i.e. it sets in contact with water.

A non-hydraulic lime-based mortar is obtained by mixing non-hydraulic lime and inert aggregates.

There are several ways of obtaining a hydraulic lime-based mortar. It can be a mixture of non-hydraulic lime and hydraulic aggregates or a mixture of natural hydraulic lime and inert or hydraulic aggregates. The degree of hydraulicity of the mortar varies depending on the types of lime and aggregates used.

In general, hydraulic mortars are harder than non-hydraulic ones and they can set even if they only have limited contact with air.

Binder-aggregate ratio

The ratio of binder to aggregates strongly influences the properties and performance of a mortar. Most of the time, one part (in volume) of binder is mixed with two to three parts of aggregates, that is, a binder-to-aggregate ratio between 1:2 and 1:3 in volume.

A mortar containing more lime (lime-rich mortar) is easier to use, more malleable, and adheres more easily, but it will tend to have larger shrinkage and will therefore crack more easily while setting. This is especially true for lime putty mortars. Once set, a lime-rich mortar is also softer than a mortar containing more aggregate.

A mortar containing less lime (lime-poor mortar) is less malleable and adheres less easily, but it will tend to shrink less. Once set, a lime-poor mortar is more friable than a mortar that contains less aggregate.

Mortar shrinkage is due to the mortar decreasing in volume when it loses water.

Particle-size distribution of aggregates

The particle-size distribution of aggregates also influences the properties and performance of a mortar. To make a good mortar, aggregates should have a good particle size distribution between coarse and fine particles.

If all the particles in a mortar are the same size, they will form unequal voids (poor compaction) and there will be a greater build-up of binder in some areas than in others. If the particles are of different sizes, they will distribute themselves so as to fill all the voids (good compaction) and the thickness of lime distributed around the particles will be constant. A more even distribution of the binder makes the mortar stronger (Figure 12, page 85).

Furthermore, aggregate size is chosen according to the required thickness of the mortar. The thicker the mortar needs to be, the larger the aggregates should be.

To obtain a mortar with a good particle size range, different kinds of sands, gravels, and stone powders can be used and sieved to obtain fractions of different sizes that are mixed in the proper proportions (Figure 13, page 85).

Proportion of water in a mortar

The amount of water used to prepare a mortar, called the mixing water, is a factor that influences the properties and performance of a mortar. Using a lot of mixing water makes the mortar more malleable, but will cause significant shrinkage when the water evaporates, causing the mortar to crack. Using too little water makes the mortar harder to work and it will adhere poorly. In addition, this will result in a poor setting of non-hydraulic and hydraulic limes.

Non-hydraulic and hydraulic mortars must be kept moist throughout the setting period to insure that the whole mass of mortar sets completely.

Liquid mortars, also called grouts, are a particular type of mortar containing a larger amount of water compared to paste mortars. The amount of water should be sufficient to make the mortar fluid but as little as possible should be used and not more than one part of water to one part of binder.

It is important to use clean water to mix mortar and to insure it does not contain salts.

DISTRIBUTION OF AGGREGATE PARTICLES

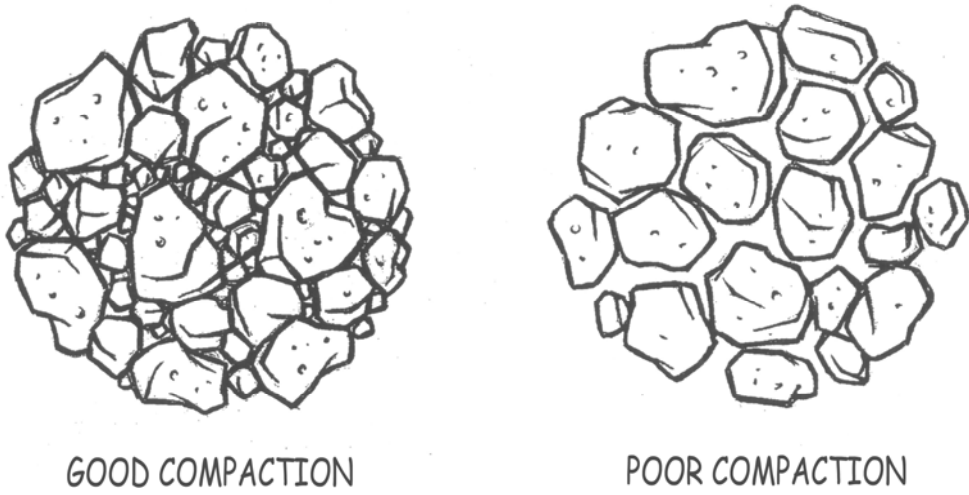


Figure 12

SIEVING OF AGGREGATES IN SEVERAL FRACTIONS

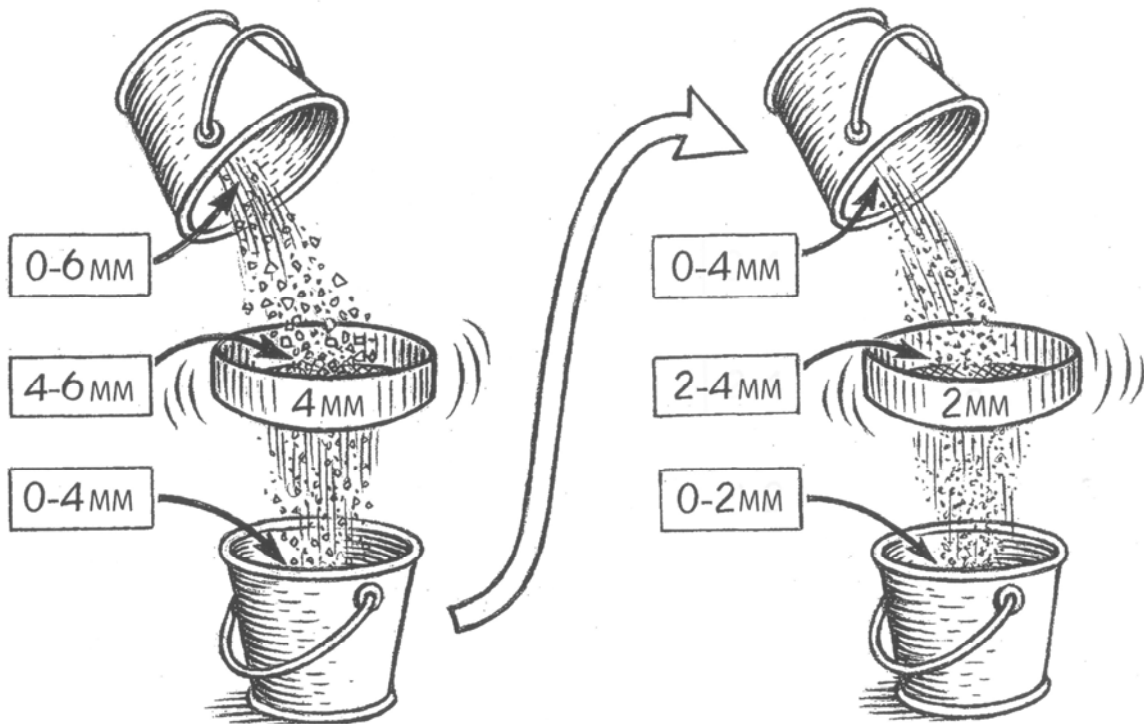


Figure 13

Color and texture

The visual appearance of a mortar, due in particular to its color and surface texture, is a result of the selection of the binder and aggregates and their ratios. The binder influences the mortar color through its own color. The aggregates influence both the mortar color and surface texture through the color, shape and size of particles. If the color of the mortar is determined by the aggregate particles then these should be made visible by removing a thin layer of binder from the mortar surface with a wet sponge before it sets.

