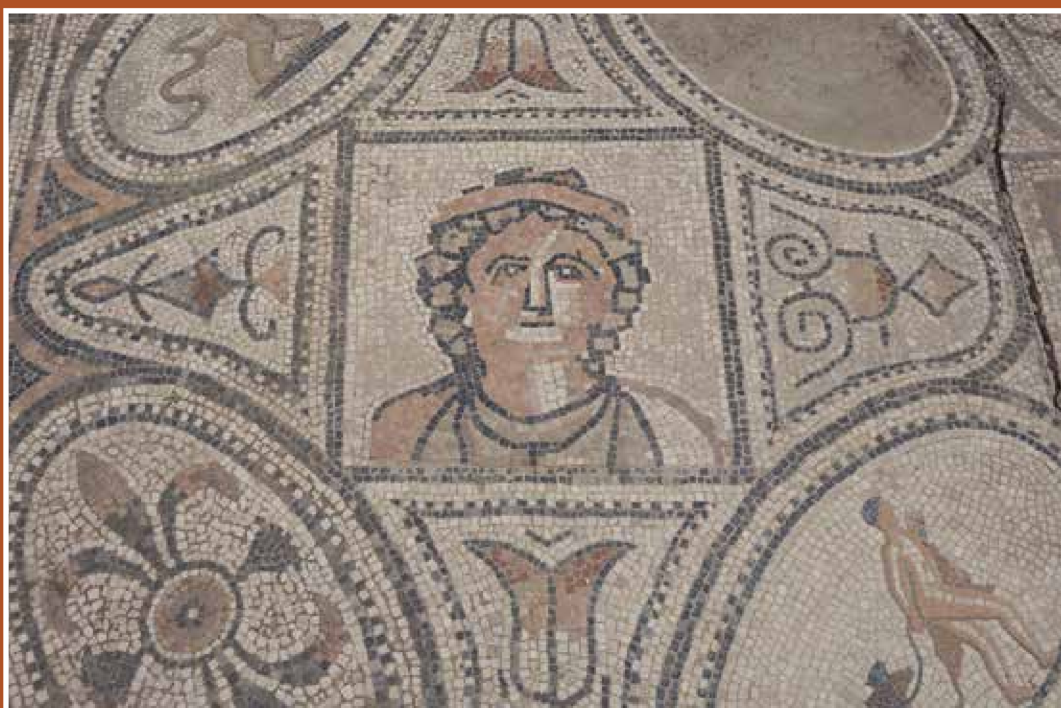
MANAGING ARCHAEOLOGICAL SITES WITH MOSAICS: FROM REAL PROBLEMS TO PRACTICAL SOLUTIONS

The 11th conference of the International Committee for the Conservation of Mosaics, Meknes, October 24-27 2011

edited by
Demetrios Michaelides and Anne-Marie Guimier-Sorbets



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The 11th conference of the International Committee for the Conservation of Mosaics,
Meknes, October 24-27 2011

The 11th Conference of the International Committee for the Conservation of Mosaics: "Managing Archaeological Sites with Mosaics: From Real Problems to Practical Solutions"

Meknes and Volubilis, 24-27 October 2011

Under the auspices of Ahmed Gouitaà, Secretary General,
with the assistance of Abdellah Salih, Director of Cultural heritage, Ministry of Culture, Morocco
and the support of The Getty Foundation, The University of Cyprus and ICCROM.

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Managing Archaeological Sites with Mosaics: From Real Problems to Practical Solutions

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On cover
Season, Labours of Hercules mosaic, House of the labours of Hercules, Volubilis, Morocco (photo: D. Michaelides)

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FOREWORD

The present volume offers the essence of what was presented during the 11th conference of the International Committee for the Conservation of Mosaics that took place in Meknes, Morocco, from the 24th to the 27th of October 2011. The main theme of the conference was "*Managing Archaeological Sites with Mosaics: From Real Problems to Practical Solutions*".

The papers are arranged in groups, which correspond to the sessions of the conference itself. I have maintained the original grouping except in the case of "Conservation and Management Planning", which I merged with "Conservation and Management of mosaics at sites", since there seemed to be little difference in the contents of their respective papers. Also, I have re-arranged the papers in each session in alphabetical order according to author, for easier reference.

It has to be admitted that the volume is not evenly balanced: The authors of both papers and posters were given no specific word limit so some papers are very long while others are short; and the texts of some of the posters are longer than a number of papers. Furthermore, and as it could have been predicted, some sessions, such as "Conservation and management of mosaics at sites" (Session III) and "Case studies" (Session VI), attracted many more papers and posters than others.

Conference proceedings usually relegate poster presentations to the end of the volume – if they publish them at all. I judged that this would be unfair in the present case, given that in their written form several posters are long and very substantial indeed. For this reason, I treat-

ed them practically like papers: they were divided into groups, according to the theme they treat, and added at the end of each appropriate session. When long, they are accompanied by an abstract just like a paper.
As is often the case after large conferences, collecting the contributions for publication was not an easy affair, and, unfortunately, some papers never materialized. All the same, of the 36 papers presented during the conference, 29 are published in the present volume.
The posters fared less well. Of the 41 presented at the conference only 28 were sent by their authors for publication. It should be noted however that, after the conference, the authors were asked to send their original poster files without any changes so that they could be put on the ICCM website. Twenty six authors responded and their posters can be found on http://iccm-mosaics.org/11th-iccm-conference-poster-presentations-2/. Included are the following seven, which do not appear in the present publication:

- Abou Baker, "An ancient pavement from the second century BC"
- W. Hwari, "Conservation of mosaic floor detached from the Yasileh site in northern Jordan"
- B. Jabbour-Gédéon, "The Blue Team pavement: Conservation, intervention: Al-Bass archaeological site, Tyre, Lebanon"
- G. Karabalis, "Restoration works for the maintenance of the mosaic floor of the conservatory of Kos"
- G. Milošević, V. Crnoglavac and N. Gavrilović, "Condition, problems and presentation of the mosaics of Mediana, Serbia"
- Y. Polat, "Conservation of the mosaic floor found in the *Gerontikon* (*Bouleuterion*) in Nysa"; and
- Županek and K. Kracina Toman, "Managing archaeological parks with *in situ* mosaics in Ljubljana, Slovenia: Evaluation, conservation and maintenance".

The conference was supported in several ways by a generous grant from The Getty Foundation, through the mediation of Joan Weinstein and Antoine Wilmering, whom I thank wholeheartedly. Without this grant, the publication of the present volume would not have been possible.

In ending this brief foreword, I would like to express my gratitude to the following colleagues and friends: Skevi Christodoulou, at the time secretary of ICCM, for mercilessly chasing the authors for their texts; Véronique Vassal for her manifold assistance with the French texts; and Raffaele Manna for deciphering and interpreting my corrections, and his help with the Arab speakers among the authors, as well as for general help with copy editing. Lastly, my sincere thanks go to the co-editor Anne-Marie Guimier-Sorbets for her precious assistance with the French papers.

Demetrios Michaelides
University of Cyprus
Nicosia, 30 March 2017

The visit to Volubilis, 24 October 2011 (Photograph: Alexis Michaelides)

President's Opening Remarks

Dear colleagues, Dear friends,

The official opening of the conference will take place this evening. Even so, I would like to say a big Thank You to the Moroccan authorities for making possible the holding of this 11th conference of the ICCM here in Meknes. I would also like to thank you for participating in the conference and giving the ICCM your support.

Organising a large conference is never an easy task. Organizing it long distance, from one end of the Mediterranean to the other, has been a daunting, at times seemingly unachievable task. In any case, we made it, and in this respect, I would like to thank Rachid Bouzidi for acting as the national coordinator. My thanks go to him and the members of the Moroccan organizing committee, in particular Hicham Rguig, for all their assistance. The conference could not, of course, have taken place without the support of the Moroccan authorities, and I am immensely grateful to Ahmed Guitaà, General Secretary of the Ministry of Culture of Morocco, and Abdellah Alaoui, Director of Moroccan Cultural Heritage at the same Ministry, for putting the conference under their auspices, and for all the assistance they have provided for the organization of a successful conference.

My gratitude goes to the Getty Foundation and all the partner organizations in the MOSAIKON programme for two substantial grants – and in particular to Joan Weinstein and to Antoine Wilmering, who is here with us for the conference, for his support and assistance during the last few years. One of these grants goes towards supporting the activities of the ICCM in a number of ways. Through this, it was possible to employ, for the first time, a secretary for the ICCM, on a part-time basis. The person that filled this post is Skevi Christodoulou, who is doing her PhD with me at the University of Cyprus, and whom you all know through the countless emails we have been exchanging during the last couple of years. I am most grateful to Skevi for the immeasurable assistance she has given me and for being ready at my command, be it in the small hours of the morning or during the weekends, and at times that most people have better things to do. I am only sorry that given the unexpected amount of work generated by this conference, she has lagged behind with writing her thesis. I am sure she will catch up once life returns to normal. Skevi has been here in Meknes for the last week, together with Niki Savvides, whom I also thank, trying to tie up loose ends before the conference begins.

Through the Getty Foundation grant it was also possible for several Board Members to come to Morocco on a number of occasions in order to discuss matters with Rachid Bouzidi and the Moroccan authorities. I am most grateful to our Vice President Roberto Nardi and Board Members John Stewart, Sabah Ferdi, Anne-Marie Guimier-Sorbets, Evelyne Chantriaux and Stephania Chlouveraki for giving a lot of their time to assist me during these visits.

I also thank Jeanne Marie Teutonico and Leslie Friedman who have also helped with the abstracts and the programme; John Stewart for helping me "tidy up" the English abstracts, and Anne-Marie Guimier-Sorbets for doing the same with the French abstracts – but also for translating the programme and everything else into French. I would also like to thank Sabah Ferdi and Alain Guimier for also helping with the French translations.

As mentioned already, organizing this conference has not been easy. Apart from personal difficulties that I have been facing, we had to adjust to the events that are changing the political landscape of the Mediterranean. In this context, I would like to extend a warm welcome to our colleagues from Syria and Libya who, despite their problems and concerns at home, still managed to come and be with us here in Meknes.

Unfortunately, the general political situation led many colleagues to cancel their participation in the conference.

Just as serious a problem is the economic crisis that has hit several European countries which led to even more cancellations, especially from Greece and, rather surprisingly, from Great Britain.
All the same, even if I do not have the final numbers yet, I believe we are around 200 participants – something that under the present circumstances is no mean achievement. We are not as many as at the previous, gigantic conference at Palermo but we are about the same as at Hammamet, two conferences ago.
The number of countries represented at the ICCM has also increased and we now have delegates from 32 different countries – a lot more than many international organizations of much longer standing. One factor that has contributed to this increase in membership is a separate Getty Foundation grant which, as in the past, has enabled the ICCM to invite mosaic conservation and other specialists to the conference. This time we have been able to invite 27 colleagues on a full grant, and also cover part of the expenses of another eight.
Managing United States funds in Cyprus for a conference taking place in Morocco, with grantees from 18 different countries was complicated to say the least – and I do not know what I would have done without the support of the University of Cyprus – especially the Accounting Department that has led me through the intricate paths of financial bureaucracy. Skevi, of course, worked hard on this front too but I must also thank my own personal secretary at the University, Ms Cryssa Gregoriou for stepping in whenever necessary and helping in a variety of ways well beyond her duties at the University.
Another big Thank You goes to the Getty Foundation for providing the ICCM with the funds that allow us to have simultaneous translation from French and English into Arabic during the conference.

As I usually do at the opening of ICCM conferences, I will give you a very short account of what has been achieved in the three years since our last conference.
One of the aims (also specified in the Getty Foundation Grant) was to improve the ICCM website. If you have visited it, you will have noticed that it has changed considerably. However, it still needs a lot of work and we

will return to it once the conference is over. Please remember that members of the ICCM are most welcome to send contributions to be posted on it, especially in the *Newsletter*.

One of my aims was to get the Proceedings of the Palermo conference ready before the Meknes meeting. The editing was done a long time ago but, unfortunately, the printing of the second proofs was halted for reasons beyond my control. I am happy to report that the printing of the volume has now been given the green light and the authors will soon be receiving the second proofs of their articles. To convince you that this is actually happening, I have a dummy of the volume – all 808 pages of it – the largest volume of ICCM proceedings so far. Many thanks to Guido Meli and Elena Lentini, but also to Adele Mormino for finally giving the go-ahead for the publication of the volume.

One day a young man who had just finished his studies in Italy came to my office in search of employment. I told him that, unfortunately, although there were lots of jobs that needed to be done I had no money to pay him. To my surprise, the young man, Mr Marios Kamenou, who is here in the audience, responded that he would rather do something without being paid rather than sit doing nothing, and this gave me a wonderful opportunity to embark on something that I had been discussing for some time with my colleague and Board Member Charalambos Bakirtzis. Thus, Marios worked under the careful guidance of Charalambos and Pelli Mastora, and a booklet containing the indices for the first ten volumes of ICCM proceedings has materialized – and it gave me great pleasure to put a copy of it in your conference bags. This publication is the first offering of the Committee for the Study and Conservation of the Mosaics of Greece and Cyprus – a committee that was conceived during the Hammamet conference and strengthened during that in Palermo. However, given the financial crisis we are all going through, the Committee has not been able to do much so far.

After your comments for improvement and possible corrections, the indices will go on the ICCM website – as will, hopefully, all the volumes of the proceedings themselves – a process that we started discussing with Paul Arenson of the Library and Archives of ICCROM.

Fig. 1. Antonio Cassio receiving the honorary medal from Demetrios Michaelides. President of ICCM

All of us here are involved with mosaic conservation and presentation one way or another. We consider this field a fairly young, almost newly-born discipline; but we are, of course, working on the foundations laid by the generation before us. One of the most eminent pioneers of mosaic conservation is undoubtedly Antonio Cassio – and I am thrilled that we managed to bring him over from Rome and have him here with us today, so that we can thank him officially and publicly for his services to mosaic conservation over many decades. Roberto will speak about Antonia Cassio's career and achievement, and, before I pass the floor to him, I would like to wish you all a fruitful conference and a pleasant stay in Morocco.

Demetrios Michaelides
24 October 2011

Speech in honour of Antonio Cassio

When Antonio Cassio was born, 80 years ago, he was already a mosaicist since a couple of generations at least: his father Lorenzo, was for about 40 years director of the "Studio del mosaico" of the Vatican City; his son, Roberto, is actually responsible for the conservation of mosaics of the Vatican Museums; his nephew Lorenzo**,** Roberto's son, is already in the art.

The production of new mosaics of Antonio, working together with his brother Fabrizio is almost endless. It is worthwhile to go through a short list just to give an idea of the variety of his work, both technical and geographical. In the early 1950s, together with his father, Antonio and Fabrizio made the mosaics of the North American College on the Gianicolo in Rome; during 1956-57, they made the mosaic of the Church of the Precious Blood in Detroit; in 1958, they worked directly for the government of the United States for the manufacturing of the mosaics of the War Cemeteries in Florence, Belgium, Luxemburg and Manila for about 3500 m^2; in 1964, they made the mosaic of the St Francis Hospital Chapel in Wichita, Kansas (USA); in 1968, they made the 'Via Crucis' for the St Stanislaus Church in Milwuakee, Wisconsin (USA); during 1966 and 1968, they made the new mosaics of the Montecassino Abbey, after the originals were destroyed by bombing during the Second World War (700 m^2)**;** in 1979, they made the mosaics of the Palace of Cinema in Bagdad. Finally, in 1985, they made the mosaic for the Memorial of John Lennon in Central Park in New York, today one of the most visited sites in the city.

Fig. 1. The ceremony: From left to right: Roberto Nardi, Antonio Cassio, Gael de Guichen, Roberto Cassio, Demetrios Michaelides

In 1967, he is classified first at the national public competition for the position of mosaic restorers at the Ministry for Education, held at the Opificio delle Pietre Dure in Florence, and chooses to work in Ostia Antica. Very soon, his new technologies are appreciated and they will be applied during the following ten years. Important mosaics, such as those of the "La casa dell'Invidioso", "Le Terme Marine", "La casa dei Dioscuri", "La casa delle Province" plus many more, are restored according to his methodology.
For what concerns mosaics restoration, Antonio began in 1958 when he was asked to restore the floor mosaics of the Baths of Caracalla in Rome. Here he worked for several years, until all the floor restoration was complete, for a total of more than 6000 m^2. Other interesting restoration projects carried out are the *Casa del Bracciale* in Pompei in 1978; in 1978-1989 the Museo Nazionale Romano and the Museo delle Terme, in Rome, where

Fig. 2. Members of ICCM honour Antonio Cassio

they lifted and re-laid most of the mosaics actually on display. During the 1980s, they removed and re-laid all mosaics and *opus sectile* of the first floor of the Museo Archeologico in Naples … and more, the mosaics of Villa Torlonia in Rome, Ostia Antica, the Capitoline Museums, the Palatine, the Vatican Museums and many many other projects on site and in museum.

But it is not the quantity of square meters or the number of projects that make the professional quality of one person. And these are not the motivation for ICCM honouring Antonio with this medal.

In the late 1970s, Antonio got a position as professor of conservation of mosaic at ICR in Rome and in this role he trained dozens and dozens of conservators. In 1983, he joined ICCM in Aquileia.

First of all, he is a great innovator: he never stopped looking for new, efficient and compatible technical solutions for conserving mosaics: amongst others, the practice of cutting the mosaic in small pieces for lifting. This is a technique that Antonio imported in conservation practice directly from the mosaic making technique and this replaced the use of removing floors by rolling them or cutting them in big square sections. The Antonio solution transformed mosaic lifting from a very complicated, costly and dangerous operation into an action that conservators without the use of equipment (like cranes and trucks) can easily implement.

Another important practice that he introduced is the intermediate passage on clay, which means to re-lay temporarily the mosaics on a fresh clay bed to treat them before the reapplication on a new support. This is extremely useful when you deal with mosaics badly detached in the past from the site and without documentation so that, before the final re-laying on a new support you need a check control and a treatment.

In 1982, at the Istituto Centrale per il Restauro, Antonio Cassio used aerolam panels as support of mosaics applied from the front side, cutting and assembling fragments of surfaces of about 1 m^2, very easy to handle, the so called "piccoli pezzi".

But, apart from the above and other, technical innovations that Antonio introduced in the profession, I would highlight the best part of his character: that is, his generosity towards his colleagues and particularly his students. His studio was always open, his projects had always room for collaborations, visitors and patrons. And, aside from the high professional standards, Antonio disseminated his enthusiasm and passion for the work.

I would like to conclude this short presentation with a story of 38 years ago, when, at the end of the academic year at ICR, I was going with Antonio to the archaeological excavation at Settefinestre, in Tuscany, for a one-month field experience in mosaic conservation. When driving there, I asked Antonio what we were supposed to do. His reply was: "*How can I know if we have not arrived yet?*". I said "*I suppose that, thanks to your experience, you know what we will do well in advance*". He was almost upset and replied: "*Remember, each mosaic is different from another and you never know in advance which will be the best strategy to follow and treatment to apply..... You must go next to the mosaic, sit and wait for the moment*

when the mosaic itself will tell you what to do". This is a lesson that lasted for 40 years and still today, before approaching a new project, it comes up in my mind, telling me to take time, to be modest, to study the monument, to look for the problems and the solutions, both written on it and ……. wait for the moment when the mosaic itself will tell me what to do.
For this and for many other reasons I am so glad that today Antonio is with us, and I would like to thank him once more for all he gave to us, to ICCM and to the world mosaic heritage.

Roberto Nardi
Vice-President of ICCM

Meknes, Morocco, October 25, 2011

In recognition of his pioneering services of many decades to the safeguard and conservation of mosaics, ICCM, the International Committee for the Conservation of Mosaics, honours Antonio Cassio with a medal.

SESSION I:
VOLUBILIS, CHELLAH AND MEKNES

Abdelilah Dekayir,
Nissma Bouzoubaa et Lahcen Bejjit

Abdeltif El Khammar

Zahra Qninba et Bidaouia Belkamel

Hicham Rguig,
Hakim Ammar et Meriem Hansali

CARACTÉRISATION DES COLORANTS ET DES OPACIFIANTS DANS LES TESSELLES A BASE DE VERRE DES MOSAÏQUES ROMAINES DE VOLUBILIS (MAROC)

Abdelilah Dekayir, Nissma Bouzoubaa and Lahcen Bejjit

Résumé

Les mosaïques romaines du site archéologique de Volubilis sont réalisées en *opus tessellatum*. Les analyses morphologiques et chimiques réalisées par microscopie électronique à balayage (MEB) sur la plupart des tesselles à base de verres montrent des aspects massifs. La couleur des tesselles de couleur verte est attribuée principalement à la présence du Cu. Le Pb est lié probablement à la bindheimite. En revanche, la couleur bleue est attribuée à la présence de fer mis en évidence par résonnance paramagnétique électronique (RPE). Dans les verres jaunes, la couleur est attribuée à la présence à la fois du Fe et du Pb exprimé sous forme de bindheimite qui sert à la fois d'opacifiant et de colorant.

Introduction

Depuis les temps anciens, les mosaïques ont joué un grand rôle dans la décoration des maisons, des églises et des places publiques. Les Grecs sont les premiers à inventer la technique de décoration en se servant des galets. Ils ont continué en décorant les murs, par du marbre et des fragments de roches. Les Romains, ont utilisé le marbre et les verres (Fig. 1). La couleur annoncée par un verre est reliée à l'état d'oxydation et la configuration électronique des métaux au sein du verre. En effet, les éléments de transition absorbent des fréquences caractéristiques dans le spectre visible à cause des transitions électroniques au sein des orbitales d.