MORTARS FOR MOSAIC STABILIZATION INTERVENTIONS

Every mortar has its own characteristics that determine its quality. This is also true for the special mortars used to stabilize ancient mosaics. It is especially important that a mortar used for mosaics not contain soluble salts and that, once set, cracking will be limited, i.e. it should be stable and durable over time.

A mortar used for the stabilization of ancient mosaics should also have additional characteristics. It should have a good affinity with the ancient materials and in particular its hardness and porosity should be similar to allow similar movement of water. A stabilization mortar should also be reversible, that is, it should be removable without deteriorating the mosaic. This is why mortars made of non-hydraulic or naturally hydraulic lime should be used. Because a mortar made of cement or artificial hydraulic lime cannot fulfill the above conditions, it is strongly advised not to use them for the stabilization of ancient in situ mosaic.

In addition, a mortar used for mosaic stabilization should also be appropriate from an aesthetic point of view; the color and surface texture of the dried mortar should not stand out; rather, the mosaic surface should always stay visually dominant.

To choose the most appropriate intervention mortar for a given in situ mosaic, its construction technique, condition, exposure conditions, as well as the climate of the archaeological site where it is located, should also be taken into consideration. Finally, a stabilization mortar should also have the properties required for the operation it will be used for.

STABILIZATION

During maintenance work, interventions on in situ mosaics consist mainly of carrying out periodic and programmed stabilization operations using lime-based mortars. The aim of these interventions is to restore the structural stability of the mosaics and prevent any new deterioration from occurring.

The main types of interventions requiring mortar are:

- Resetting detached tesserae in their original position and orientation (Figure 14, page 89);
- Filling interstices between tesserae (Figure 15, page 89);
- Applying edging (Figure 16, page 89);
- Filling lacunae and cracks (Figure 16, page 89);
- Grouting voids located between the preparatory layers of the mosaic (Figure 17, page 91).

The tools most commonly used for stabilization interventions are: spatulas, tweezers, small rubber bowls for small-scale operations, trowels, mortar buckets for larger-scale operations, hand drills, syringes and needles for grouting with liquid mortar. Sieves of different sizes are used to prepare the aggregates. Water buckets, sponges and hand held water sprayers are used to give a good finish to the mortars, while wet floor cloths and plastic sheets insure that the mortars dry slowly.

Cleaning must be carried out to remove dust, soil, and micro-organisms before any stabilization intervention, to insure that stabilization mortars can adhere properly to the surfaces of preparatory layers and to the sides of the tesserae.

If the surfaces of preparatory layers inside lacunae are fragile, they can be consolidated with limewater before undertaking stabilization operations.

Each stabilization intervention requires a specific mortar with particular characteristics. Depending on the intended use, a mortar may require a specific hardness and workability and, if the mortar is to be visible, a specific color and texture.

For example to reset detached tesserae, the use of a lime-rich mortar made of lime putty and a fine aggregate is recommended. Lime putty is chosen as a binder because the mortar should have good adhesive properties and be malleable – two characteristics of lime putty that are accentuated by the fact that the mortar contains a lot of binder. A fine aggregate should be used so that the mortar does not create an additional thickness under the tesserae and that it fills the narrow spaces around each tessera.

A liquid mortar containing very fine aggregates should be used to fill a void between preparatory layers, by injection using a syringe. Hydraulic lime should be used as a binder because the mortar must be able to set without being in contact with air.

To fill a very deep lacuna, either a hydraulic mortar applied in one layer, or a non-hydraulic mortar applied in several layers, can be used. The thicker the mortar layer needs to be, the larger the aggregates should be to improve strength and to diminish shrinkage and cracking of the mortar.

To make a surface fill of a lacuna that will be exposed to the weather and walked on, a hydraulic mortar should be used because it is harder and more resistant. Aggregates of the appropriate color and size should be chosen carefully for, as with any surface mortar, aesthetic issues have to be considered. When looking at the mosaic, attention should not be drawn to the intervention mortars. The color and texture of the mortar should therefore blend in visually with those of the mosaic so that the mosaic surface always remains visually dominant.

To achieve indiscernible repairs, during Antiquity and in the last century, lacunae were sometimes filled with ancient tesserae set in a new bedding mortar. This kind of operation is called reintegration with tesserae because it aims to integrate or to complete the mosaic surface thereby restoring it to its original appearance. Today, it is considered more appropriate to emphasize the original pavement by making it easier to recognize the original areas of the mosaic from the areas where materials have been recently added

RESETTING DETACHED TESSERAEE

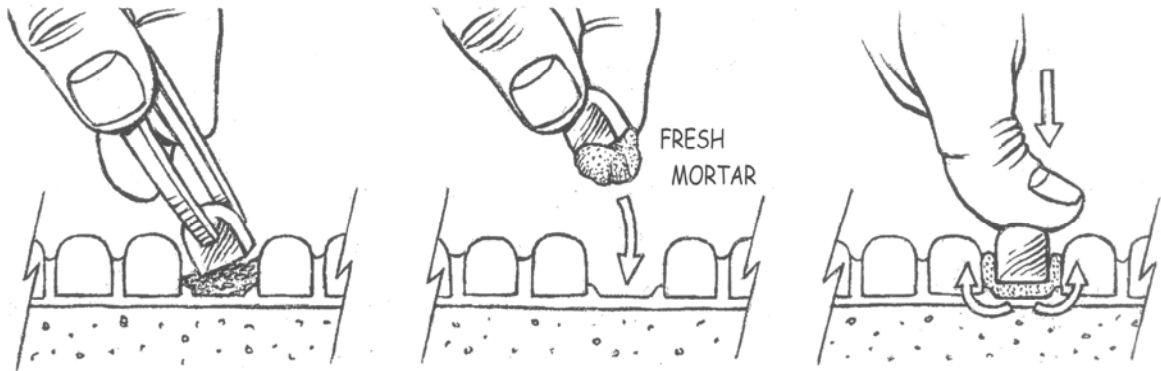


Figure 14

FILLING OF INTERSTICES BETWEEN TESSERAE

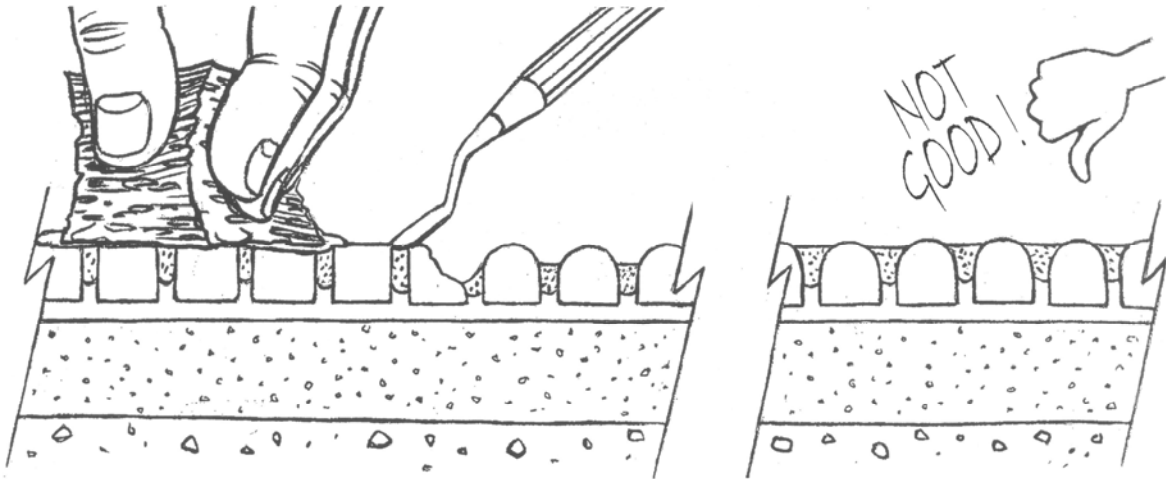


Figure 15

FILLING LACUNAE AND EDGING REPAIRS

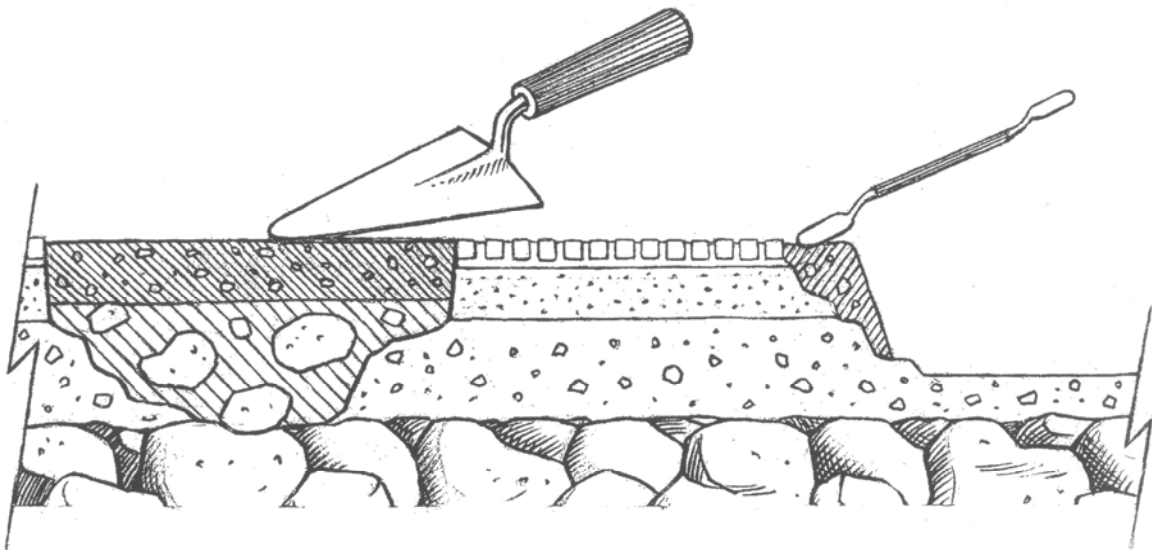


Figure 16

to stabilize it and fill in missing parts. The reintegration of a lacuna with tesserae is therefore not a recommended stabilization intervention.

To choose the composition of mortars needed for stabilization, it is useful to gather a range of binders and aggregates and to prepare a number of mortar samples to evaluate them in the field and, if possible, also in the laboratory. It is preferable to make samples of each mortar one intends to use. When the mortars are chosen, their composition (mortar formula) should be written down specifying for which kind of interventions they will be used.

For certain conservation problems, a conservator should be called upon. For example, if the preparatory layers of a mosaic or its individual tesserae are too fragile to be stabilized using only lime-based treatments, a conservation specialist can consolidate the deteriorated constituent materials with other types of products.