La caractérisation des colorants et des agents décolorants est très importante dans la compréhension des anciennes techniques de façonnage des verres.
L'objectif de ce travail est la détermination des métaux, responsables de la coloration des verres des mosaïques dans le but de reconstituer les techniques de préparation des verres à cette époque et d'obtenir des informations relatives à la datation de ces mosaïques.

Fig. 1. Exemple de mosaïques de Volubilis avec la présence de tesselles à base de verre

Matériel et méthodes

Les matériaux utilisés dans la construction des mosaïques romaines de Volubilis sont représentés par des calcaires de couleurs différentes et par des verres bleu, vert, jaune et gris. Les tesselles à base de verre ont été utilisées essentiellement pour rendre un détail dans un dessin donné (cheveux, blanc d'œil, etc.). Les échantillons, étudiés ont été récoltés dans la mosaïque de l'Éphèbe du site archéologique de Volubilis.

La morphologie des tesselles à base de verre a été étudiée par microscopie électronique à balayage couplée à l'analyse chimique EDS (Energy Dispersive X-ray Spectroscopy). En raison de sa limite de détection, les verres ont fait l'objet d'autre analyse complémentaire telle que la résonance paramagnétique électronique.

Résultats

a. Tesselles de couleur verte

Ce type de tesselle montre une structure massive au microscope électronique à balayage, avec la présence de vésicules de dégazage. Sa composition chimique montre qu'il s'agit d'un verre riche en Si, Na et Ca avec des traces d'Al et de Pb. Dans le cas des échantillons verts, les raies attribuées au fer sont superposées à une structure hyperfine à quatre raies attribuée aux ions Cu^{2+} en très faible quantité. Les paramètres spectraux du signal RPE du cuivre sont : $g_{/\!/} \approx 2.40$, $g_{\perp} \approx 2.14$ et $A_{/\!/} \approx 140$ Gauss. L'échantillon vert gris présente très peu de cuivre par rapport aux échantillons vert foncé et vert laiteux (Fig. 2).

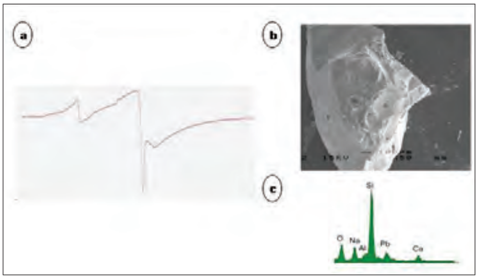

Fig. 2. a: Spectre RPE, et b, c: Photo MEB couplée à l'analyse chimique de tesselle à base de verre de couleur verte

b. Tesselles de couleur bleue

Ce type de tesselle montre une structure massive qui ressemble à celle du verre de couleur verte. L'analyse chimique montre qu'il s'agit d'un verre riche en Si, Na et Ca avec des traces d'Al avec une absence de Pb. L'échantillon bleu montre, en plus des raies de Fer, une structure hyperfine au voisinage de $g \approx 2$, il s'agit vraisemblablement du signal à 6 raies dû aux ions Mn^{2+} à l'état de traces (Fig. 3).

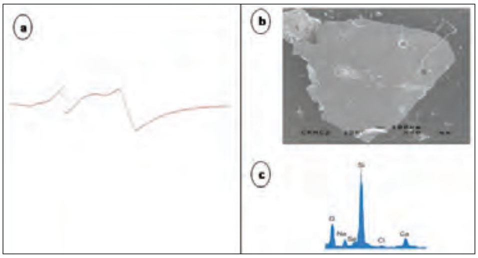

Fig. 3. a: Spectre RPE, et b, c: Photo MEB couplée à l'analyse chimique de tesselle à base de verre de couleur bleue

c. Tesselles de couleur jaune

Ce type de tesselle montre une structure massive identique aux verres précédents. L'analyse chimique montre qu'il s'agit d'un verre riche en Si, Na et Ca avec des traces d'Al et de Pb. Le spectre RPE de ce verre montre la présence de Fer (Fig. 4).

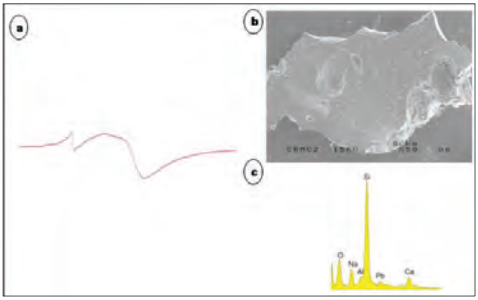

Fig. 4. a: Spectre RPE, et b, c: Photo MEB couplée à l'analyse chimique de tesselle à base de verre de couleur jaune

Conclusion et Discussion

D'après les recherches bibliographiques, la bindheimite ($Pb_2Sb_2O_7$) est un oxyde de plomb et d'antimoine, qui offre la coloration à de nombreux types de verre. Elle agit de manière différente dans les verres jaunes et verts. Dans le verre de couleur verte, la couleur est attribuée à la présence du Cu alors que la bindheimite joue un rôle d'opacifiant. En revanche dans les verres jaunes, elle agit comme opacifiant et comme colorant à la fois. La bindheimite ($Pb_2Sb_2O_7$) est un produit d'altération de la jamesonite ($Pb_4FeSb_6S_{14}$) (Galli *et al.*, 2004). L'analyse par RPE a permis de détecter des raies attribuées aux ions Fe^{3+} dans toutes les mosaïques étudiées ; les raies les plus intenses sont situées à g ≈ 4.3, due aux ions Fe^{3+} isolés (répartition aléatoire), et à g ≈ 2, qui caractérise la formation de clusters. A l'exception de l'échantillon bleu, le rapport des intensités de ces deux raies indique que le nombre de fer engagés dans des liaisons Fe-Fe est beaucoup plus important que celui des ions isolés. D'autres signaux pouvant être attribués au Fer^{3+} sont présents, en particulier un épaulement à g ≈ 9,8 et une raie de très faible intensité à g ≈ 2,76.

Au Maroc, les régions limitrophes du site de Volubilis, à savoir les formations paléozoïques du Maroc central, hébergent plusieurs mines d'étain, d'antimoine et de Pb et Zn (stibine Sb_2S_3, de sulfures de Pb et de Zn (galène, blende)). Les produits d'altération des sulfures d'antimoine sont représentés par des ocres de couleur jaune, utilisés dans les techniques de coloration des verres (Michard, 1976)

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LE ZELLIJ DES MONUMENTS HISTORIQUES DE MEKNÈS : TECHNIQUES DE FABRICATION, MODES D'UTILISATION ET FORMES DÉCORATIVES

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Résumé

La présente étude porte sur le zellij des édifices médiévaux et post-médiévaux de Meknès. Elle tente d'appréhender le sujet en question selon une approche double qui s'appuie sur le croisement des données archéologiques recueillies sur le terrain avec les informations collectées lors de nos enquêtes ethnoarchéologiques. Elle essaie d'éclaircir les différents aspects relatifs aux techniques de fabrication de ce matériau dans les ateliers de céramique à Meknès (le quartier d'al-Fakhārīn), depuis l'extraction et la préparation de l'argile jusqu'à la cuisson, l'émaillage et la finition des pièces façonnées. Cette démarche permet de bien comprendre les différentes étapes parcourues lors de la fabrication de ces pièces avant qu'elles soient utilisées dans ces monuments historiques. Ces informations sont complétées et enrichies par les renseignements archéologiques qui nous ont permis, d'autre part, d'avoir une idée assez globale et précise sur les différents usages et modes d'emploi des carreaux de zellij, et les règles et les principes de base mis en œuvre pour l'obtention des combinaisons et schémas décoratifs repérés dans les masses architecturales de ces monuments. Cette recherche trace, à partir de toutes ces données matérielles, les grands traits et caractéristiques de l'école artisanale de Meknès.

Le zellij est un terme générique, désignant au Maghreb occidental la marqueterie de céramique : c'est un mot spécifique à cet espace géographique. Le mot *qishānī* est utilisé par les pays de l'Orient musulman pour indiquer les mêmes carreaux de céramiques. L'apparition de zellij au Maroc remonte, d'après les témoignages archéologiques, à la fin du XII^e^ siècle. Les plus anciennes marqueteries de céramique sont attestées dans les hautes frises et bandeaux garnissant la partie supérieure des minarets almohades de la mosquée de la Kutubiya et de la mosquée de la Qasba à Marrakech (Basset et Terrasse 2001, 123-124). Ces plaques bichromes (blanches et vertes) à grande échelle, ne vont pas sans présenter des analogies avec les pavements et les carreaux de mosaïques retrouvés à la Qal'a des Banī Hammād (débuts du XI^e^ siècle ; cf. Golvin 1962, 391-401 ; et Amara 2001, 91-110) au Maghreb Central (l'Algérie actuelle), s'inspirant, dans leurs techniques de fabrication, de la marqueterie céramique que l'on retrouve dans les monuments aghlabides (IX^e^ siècle ; cf. Erzni 1993a, 158) de l'Ifriqiya (la Tunisie actuelle). La technique est fort différente de celle du zellij de Meknès : les énormes carrés de faïence, percés dans leur centre, sont fixés par des clous à des madriers encastrés dans la maçonnerie. Le zellij almohade reste simple dans sa facture et sa coloration, et diffère du style mérinide, non seulement par la technique de découpe du carreau et la coloration, mais encore

Fig. 1. Vue panoramique de l'ancien quartier d'al-Fakhārīn à Meknès (cliché : Archives)

par le mode de pose qui doit s'adapter à la grande échelle des motifs et au poids des plaques. Sous sa forme médiévale la plus connue, le zellij ne connut pas d'essor avant la fin du XIII[e] siècle et le début du XIV[e] siècle (Erzni 1993a, 158-161 ; Cambazard-Amahan 1993, 147).

Notre étude est principalement axée sur le zellij des édifices médiévaux et post-médiévaux de la ville de Meknès. Elle n'est pas restreinte aux renseignements que nous procure la documentation archéologique, mais tient également compte des informations livrées par les enquêtes ethnoarchéologiques menées dans le quartier d'al-Fakhārīn à Meknès (Fig. 1 et 2). Le recours à la démarche ethnoarchéologique s'avère d'une utilité non négligeable pour les recherches archéologiques, mais à con-

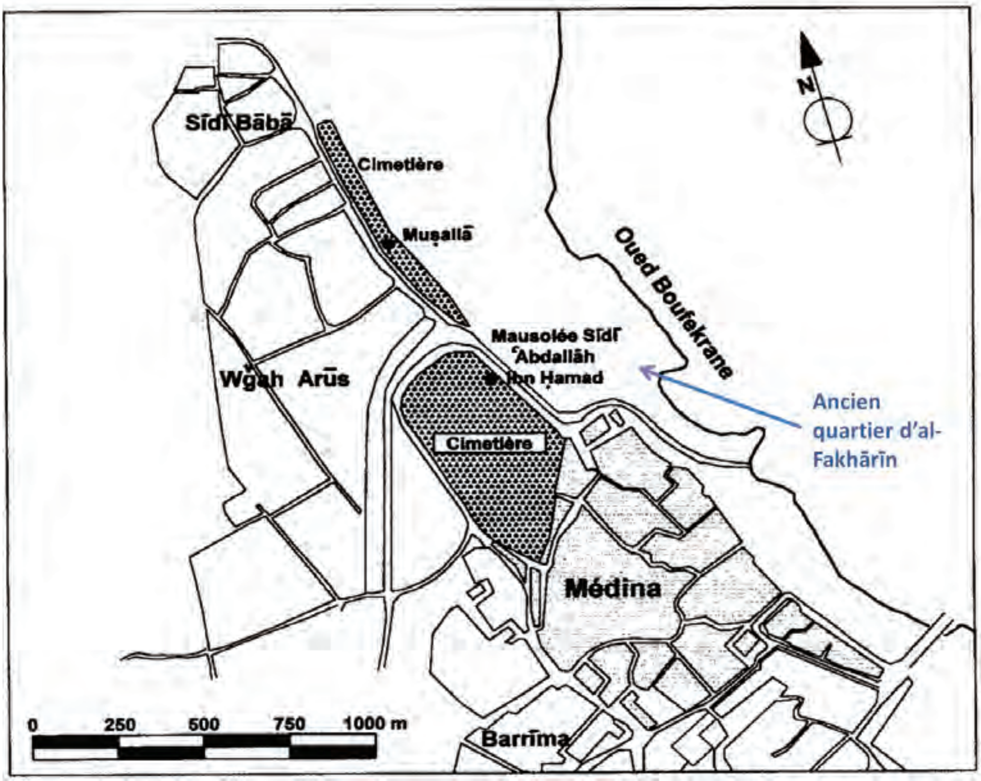

Fig. 2. Situation de l'ancien quartier d'al-Fakhārīn à Meknès (dessin : A. El Khammar)

dition que celui-ci évite, autant que possible, le risque d'assimiler complètement la société d'hier à celle d'aujourd'hui ; il ne faudrait sélectionner que les données ethnographiques qui peuvent être placées au même degré de généralité que les indices archéologiques (pour plus de détails sur l'approche ethnoarchéologique et son application dans le domaine de l'archéologie, cf. Bazzana 1992, 17).

Confrontées aux données archéologiques, les informations d'ordre ethnographique seraient susceptibles de mieux nous éclairer sur plusieurs volets relatifs au métier du zellij, et de tracer les tendances majeures et les grandes lignes caractéristiques de l'école artisanale de Meknès.

Spécialisé dans la production de la poterie et de la céramique architecturale traditionnelle, le quartier al-Fakhārīn était situé *extra-muros* de la médina ancienne, à proximité de l'oued Boufekrane, non loin de Bāb al-Brād'iyīn, la porte septentrionale de l'enceinte de la médina. Ce quartier a été rasé il y a quelques années suite à des réaménagements urbains effectués par la mairie de Meknès ; du coup, les ateliers étaient déplacés dans la localité d'al-Rmīka qui se trouve dans les environs immédiats de Meknès, sur la route reliant cette ville au site archéologique de Volubilis. Le choix de cet emplacement n'est pas fortuit, mais s'explique par l'immensité du terrain qui se trouve loin des quartiers résidentiels, et par sa proximité par rapport aux carrières d'argile d'al-Rmīka. Ce phénomène urbain ne va pas sans rappeler le cas du quartier al-Fakhārīn à Fès qui a connu le même sort durant le siècle dernier ; ces décisions étaient incontestablement prises dans le souci d'écarter les nuisances causées aux quartiers résidentiels. Dans ce sens, les auteurs des *Palais et Demeures de Fès* signalent : « Au temps où A. Bel menait son enquête (vers 1914-1915), les ateliers de céramistes (potiers, zellijeurs, etc.) se trouvaient en ville à proximité de la porte dite Bāb Ftūh, en direction de Taza, dans un quartier appelé Fekhārīn. La fumée de leurs fours n'était pas sans incommoder les habitants du voisinage. Des mesures assez récentes ont obligé ces artisans à déménager et à installer ailleurs leurs fours. Ils se sont regroupés alors, hors les murs, non loin d'ailleurs de leurs anciennes installations, à gauche de la route de Taza » (cf. Revault, Golvin et Amahan 1985, 52).

Selon le témoignage des artisans céramistes, l'argile servant de base pour la production du zellij et les autres types de la céramique architecturale (la brique et la tuile), ainsi que la poterie, est actuellement extraite de la carrière dénommée al-Rmīka qui se trouve au nord de la médina, sur la route reliant Meknès à Sidi Kacem. Elle est de couleur rouge et de mauvaise qualité par rapport à l'argile blanche qui fut jadis importée de la carrière ancienne de Bāb al-Matrab, aux environs de l'ancien quartier d'al-Fakhārīn.

La préparation des pièces de zellij comporte plusieurs opérations. Tout d'abord, les ouvriers brisent les gros blocs d'argile et les découpent en petits morceaux qui sont jetés dans des fosses (*zūba-s*), dont les bords sont incurvés et non maçonnés (Fig. 3). Après quoi, on verse l'eau dans la fosse jusqu'à ce que celle-ci soit pleine, et on laisse l'argile se déliter et se désagréger durant un ou deux jours. Ce délai passé, un ouvrier descend dans la fosse et procède au malaxage de la pâte afin qu'il puisse la débarrasser des impuretés, telles que les galets ronds, les cailloux et les particules dures. Si le

Fig. 3. Fosse (*zūba*) destinée au trempage de l'argile servant à la fabrication de la brique, du zellij et de la poterie : Nouveau quartier d'al-Fakhārīn à Meknès. (al-Rmīka) (cliché : A. El Khammar)

Fig. 4. Un jeune apprenti fabrique des pièces rectangulaires de zellij (*bajmāt*) : Il se sert de la *qarta*, de la *jallāda*, du *qāla* et de la *karrāta* (nouveau quartier d'al-Fakhārīn à Meknès : al-Rmī ka) (cliché : Archives)

procédé d'élimination des impuretés de la matière première n'est pas effectué avec le plus grand soin, des fissures vont apparaître immédiatement après le séchage.
L'artisan dépose ensuite la pâte malaxée à côté de la fosse et l'étale sur une surface plane pour qu'elle soit exposée au soleil pendant une demi-journée ou une journée complète. Plus l'argile est propre, plus elle sera facile à découper dans les formes désirées ; le trempage et le malaxage de l'argile protègent les pièces déjà séchées contre la fissuration. Une fois cette opération terminée, la pâte est prête à être utilisée. La pâte servant à la fabrication du zellij est préparée suivant les mêmes méthodes appliquées à celle des briques et des tuiles. Une fois la pâte prête, les ouvriers se servent d'un seau rempli d'eau et d'un moule à deux compartiments carrés (11x11 cm). Les carreaux démoulés sont exposés au soleil pour le séchage, puis transportés au magasin pour le façonnage.
Cette opération nécessite l'utilisation d'un matériel rudimentaire, constitué essentiellement d'une *qarta*, d'une *jallāda*, d'un *qāla* et d'une *karrāta* (Fig. 4). La *qarta* est une planche rectangulaire épaisse en bois, servant de support pour l'artisan qui s'assoit et la pose bien plate sur le sol, entre ses jambes allongées. La *jallāda* est un outil en bois muni d'un manche qui permet à l'artisan d'aplatir les pièces rectangulaires déjà séchées au soleil. Le *qāla* est un moule en bois, servant à étaler la pâte et correspond à une mesure étalon, tandis que la *karrāta* est un couteau qui permet à l'artisan de lisser les deux faces de la surface de zellij et d'obtenir la forme voulue.
Après leur façonnage, les carreaux de zellij sont de nouveau séchés pendant une période de quatre jours, et transportés ensuite au four pour la cuisson.
Les fours du quartier al-Fakhārīn (Fig. 5) sont tous bâtis en briques, liées avec un mortier de terre. L'enduit est constitué de l'argile rugueuse et une bonne quantité de paille. Ils se composent de deux parties superposées. La partie inférieure est une chambre à feu, destinée à recevoir le combustible : elle est la source de l'allumage du four (Fig. 6). Elle est enfoncée dans le sol, à une profondeur qui dépasse un mètre, et s'ouvre par une petite baie arquée qui est fermée au moment de la cuisson des briques. Cette chambre est pourvue d'une voûte très épaisse, permettant de supporter les centaines de briques posées au-dessus. La présence d'une voûte, comme l'a bien noté Armand Desbat (Desbat 1995, 17), n'est pas une nécessité pour obtenir des fours permettant des cuissons à température élevée. La voûte joue un rôle plus important pour le refroidissement de la fournée, en conservant la chaleur et évitant le choc thermique d'un refroidissement trop rapide, que pour l'obtention des températures de cuisson élevées. La partie supérieure (*frīna*) est de section circulaire et reçoit les plaques de zellij à cuire (Fig. 7). Sa partie inférieure est munie d'une sole (*ghurbāl*) de section circulaire (Fig. 8) qui repose sur la voûte de la chambre à feu et est creusée d'un ensemble de trous de sections et tailles variables qui permettent la communication entre la chambre à feu et la partie supérieure du four, ainsi que la circulation de la chaleur dans la partie supérieure du four. Le creusement en profondeur de la chambre à feu, et l'allongement de la partie supérieure du four contribuent puissamment aux performances thermiques et à l'obtention de températures de cuisson très élevées.