GROUTING VOIDS BETWEEN PREPARATORY LAYERS

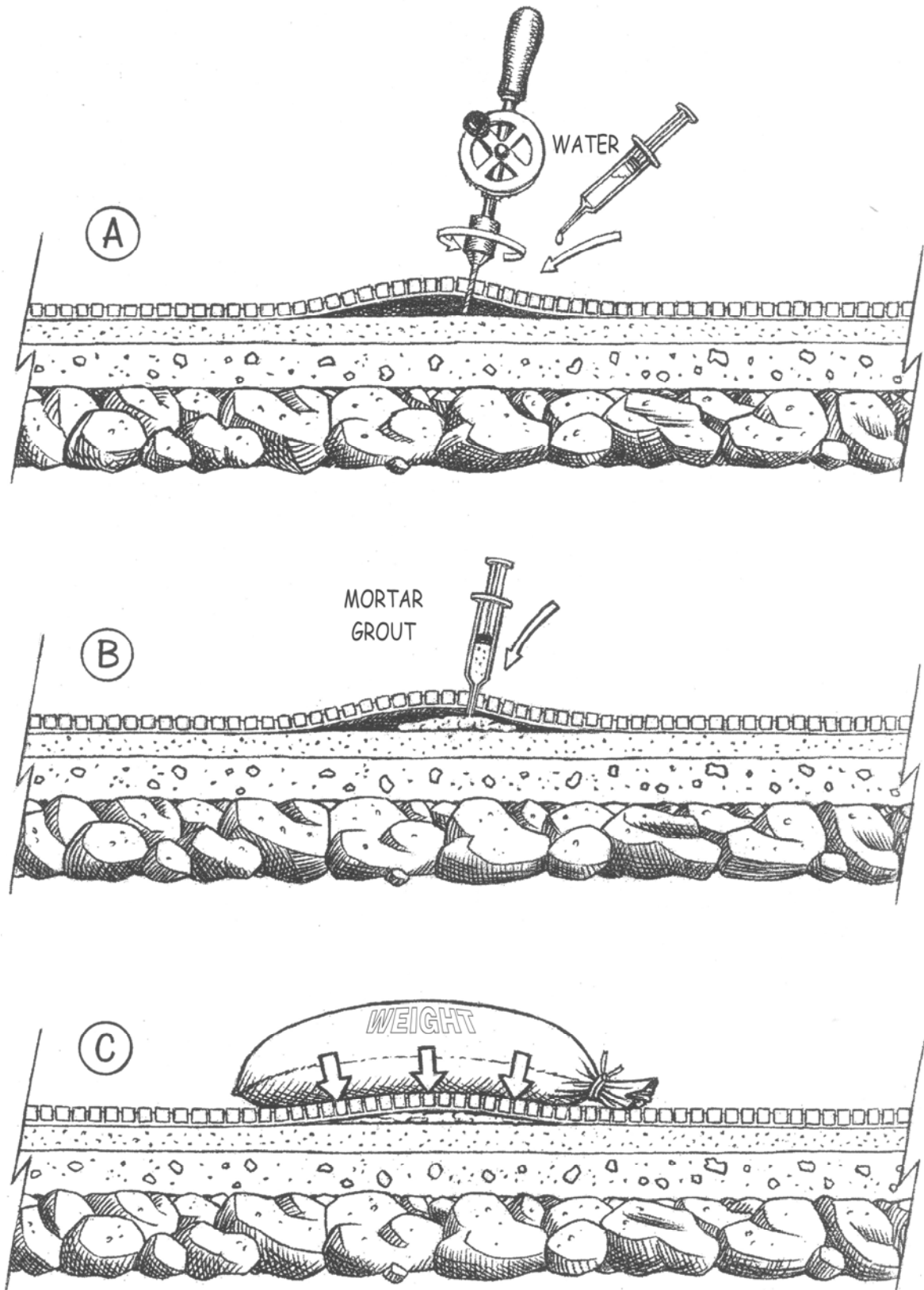


Figure 17

HEALTH AND SAFETY MEASURES REGARDING LIME

Lime is not a toxic product; however, its prolonged use without protection can be hazardous.

Hand protection

Lime in its different forms as putty, powder, in a mortar or dissolved in water dries the skin. Extended exposure can cause skin lesions that can become deep. It is therefore necessary to protect one's hands by wearing rubber gloves during all operations using lime.

Respiratory tract protection

Airborne dust blowing around during the handling and sieving of lime-based powder materials is harmful to the lungs. It causes respiratory tract irritations and, over a long period of time, accumulates in the body, which can only eliminate a small fraction of it. It is therefore necessary to wear a paper dust mask during all these operations.

Eye protection

If lime gets in contact with the eyes, it causes strong burning. The eyes should be thoroughly rinsed with clear water immediately and at length. In case of a prolonged irritation, see a doctor. It is therefore necessary to wear protective goggles during some operations.

Safety measures to be taken when slaking quicklime

Mixing water and quicklime during slaking causes a chemical reaction that produces heat, causing the water to boil quickly. The reaction can be more or less violent depending on the quality or purity of the quicklime, its past exposure to humidity and whether it is in the form of stones or powder.

Great care must be taken when slaking quicklime to add small amounts of lime to the water to limit the effects of the reaction and avoid splashing of boiling water or lime. This operation should be carried out in clean containers that are not sensitive to heat (plastic containers are generally not appropriate) and in an open area.

When slaking quicklime, gloves and protective goggles should be worn.

REBURIAL

Reburial is the temporary or permanent re-covering of archaeological remains exposed during the excavation of a site. It is done by using fill materials and separation layers, used alone or in various combinations and in different orders (see examples page 100).

Reburial is a protective measure designed to insure the in situ conservation of mosaics. Like a shelter, its purpose is to slow down the deterioration of a mosaic by controlling some environmental factors to which an open-air mosaic is normally exposed. Like a shelter, the reburial of a mosaic will protect it against the direct action of the weather. In addition, it will provide greater temperature and moisture stability to the mosaic. Finally, due to its thickness, it will protect the mosaic surface from mechanical deterioration caused by people walking on it, for example. Like any intervention, a reburial requires regular maintenance to remain effective.

A number of elements must be taken into consideration to insure that the effects of reburial on the conservation of a mosaic are positive, and to minimize the potential negative effects. First of all, a condition assessment of the mosaic should be made, trying also to understand the causes of its deterioration. It is necessary to understand the properties of each material intended to be used, so that the reburial protects the mosaic from environmental conditions.

Fill materials such as soil or sand are used in more or less thin or thick layers to create a more stable environment, and to better protect the remains on the site. Separation layers, such as plastic netting, are thin layers used in sheets to avoid mixing the different fill materials, or to mark the boundary between these materials and the archeological remains, and to avoid their contamination. Separation layers can also be used in the form of bags containing fill materials.

IMPORTANT FACTORS AFFECTING THE PERFORMANCE OF A REBURIAL

Water transport through the materials

It is important for water to circulate freely through the burial environment. If liquid-water contained in the soil cannot pass easily from the mosaic to the fill materials above it (causing discontinuity in the capillary moisture rise), then water will evaporate from the mosaic and salts may crystallize within it and deteriorate it.

Fill materials that do not allow liquid-water to pass through (impermeable materials) will trap moisture inside the mosaic, leading to the growth of micro-organisms and the development of roots.

It is also important that fill materials allow the mosaic to dry slowly when it is damp and to absorb water slowly when it is dry, i.e. they should provide stable relative humidity.

Temperature stability (thermal insulation)

Fill materials should insulate the mosaic as much as possible from temperature variations and prevent it from freezing in the winter or becoming too hot in summer. Extremely low or high temperatures or very frequent changes in temperature cause deterioration of stone and mortar. A material will provide better insulation, if it is used in a greater thickness.

Vegetation growth and burrowing animals

Preferably, fill materials should impede vegetation growth. Therefore, materials should not retain moisture for long periods of time. They should not contain nutrients for plants or micro-organisms and must be difficult for roots to penetrate. Furthermore, materials should preferably impede animals or insects from digging tunnels and holes and building nests.

Durability of materials over time

Preferably, fill materials should not deteriorate rapidly so that they do not damage the mosaic, and they continue to fulfill their function. For example, metallic netting buried just above the mosaic surface will rust and stain the mosaic. Plastic materials will deteriorate quickly if exposed to the sun. Natural fibers, such as cotton, decompose in humid conditions and in the presence of micro-organisms.

PRACTICAL CONSIDERATIONS

Maintenance requirements

Reburials should be maintained regularly. Some materials require more time and work to be maintained in good condition. For example, soil allows plants to grow more easily. It is also easily eroded by rain and wind.

Accessibility

It is also important to consider the ease of moving and manipulating the materials. For temporary reburials in particular, it is preferable to work with materials that are easy to disassemble and remove from the mosaic surface without causing damage.

Separation of reburial layers

For a separation membrane to be an efficient divider, the mesh size should be smaller than the particle size of the fill material above.

Availability and costs

The choice of materials is often limited by their cost and their local availability. For example, soil removed during excavation can be used for mosaic reburial because it is readily available and at no cost.

FILL MATERIALS

Fill materials generally used for reburial are soil, sand, gravel or specialized materials (expanded clay pellets - Leca™, volcanic tuff pellets, beads or plates of expanded polystyrene, etc). Each has its own advantages and disadvantages, and their use have positive and negative impacts.

Soil

Soil is the material that is most similar to the one that preserved the mosaic for centuries until its excavation. There are a great variety of soils, each with their own properties. In general, soil provides good liquid-water/water-vapor transport. It also

provides stability in temperature and humidity, if sufficiently thick. It is often readily available during or after excavation and, in this case, it does not cost anything. However, it generally contains seeds and little plants, and facilitates vegetation growth and animal activity. Consequently, it sometimes needs preliminary sieving and requires more frequent maintenance. It can also be eroded by rain and wind. Finally, soil will dirty the mosaic when in direct contact, which will require extensive cleaning, if the mosaic is later presented, especially if the mosaic is in poor condition.

Sand

Sand is generally less prone to vegetation growth and animal activity than soil. It therefore requires less maintenance. Sand is also cleaner, but may contain salts. It will require less cleaning after its removal, but its small grains can still be difficult to remove from the most damaged parts of the mosaic. Moreover, liquid-water/water-vapor transport and temperature stability are not insured as effectively by sand as by soil. It can be eroded by rain.

Gravel

Gravel is the material that best prevents vegetation growth and animal activity due to the size of its particles. It is also easy to remove from the mosaic surface and is less eroded by rain. However, it can be heavy and is hard with sharp edges. It does not provide good liquid-water transport and good temperature and moisture stability because of the spaces between particles.

Specialized materials (expanded clay pellets - Leca™, volcanic tuff pellets, beads or plates of expanded polystyrene, etc).

These materials are generally chosen because they are lightweight, making them easy to use, and because of their insulating properties. However, they do not allow good transport of liquid-water, nor maintain stable moisture levels. They are expensive and not easily available.

SEPARATION MEMBRANES

The most commonly used separation membranes are plastic sheets, plastic netting, woven plastic sheets (used to make storage bags), geotextiles and other synthetic fabrics. Each has its own advantages and disadvantages and its positive and negative impacts.

Plastic sheets

It is strongly recommended not to use plastic sheeting because it will stop any liquid-water/water-vapor transport. The water trapped under it will foster vegetation growth. However, plastic sheets are efficient in separating fill materials from each other and from the mosaic. They are readily available and inexpensive.

Plastic netting

Plastic netting, such as mosquito nets, allows liquid-water/water-vapor transport. It efficiently separates coarse materials, such as gravel, from other fill materials, but it will let finer materials, such as soil and sand, through. It will not prevent vegetation penetration and animal activity, but is inexpensive and easily available.

Woven plastic sheets

Woven plastic sheeting, used for example to make storage bags, allows water-vapor transport, but strongly reduces liquid-water transport. It efficiently separates all fill materials, is not too expensive and often locally available. It only partially stops vegetation growth and animal activity.

Geotextiles and other synthetic fabrics

Geotextiles are made to be used underground. They are used particularly in road construction work and other civil engineering projects. They are generally expensive and can be difficult to obtain. There are many different types of geotextiles and each type has its own properties. They are two main categories: woven and non-woven geotextiles. The latter are recommended for reburials.

Geotextiles are effective separators of fill materials and prevent erosion of materials under them. They generally avert root penetration and animal activity. Performance related

to liquid-water/water-vapor transport depends on each type of geotextile, which is why it is important to choose a geotextile carefully and insure it is suited to the purpose it will serve in a reburial design.

It is not always recommended to lay a geotextile directly over a mosaic because it is often difficult to insure the intimate contact between the geotextile and the entire mosaic surface, and in places where this contact does not occur, liquid-water transport between the mosaic and the burial materials will not occur.

REBURYING A MOSAIC

As for any intervention, reburial should be preceded by a thorough study of the mosaic including a condition assessment. Some stabilization work should also be carried out before reburial. It is especially important to remove any plants and their associated roots because the reburial environment is generally favorable to their growth. It is imperative to stabilize the most damaged areas and address structural problems that could worsen during the reburial or when the fill is removed.

In designing a reburial, it is necessary to find a way to contain the fill materials. In areas where the walls of the room cannot be used for this purpose, wooden planks can be used, a dry stone wall (without mortar) can be built, or a wall made of soil- or sand-filled bags can be made.

When uncovering a buried mosaic, fill materials and separation layers should be carefully and gradually removed one after the other, paying particular attention to the removal of materials in direct contact with the mosaic.

A reburial design will differ depending on the type of protection required. Reburial can be temporary, between two excavation seasons or during the winter for example. In these cases, easily removable fill materials should be used, e.g. by placing the materials in bags and not in too great a thickness (see example A, Figure 18).

Reburial can also be a long-term protection measure if, for example, the choice is made to present only a few mosaics of a site to the public, while covering others. In this case, the reburial design should provide for greater depth of fill materials (see examples B and C, Figure 18).

Reburial can also be a rescue measure to provide urgent protection for a mosaic in cases when a full intervention is not immediately feasible (see example D, Figure 18).

Reburial must be part of the general management and maintenance plan for a site. Like any intervention, it requires regular maintenance, in particular, regular weeding, to avoid further deterioration of the reburied mosaic. However, the maintenance of a reburied mosaic is generally less time-consuming than that of a mosaic left exposed in the open air. Reburial is therefore an intervention that should be carried out when resources are not sufficient to properly maintain a mosaic left in the open air or under a shelter.