Fig. 5. Vue générale d'un four de zellij : Nouveau quartier d'al-Fakhārīn à Meknès (al-Rmīka) (cliché : A. El Khammar)

La disposition des pièces de zellij est soumise à certaines règles. Les pièces à cuire de la première rangée sont mises entre les trous de la sole, de façon à ce qu'elles ne les obstruent pas ; elles sont disposées de chant et sont légèrement espacées les unes des autres. Les pièces de la deuxième rangée sont empilées sur celles du premier lit selon les mêmes principes, mais sont disposées dans le sens perpendiculaire. La troisième rangée reprend la même disposition que celle de la première rangée, et ainsi de suite : les lits sont, donc, posés en alternance. Les vides intérieurs entre les carreaux de zellij sont agencés de telle manière que la chaleur puisse circuler dans tout le four. Lorsque la partie supérieure du four est entièrement chargée, on obstrue son ouverture supérieure et on bouche sa porte d'accès par un mur de briques. Après quoi, un ouvrier se charge d'enflammer le combustible dans la chambre à feu pour préparer la cuisson qui passe par deux étapes. La première est préliminaire et dure approximativement dix heures ; elle consiste à chauffer les briques

Fig. 6. Vue de la partie inférieure d'un four de zellij (*sjan*) : Nouveau quartier d'al-Fakhārīn à Meknès (al-Rmīka) (cliché : A. El Khammar)

Fig. 7. Vue de la partie supérieure d'un four de zellij : Nouveau quartier d'al-Fakhārīn à Meknès (al-Rmīka) (cliché : A. El Khammar)

Fig. 8. Vue de la sole (*ghurbāl*) d'un four de zellij : Nouveau quartier d'al-Fakhārīn à Meknès (al-Rmīka) (cliché : A. El Khammar)

à une faible température pour qu'elles soient complètement libérées de l'eau et de l'humidité. Une fois cette opération accomplie, on commence la deuxième étape qui consiste à augmenter graduellement le feu jusqu'à atteindre la température désirée et à obstruer ensuite l'ouverture d'accès à la chambre à feu par des briques liées à un mortier de terre et de paille. La cuisson proprement dite est lancée à partir de ce moment-là et dure treize heures ; le degré de température peut atteindre 900° à 950°. Le contrôle de cette opération incombe à un ouvrier spécialiste, qualifié pour cette tâche délicate.

Après l'accomplissement de cette opération, on laisse les pièces de zellij dans le four pendant quelques jours afin qu'elles refroidissent doucement et ne soient pas cassées par un changement brusque de température. La qualité des pièces est reconnue à partir de leurs couleurs ; les pièces tendant vers le beige sont bien cuites et sont bonnes pour la construction, tandis que les pièces ayant une couleur rouge sont mal cuites et risquent de se casser facilement. Les briques diminuent de volume après la cuisson.

D'autre part, le zellij émaillé n'est pas produit de nos jours dans les ateliers de Meknès, en raison de la mauvaise qualité de l'argile extraite de la carrière d'al-Rmīka ; lorsqu'on applique une couche d'émail sur les pièces déjà cuites et on les réintroduit dans le four pour une deuxième cuisson, celles-ci s'effritent et se cassent facilement.

Ainsi, les carreaux de zellij produits jadis dans le quartier d'al-Fakhārīn, et actuellement dans les ateliers d'al-Rmīka servent uniquement au pavage des sols : les *bajmāt-s* (15x5 cm), les pièces carrées (10x10 cm) et les octogones (*al-kūra*). La nature géologique de cette argile rouge agit donc concrètement sur la nature de la production et sur les types de zellij fabriqués dans ces ateliers, ainsi que sur les techniques mises en œuvre par les artisans. Dans un article réservé à quelques aspects techniques et ethnographiques de la céramique marocaine, Maurice Picon a remarqué le même phénomène dans la production potière du nord marocain. Il note à cet égard : « Parmi les données importantes pour la compréhension de l'artisanat céramique (et celle de son évolution) on aura retenu la place essentielle, bien que trop négligée jusqu'alors, des qualités d'argile…la simple amélioration des qualités d'argile suffit souvent à entraîner des transformations importantes, dans le domaine des techniques… A l'opposé, c'est à la mauvaise qualité moyenne de leurs argiles, et à l'impossibilité de les sélectionner, que les céramiques du Rif doivent l'essentiel de leurs caractéristiques techniques. De même, ce sont les caractéristiques des céramiques calcaires cuites à température élevée qui confèrent aux ateliers du nord-ouest du Maroc quelques-uns de leurs traits marquants » (Picon 1995, 157). Actuellement, le zellij émaillé utilisé dans l'architecture de Meknès est importé des ateliers de la céramique architecturale traditionnelle de Fès.

A Fès, les artisans spécialisés dans le métier du zellij continuent encore à broyer quelques émaux, et à fabriquer la calcine (mélange de plomb et d'étain) dans des fours accolés à un four de potier. La cuisson complète de la combinaison étain-plomb demande de trois à quatre heures. L'oxydation de ce mélange donne naissance à une matière jaune-brun qui sert de base à tous les émaux. Une fois refroidie, la calcine est broyée dans de l'eau à l'aide d'un galet, et mélangée au sable fin, et le tout est mis dans un récipient d'eau. La pâte préparée sert de fond au zellij, et sert de base pour l'obtention d'autres émaux de divers tons : noir, bleu, vert, jaune, etc. (cf. Revault, Golvin et Amahan 1985, 62-64).

Le zellij émaillé subit deux cuissons au four, l'une avant l'émaillage et la deuxième après l'application de celui-ci. Les carreaux cuits sont émaillés par un ouvrier et sont remis dans la partie supérieure du four, et le temps de leur cuisson est identique à celui de la première cuisson. Chaque couleur nécessite une température spécifique, ce qui détermine la position du carreau dans la partie supérieure du four. Ainsi, le blanc et le bleu sont placés au niveau inférieur car ils exigent une chaleur très intense ; le rouge et le jaune, nécessitant moins de chaleur, sont immédiatement rangés dessus. Les carreaux verts sont mis tout en haut du four car ils demandent une température plus basse que les carreaux ayant les couleurs déjà mentionnées (pour plus de détails sur les techniques relatives à la fabrication de l'émail et au vernissage des pièces de zellij à Fès, cf. Revault, Golvin et Amahan 1985, 62-64 ; Samar Damluji 1993, 276-280).

Une fois émaillés et recuits, les carreaux de zellij refroidissent dans le four pendant quelques jours, et sont ensuite défournés et transportés vers les locaux, destinés au découpage de zellij. Le traçage des motifs nécessite l'emploi d'un gabarit qui n'est rien autre qu'un tesson déjà émaillé et cuit. L'ouvrier pose cette pièce sur le carreau monochrome et il trace en suivant les bords. Après quoi, un autre ouvrier se charge de la taille des carreaux déjà tracés en petites pièces à l'aide d'une herminette tranchante. Il frappe, à l'aide de celle-ci, à petits coups secs le long du trait, et le carreau se casse généralement assez vite.

A l'image de la quasi-totalité des villes marocaines, les techniques d'obtention du zellij à Meknès s'inspirent de l'école de Fès, le plus grand centre de fabrication de zellij traditionnel. Au Maroc, seule la ville de Tétouan offre une technique de production différente de celle de l'industrie de Fès. Dans cette ville du nord-ouest marocain, chaque pièce de zellij est taillée individuellement à partir d'un panneau d'argile séché, c'est-à-dire on découpe les pièces de zellij bien avant la cuisson. La raison à cela réside, selon les artisans de Tétouan, dans la qualité de l'argile qui n'est ni assez souple ni assez tendre pour le découpage. Si on cuit le carreau de céramique et on essaye de découper les pièces, celui-ci risque de se casser facilement (pour plus de détails sur le zellij de Tétouan, cf. Samar Damluji 1993, 303-308 ; Erzni 1993b, 173-202).

Contrairement aux techniques chères aux artisans de Tétouan, les artisans de Fès découpent le carreau individuel de zellij après la cuisson, à partir d'un grand panneau émaillé, Les avantages de la technique de Fès résident dans la vitesse de fabrication et l'ajustement beaucoup plus précis des bords de panneaux finis (cf. Erzni 1993b, 174).

Découpés et assemblés selon les techniques chères à l'école de Fès, les pièces de zellij sont omniprésentes dans l'architecture de la médina médiévale et dans les *qasbas* de Mūlāy Isma'īl (XVII^{e}-XVIII^{e} siècle), et interviennent dans le pavage des sols des vestibules, des couloirs, des cours des mosquées, madrasas et maisons, des salles de prière des mosquées, des salles d'ablutions-latrines, ainsi que dans le carrelage

Fig. 9. Vue du minaret de la Grande Mosquée de Meknès (cliché : A. El Khammar)
Fig. 10. Vue de la mosquée-zāwiya de Sīdī Qaddūr al-ʿAlamī à Meknès (cliché : A. El Khammar)

des marches d'escalier et des terrasses. Son emploi est également attesté dans le revêtement des lambris des murs, des piliers, des quatre façades des minarets (Fig. 9 et 10), et des piédroits des portes d'entrée. Les panneaux de zellij servent également de support pour l'excision des inscriptions historiques ; celles-ci sont découpées selon la technique du zellij excisé ou champlevé qui consiste à écorcher au burin des carreaux monochromes (Fig. 11 et 12).

Les schémas repérés dans les monuments étudiés sont agencés par l'assemblage de pièces de différentes couleurs. Les compositions décoratives peuvent paraître très complexes et témoignent non seulement d'un sens inné de la géométrie plane, mais d'un réel talent de compositeur. Toute la décoration est abstraite à l'instar de celle qui existe dans la quasi-totalité des monuments islamiques : les motifs taillés sont assemblés suivant les règles et les schémas d'une décoration stylisée et schématisée. Selon la théologie musulmane, Dieu est le seul créateur et ne peut admettre de rivaux, et de là vient l'interdiction des idoles et des images créées par l'homme, et le recours, en revanche, à des motifs abstraits : géométriques, floraux et épigraphiques (pour plus de détails sur les principes de la décoration islamique, et sur les schémas géométriques omniprésents dans le zellij de l'architecture islamique marocaine, voir respectivement Grabar, 1987, Critchlow et Marchant, 1993, 203-229).

Les compositions décoratives sont nombreuses et variées dans ces édifices et se présentent comme suit :

Fig. 11. Inscription coranique champlevée dans une plaque de zellij à tonalité noire ; elle est inscrite dans un encadrement rectangulaire à base d'un entrelacs d'étoiles polygonales : façade sud de la cour de la madrasa al-Bū'nāniya à Meknès (cliché : A. El Khammar)

Fig. 12. Inscription historique excisée dans une plaque de zellij de couleur noire : Partie supérieure de la porte de Bāb Mansūr la'laj à Meknès (cliché : A. El Khammar)

– Pièces rectangulaires de terre cuite (15x5 cm) disposées en chevrons (*bajmāt*) (Fig. 13).
– Schéma en carrés (10x10 cm) : il est utilisé surtout dans le pavage des sols et des marches d'escalier (Fig. 14).

Fig. 13. Pavage en pièces rectangulaires (15x5 cm) de zellij disposées en chevrons (*Bajmāt*) : Cour de la madrasa al-Bū'nāniya à Meknès (cliché : A. El Khammar)

Fig. 14. Pavage en pièces carrées de terre cuite (10x10 cm) : escalier supérieur de la madrasa al-Bū'nāniya à Meknès (cliché : A. El Khammar)

– Composition en *Shghal bān* (ouvrage transparent) : elle est constituée par la répétition d'un décor de pièces octogonales dont les quatre côtés sont occupés par de petits carrés étoilés (Fig. 15).

Fig. 15. Ouvrage transparent (*Shghal bān*) : Pièces octogonales (*Kūra*) bordées aux quatre côtés par des carrés étoilés (pavage du vestibule d'entrée de Fondouk al-Hanna à Meknès) (cliché : A. El Khammar)

Fig. 16. Schéma en petits carrés étoilés (5,5x5,5 cm) : Pavage de la salle de prière de la madrasa al-Bū'nāniya à Meknès (cliché : A. El Khammar)

– Schéma en carrés étoilés polychromes (*mjaddaj 'alā harfū*).
– Schéma en petits carrés étoilés : il est fait de pièces carrées (5.5x5.5 cm), disposées sur leurs bordures (Fig. 16).
– Combinaison géométrique en *mdawdab balqtīb maqsūm baldrihm* : elle est faite de carrés (10x10 cm) disposés sur la pointe, bordés par de petits carrés (5.5x5.5 cm), disposés également en pointe (Fig. 17).

– Schéma en *mdawdab balqtīb walkhātam* : il correspond à des carrés disposés en ligne, et des étoiles à huit pointes (*khātam al-slīmānī*) (Fig. 18).
– Schéma à base d'étoiles à 12, à 16 ou à 24 branches.

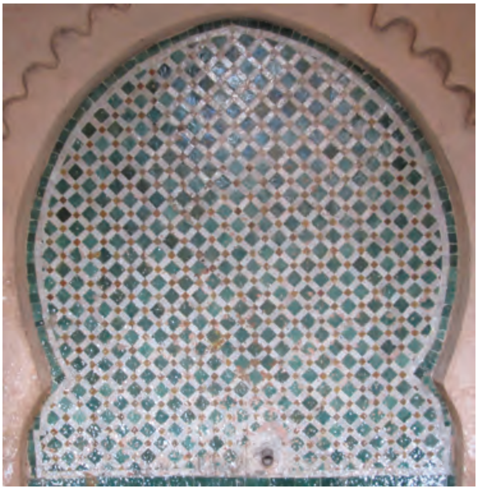

Fig. 17. Schéma en carrés étoilés (10x10 cm) bordés sur les quatre côtés par des petits carrés étoilés (5,5x5,5 cm) (*mdawdab balqtīb maqsūm baldrihm*) : fontaine murale (saqqāya) de Sīdī Qaddūr al-'Alamī à Meknès (cliché : A. El Khammar)

Fig. 18. Carrés disposés sur leurs pointes délimités sur les quatre côtés par des étoiles à huit pointes (*mdawdab balqtīb wa Lkhātam*) : Pavage de la cour de la mosquée al-Zaytūna à Meknès (cliché : A. El Khammar)

En guise de conclusion, le présent travail s'est proposé d'étudier le zellij de Meknès selon une approche bidimensionnelle, conciliant les données de l'archéologie avec celles de l'ethnoarchéologie. Il tente de combler – dans la mesure du possible – un vide documentaire, dû à la rareté des recherches relatives à ce sujet. Il nous a permis d'approfondir nos connaissances sur plusieurs aspects touchant au métier de zellij à Meknès, et de bien comprendre les multiples usages de la marqueterie de céramique dans l'architecture médiévale et post-médiévale de Meknès. Les enquêtes menées sur le terrain prouvent bel et bien que l'école de zellij de Meknès ne s'inscrit guère dans la tradition almohade, ni dans tendances artisanales de la ville de Tétouan, mais reprend plutôt l'héritage de l'art mérinide dont le centre est situé dans la ville de Fès.

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LA MOSAÏQUE FIGURÉE DE VOLUBILIS : BANALITÉ OU ORIGINALITÉ ?

Zahra Qninba et Bidaouia Belkamel

Résumé
Bien que les sujets traités dans les pavements figurés de Volubilis réfèrent au répertoire connu dans le monde gréco-romain, elles se distinguent par le choix des compositions et par la diversité des sources d'inspiration des mosaïstes volubilitains qui ont montré une grande originalité dans le traitement de thèmes très connus par ailleurs.

Les mosaïques de Volubilis, contrairement à celles des autres sites de la Tingitane, sont pour la plupart *in situ*, ce qui les expose aux intempéries et les rend vulnérables. Elles doivent donc retenir l'attention des restaurateurs. Si la reconstitution de la mosaïque géométrique est en général assez aisée, il n'en est pas de même des pavements figurés. C'est pourquoi ces derniers doivent être consolidés en priorité. Ceux-ci traitant des thèmes « banals », puisés pour la plupart dans le répertoire de la mythologie gréco-romaine, mettent en scène des divinités principales, secondaires et des héros.
Le constat qui vient d'être présenté donne l'impression que le répertoire mythologique volubilitain est assez riche. Il ne reflète pas entièrement la réalité de la mosaïque volubilitaine. Les mosaïques mettant en scène des divinités principales sont au nombre de huit :

– Cinq d'entre elles concernent Dionysos qui se retrouve dans les maisons de Vénus (Thouvenot 1958, 49-86), de Dionysos et les Quatre Saisons (Fig. 1) (Etienne 1951, 93-118 ; Belkamel 1986), de Flavius Germanus, du Cavalier (Thouvenot 1945b, 146-155) et à l'Ephèbe (Thouvenot 1945a, 114-131).
– Deux sont relatives à Diane qui figure dans la Maison de Vénus (Rebuffat 1965, 193-218) et dans celle du Bain de Diane (Fig. 2).

Fig. 1. Dionysos et les Quatre Saisons, maison homonyme, Volubilis (cliché : Med Benhaddou)

Fig. 2. Bain de Diane, maison homonyme, Volubilis (cliché : Centre Henri Stern)

– Le huitième pavement concerne Vénus (Fig. 3) qui ornait le triclinium de la maison homonyme et qui est actuellement exposé au musée de la Casbah à Tanger (Thouvenot 1977, 37-52).

Quant aux dieux de la première génération, ils sont représentés par Océan (Fig. 4) dont la tête orne une des parois externes du bassin de la Maison des Néréides (Thouvenot 1936, 25-36). Les divinités secondaires en tant que personnages centraux figurent dans quatre pavements :

– Les Néréides (Fig. 5) se retrouvent deux fois. Elles ornent le bassin de la maison homonyme (Thouvenot 1936, 25-36) et le triclinium de la Maison à l'Ephèbe (Thouvenot 1945a, 114-131).
– Le Triton figure devant le triclinium de la Maison d'Orphée (Qninba 1988),
– Les Amours donnant à manger aux oiseaux, ornent la pièce 9 de la Maison de Vénus (Thouvenot 1958, 49-86).

Le nombre des divinités secondaires qui sont associées aux dieux principaux est plus important. Ainsi les Amours, les Tritons, les Tritonesses, les Grâces et les Néréides accompagnent Vénus ; Les nymphes accompagnent Diane alors que les Saisons, les Ménades, les génies des Saisons, Méduse et Némésis figurent dans

Fig. 3. Vénus, maison homonyme, Volubilis (cliché : Centre Henri Stern)

Fig. 4. Océan, Maison des Néréides, Volubilis (cliché : Centre Henri Stern)

Fig. 5. Néréides, maison homonyme, Volubilis (cliché : Centre Henri Stern)

le pavement de Dionysos et les Quatre Saisons. Quant aux centaures, ils sont présents dans les panneaux secondaires de la mosaïque des Néréides et Triton, dans ceux de la mosaïque d'Orphée. Les personnages héroïques sont au nombre de six : Hylas et Orphée figurent chacun dans un pavement, Ganymède et Hercule occupent le même pavement alors qu'Ariane figure avec Dionysos, et Actéon avec Diane. Il ressort donc que le nombre des héros et des divinités secondaires dépasse largement celui des divinités principales. Cependant, ces dernières constituent les personnages centraux de huit pavements, alors que seuls quatre pavements présentent des divinités secondaires et trois des figures héroïques en tant que personnages centraux. Notons à propos de la mosaïque volubilitaine, que la figure féminine est omniprésente en tant que déesse principale, secondaire et en tant qu'héroïne. Ceci est probablement dû au fait que la femme a toujours exercé une attraction sur les dieux et les mortels. Elle est d'ailleurs représentative de toutes les catégories de femmes : les farouches (Diane), les légères (Vénus), les épouses légitimes (Ariane) et les besogneuses (Grâces, Saisons, etc.). Par ailleurs, elles sont liées à l'eau d'une

manière ou d'une autre. Vénus, par exemple, trône dans un vaisseau en pleine mer et Diane prend son bain dans un bassin. L'eau est le symbole de la fertilité qui est une des qualités attribuées à la femme. Celle-ci est représentée également sous une autre facette ; celle de la femme fatale qui représente le pouvoir maléfique illustré par la métamorphose (transformation d'Actéon en cerf par Diane) et le rapt (enlèvement d'Hylas par les nymphes).
De ce qui précède, nous voyons que les mosaïstes volubilitains ont privilégié les thèmes courants, mais se sont-ils contentés de copier servilement des modèles quelconques ou ont-ils, au contraire, fait preuve d'originalité dans le traitement de leurs sujets ? Nous répondons à cette question par le biais des mosaïques suivantes : Dionysos et les quatre Saisons, Hylas et Orphée.

Dionysos et les quatre Saisons (Fig. 1)

La mosaïque de Dionysos et les quatre Saisons orne le triclinium de la maison homonyme. La construction de celle-ci remonterait au plus tôt à la fin du II^{e} siècle (Etienne 1960, 41 ; Rebuffat 1965-66, 239-240). Elle est en U + T. Ce sujet figure dans une composition en quadrillage de cercles et de fuseaux tangents en lacis de tresses à deux brins déterminant quatre octogones concaves réguliers (Balmelle *et al.*1985, pl. 150 c, d et f.). Cette mosaïque présente l'avantage de la diversité des figures :

– Les médaillons ovales portent les images des poissons, des oiseaux aquatiques et des mollusques.
– Les médaillons circulaires sont ornés d'une double représentation des Saisons, en bustes féminins et en génie.
– Les médaillons octogonaux, au nombre de quatre, présentent chacun une figure différente. Celui du fond de la pièce présente une Ménade jouant du tambourin tout en dansant. Le second montre un personnage masculin debout s'appuyant sur un autel de son coude gauche d'où pendent les pans de son drapé. Sa main droite est posée sur sa hanche. Sa tête est ceinte d'une couronne de pampres. Il s'agit de Dionysos. Le troisième octogone présente une Ménade en marche qui joue de la double flûte. Et le dernier octogone est occupé par un personnage assis sur un rocher ; de sa main droite il touche une paroi rocailleuse, de sa main gauche il tient le thyrse. Le drapé laisse voir son épaule droite, ses genoux et la partie supérieure de son corps. Les seins sont à peine soulignés contrairement au ventre proéminent. Le thyrse et la paroi rocailleuse indiquent qu'il s'agit de Dionysos dans l'île de Naxos.

Dans cette mosaïque Dionysos apparaît dans deux positions différentes :

1. Il s'appuie sur un autel ; attitude qui se retrouve plutôt en sculpture. Elle rappelle l'Apollon sauroctone de Praxitèle dont une des copies est l'Apollon Borghèse du musée du Louvre.
2. Il est assis seul ; quand il est assis, il figure plutôt entouré de sa femme et de son cortège. Cela est peut-être dû au schéma compartimenté qui fragmente la scène. Ainsi au lieu que ce soit le mosaïste qui regroupe tous les personnages dans la même scène, c'est au visiteur de le faire. Le même parti pris se retrouve dans la mosaïque d'Orphée (Qninba 1998, 183).

La représentation des Ménades reflète également une certaine singularité. En effet, l'une des Ménades est présentée jouant de la flûte qui est habituellement un instrument réservé aux Satyres. Cette particularité est assez rare en mosaïque. La Ménade qui joue de la flûte se retrouve sur un vase de la nécropole de Spina (Aurigemma 1960, pl. 22) et sur une peinture qui ornait les Thermes de Titus (79-81 ap. J.-C.) à Rome (Vellay 1901, 279). Ce n'est qu'à Cologne qu'on peut voir une Ménade jouant de la double flûte. Ce pavement présente, par ailleurs, un autre point commun avec le nôtre puisqu'il montre Dionysos assis.

Quant aux Saisons, elles accompagnent un grand nombre de dieux et héros. Mais c'est avec Dionysos qu'elles apparaissent le plus souvent. Il s'agit donc d'une association familière qui apparaît pour la première fois durant le règne de Ptolémée Philadelphe (285-242 av. J.-C.) (Hanfmann 1951, 82, 112 ; Foucher 1963, 129-137). Cependant rares sont les mosaïques qui présentent à l'intérieur du même tableau les Saisons en buste et en pied.

On note que les mosaïques volubilitaines ont particulièrement représenté Dionysos (Thouvenot 1948, 351-353) ; elles sont d'ailleurs datées de l'époque des Sévères, dynastie qui a fait de Dionysos et Hercule les dieux de la patrie (particulièrement Septime Sévère) (Belkamel 1986, 121)

L'intérêt de cette mosaïque réside dans le dédoublement de Dionysos auquel correspond celui des Saisons. Le choix de représenter Dionysos dans deux attitudes différentes n'est pas fortuit :

- Le Dionysos assis renvoie à son mariage avec Ariane.
- Le Dionysos qui s'appuie sur l'autel fait référence au dieu qui reçoit les fidèles et leurs dons. Cette dernière scène se rapporte au culte dionysiaque que les inscriptions de la Tingitane n'ont pas mentionné.

Les Saisons en double mettent l'accent sur l'idée du renouveau de la nature qui renvoie à l'idée de la résurrection et à celle de l'immortalité. Les Saisons en buste sont très fréquentes dans le monde gréco-romain, leurs attributs dans notre pavement sont typiques de l'époque des Sévères. Les génies des saisons quant à eux sont plus rares en mosaïque. Ils sont apparus pour la première fois au IIe siècle (Ben Mansour 2000, 59) dans les arcs de triomphe, les médaillons en bronze et les sarcophages (Hanfmann 1951, 215-220 ; Parrish 1977, 147-184 ; Belkamel 1986, 117). Leur apparition en mosaïque n'a commencé qu'au IIIe siècle (Hanfmann 1951, 180).

Hylas (Fig. 6)

Le sujet de l'enlèvement d'Hylas pave la pièce n° 16 de la Maison de Vénus. Le premier état de la maison daterait de la fin du Ier siècle de notre ère (Makdoun 1994, 280 ; et Benhaddou 2008, 21-22 pour les datations proposées pour la maison) ou le début du IIe (Rebuffat 1965-66, 239, note 29). Les mosaïques de la maison ont été posées durant le deuxième état de la maison daté d'avant la fin du IIe siècle (Rebuffat 1965-66, 238).

C'est une mosaïque en tapis juxtaposés en rallonge. Hylas y figure au centre, assailli par deux nymphes qui le tiennent par le bras et le menton. La scène est empreinte de violence transparaissant dans la position des bras et des jambes des personnages et l'hydrie lâchée dans l'eau par Hylas. Le paysage stylisé est évoqué par des arcs qui représentent les collines et un arbre à feuilles qui représente la végétation. La relation

Fig. 6. Rapt d'Hylas, Maison de Vénus, Volubilis (cliché : Centre Henri Stern)

nymphes/eau est soulignée par les plantes aquatiques qui ornent leurs cheveux. La nymphe de droite tient un vase d'où coule un filet d'eau qui évoque l'eau de source.

Le traitement de ce sujet diffère d'une mosaïque à l'autre. Quelques détails se retrouvent dans plusieurs tableaux dont le plus proche du nôtre est celui de Saint-Romain-en-Gal (Vienne) (Lafaye 1909, n° 224). Les personnages de ce dernier semblent inversés par rapport à celui de Volubilis qui montre la fin du rapt, alors que celui de Saint-Romain-en-Gal présente une séquence antérieure. D'ailleurs, le pavement volubilitain exprime mieux la violence de l'enlèvement par l'attitude des personnages, quoiqu'on pourrait reprocher au mosaïste de ne pas avoir montré les sentiments que devrait exprimer leur visage. D'autres détails marquent la différence entre les deux modèles. Outre l'attitude des nymphes, la végétation évoquée par les branches d'arbre à Volubilis manque à Saint-Romain-en-Gal et les pierres très présentes dans cette dernière sont à peine visibles à Volubilis.

Notons que le tableau d'Hylas constitue à Volubilis la partie centrale de la mosaïque qui présente deux petits tableaux traitant le châtiment d'Éros qui aurait tué un oiseau. Ce sujet humoristique évoque l'esprit caricatural qui distingue l'école alexandrine. Rappelons que ces deux tableaux ne sont pas l'unique exemple de ce genre de sujet dans cette maison : les mosaïques du chat et de la souris (perdue), la course de chars et les Amours donnant à manger aux oiseaux nous donnent une idée sur un des aspects de la personnalité du propriétaire qui semble posséder un grand sens de l'humour puisqu'à côté des sujets sérieux tels Vénus, Diane et Hylas, il choisit des sujets anecdotiques parodiant les scènes de cirque et d'amphithéâtre.

Orphée (Fig. 7)

Le thème d'Orphée charmant les animaux est très populaire dans la mosaïque gréco-romaine. Les pavements traitant ce sujet ont été l'objet de plusieurs classifications selon leur canevas (Guidi 1935, 110-143 ; Stern 1955, 40-77 ; Smith 1983, 315-328 ; Michaelides 1986 ; Qninba 1988, 57-86 ; Jesnick 1997 ; Qninba 1998, 181-202). En Maurétanie tingitane, seuls les fragments de Tanger (De Pachtère 1911, 112, n° 458 ; Chatelain 1935, 67-68 ; Ponsich 1966, 479-481) et le pavement de Volubilis le traitent. Ce dernier a attiré l'attention des chercheurs et des visiteurs en raison de son traitement. La mosaïque de Volubilis est en U + T. Elle orne le triclinium de la maison homonyme dont le premier état daterait du Ier siècle de notre ère (Thouvenot 1948, 45) et dont le remaniement serait antérieur à l'Arc de triomphe érigé vers 217 (Thouvenot 1941, 64-65).

Elle est traitée selon un schéma circulaire concentrique qui la place parmi les pavements du type III (Qninba 1998, 196-197) qui regroupe les pavements de Grande Bretagne et de Salone (Split) en Yougoslavie. L'éloignement géographique et chronologique des pavements de ce groupe ne permet pas de préciser l'influence des uns sur les autres. C'est pourquoi

Fig. 7. Orphée, maison homonyme, Volubilis (cliché : www.google.com.cy/ search?q = orphee + volubilis&source = lnms&tbm = isch&sa = X&ved = 0ahUKEwiYqZ6m_5TTAhUB1xQKHb-47Cf4Q_AUIBigB&biw = 1286&bih = 718&dpr = 1.25#imgrc = WdL-13ZPn6BP6M :)

la proposition émise par Kenner – suite à une communication présentée lors du 1er Colloque International sur la Mosaïque Antique (Picard and Stern 1965, 294) – qui consiste à envisager la possibilité de l'existence d'un modèle commun qui aurait inspiré toutes les compositions circulaires de Bretagne, de Salone et de Volubilis, nous a semblée pertinente. Nous pensons avoir trouvé ce modèle commun dans le décor des plafonds à qui ce genre de schéma convient parfaitement. Il se retrouve en Italie dès le I^er^ siècle de notre ère. Les exemples les plus proches proviennent de la Villa de Poppée à Oplontis et de l'Insula des Voûtes peintes à Ostie (Bianchi Bandinelli 1969, 293, fig. 335). Cette dernière présente beaucoup d'affinités avec la composition de Volubilis ainsi que le pavement des Thermes d'Otricoli (Picard 1983, 307) qui reflète une voûte. Ces deux exemples proviennent d'Italie, il n'est donc pas exclu que la source d'inspiration du schéma de notre pavement provienne de cette province.

D'autres éléments du pavement volubilitain se retrouvent ailleurs. Orphée apparaît dans un certain nombre de mosaïques à l'intérieur d'un cadre. Les cadres circulaires et octogonaux sont plus répandus alors que la forme carrée est la moins fréquente (Qninba 1998, 184, notes 10-12). L'Orphée de Volubilis apparaît dans un octogone tout comme celui de Winterton (Stern 1955, 76 n° 42 ; Smith 1983, 321, n° 7, pl. CCVII). Il est vêtu à la grecque comme ceux de Salone et d'Yvonand (Suisse) qui sont datés du début du III^e^ siècle (Qninba 2007, 106). Sa lyre de forme arrondie appartient également au monde grec (Qninba 2007, 109). L'Orphée grec est très peu répandu en mosaïque. De plus, il semble limité à la partie nord de la Méditerranée. L'Orphée de Volubilis représente donc un cas particulier. Les animaux qui figurent avec notre personnage ne sont ni les mêmes, ni au même nombre dans les différentes mosaïques : certains d'entre eux sont familiers de la scène (comme le lion, les cervidés, le cheval, le taureau, l'ours, l'éléphant, la panthère) et se retrouvent à Volubilis. D'autres sont plus rares tels les griffons (Qninba 2007, 110-112). Les oiseaux toujours présents sont plus ou moins nombreux selon les cas. A Volubilis ils sont 32 et se caractérisent par le fait qu'ils soient tous perchés sur les branches d'arbres, même le paon (Qninba 2007, 112-113).

L'arbre est – à quelques exceptions près – présent dans toutes les mosaïques traitant ce thème. Cependant la mosaïque de Volubilis présente ses arbres d'une manière qui lui est propre. Les arbres y jouent le rôle d'élément de compartimentation et leurs branches se mêlent pour envelopper le héros ; comme si le mosaïste volubilitain a cherché à illustrer une partie du tableau que Philostrate le Jeune a admiré à Naples : « se joignant comme deux mains entourant Orphée » (*Imagines* 6, 10-15). La mosaïque de Volubilis présente non seulement un schéma inhabituel en Afrique du Nord, mais, en plus, elle accentue son originalité en employant les arbres comme instrument de compartimentation. Ils s'inclinent vers Orphée pour illustrer le fait que ce héros charme même la nature. Le mosaïste de Volubilis a fait preuve de beaucoup d'originalité en variant ses sources d'inspiration, mais c'est l'utilisation ingénieuse des arbres qui a conféré au pavement volubilitain son originalité.

Les mosaïques de Volubilis présentent des thèmes courants inspirés pour la plupart de la mythologie gréco-romaine ; il n'en reste pas moins qu'elles présentent des caractéristiques qui les distinguent tels le choix des compositions qui est assez particulier et la multiplication des sources d'inspiration, ce qui confère aux tableaux volubilitains leur originalité. En outre, Orphée est en relation avec Dionysos. Le lien de ces deux personnages à la nature est particulier à Volubilis. Quant à Hylas, sa relation avec Hercule évoque non seulement les aventures des Argonautes, mais, également, les exploits d'Hercule en Tingitane.

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LA CONSERVATION DES MOSAÏQUES DE CHELLAH (RABAT, MAROC)

Hicham Rguig, Hakim Ammar et Meriem Hansali

Résumé

Cet article analyse l'état de conservation des mosaïques de Sala et met en lumière les principales causes d'altération et les facteurs de détérioration les affectant. Nous nous y attachons également à développer le processus des différentes interventions ayant intéressé ses pavements pour garantir, autant que faire se peut, leur préservation *in situ*. Ce projet de conservation ambitionne de déboucher sur un programme de restauration et de mise en valeur de ces mosaïques.

Introduction

Le projet intitulé la « Conservation des mosaïques de Chellah » a vu le jour en juin 2010 à notre initiative, avec pour ambition de sauvegarder, de protéger et de mettre en valeur les mosaïques du site. La réalisation, en cours, du dit projet coïncide avec la soumission du dossier de candidature de la ville de Rabat, dont le site de Chellah constitue l'une des pièces maîtresses, pour son inscription sur la liste du patrimoine mondial de l'UNESCO (classement depuis le 29 juin 2012).

Il est à noter que ce projet est soutenu par l'administration chargée de la gestion du site, la Direction du patrimoine culturel (Ministère de la Culture au Maroc) et par le Getty Conservation Institute.

Chellah et ses mosaïques

Le site de Chellah est sis en amont de l'embouchure sur la rive gauche du fleuve Bouregreg à environ 2 km au sud-est du centre-ville de Rabat. Ce site est densément urbanisé en raison des phases d'occupations multiples et successives qu'il a connues (maurétanienne, romaine et islamique). Aussi, durant chacune de ces phases, les urbanistes ont érigé plusieurs édifices de différentes configurations architecturales (Fig. 1), lesquels devaient répondre aux besoins des populations en matière d'hydraulique (cf. Ammar 2007), d'artisanat (Ammar et Hansali 2011, 203-211 ; Hansali 2012), d'économie, de politique, de religion...

Chellah possède une riche collection d'éléments de décors architecturaux, dont beaucoup sont déposés dans ses réserves. Des mosaïques mises au jour lors des fouilles entreprises au cours du XX^{e} siècle sont encore *in situ*. Leur découverte n'a pas toujours été accompagnée d'inventaire ou de notes de terrain ; leur attribution à un contexte archéologique précis n'est donc pas toujours facile. Cela étant dit, la description des mosaïques de Chellah et la reconstitution du cadre archéologique, dans la mesure du possible, de certaines d'entre elles, constituent les premières réalisations

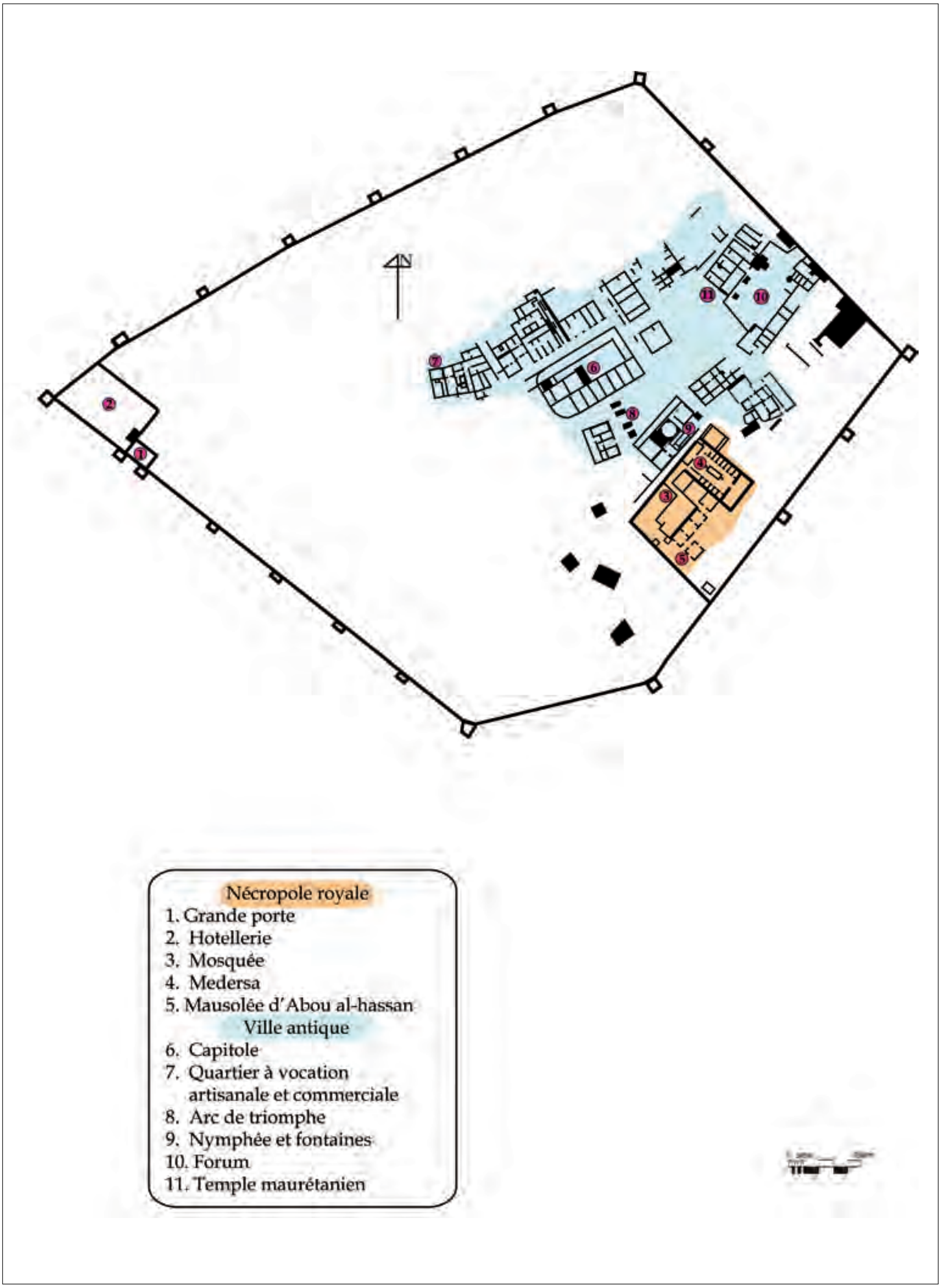

Fig. 1. Le site historique de Chellah, plan d'ensemble (copyright : Conservation des sites archéologiques de Chellah et des Oudayas)