EXAMPLES OF REBURIAL

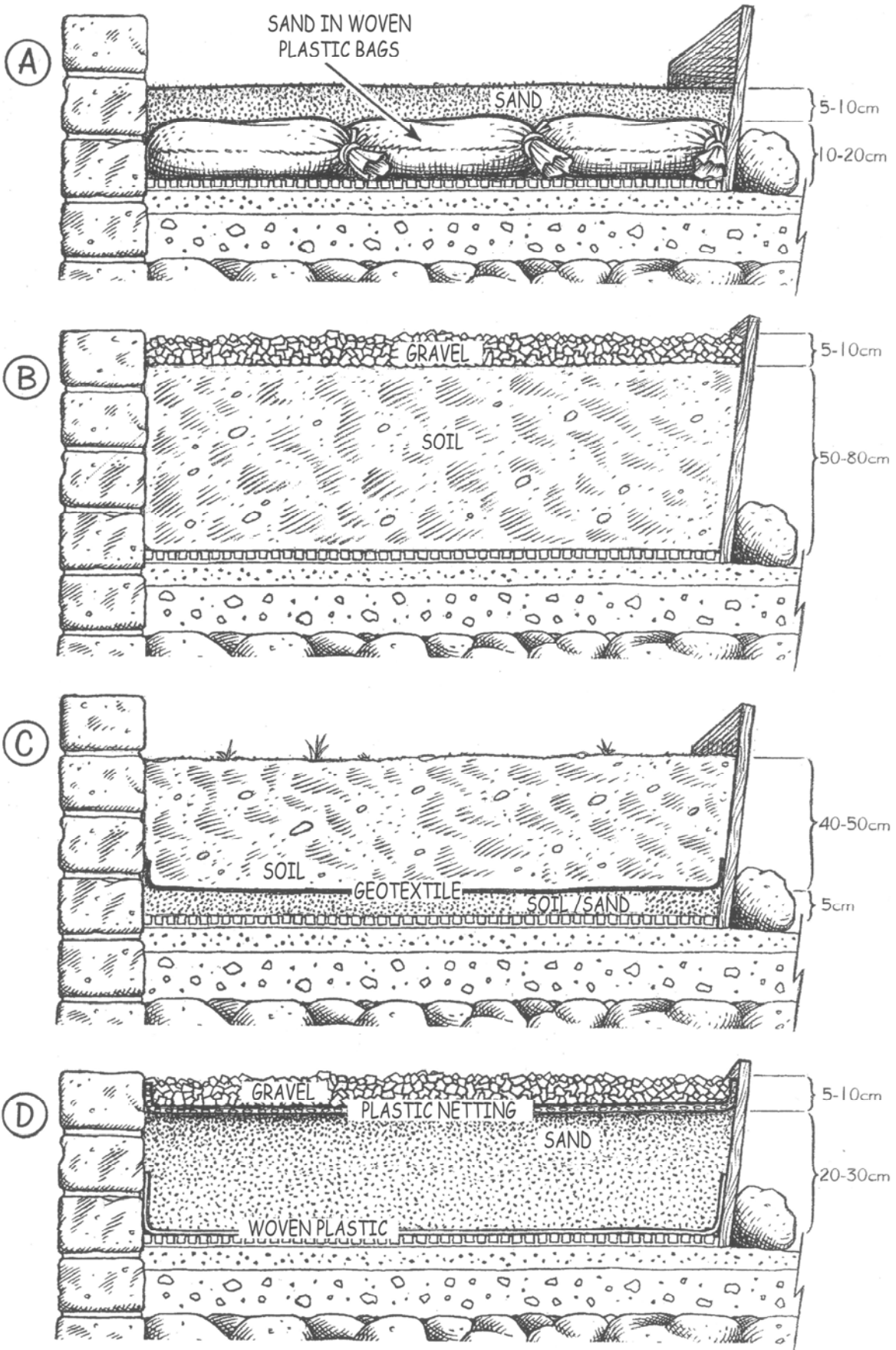


Figure 18

Fill Materials

<i>Type</i>	<i>Advantages</i>	<i>Disadvantages</i>
Soil	<ul style="list-style-type: none"> • Allows continuous water transport • Maintains good moisture and temperature stability • Readily available and inexpensive 	<ul style="list-style-type: none"> • Contains seeds and small plants • Prone to vegetation growth and animal activity • Difficult to remove from the mosaic surface
Sand	<ul style="list-style-type: none"> • Less prone to vegetation growth and animal activity • Maintains fairly stable moisture and temperature levels • Clean • Readily available and inexpensive 	<ul style="list-style-type: none"> • Limits the continuous movement of water
Gravel	<ul style="list-style-type: none"> • Less prone to vegetation growth and animal activity • Clean • Easy to remove • Readily available and inexpensive 	<ul style="list-style-type: none"> • Inhibits the continuous movement of water • Poor moisture and temperature stability • Sharp edges
Specialized materials <i>(Expanded clay pellets - Leca™, volcanic tuff pellets, beads or plates of expanded polystyrene, etc.)</i>	<ul style="list-style-type: none"> • Less prone to vegetation growth and animal activity • Clean • Very easy to remove • Lightweight 	<ul style="list-style-type: none"> • Inhibits the continuous movement of water • Poor moisture and temperature stability • Hard to obtain and expensive

Separation Membranes

<i>Type</i>	<i>Advantages</i>	<i>Disadvantages</i>
Plastic sheets	<ul style="list-style-type: none"> • Partially effective against vegetation penetration and animal activity • Effective separation between all fill materials • Available and inexpensive 	<ul style="list-style-type: none"> • Inhibits liquid-water/water-vapor transport • Promotes root growth underneath
Plastic netting	<ul style="list-style-type: none"> • Permits liquid-water/water-vapor transport • Does not promote root growth underneath • Available and inexpensive 	<ul style="list-style-type: none"> • Ineffective barrier to vegetation penetration and animal activity • Ineffective separation of smaller fill particles
Woven plastic sheeting	<ul style="list-style-type: none"> • Allows water-vapor transport • Effective separation between all types of fill materials • Available and inexpensive 	<ul style="list-style-type: none"> • Reduces liquid-water transport • Fairly ineffective barrier to vegetation penetration and animal activity • Growth of roots underneath
Non-woven geotextiles and other synthetic fabrics	<ul style="list-style-type: none"> • Permits water-vapor transport • Partially effective against vegetation penetration and animal activity • Effective separation between all types of fill materials 	<ul style="list-style-type: none"> • Reduces liquid-water transport • Growth of roots underneath • Hard to obtain and very expensive

LIST OF MATERIALS FOR AN INTERVENTION CAMPAIGN

_____ Tool box	_____ Pliers
_____ Scalpels with interchangeable blades	_____ Pincers
_____ Scalpel blades	_____ Screwdrivers
_____ Scalpels with fixed blade	_____ Wood and metal saws
_____ Spatulas	_____ Nails
_____ Dental spatulas	_____ Sharpening stone and mineral oil
_____ Dental picks	
_____ Tweezers	_____ Vacuum cleaner
_____ Chisels (width 3-10 mm)	_____ Storage bins for aggregates and binders
_____ Hammers (weight 200-500 g)	_____ Plastic pitchers
_____ Hand drills and bits (2-2.2 mm)	_____ Plastic containers for tesserae
_____ Syringes (volume 20-50 cc)	_____ Mortar buckets
_____ Needles for syringes (diameter 1.8 – 2.2 mm)	_____ Sieves (opening sizes 0.25 cm, 0.5 cm, 1 to 5 cm)
_____ Petroleum jelly	_____ Wheelbarrow
_____ Trowels	_____ Mortar mixer
	_____ Shovels
_____ Small dustpans and brushes	_____ Brooms
_____ Flat paint brushes (width 2-6 cm)	_____ Floor cloths
_____ Toothbrushes	_____ Plastic sheets
_____ Nailbrushes	_____ String
_____ Large brushes	
_____ Sponges	_____ Storage tent for materials
_____ Cotton	_____ Water hose
_____ Colored sticker dots	_____ Water cistern
_____ Wooden sticks	_____ Electrical extension cord
_____ Rubber manual blower bulbs	_____ Generator
_____ Small rubber bowls to mix mortar	
_____ Hand held water sprayers	_____ Lime putty
_____ Water buckets	_____ Natural hydraulic lime
	_____ Sands
_____ Rubber gloves	_____ Gravel
_____ Disposable gloves	_____ Crushed brick
_____ Small knee pad	_____ Fine ceramic powder for grouting
_____ Sun umbrellas	
_____ Paper dust mask	_____ Woven plastic sheeting
_____ Goggles	_____ Plastic netting (mosquito net)
	_____ Geotextile

A BEGINNING

This collection of training material was produced to be used by mosaic maintenance technicians during and after a short course combining several training sessions on site and independent practical exercises between sessions. The training is part of a broader effort to enable the Institut National du Patrimoine to better care for the large number of in situ mosaics located throughout the country. Training INP personnel already employed on sites with mosaics seemed to be an effective and immediate response to the lack of trained professional conservators or technicians specialized in mosaic conservation.

The training provided during this short course will enable technicians to considerably improve the condition of in situ mosaics and work independently on tasks corresponding to the technical level they have achieved. They will, however, need the supervision of a conservator to help them organize their work and guide them in operations above a certain level of difficulty and complexity. Their work is first of all based on the documentation and assessment of the condition of a mosaic, followed by interventions using lime mortars to stabilize in situ mosaics. Lifting mosaics and the reintegration of surface lacunae with tesserae is not part of their training. Technicians are taught respect for the work of art and its authenticity and consequently their stabilization work should not be overdone or visually obvious.