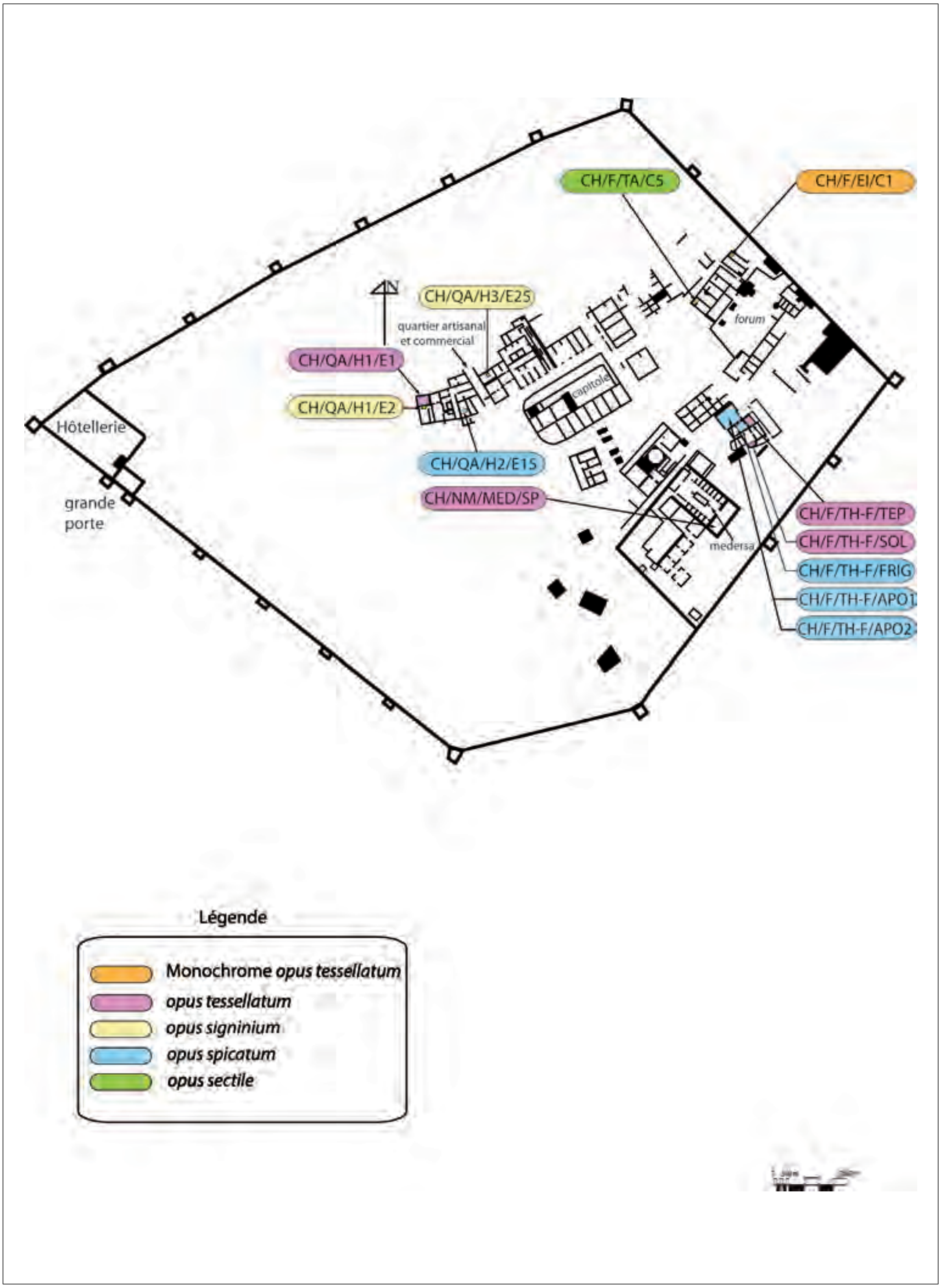

Fig. 2. Répartition et typologie des mosaïques de Chellah (copyright : Conservation des sites archéologiques de Chellah et des Oudayas)

du projet (Fig. 2). Comparée à Volubilis, à Lixus ou encore à Banasa, toutes abondamment décorées de pavements mosaïqués (cf. Qninba 2001, 132-146), Chellah, l'ancienne Sala, fait figure de ville « pauvre » car seulement sept pavements en mosaïque y ont été dénombrés, d'autant plus que ces mosaïques ne montrent qu'un décor simple : trames et bordures courante. De ce recensement, nous excluons les pavements en *opus spicatum*, nombreux à Chellah où ils étaient utilisés dans les espaces fortement sollicités et où une particulière solidité des sols doit être de mise ; ainsi que ceux en *opus signinum* utilisés bruts (béton de tuileau) pour la réalisation de certains sols comme pour les bassins et les citernes. N'est-ce pas paradoxal qu'une cité réputée comme une ville importante de la Maurétanie tingitane n'ait livré qu'un nombre réduit de pavements mosaïqués ? Sans remettre totalement en cause l'idée qui voit, entre autres, en la rareté des mosaïques dans une ville, le reflet d'une matière première qui faisait défaut ou d'une technique non acquise, nous pensons que c'est le problème de l'état de la recherche qui est là, à soulever. Sur les vingtaines d'hectares que compte la superficie présumée de la ville antique, seuls quatre ont été dégagés. Menées depuis la première décennie du XX^{e} siècle, les recherches archéologiques n'ont touché que le centre monumental avec ses édifices publics et religieux, et les nécropoles situées aux abords de la ville (Boube 2004). Plusieurs des composantes de la ville reposeraient encore sous terre, notamment la zone portuaire et celle résidentielle. Signalons à cet effet que J. Boube (1999, 16) déclare les avoir repérés sans toutefois donner plus de détails. Ainsi donc, notre bilan sur les mosaïques du site est à considérer avec prudence. Il est en effet subordonné à l'état de nos informations tirées d'une littérature lacunaire. Si ceci rend l'interprétation des données difficile et quelquefois aléatoires il permet, toutefois, de soulever un grand nombre d'interrogations ouvrant pour l'avenir plus d'une perspective de recherche. Nul besoin de rappeler que la découverte de la mosaïque s'associe généralement avec la fouille des quartiers résidentiels et des établissements thermaux. A Volubilis, par exemple, ce sont les maisons de maître, dans le quartier nord-est et celui de l'Arc de triomphe qui ont livré la majorité des mosaïques volubilitaines (Limane, Rebuffat, et Drocourt 1998, 20), alors que celles de Banasa proviennent des édifices thermaux, tels que les thermes aux fresques, pour ne citer que cet exemple. Pour sa part, Sala attendrait la découverte de sa zone résidentielle qui enrichirait le répertoire des pavements mosaïqués du Maroc. L'état actuel de la recherche archéologique ne suffit pas, à lui seul, à expliquer la rareté des mosaïques. Chellah, la nécropole islamique, repose sur une grande partie des vestiges de Sala, la ville antique.

Une découverte, qui date de 1961, illustre ce constat : une mosaïque antique dessinant de grands damiers blancs et noirs a été en partie retrouvée dans un sondage ouvert par le chercheur égyptien O. Othmane-Ismail (1978, 158), sous le mur sud-ouest de la salle de prière de la Medersa datant du milieu du XIV^{e} siècle. En somme, il paraît prématuré de tirer des synthèses d'ordre chronologique ou stylistique sur la base du peu de mosaïques recensées au Chellah. Nous nous permettons de rappeler la prépondérance, dans le site, des pavements à motif géométrique, à l'instar d'ailleurs des principales villes de la Maurétanie tingitane. Seuls quelques

Fig. 3. Fragments d'une mosaïque figurée découverte à Chellah en 1968 (copyright : Centre Camille Julian, MMSH, Aix en Provence, France)

fragments d'une mosaïque figurée polychrome, actuellement mis en dépôt, furent collectés en 1963. On y distingue une partie de la tête d'une néréide, le front parée d'un diadème, la partie inférieure d'un volatile et des éléments de bordures tels les lignes de triangle et les tresses à deux brins (Fig. 3). Nous ne possédons aucune indication sur l'emplacement originel de ces fragments à l'exception d'une mention de N. Khatib-Boujibar (1964, 367) qui a signalé leur découverte par J. Boube dans l'une des douze boutiques au nord du Capitole, sans toutefois préciser dans quel contexte archéologique ces fragments ont été retrouvés.

La carte des risques

Le second volet du projet a porté sur l'élaboration d'une carte qui a permis de préciser la répartition et le degré des risques qui menacent d'une manière générale le site et particulièrement ses mosaïques (Fig. 4). Cette carte, représentant un outil de travail indispensable pour tout plan de conservation, fut associée à une série de recommandations qui concernent les différentes phases de la gestion intégrale des risques (zones de dangers, degré de gravité, outils à mettre en œuvre pour diminuer les risques, prévention).

Cela étant dit, le risque de l'effondrement des structures est la menace principale qui affecterait les mosaïques en de nombreux endroits. Le cas des thermes du forum est, à cet égard, éloquent. En effet, plusieurs de ses murs ou ce qu'il en subsiste, menacent ruine, à cause de la dégradation liée à l'action conjuguée du temps et des hommes, ce qui présente aussi un danger pour les pavements mosaïqués qui tapissent certains espaces de l'établissement thermal. En outre, les précipitations causent annuellement une érosion dans plusieurs secteurs du site, dont la zone du quartier à vocation artisanale et commerciale, et celle du forum. Ceci est essentiellement dû à la configuration du site, édifié sur un terrain pentu vers le sud. Les coulées de boue affectent par conséquent plusieurs pavements mosaïqués. Des mesures de sécurité doivent donc être impérativement prises pour assurer la stabilité du terrain au niveau des zones à risque. Les espaces verts à l'intérieur de Chellah constituent, à leur tour, une menace pour les structures, en particulier pour celles qui se trouvent dans les secteurs nord-est et sud-ouest du site. Rien de plus alarmant que de voir par-

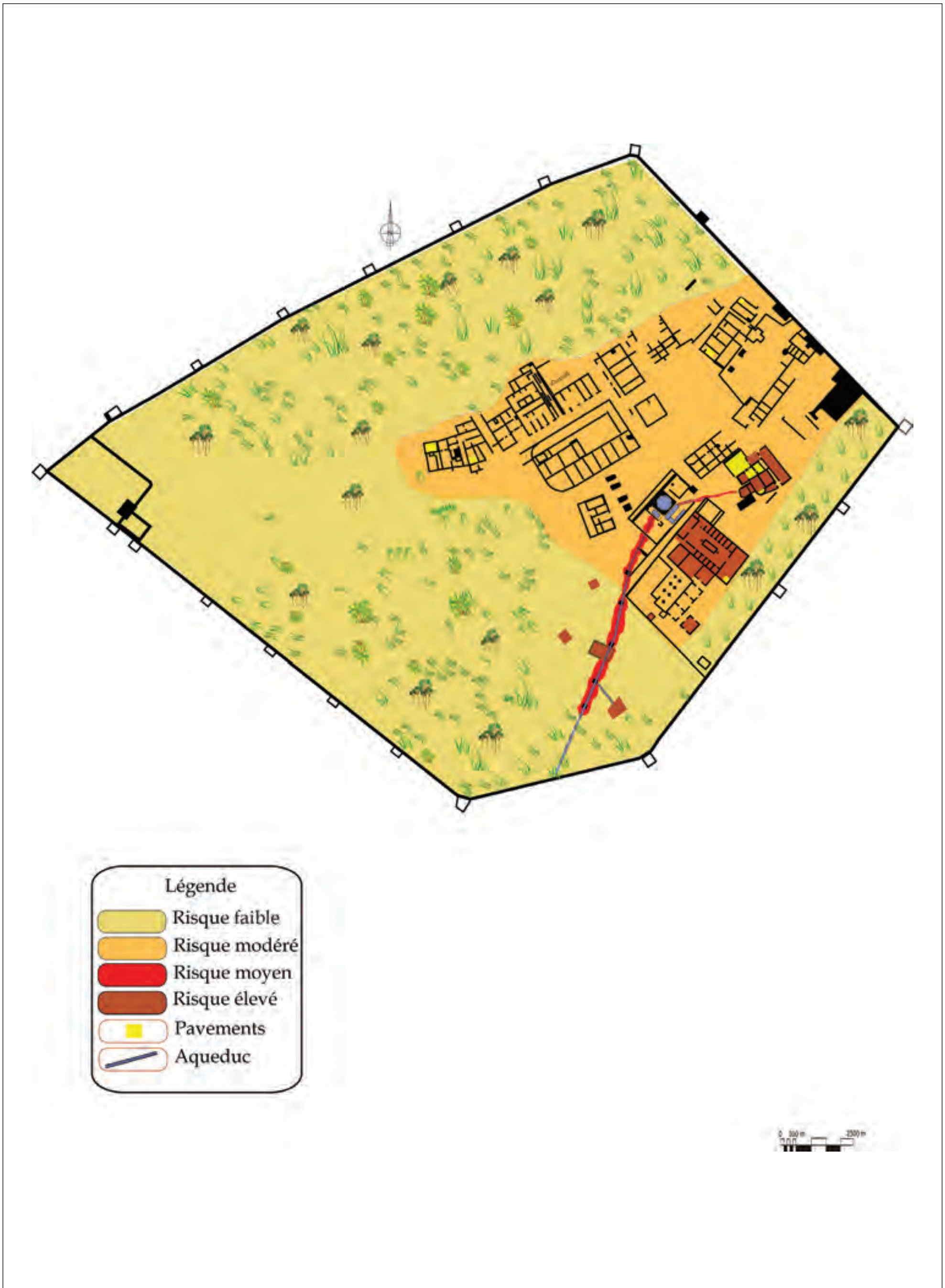

Fig. 4. Carte des risques menaçant le site de Chellah et ses mosaïques (copyright : M. Hansali et H. Ammar)

fois, des agents responsables du désherbage censés contribuer à l'embellissement et à la promotion du site en le nettoyant, prendre part à la destruction de celui-ci, au moyen de la méthode délétère qu'ils utilisaient pour sarcler le site et le débarrasser des mauvaises herbes et plantes sauvages. Cette méthode consistait à couper ces plantes, les amasser où bon leur semble et à les enflammer ; ce qui causait au moins deux fois par an, des départs de feu à l'intérieur du site. Il s'agit bel et bien d'une destruction sans appel, qui engendre la perte à jamais d'indices archéologiques. À ces facteurs de dégradation, s'ajoute un autre problème qui n'est pas de moindre importance ; il s'agit des remontées hydriques localisées dans certaines zones de la partie basse du site, ce qui engendre, d'une part, un sol regorgeant d'eau qui coule à faible profondeur menaçant ainsi certaines fondations et, d'autre part, des traces d'humidité visibles sur la partie inférieure de certaines structures. Ces dégâts sont dus essentiellement aux fuites d'eau découlant des fissures de l'aqueduc souterrain vieilli et détérioré en raison des vicissitudes du temps.

Enfin, la fréquentation touristique (cent mille visiteurs par an en moyenne selon les statistiques émises par l'administration du site de Chellah) en hausse constante constitue également une menace pour les vestiges du site, situé en plein cœur de la ville de Rabat, est alors considéré par les habitants, comme un espace de promenade et de détente, en particulier le vendredi et les jours de fête lorsque le site est accessible gratuitement. Seulement, aucun circuit de visite n'y est défini, laissant ainsi libre cours aux visiteurs d'« explorer » la cité. Les dommages imputables aux touristes sont aussi redoutables que les méfaits naturels. Ils vont des graffiti jusqu'à la destruction des structures et des pavements par piétinement ou encore par arrachement des tesselles, dans le cas des mosaïques. Ce sont, certes, des actes limités dans leur action, mais intensifs dans le temps. On ne saurait conclure ce volet sans mentionner l'impact néfaste des choix de certains chercheurs qui, au cours de leurs travaux sur le site, n'ont guère allié fouille et conservation des vestiges mis au jour. Dans les thermes du forum, le *tepidarium* a vu se détruire, vraisemblablement, à l'issue d'un ancien sondage de datation, la partie centrale de sa mosaïque supportée, autrefois, par les dalles recouvrant l'hypocauste à canaux.

État de conservation

En parallèle à l'évaluation des risques, un diagnostic a été réalisé afin de déterminer l'état pathologique des mosaïques. Notre projet a associé travail de terrain et outil informatique. Le premier a consisté à établir un diagnostic minutieux principalement basé sur l'observation, visant à relever l'état de conservation des pavements en identifiant les anciennes interventions de restauration et les dommages qu'elles ont subis. Une telle approche a permis de définir la détérioration structurelle des pavements ainsi que celle due aux facteurs biologiques. En complément à nos observations, une couverture photographique a été réalisée. L'outil informatique, quant à lui, intervient pour la traduction de ces données en plans· (Fig. 5).

Le plan de conservation

Les mosaïques de Chellah présentent une grande importance de par l'utilisation – à

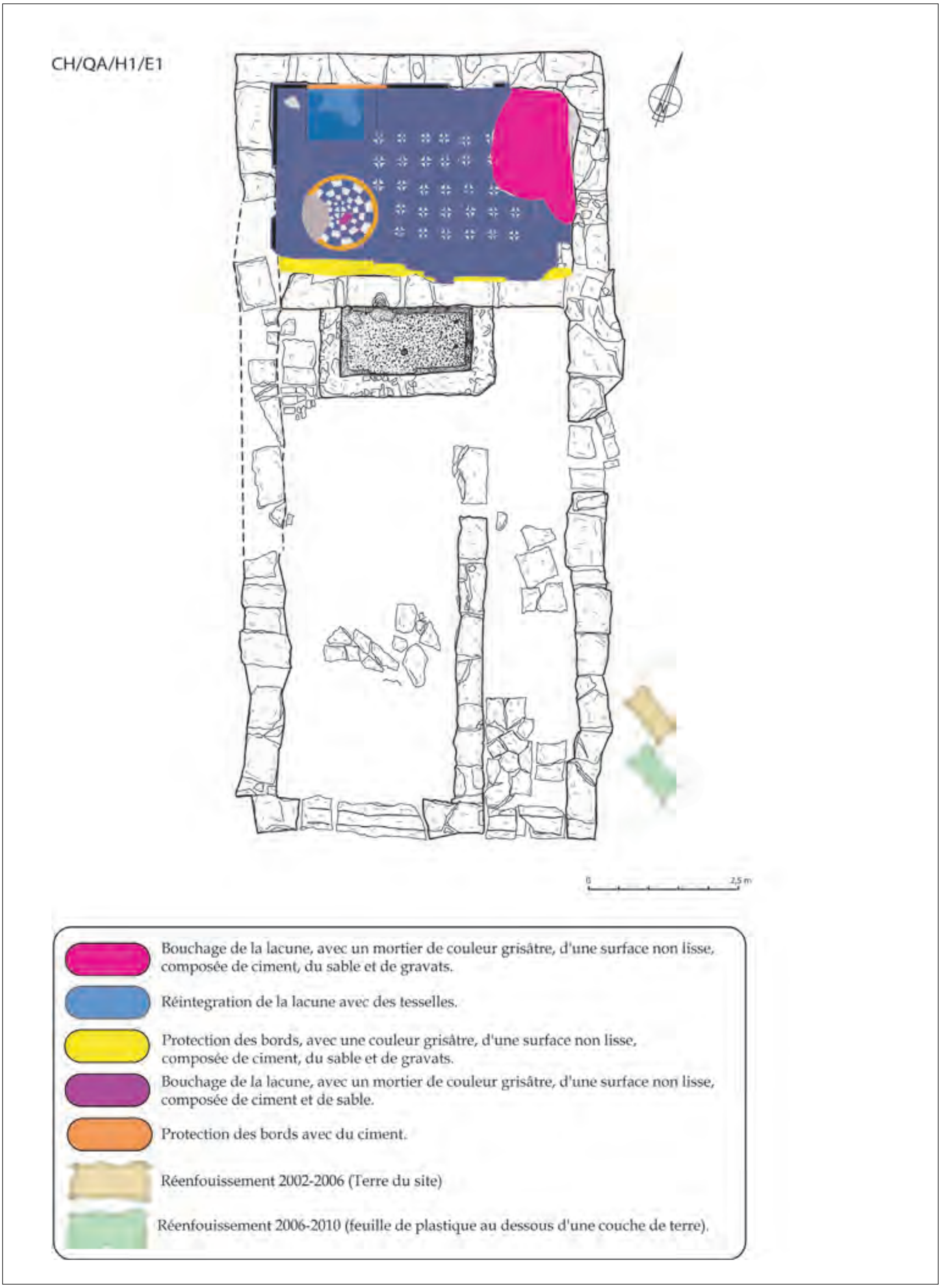

Fig. 5. Exemple de la documentation graphique réalisée lors de l'étude pathologique (copyright : M. Hansali)

notre connaissance – exclusive dans toute la Tingitane, des décors à trame blanche sur fond foncé (ici gris).

Notre démarche tient compte de cette valeur et vise à conserver *in situ* ces mosaïques en leur ménageant, autant que faire se peut, les conditions appropriées en vue de les préserver. Dans quelle mesure peut-on trouver un équilibre entre la hausse incessante des risques qui menacent les mosaïques attendu qu'elles sont fragiles et paradoxalement, un budget restreint, alloué au plan de conservation, ne permettant que des actions limitées ? En effet, ce plan de conservation relève la gageure d'associer nos efforts et ceux des responsables de l'administration, coordinateurs actifs, chargés de la gestion du site. Certaines de ces interventions revêtent un caractère d'urgence, alors que d'autres peuvent s'échelonner sur le moyen et le long terme :

1. Actions à court terme *:* deux mesures d'urgence ont été prises jusqu'à présent. Elles ont intéressé une mosaïque exceptionnelle (Ammar et Hansali 2015) qui a l'originalité de paver le sol d'un pressoir à huile, situé dans le quartier à vocation artisanale et commerciale de Sala et ce, en raison de son état de dégradation avancée. Celui-ci est imputable, entre autres, à son exposition permanente aux intempéries ainsi qu'aux piétinements des visiteurs, depuis sa découverte en 1967.
   - Une opération de réenfouissement a été réalisée en juillet 2010. Le travail s'est effectué en deux étapes : premièrement, une couverture réalisée avec des sacs en polypropylène tissé, et fixée sur les bords au moyen de planches épaisses en bois, a été étendue directement sur la mosaïque. « Cette bâche » fut recouverte d'une couche de sable lavé, épaisse de 10 cm, recouverte à son tour, d'une couche de terre ordinaire provenant du site et épaisse de 10 cm. Notre objectif est de mettre le pavement à l'abri des dégradations dues à la nature et aux agents extérieurs, tout en lui permettant de bénéficier d'échanges normaux de l'humidité et de l'air. Il s'agit d'une protection provisoire en attendant qu'une solution définitive soit trouvée pour sa conservation et sa présentation. À la lumière des inspections régulièrement menées, il s'avère que les résultats de ce mode opératoire, à caractère temporaire, sont probants.
   - La seconde mesure d'urgence consiste en la lutte contre l'érosion permanente dont souffre le quartier à vocation artisanale et commerciale puisqu'il est construit sur un terrain accusant une forte déclivité vers le sud. Sur les pentes aux alentours du pavement, nous avons implanté des ficoïdes (*Corpobrotus acinaciformis*), des plantes aux racines très fines, dont l'expérience, au Maroc, a montré l'efficacité dans la stabilisation des talus des autoroutes.

Cette expérience pilote au Maroc est une contribution expérimentale à la mise en place d'un procédé écologique, réversible et peu coûteux, qui pourrait être dupliquée sur d'autres sites à l'échelle nationale.

2. Actions à moyen et long terme : le projet devrait se poursuivre dans la deuxième moitié de l'année 2012 grâce

au soutien financier de la Direction du Patrimoine Culturel et du Getty Conservation Institute. La prochaine mission sera axée sur les interventions techniques sur les mosaïques. Ces interventions se baseront sur une étude que nous avons effectuée sur les principes de restauration adaptés à chaque pavement, la nature et la qualité des matériaux et les techniques à employer, les modalités générales et les délais d'exécution, le coût évaluatif et enfin le planning prospectif des travaux. À la restauration des mosaïques se joindront un programme de maintenance et d'entretien à intervalles réguliers, un mode de présentation adéquat et une qualification du personnel du site qui sont inévitablement le gage du succès d'un projet de conservation.

Conclusion

Notre projet en cours ayant pour but de sauvegarder, de conserver et de mettre en valeur les pavements du site de Chellah se décline en deux plans d'action : le premier qui est prioritaire concerne la mosaïque tapissant la maie de l'huilerie H1 au vu de son état de dégradation avancée, le second quant à lui ambitionne d'intervenir sur les autres pavements du site afin de les consolider et assurer leur préservation. D'un autre côté, cette expérience, qui est l'une des premières en son genre au Maroc, a une visée prospective, tirer les meilleurs enseignements dans le but de les reproduire, sur l'échelle du site de Chellah, et sur celle du Maroc où la conservation des mosaïques est appelée à se développer.

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SESSION II: METHODS OF SURVEY AND DOCUMENTATION

THE AL-MAJDAL MOSAIC: DOCUMENTATION, STUDY, URGENT INTERVENTION, REBURIAL

Mohannad Al Taweel, Maher Jbaee, Nesreen Bouza and Alaa Hammoud

Abstract

This work at the Al-Majdal site was the second step of the Conservation and Management of Mosaics on Archaeological Sites course which was held in Tyre, Lebanon, 3-21 May 2010, and which was one of the MOSAIKON projects.

Al-Majdal is one of the villages of the Al-Swaida region of Syria, situated 18 km north-west of Al-Swaida city. It has been inhabited during various epochs particularly in the Roman and Byzantine periods, and it has many towers and well-preserved buildings and cisterns belonging to these periods.

The property containing the mosaic

This property is composed of a Roman basalt house containing two inhabited arched and roofed rooms and a long stable behind them. It is close to an archaeological complex, which consists of Roman and Byzantine buildings (Fig. 1). The mosaic room which measures 4×4 m is located at the west limit of the property and to the southwest of the two ancient rooms. It is a modern structure of basalt stones and cement blocks built on ancient foundations and roofed with sheets of corrugated iron, and was, until recently and before the mosaic was discovered, used as a barn (Fig. 2).

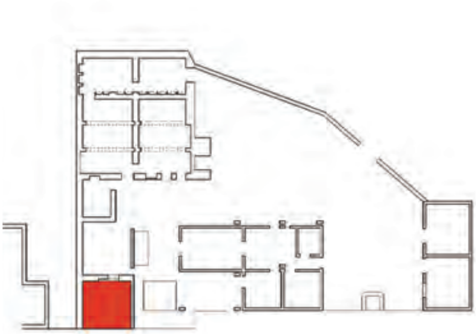

Fig. 1. Location and plan of the house (Google; Plan: Nesreen Bouza)

Fig. 2. The room of the mosaic (Photo: the team)

Previous information and documentations of the mosaic

The mosaic was discovered in June 2006 by the house owner. The Al-Swaida Museum documented it photographically only, and reburied it using soil mixed with sawdust. The mosaic remained in this situation until the 22nd of July 2007, when the excavation department of Al-Swaida Museum started to work by uncovering it again and digging around it. The team did not find any other mosaics on the south, east and north of the mosaic, while on the west side, the level of which is 2.70 metres higher, they did not reach the level of the mosaic. After finishing work they reburied the mosaic with the same materials (mixture of soil and sawdust). On the 10th of May 2010, the excavation department of Al-Swaida Museum uncovered the mosaic for the third time in order to study it and its condition, and buried it again using the same materials (Al-Swaida Museum 2007). On the 10th of October 2010, the DGAM formed a combined team from DGAM Damascus (Maher Jbaee and Nesreen Bouza) and the restoration department of Al-Swaida Museum (Mohannad Al Taweel) in order to study, conserve and rebury the mosaic. Furthermore, Alaa Hammoud took care of the logistics of the project. The team finished work on the 20th of October 2010 after carrying out all the urgent treatment and conservation, as well as the proper and regular reburial of the mosaic (Fig. 3). During the process, analyses were carried out by Basel Myhoub and Qasem Yehya in the chemical laboratory of the Syrian DGAM.

Fig. 3. The work team (Photo: the team)

Mosaic description

According to the Al-Swaida Museum, and despite the unfinished excavation in the private property to the west of the pavement, the mosaic could be a part of a Roman bath, given its subject (naked women) and water channel, which has been discovered near it and coming from a nearby pond to its west. In addition to this, we can also say that the use of small tesserae especially in the faces, and the precise execution is one of the most important characteristics of Roman mosaics. The decoration includes fluvial, animal, human and botanical themes, and the present dimensions of the mosaic are 3.75×3.30 m (Fig. 4).

About 50% of the mosaic survives and the major scene represents naked women. The mosaicist has arranged the persons in two parallel rows where we can see in the centre of the upper row a naked woman with black hair hanging down onto her shoulders. She is seated on a stool, her left hand supporting her left cheek, while her right hangs over her left knee. She is wearing an armlet and a bracelet on each hand, and an anklet on her left leg, all khaki-coloured and made of two rings. Her right foot has been destroyed. There are another two women on this register,

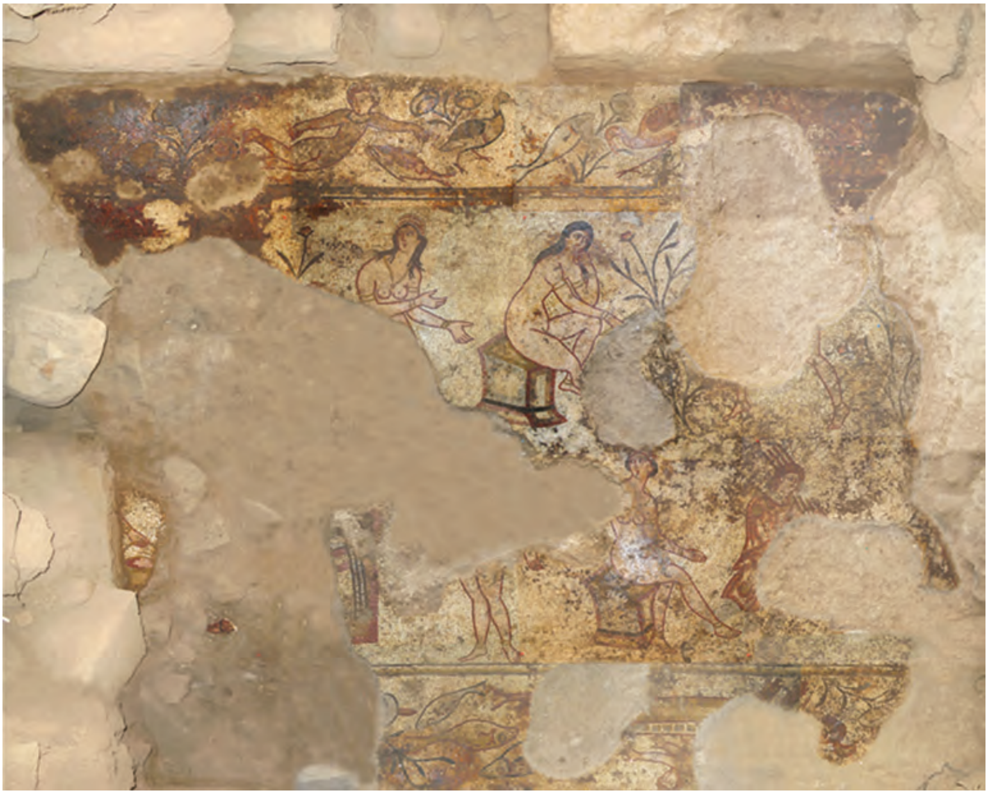

Fig. 4. The mosaic (Photo: the team)

and behind each there is a red rose on a long-branched plant. Only the legs of the woman on the right have survived, both of which wear a khaki anklet composed of just one ring. Her legs are parted, the right one extended forward, and the knees are flexed. Behind this woman, we note the left hand and forearm of a lost figure; with a bracelet composed of two rings. The palm is open and turned upward, and the elbow is flexed. Only the upper half of the second woman to the left survives. It resembles the seated woman in the hair which hangs down the shoulders and the bracelets and anklets she is wearing, but differs in that she is wearing a khaki necklace on her chest and a crown on her head. She stretches her open palms towards the sitting woman but looks in the opposite direction.

In the lower row of the scene, there is a woman seated on a stool similar to the one the woman in the upper row is seated on, crossing her legs (the right leg over the left) with the left hand half closed and half stretched forward. The woman resembles the previous seated woman in the bracelets and anklets she wears but differs in that she wears a large circular khaki necklace, and her hair is tied behind her head, which is decorated with a crown. She also differs in that she looks in the direction opposite to her body orientation.

Behind this, the legs and the open left palm is all that survives of the figure of another woman. She is standing and wears a khaki anklet composed of two rings on each leg. In front of the seated woman, we see a man wearing a long coat, which reaches down to his knees, and carrying something on his left shoulder. It seems clear, judging by the leg position (the right extended backward and the left flexed at the knee), that he is walking, distancing himself from the sitting woman. It seems that this man is the servant as he is carrying something on his shoulder.

In front of this man, we have discovered the upper half of another man, whose head is missing, wearing a long coat. We

Fig. 5. The northern and southern frames of the mosaic (Photo: the team)

Fig. 6. Typology, size, materials and colours of tesserae (Photo: the team)

can say that he is the master of the servant. In the middle of the far left of the scene, we have also discovered the left hand of a woman carrying a basket, ornamented with a khaki bracelet composed of two rings.

On the north and south of the main scene of the mosaic there is a frame reaching 50 cm in width and separated from the main scene by a band of five rows of tesserae (Fig. 5).

The northern frame represents a fluvial scene where we see a boy swimming. He wears a necklace, and on his left there are two fishes, a duck and what seems to be a heron, with several plants among them. The south frame also represents a fluvial scene containing what remains of the body of another boy. Here, however, judging by the movement of his hands and the shape that appears under him, which could be a boat, he seems to be fishing. In this fluvial scene, there are also three fishes, two plants and the anterior part of the body of a bird.

The pavement is made of *opus tessellatum* and the tesserae that have been used are of limestone, marble and red brick. They measure from 5 to 10 mm and are of various colours: white, black, yellow, red, rose, khaki, grey and coral (Fig. 6).

We bore a hole in one of the big lacunae of the mosaic in order to check its stratigraphy and discovered that this consists of *statumen*, *nucleus*, bedding layer and the *tessellatum* (Fig. 7).

Fig. 7. Stratigraphy of the mosaic (Photo: the team)

Fig. 8. Preparing the mosaic for photography (Photo: the team)
Fig. 9. Reassembling the photographs using Photoshop (Photo: the team)

Fig. 10. Documentation work (Drawing: the team)

Documentation

After cleaning the surface using just water and brushes, the mosaic was documented (Fig. 8) by photographing it from the same height, square by square, and then re-assembling the photographs using Photoshop (Fig. 9).

Condition Assessment

The documentation and poor images of the mosaic upon discovery had deprived us of much important information about the conditions of the room and its pavement. However, we can say that the recent use of the room as a barn for cattle put a lot of pressure on the surface of the mosaic. The rainwater that came down on the cor-

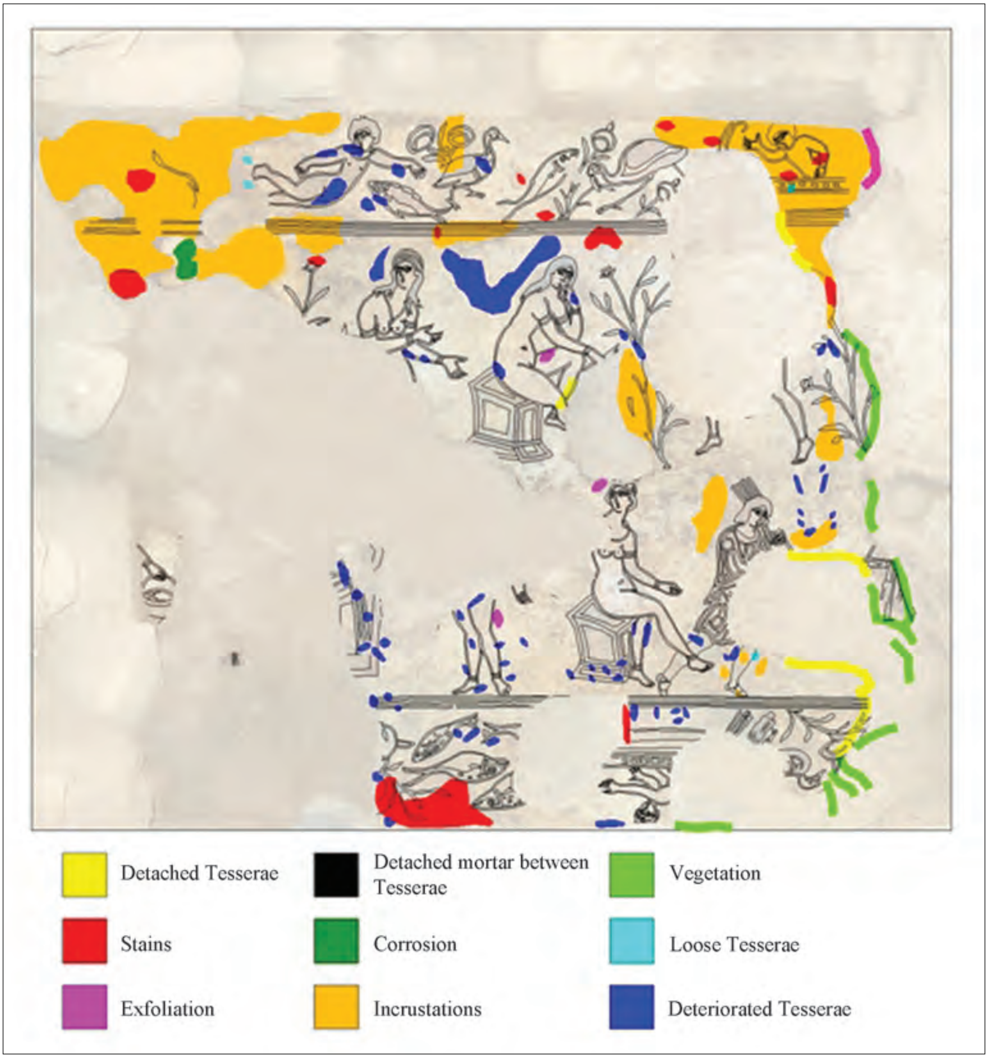

Fig. 11. Condition assessment-structural deterioration (Drawing: the team)

rugated iron shelter and iron pillars led to oxidation, and the oxidized water reached the mosaic surface through the soil layer which was mostly thin. In addition, the roots of a vine growing close to the room had entered through the walls and reached the preparatory layers in small areas at the eastern edges of the mosaic. We also have noticed a concentration of water in many parts of the mosaic especially in the northwest corner and it is clear that this is leaking from the property on the west, the ground level of which is 270 cm higher than the level of the mosaic. These bad conditions have caused many problems to the mosaic.

Fig. 12. Preparing the edges of the mosaic (Photo: the team)

1. Structural Deterioration
The mosaic contains many lacunae, estimated at about 50% of the general surface. Therefore, several important details of the scene have been lost. Some cracks have been noticed in the centre of the mosaic while only one bulge, in front of the head of the sitting woman in the upper register has been detected. We also noticed some depressions, especially in the northern frame, and some detachments, which concentrated at the edges of the mosaic especially around the lacunae.

2. Surface Deterioration
Some of the tesserae exhibited erosion and exfoliation and a few others have been lost (Fig. 10 and 11). There were also detached tesserae near the edges and, in a few areas, deteriorated mortar between the tesserae. Moreover, the surface has stains caused by the oxidized water mentioned above. But the main problems of the surface were the numerous damaged tesserae and the stains, which, with time, had often turned into incrustations, especially in the north-western and the north-eastern areas of the mosaic.

3. Biological Deterioration
The vine roots have caused detachment between the mosaic layers in some areas near the western edges of the floor.

The Intervention

1. Interventions carried out on the mosaic
We started by cleaning and preparing the mosaic edges in order to repair them using mortar (Fig. 12). Then, we prepared mortar that was composed of 1 part hydraulic lime, 1 part powdered limestone, ½ part yellow sand (grain size less than 4 mm), ¼ part volcanic sand (pozzolana) (grain size less than 6 mm) and ¼ part red sand (grain size less than 4 mm). For this mixture we took into consideration many factors, such as hardness, coherence, porosity, colour harmony and reversibility. Regarding our choice to use yellow, red and black (volcanic) sand, this was done in order to achieve harmony between the mortar and tesserae colours. The use of volcanic sand which is rich in minerals has given the mortar a good porosity and more rigidity. After that, we protected all edges of the mosaic, we filled the small lacunae and reset the detached tesserae using the same mortar (Fig. 13). We have found one detached piece of mosaic (the left open palm of the standing woman in the lower row of the panel), so we reset it using mortar composed of 1 part hydraulic lime, 1 part limestone powder and 1 part marble powder. Then, we cut the vine roots and covered them with petrol to prevent growth. Finally, we reburied the mosaic (Fig. 14) with a first layer of 20 cm of sieved sand free of salt. We then put a net as a separation layer and 25 cm of soil on top (we preferred to make the layers of reburial deeper in order to protect the mosaic in case of collapse of the walls) (Fig. 15).

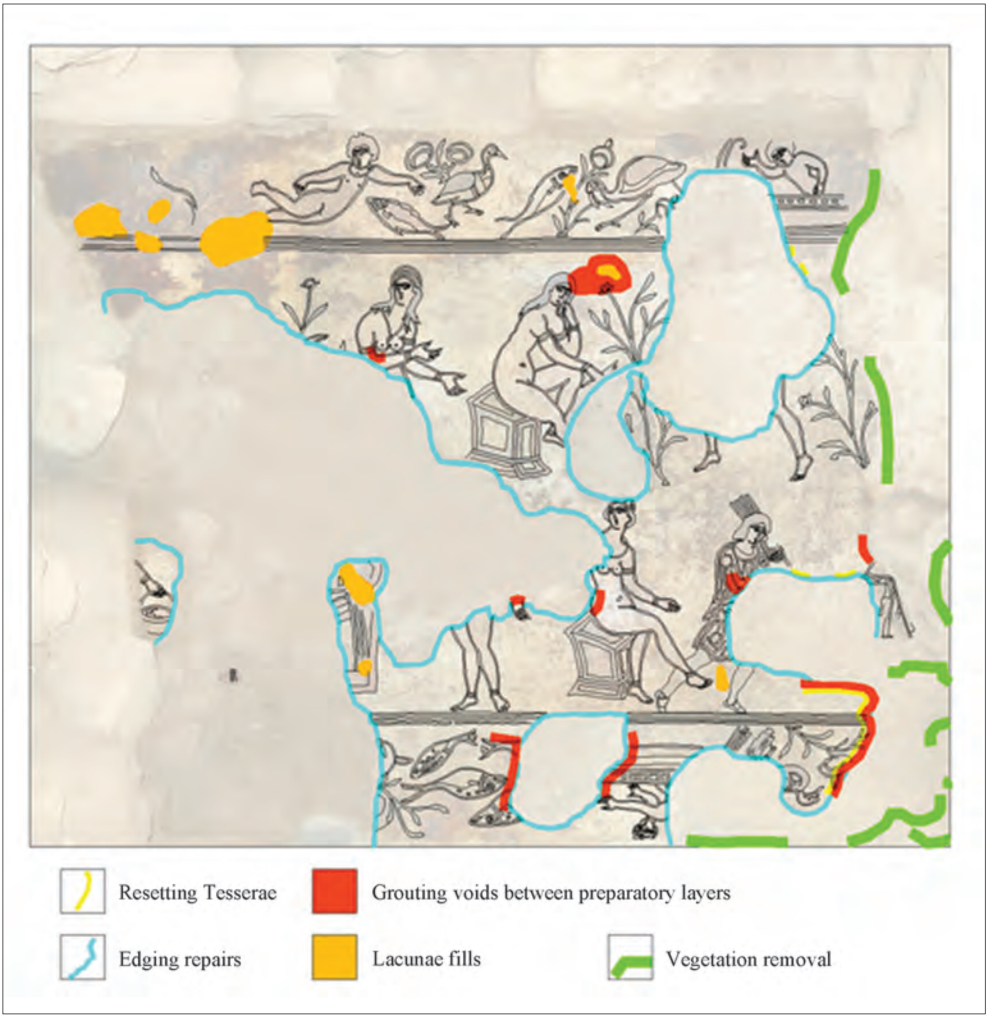

Fig. 13. Condition assessment-surface and biological deterioration (Drawing: the team)

2. Interventions carried out around the mosaic

We put a removable plastic cover on the corrugated iron shelter to avoid rain water from reaching inside the room as much as possible and we cut the vine, which is very close to the room, and covered it with petrol to make sure that it would not grow again.

3. Sample of incrustation for analysis

A small piece of mosaic has been removed for analysis in order to find out exactly what the incrustation layer consisted of. The XRF analysis has shown a large amount of iron and a small amount of calcium in the incrustation layer, and a large amount of calcium and a small amount of iron in the tessera itself (Fig. 16). The incrustation was then treated with carbon

Fig. 14. Reburial of the mosaic with sand (Photo: the team)

Fig. 15. Soil used as top layer of reburial (Photo: the team)

tetrachloride in order to solve any organic materials. Then an infrared spectrum analysis was done, which showed a complete identity between the spectrums of the sample and the pure carbon tetrachloride, and so the sample is free of any organic materials. So, we are certain that the incrustation was due to the oxidization that had come from the corrugated iron roof.