It is important to realize that mosaic maintenance work is by nature a slow process that must be thorough in order to be effective. Technicians should frequently inspect the condition of the mosaic and their previous work, and treat it again if necessary, so as to prevent new damage as much as possible. This painstaking process of maintenance is required to insure the conservation of in situ mosaics for the future. With the training of maintenance technicians, INP has taken an important step towards reaching that goal.

Glossary



ILLUSTRATED GLOSSARY FOR TECHNICIAN TRAINING

Definitions of terms used for the graphic documentation of in situ floor mosaics.

The objective of this glossary is to establish a common vocabulary for the documentation of construction techniques, previous interventions, the condition of the mosaic and the current interventions carried out on the mosaic.

To examine the construction techniques, a reference stratigraphy is provided and the most common types of mosaic floors presented.

Terms pertaining to mosaic condition have been divided into four categories: structural deterioration, surface deterioration, biological deterioration and deterioration of interventions.

This glossary has been developed to achieve constant and objective recording. The written descriptions do not refer to the causes of deterioration, but only to the visual evidence observed on site.



LIST OF TERMS USED

1. MOSAIC STRATIGRAPHY

2. MOSAIC FLOOR TYPES

Opus tessellatum
Opus scutulatum, also called Lithostroton
Opus sectile
Opus figlinum
Opus signinum

3. PREVIOUS INTERVENTIONS

Fill
Edging repair
Reintegration of lacunae
Filling of interstices between tesserae
Section lifted and re-laid in situ
Joints between re-laid panels

4. CONDITION

4.1. *Structural deterioration*

Lacuna
Crack
Detachment between mosaic layers
Bulge
Depression

4.2. *Surface deterioration*

Detached tesserae
Deteriorated tesserae
Deteriorated mortar between tesserae
Stain
Incrustation
Efflorescence

4.3. *Biological deterioration*

Micro-organisms
Vegetation
Deterioration caused by insects and other animals

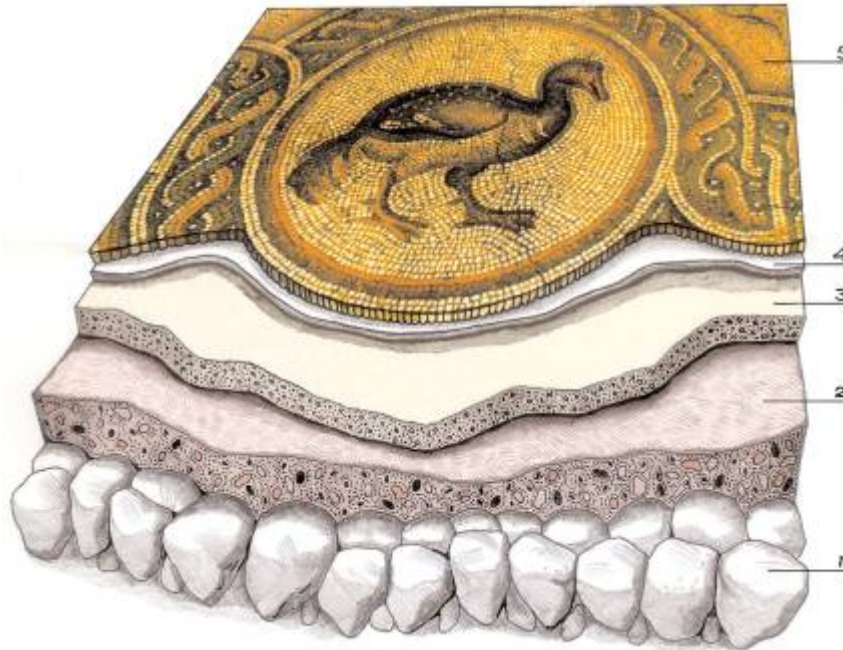
4.4. *Deterioration of interventions*

Deteriorated repair mortar
Deteriorated metal reinforcements in the support panel

5. INTERVENTIONS

Vegetation removal
Cleaning
Removal of modern repair mortars
Resetting tesserae
Filling between tesserae
Grouting between preparatory layers
Lacuna fill
Edging repair
Reburial

MOSAIC STRATIGRAPHY



The following stratigraphy is adapted from ancient literary sources. Not all mosaics in practice necessarily display this complete stratigraphy. It should only be used as a general reference.

A mosaic can be built on natural ground made of soil or rock, or on top of a previous pavement. The mosaic itself is composed of several preparatory layers supporting the decorative layer of tesserae.

1 - Statumen - First preparatory layer made of large stones inserted into the ground or with a coarse mortar to create a leveled surface and to stabilize the soil to avoid settlement and deformation.

2 - Rudus - Second preparatory layer spread over the statumen. This layer is made of a lime mortar with large aggregates.

3 - Nucleus - Third preparatory layer spread over the rudus. This layer is thinner than the previous one and is made of a lime mortar with fine aggregates.

4 - Bedding layer - Thin layer of mortar, very rich in lime, applied in small sections over the nucleus. Tesserae are inserted in this layer before the mortar sets.

5 - Tessellatum - Layer constituting the mosaic surface and composed of the tesserae and the mortar filling the interstices between them.

PAVEMENT TYPOLOGY

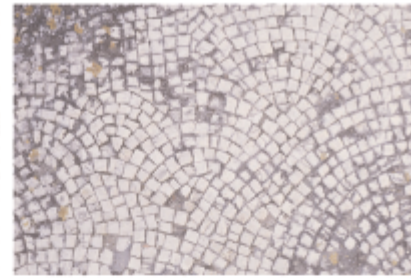
OPUS TESSELLATUM

Pavement made of small, regularly shaped, usually quadrangular, elements (generally 5 to 20 millimetres wide) placed side by side in rows. These elements, called tesserae, are obtained by cutting different materials such as stone (often marble or limestone), ceramic or glass.

When the tesserae used are very small, less than 4 mm wide, the mosaic is called **opus vermiculatum**



Monochrome opus tessellatum



Monochrome opus tessellatum



Bi-chrome geometric opus tessellatum



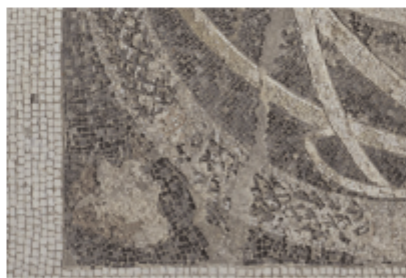
Bi-chrome figurative opus tessellatum



Polychrome geometric opus tessellatum



Polychrome figurative opus tessellatum



Opus vermiculatum



Opus vermiculatum

OPUS SCUTULATUM also LITHOSTROTON

Pavement made of a usually monochrome *opus tessellatum* background into which are inserted usually irregularly shaped stone fragments of various colors.



Opus scutulatum with white background



Opus scutulatum with black background

PAVEMENT TYPOLOGY

OPUS SECTILE

Pavement made of stone slabs, most commonly of different colored marble, cut in regular shapes and placed side by side to create a geometric design.



Marble opus sectile



Marble and limestone opus sectile

OPUS FIGLINUM

Pavement usually made of same size rectangular ceramic tesserae, grouped together and juxtaposed to create the visual impression of a basket weave.

When the tesserae have different colors and are made of materials other than ceramic, the pavement is then called **opus pseudo-figlinum**. When the ceramic elements are arranged in a herringbone pattern, it is called **opus spicatum**.