Recommendations

After we finished work on the mosaic, we prepared our report, which contained the following recommendations:

- Acquisition of the property that contains the mosaic, as well as the adjoining property to the west in order to continue the excavation in the area (possibility of discovering other mosaics and building remains).
- This mosaic needs an urgent drainage plan because water reaches it from the western side, where the ground level is 270 cm higher than the mosaic.
- The foundations of the lost original walls of this room limit the mosaic only on the north and south, whereas on the east and west sides the mosaic extends underneath the modern walls. These walls need to be removed in order to expose the whole mosaic.

Acknowledgments

Thanks are due to all the organizers and instructors in the MOSAIKON program for the information which we have got from the Tyre-Lebanon course and for their efforts, which helped us in this work.

Special thanks o to Dr Ammar Haidar, the manager of the scientific laboratory in the DGAM of Damascus for his support and supervision; and to Mr Basel Myhoub and Mr Qasem Yehya for carrying out the chemical analyses.

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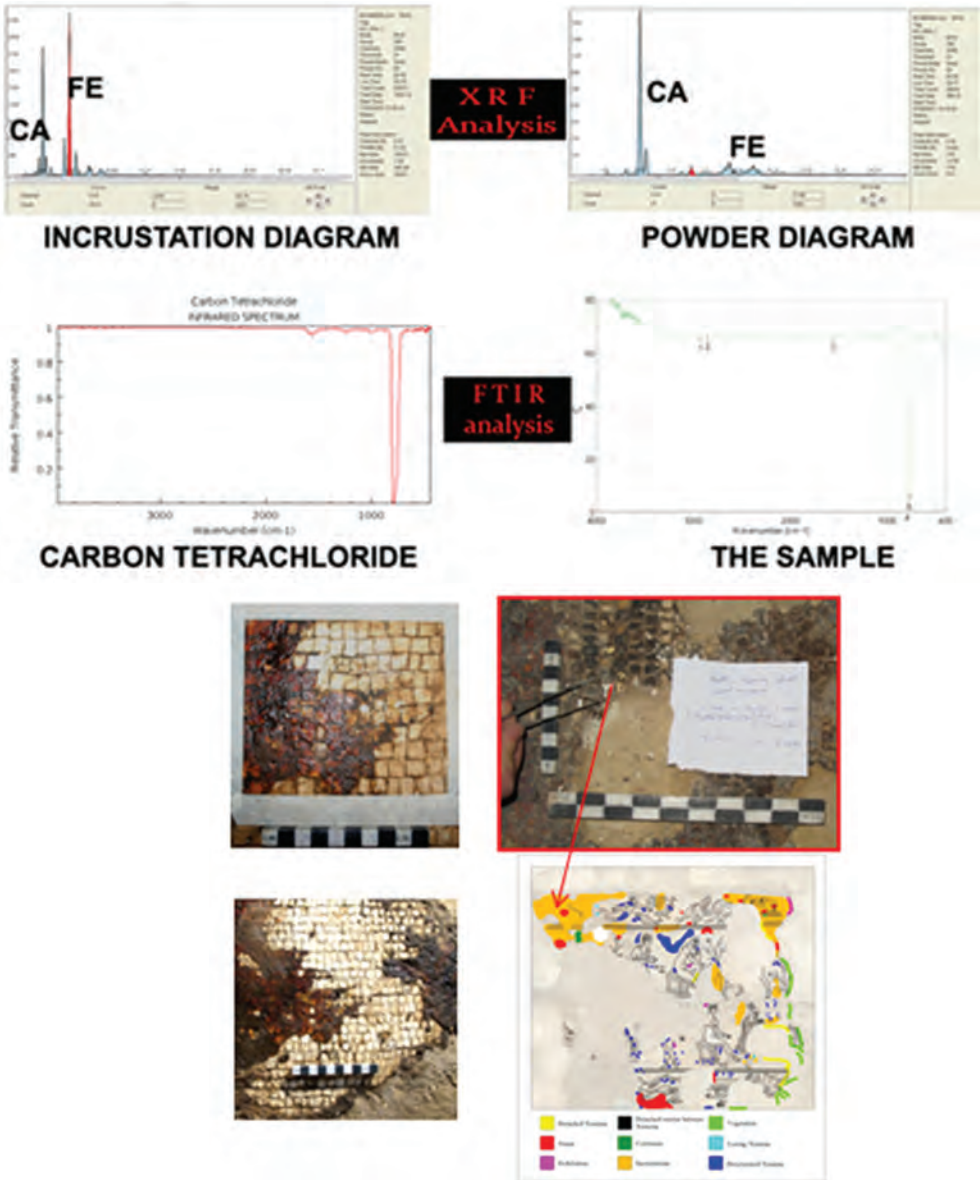

Fig. 16. Samples and incrustation analyses (Photo: the team)

Bibiography

Al-Swaida Museum, unpublished excavation report, 2007.

SURVEYING AS A MEANS FOR THE DEVELOPMENT OF A NATIONAL STRATEGY FOR THE CONSERVATION AND MANAGEMENT OF THE MOSAICS OF GREECE

Stefania Chlouveraki,
Maria Krini and Elisavet Anamaterou

Abstract

Two surveys, which examine the condition of lifted and in situ mosaics in Greece, are aiming to be the initial phase of long-term planning for the conservation of mosaics in Greece and the development of a national strategy. This paper reports the results of the first survey, implemented in 2010, concerning lifted mosaics that are stored and/or exhibited at Greek museums and storage depots. The survey was based on a questionnaire developed by ICCROM in the framework of the MOSAIKON program. The analysis of the data proves that the qualified staff that is currently employed by the museums and archaeological services is not analogous to the large amount of mosaics that has accumulated over several years of archaeological research. Furthermore, financial issues and the complexity of the administration system prolong the problems. A first account of the major problems that have been recorded through the survey, leads to a better understanding of the weaknesses that exist at operational /managerial level and gives insights for the development of strategies that are feasible and can be effective in preventing further damage to Greek mosaics, taking into account the administrative structure, as well as the human and financial resources that are available in the country.

Introduction

Mosaics are amongst the most outstanding form of cultural material for which Greece is renowned and several of them are linked to high visitor rates at Greek museums and sites such as the Hellenistic mosaics of Pella and Delos, or the Byzantine mosaics in Thessaloniki. The pebble mosaics or *opus lapilli* with organized compositions of geometric and pictorial designs appear in Greece in the middle of the 5th century BC, and are the earliest known examples of this form of art (Dunbabin 1990, 1, 5-17). Towards the end of the 4th century mosaics of exceptional pictorial quality were produced in Pella, the Macedonian capital, the finest examples of which are now exhibited at the museum of Pella (Lilibaki-Akamati *et al.* 2011). The mosaic tradition continued for several centuries in Greece and gave numerous examples of high quality mosaics such as the pavements of Delos and the wall mosaics of the Byzantine monastery of Daphni. Despite the long and continuing tradition of mosaic art in Greece there is no corpus of the Greek mosaics and therefore we do not know how many mosaics there are, where they are kept and what condition they are in. Nevertheless, there are some major publications, which give a detailed record of the mosaics of specific chronological periods, such as the three volumes of the corpus of the early Christian mosaics of Greece (Pelekanidis and Atzaka 1974; Asimakopoulou-Atzaka and Pelekanidou 1987; Asimakopoulou-Atzaka 1998) or single sites such as the mosaics of Delos (Bruneau 1972).

Lifting mosaics as a conservation method was common in Greece as in most Mediterranean countries. Some of these mosaics were reinstalled on site on new bedding while others were exhibited in museums. Furthermore, a large number of rescue excavations all over the country, led the majority of the mosaics found into storage. This resulted in the accumulation of a large number of lifted mosaics in the museums of Greece at a time that professional conservators and conservation recourses in the country were limited. Over the last two decades there has been a remarkable progress in the field of conservation in Greece, and especially on methodology and philosophical issues, and the general approach towards the conservation and protection of cultural heritage. Conservation professionals are now trying to highlight the problems and seek solutions. The conditions under which archaeology is practiced in Greece are also changing. An overview of recently undertaken initiatives and research projects, demonstrates that a more inclusive and public approach to the protection and management of archaeological heritage is adopted (Lekakis 2008; Sakelariadi 2008). The assessment and documentation of the condition of cultural material is today recognized as an essential tool for the development of a strategy that aims at the conservation and long-term protection of cultural property, which was the motive for initiating these surveys.

The present survey, undertaken by the Directorate for the Conservation of Ancient and Modern Monuments of Greece (DCAMM), is the first national survey which attempts the documentation and assessment of the lifted mosaics, and the first step towards the development of a strategy for their conservation. The survey was realized by means of written questionnaires, which were distributed to all the archaeological services and museums of Greece. The questionnaires, which were provided by ICCROM, were initially designed for the research undertaken in the framework of the MOSAIKON program (http://www.getty.edu/conservation/our_projects/education/mosaikon/). A second survey, currently (2011) in progress, explores the problems of the in situ mosaics, aiming at a first evaluation of the condition of the mosaics and of the prominent priorities in the field.

The Greek archaeological service management structure

Archaeological heritage management in Greece is regulated exclusively by the State. The so-called "Archaeological Service" was established in the public sector in 1833, just three years after the foundation of the independent Hellenic State in 1830, aiming at the protection of antiquities (Kokkou 1977, 70). This body is nowadays one of the major sectors of the Ministry of Culture and Tourism. Its structure is totally hierarchical, and it more or less retains its administrative system since the late 1970s (Sakellariadi 2008).

There are two General Directorates related to cultural heritage, the General Directorate of Antiquities and Cultural Heritage and the General Directorate for Restoration, Museums and Technical Works, which coordinate and supervise the works of the central, regional and special departments The Directorate of Conservation of

Ancient and Modern Monuments is one of the central services under the General Directorate of Antiquities and Cultural Heritage and it is engaged with the supervision of all conservation works conducted in Greece, either by the Ministry of Culture or by private bodies. The Regional Services, the so-called Ephorates, are specialized in three different chronological periods: there are 39 Ephorates of Prehistoric and Classical Antiquities (that is antiquities from the Prehistoric to the Hellenistic and Roman periods), 28 Ephorates of Byzantine Antiquities (from the Early Christian to the Post-Byzantine periods), 15 for Modern and Contemporary Monuments and several special services (underwater, caves, etc.). The majority of museums and all archaeological sites in Greece are run and supervised by one of the aforementioned regional services, except for eight major museums, which operate independently as special departments. The main advisory council and instrument for planning in archaeological policy is the Central Archaeological Council, which consists of academics, heads of central and peripheral services, and the General Secretary of the Ministry, all appointed by the Minister of Culture and Tourism. This tight structure aims to provide protection for antiquities because every decision involves many different levels of control but, on the other hand, it is a strongly bureaucratic model that lacks flexibility and decelerates the decision-making process (Government Gazette no 153*)*.

The survey

The questionnaire of ICCROM was made available to us in English and was translated into Greek and then submitted to the Directorate of Conservation of Ancient and Modern Monuments (DCAMM) with the invitation to participate in the survey. Following the official procedures, the survey was approved by the Director of DCAMM, then by the General Director of Antiquities, and, finally, the questionnaire was sent to all relevant ephorates and to the major museums, which operate independently.

The questionnaire was sent in July 2010 in order to be completed during the summer, when extra seasonal personnel are usually employed. A two-month period was allowed for the completion of the survey with an one-month extension at the end.

The questionnaire included nine questions targeting the following information:

- Number and total surface of lifted mosaics
- Location of the mosaics (floor, wall or movable)
- Principal materials and methods used for mounting
- Condition of the mosaics
- International programs undertaken or in progress
- Relevant publications
- Professionals in charge of the collection and their level of education
- Members of staff
- Professionals engaged with mosaic conservation and their level of education; and
- Mosaic conservation facilities
- 39 Ephorates of Prehistoric and Classical Antiquities, 28 Ephorates of Byzantine Antiquities, and six independent museums were contacted (Fig. 1). Questionnaires were sent to a total of 73 departments.

Problems encountered in collecting and analysing the data

The questionnaire that was used in this survey was designed to meet the needs of a regional survey in the South Eastern Mediterranean region. However, translating in Greek and distributing a questionnaire that was designed by an international organization was not as suitable as thought to be. As a result, various questions were not understood or misinterpreted. This can be attributed to different factors:

a. First of all, 37% of the questionnaires were completed by archaeologists, while in another 8%, the profession of the person in charge of the survey is not specified. This means that conservators were involved only in 55% of the survey (Fig. 2). As a result, various mistakes were made in the description of the materials and the methods used for mounting the mosaics. It was also observed that the questionnaires that were completed by conservators were more detailed and often included additional descriptions of the mosaics and the conditions to which they are exposed, i.e. high humidity, superimposed mechanical stresses etc. Their assessment

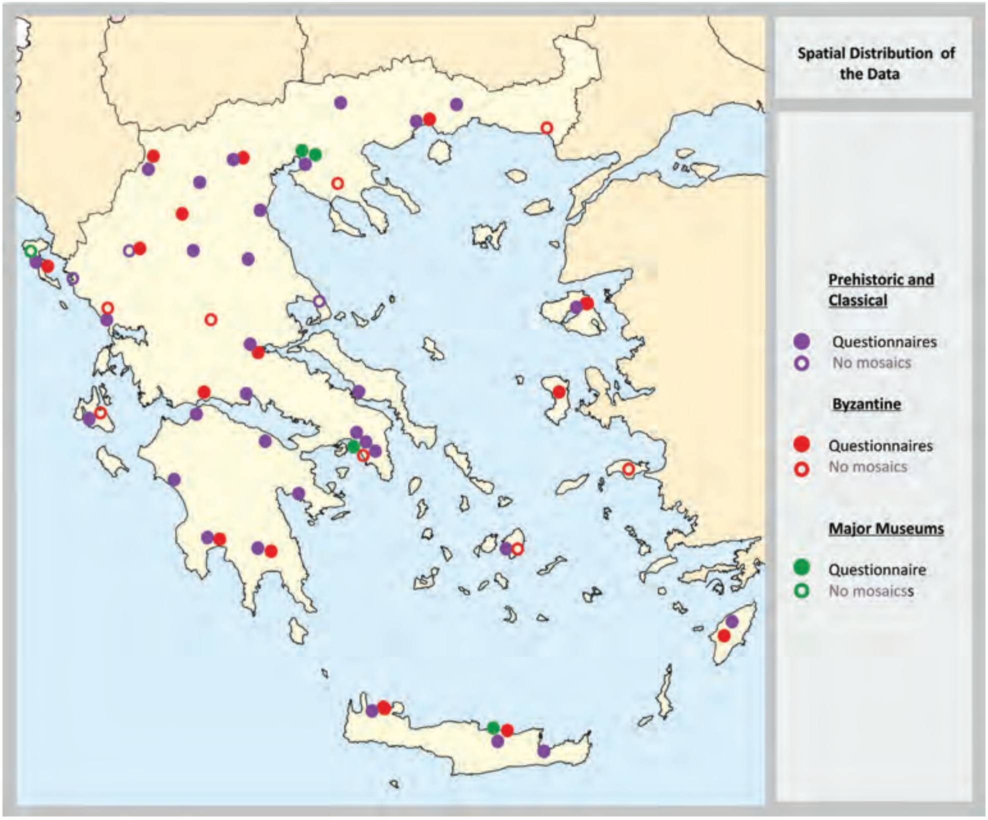

Fig. 1. Map of Greece: spatial distribution of the data

on the general condition of mosaics also tended to be stricter and probably more objective than that of the archaeologists, and seems to be leaning towards moderate to bad rating.

b. Other mistakes can be attributed to the translation. Some departments included the in situ mosaics of their region in the fields concerned with mosaics 'exhibited outdoors', considering the sites, which are open to the public, as outdoor exhibition areas. This problem was realized as soon as the analysis of the data started, which meant that we had to figure out how many of these were recorded in order to subtract them from the total number so as to be able to use the rest of the data.
c. Some mistakes are also attributed to the design of the questionnaire, where not all fields were suitable for Greece. The questionnaire was designed for a single museum, and although we sent an explanatory note for filling it in, the fields concerning staff and responsibilities were misinterpreted due to the structure of the archaeological service. Another example is the questions concerning mounting, where the choices do not represent the common practices that are used in Greece, hence the fields could not be completed properly.
d. A few of the regional archaeological services, especially those which include islands, noted that there are not enough personnel to undertake the survey. These departments completed the questionnaires by consulting their records, without giving specific information such as dimensions, number of mosaic panels or sections of mosaic. This information although useful, could not be quantified and added to the main data and therefore the completion of the full data in these departments is pending.
e. A large number of the mosaics in storage come from rescue excavations. They were lifted and stored in sections for a long time, as the regional services could not fund their conservation and do not have appropriate space for future exhibition or proper storage. In most cases, mosaics in storage were inaccessible and their examination for this survey was impossible. As a result several sections of lifted mosaics were reported, which, either because of lack of records or because of lack of personnel, were not linked to individual mosaic panels.

In order to verify unclear or non-logical data the personnel of the DCAMM, contacted by phone each of the departments that had presented problematic or unclear answers to the questionnaire.

The data and the outcome of the survey

The majority of the data comes from the 39 Regional Services of Prehistoric and Classical Antiquities: **30** of them completed **44** questionnaires, as they often oversee more than one museums and/or storage depots, **3** replied that they have no mosaics and another **6** did not respond (Fig. 1).
From the **28** Regional Services of Byzantine and Post Byzantine Antiquities, **15** completed an equal number of questionnaires, **7** replied that they have no mosaics and **6** did not respond (Fig. 1). Of the **6** major museums **4** completed an equal number of questionnaires, **1** replied that they have no mosaics and **1** did not respond (Fig. 1). In total, **48** departments completed questionnaires, **12** replied that

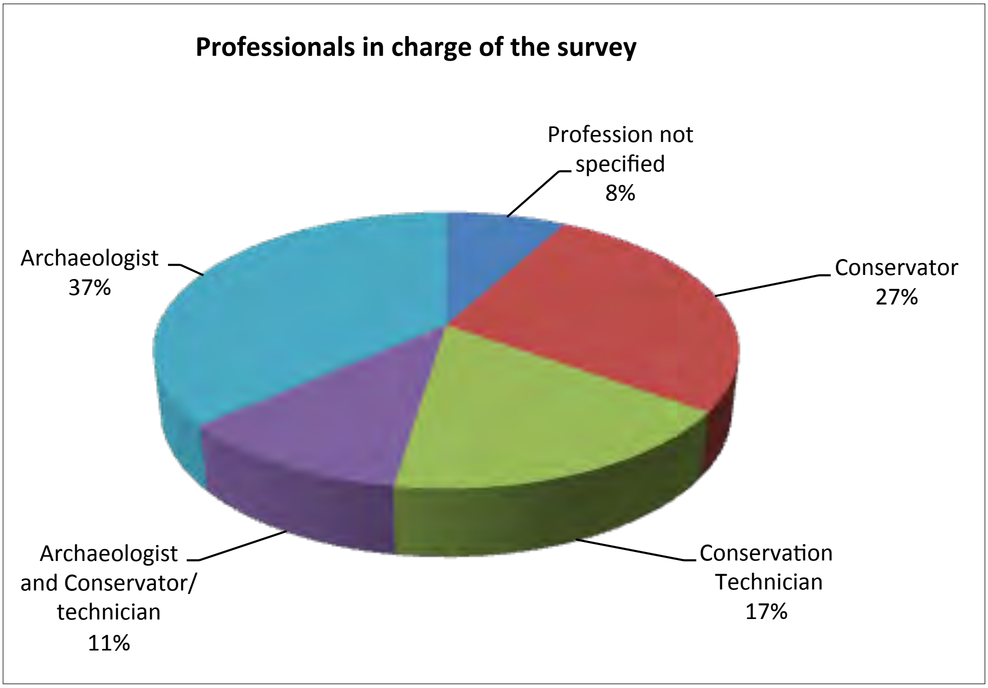

Fig. 2. Professionals in charge of the survey: Conservators were in charge of the survey in 55 % of the departments

they have no mosaics in their collections while another **13** did not respond. Overall, there was a very good response from all the regional departments and we were able to collect a large sample of data with a good spatial distribution (Fig. 1). Of the contacted services, 82% responded to the survey either by completing questionnaires (66%) or replying that there are no mosaics in their collections (16%).

In total, 62 questionnaires were collected and analysed. The analysis of the data allows us to speak in numbers about the lifted mosaics of Greece and points out the prominent priorities in this field (Fig. 3). There are 658 mosaics and 1865 unidentified sections with a total surface of 12112 m^2. The majority of the mosaics on display, 167 mosaics with a total surface of 2308 m^2, are exhibited indoors in 37 museums. Another 35 mosaics, with a total surface of 1549 m^2, are exhibited outdoors in 19 museums and 456 mosaics are found in 38 depots. The 1865 unidentified sections of mosaic are found in ten depots. Of these, 1531 sections measure 1745 m^2, and 334 sections (from one depot) are reported without surface measurements (Fig 4). Therefore, around 24% of the mosaics in storage were unidentified in our survey. It should be noted that for the purpose of this survey we called "unidentified" all sections of mosaics not corresponding to the number of mosaics they belong to.