Opus figlinum



Opus pseudo-figlinum



Opus spicatum

OPUS SIGNINUM

Pavement made of a lime mortar mixed with ceramic fragments into which quadrangular tesserae or small stone fragments are inserted, either randomly or to form geometric designs. When this type of pavement does not include inserted elements, it is called **cocciopesto**.



Opus signinum with scattered tesserae



Opus signinum with geometric design



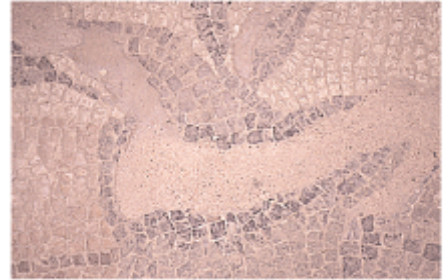
Cocciopesto

PREVIOUS INTERVENTIONS

FILL

An area of the pavement where the original tessellatum is missing and has been replaced with a repair mortar.

In addition to the tessellatum, a repair mortar can also be used to fill loss in preparatory layers.



EDGING REPAIR

Reinforcing the edges of a mosaic using mortar as a support.



REINTEGRATION OF LACUNAE

Area of the pavement where the original tessellatum is missing and has been replaced by original tesserae, new tesserae or other materials such as pieces of stone or brick imbedded in the mortar.



FILLING OF INTERSTICES BETWEEN TESSERAE

Area where the original mortar in the interstices between the tesserae has been replaced.



PREVIOUS INTERVENTIONS

SECTION LIFTED AND RE-LAID IN SITU

Part of the mosaic that was detached from its preparatory layers, in sections or in one piece, and re-laid in situ on a new backing.



JOINTS BETWEEN RE-LAID PANELS

Spaces between the cut and detached sections of a mosaic that have been re-laid in situ.





The section lines may or may not follow the mosaic pattern. Joints may have been filled with materials such as mortar or tesserae to restore the continuity of the mosaic surface, or they may have been left unfilled.



CONDITION ASSESSMENT – Structural deterioration

LACUNA

Area of a mosaic where the tessellatum is missing.



CRACK



Linear break that is visible on the surface of the mosaic and may also penetrate into its lower layers.



DETACHMENT BETWEEN MOSAIC LAYERS

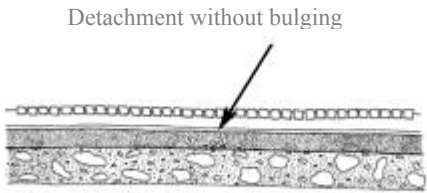
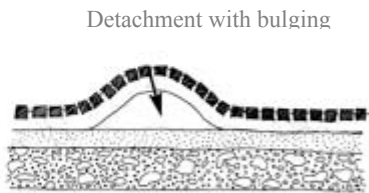
Separation or void between two layers of the mosaic.

A detachment is generally not visible and can be detected by the corresponding hollow sound produced when the surface of the mosaic is tapped.



Detachment with bulging

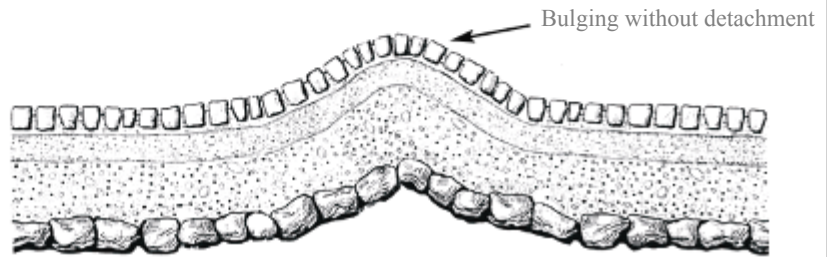
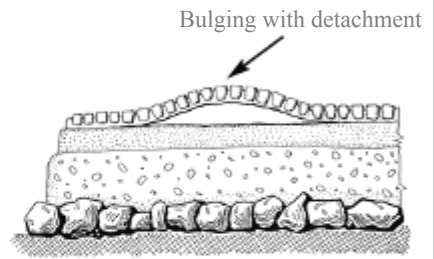
Detachment without bulging



CONDITION ASSESSMENT – Structural deterioration

BULGE

Upward deformation of the mosaic above its original surface level.



DEPRESSION

Downward deformation of the mosaic below its original surface level.



CONDITION ASSESSMENT – Surface deterioration

DETACHED TESSERAE

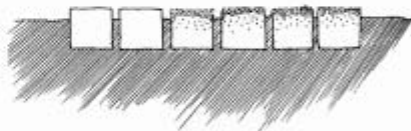
Tesserae that are still in their original location but no longer fixed to the bedding layer and, as a result, move when lightly touched.



DETERIORATED TESSERAE

Tesserae that are no longer in good condition.

Deteriorated tesserae can be broken, fractured or otherwise damaged.



CONDITION ASSESSMENT – Surface deterioration

DETERIORATED MORTAR BETWEEN TESSERAE

Mortar in the interstices between the tesserae that is lost or no longer in good condition.



STAIN

Localized change in color of the mosaic surface.



INCRUSTATION

Mineral crust of variable thickness and area that is often hard and compact.



EFFLORESCENCE

Generally white and crystalline substance, loosely adhering to the mosaic surface, powder-like or whisker-like in appearance.



CONDITION ASSESSMENT – Biological deterioration

MICRO-ORGANISMS

Small organisms varying in color and shape, and adhering to the mosaic surface, such as algae, lichens, mosses, etc.



VEGETATION

Plants such as grasses, weeds, bushes, as well as trees and their associated roots growing under, inside or on top of the mosaic.



DETERIORATION CAUSED BY INSECTS AND OTHER ANIMALS

Area of the mosaic where insects and other animals have burrowed, made nests or caused other types of damage.



CONDITION ASSESSMENT – Deterioration of interventions

**DETERIORATED
REPAIR MORTAR**

Edging repair or fill in poor condition presenting cracks, erosion or other types of damage.



**DETERIORATED
METAL
REINFORCEMENTS
IN THE SUPPORT
PANEL**

Structural reinforcements in the new support of a re-laid mosaic that are in poor condition.



TREATMENTS

VEGETATION REMOVAL

Cutting or removal of weeds, grasses, bushes and trees by mechanical means using tools.

CLEANING

Removal with or without water of substances such as dirt, debris or micro-organisms, which have accumulated on the mosaic surface.

REMOVAL OF MODERN REPAIR MORTARS

Removal of fill and edging mortars from previous interventions.

RESETTING TESSERAE

Placing detached tesserae back in their original position and with their original orientation using mortar.

FILLING BETWEEN TESSERAE

Applying mortar in interstices between tesserae.

GROUTING BETWEEN PREPARATORY LAYERS

Introducing a grout (liquid mortar) into a void caused by a detachment between preparatory layers.

LACUNA FILL

Filling a lacuna in the mosaic surface with a mortar.

EDGING REPAIR

Application of a sufficiently thick layer of mortar along the edges of a mosaic that functions as a fill.

REBURIAL

Covering a mosaic using fill materials such as soil or sand to protect it.