The total number and surface of mosaics represent the **minimum values**. A few museums reported mosaics without surface measurements and others reported the sur-

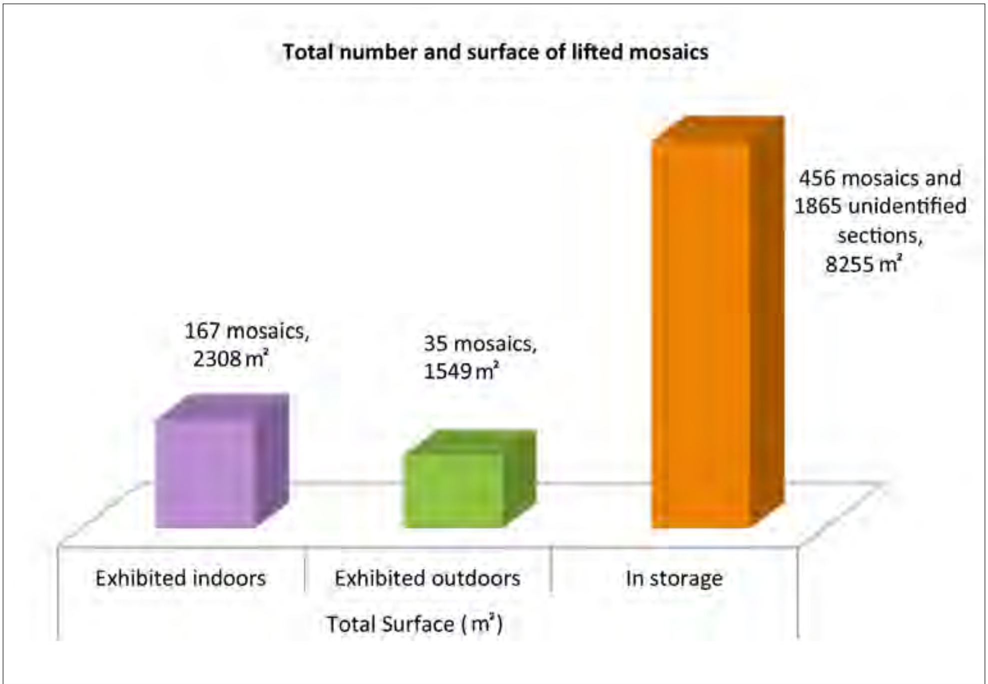

Fig. 3. Total number and surface of lifted mosaics, which were recorded throughout the country

face without specifying the number of mosaics. In addition, the number of mosaics at the departments, which did not respond to the survey, remains unknown. However, absolute values are not expected to be much higher, as there was a very good response to the survey. Apart from the quantity of detached mosaics and their location, we were able to answer a series of questions which are of vital importance for planning and adopting a conservation policy. The most significant ones are presented below:

a. Where and how are the mosaics installed?

The mosaics that are exhibited indoors and outdoors are mostly fixed to the floor and less on movable supports, while the great majority of the mosaics in storage are found on movable supports, including the non-mounted mosaics, which are supported by the facing fabric and are placed on movable boards (Fig. 5).

b. What are the principal methods of mounting used?

The principal materials used for the mounting of mosaics in indoor and outdoor exhibitions are cement and various mixtures of lime mortars or cement-lime mortars. The same applies in storage where less than half of the mosaics are mounted (Fig. 6).

c. What is the condition of the mosaics?

The condition of the mosaics exhibited indoors is predominantly very good, while the condition of the mosaics kept outdoors is mostly good. Mosaics in very good and very bad condition also exist. In storage,

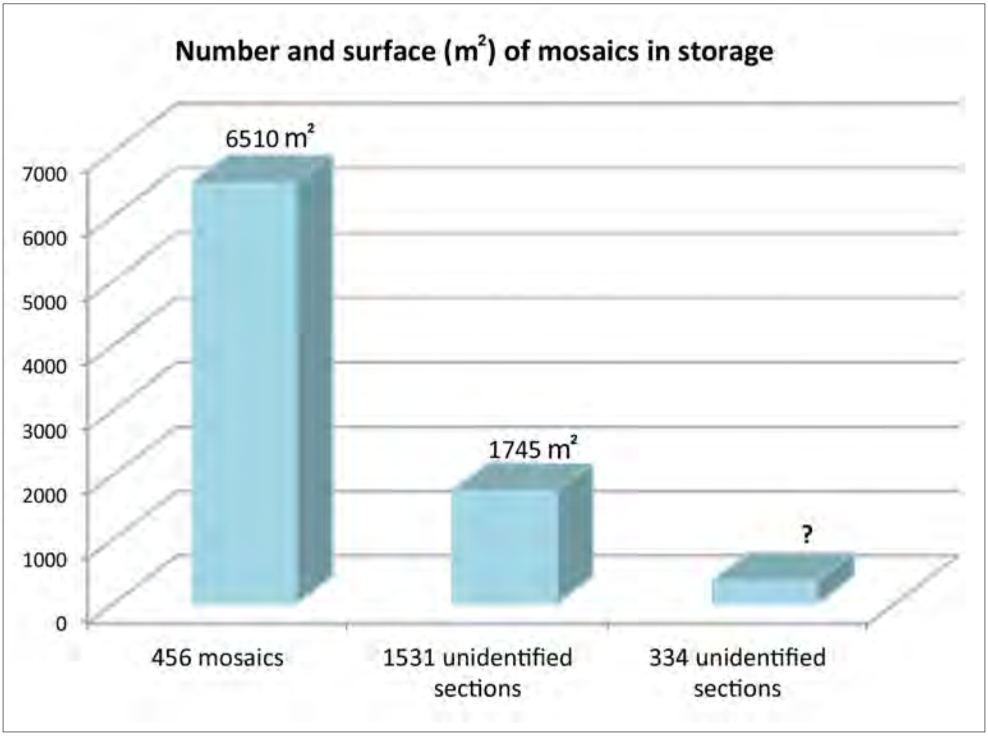

Fig. 4. Total number and surface of the mosaics, which were recorded in the depots of museums and/or archaeology departments

roughly one third of the mosaics are in a moderate condition, the second third in very good to good, and the last third in bad to very bad condition (Fig. 7). As expected, the mosaics on exhibition are in a much better condition than those in storage as they are maintained more often although not regularly. On the contrary, the mosaics in storage, which are rarely inspected and often inaccessible, are in a worse condition.

d. How many of the regional services have mosaic conservation laboratory?

There are only nine organized mosaic conservation laboratories, two of which are found in in major museums and seven in large ephorates.

e. Who is engaged in mosaic conservation?

In 24 departments there are professional conservators with a higher education degree who are in charge of mosaic conservation, representing 40% of the departments who responded to the survey. In another 12 departments, representing 20% of the total, the professionals in charge of mosaic conservation are conservation technicians from vocational schools. In eight departments, representing 13% of the total, mosaic conservation is undertaken by conservators in collaboration with technicians, in one department by a technician, in two departments by short-contract conservators and finally another three departments have reported that they are assisted by the

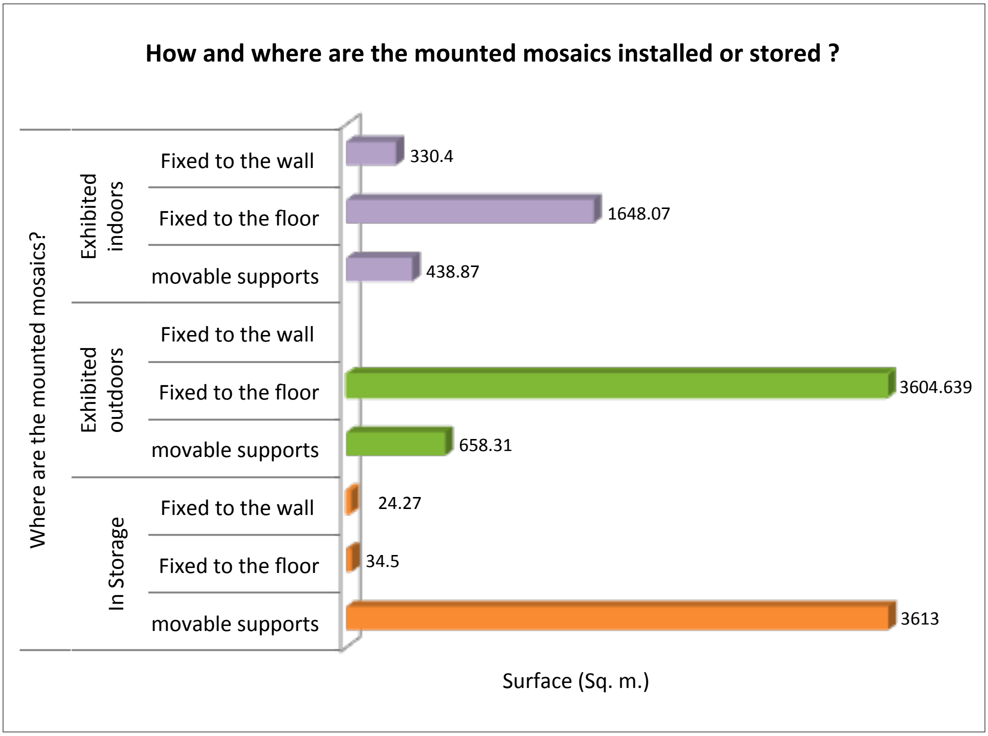

Fig. 5. The majority of the mosaics on exhibition are fixed to the floor or the wall while those in storage are on movable panels mostly not mounted

Directorate of Conservation of Ancient and Modern Monuments for the conservation of their mosaics. It is not negligible that ten departments, representing 17% of the total gave no answer to this question, a fact that can be interpreted in different ways and needs further clarification.

Discussion

Despite the problems encountered in the completion of this survey, the data that was collected has definitely helped us to track down the problems, to prioritize the needs and to start developing a strategy for the protection of these mosaics. The account of the problems that have been recorded also leads to a better understanding of the weaknesses that exist at an operational/managerial level and gives insights for adopting feasible and effective solutions in order to prevent further damage to the mosaics of Greece, taking into account the administrative structure, the human and financial resources that are available in the country.

It is apparent that there are problems in the depots of the museums and other buildings of the regional departments, where a considerable number of mosaics could not be accessed, identified and recorded. More than half of the mosaics in storage are not mounted and their condi-

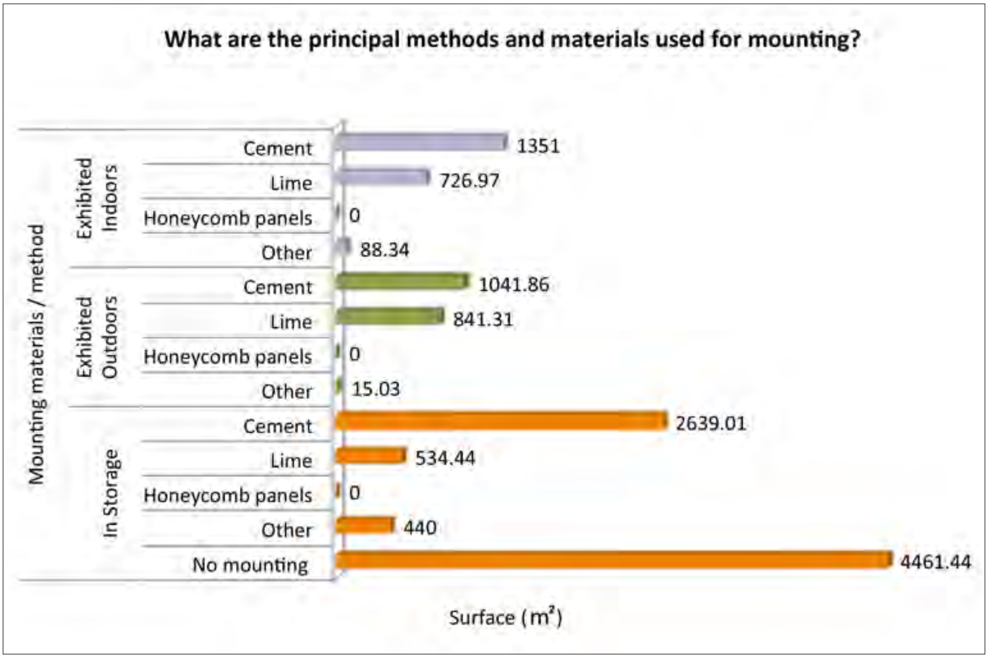

Fig. 6. The main materials used for mounting mosaics are lime and white cement in various mixtures and reinforced with aluminum and stainless steel frames. Honeycomb panels have not been used at all and the mosaics in storage are not mounted

tion is graded from moderate to bad (Fig. 6 and 7). Since the mosaics in storage represent almost 70% of the lifted mosaics, it means that the problem concerns a large number of lifted mosaics in Greece. It is clearly pointed out that priority should be given to the documentation of the mosaics in the departments which had no personnel to undertake the survey, or the mosaics were inaccessible due to inappropriate storage conditions and lack of space for their examination and documentation. At the same time, the analysis of the data also indicates that the qualified staff that is currently employed by the museums and archaeological services is not proportionate to the large amount of cultural material that has accumulated over several years of archaeological research and rescue excavations. This can be explained to a certain extent by the fact that conservation as a scientific discipline is relatively recent in Greece. The first conservation department at the level of higher education was established in 1985. Since then, almost a thousand conservators have graduated, many of whom have also continued their studies at a postgraduate level. However, they are mostly employed in the central service or in major ephorates and museums in the capital cities, while in smaller departments there is a lack of specialized personnel. Furthermore, few of these highly specialized conservators have positions to enable them to take part in the decision-making process. The lack of specialized personnel, lack

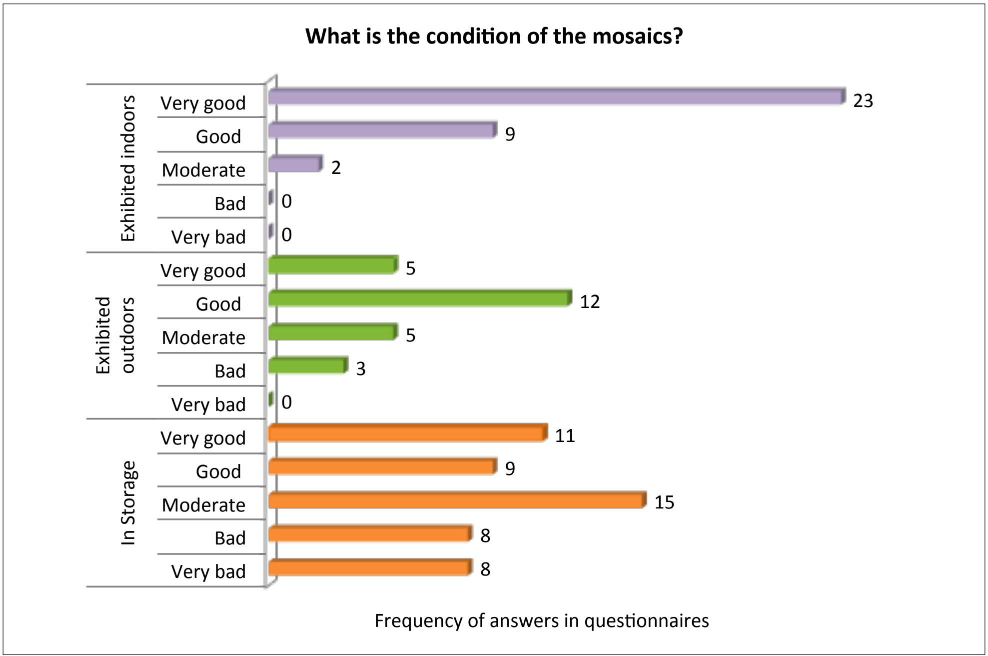

Fig. 7. The mosaics, which are displayed either indoors or outdoors, are in a better condition than those in storage, as most of them are regularly maintained

of infrastructure, financial issues and the tight and introvert administrative structure are the main weaknesses in the operational capacity of the Greek system. The present prolonged recession in the Greek economy and the current reformation in the public sector services, does not really allow for much planning, and certainly no conservation programs can be initiated except for emergencies and the few large on-going projects. A number of projects are also implemented with the financial support of the European Union, through the Community Support Frameworks and the National Strategic Reference Framework. The administrative structure of the Ministry of Culture and Tourism is now being revised into a more decentralized and flexible scheme, but still there are no recourses at present for the employment of conservation professionals.

The results of this first survey lead us towards a better understanding not only of the problems evident in the condition of the mosaics, but also of the needs of the conservators and the infrastructures, that would enable us to develop of a strategy for the protection of the mosaics. Simple solutions such as the setup of an open network between the central conservation service and the conservators in the regional services will first of all enable the continuation and improvement of the first survey and the in-depth examination and assessment of the problems. This would also act as an advisory network for sharing knowledge

and experience. The specialization of the personnel was also a need that was highlighted through the survey. A great interest for educational seminars specially designed for the maintenance of mosaics was expressed by most services we contacted and not only by conservators and conservation technicians, but other employees as well.
The voluntary participation of students from the Conservation School of the TEI of Athens, or other educational institutions, in collaboration projects between the central conservation directorate and a school of conservation is considered as low cost solution that can be beneficial to both parties for achieving their goals. Students are offered the opportunity to build their experience in museum or field conservation projects during their studies while the archaeological services can make some progress towards the conservation and maintenance of mosaic sites which lack funding or the proper organization of storage depots. Financial recourses are even more limited for research and the only means of investigating and improving materials and methodologies is through academic studies such as Master or PhD level theses.
The results of the present survey can be used in several ways and definitely for putting pressure on the decision-makers for allocating funding and initiating rescue conservation programs. Furthermore, the results of this survey demonstrate the real needs of each region and can be used in raising public awareness and advocacy, as well as raising funds from local, national and international sources. Public involvement and volunteer programs can be successfully incorporated in site-maintenance projects and the protection of sites, and are on the frontline of our efforts. Since we now have all these data in our hands we are able to put together proposals with close estimations of budget, which target the real problems, in the hope that we will be able to seek funding in all possible directions in order to secure the mosaics in storage and to prevent further damage of those in situ. We are also moving forward to the second survey, which explores the problems of the in situ mosaics, aiming at a first evaluation of their condition and the prominent priorities in the field. As this is expected to be a more lengthy and difficult survey to undertake, we are carefully designing and testing the questionnaire before it can be sent to all these departments. The experience we gained from the first survey is really valuable as it helps us to foresee and resolve the potential problems in the completion of the survey of in situ mosaics, which is a much more complicated case.

Acknowledgments

The survey was an initiative of Stefania Chlouveraki, member of the ICCM Board. It could never have been completed without the support of N. Minos, Director of DCAAM, and the approval of M. Vlazaki, General Director of Antiquities, to whom we are grateful. We would also like to thank Katerina Ftikou, conservator of DCAMM, for her assistance for collecting further data by contacting several departments.

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DOCUMENTATION FOR MOSAICS: A CONSERVATION TECHNIQUE

Andreina Costanzi Cobau and Roberto Nardi

One of the great challenges facing the profession of conservation of cultural properties towards the end of the last century was that of documentation. We can confidently say that in this matter, the period from the 1960s to the 1980s represented the passage from prehistory to history, from total absence of any type of documentation to definition and application of methodologies and techniques that are now regularly applied, and subject to continuous development, thanks to the formidable evolution of digital technologies. For the particular area of mosaics, and for the ICCM, documentation was one of the great battles: one of the themes that together with the abandonment of the use of cement, and development of in situ conservation and specific training, led to the formation of the ICCM itself.

In light of these developments, we can now be assured that a conservation intervention shall only be considered complete when all the data collected have been adequately documented. Pursuant to this, documentation becomes the measuring stick for evaluating the methodological quality of the intervention, and reflects the point of view and reasoning that determined it. As early as 1992, Alessandra Melucco (Melucco 1992) argued: "*We can safely assert that the lack of adequate documentation is often the signal of an insufficient philological dimension in the approach to and in execution of a mosaic restoration...*". According to this reasoning, the evaluation of documentation of an intervention is revelatory of its fundamental philological dimension. Here, we stress that in conservation, when speaking of information and documentation, we refer to all data concerning the initial conservation assessment of a work or monument, the information regarding the interventions conducted, as well as that included in the maintenance plan, and the historical-archaeological data gathered during the research and intervention.

In mosaics conservation, documentation is an indispensable instrument, since it provides the comparative data fundamental to monitoring the status and context of any conservation intervention, for monitoring the effectiveness of treatments implemented, and for study of the mosaic itself.

For purposes of explicating a complex process, we can distinguish three summary stages within the practice of documentation, respectively: *data collection, rendering,* and *communication of information.* The *data collection* stage refers to logical management of the data gathered in the research, planning and execution stages of the intervention; *rendering* refers to the elaboration, archiving and publication of the information at completion. Both of these stages are preparatory to the final one, which represents the logical conclusion of the first two: the *communication of information* produced. It is important to note that two instruments have come to assume great weight in the technical toolkit available for this sequential process, and that we now draw on these daily and would have great difficulty without them: we refer to the tools of video technology and the World Wide Web.

Given the new, readily accessible instruments for recording and editing, video technology has become a habitual tool, equal to photography, offering enormous added potentials for both documentation and communication. Taking a historical view of current events, we could hazard a parallel that, just as drawing came to be accompanied and substituted by photography, video documentation is now flanking and substituting photography.

The second area experiencing impressive evolution, both in general and concerning our own profession, is the Web. Regarding mosaics conservation, the continuous technological evolution of the Internet offers highly innovative and interesting prospects for documentation practices, both in the dynamics of acquiring and transcribing data and its rendering and communication.

In taking a critical-historical view of the methods used by the Centro di Conservazione Archeologica in documentation of mosaics conservation, we can see how the initial question of "what" to document has always been balanced by the query of "how", the latter referring to the purely technical level of preparing documentation, and managing and communicating the material produced.

A concrete response to the "what" question arrived in the 1980s and 1990s, with the definition of a methodology for documentation pursuant to institution of the UNI-Normal Committee for Definition of Technical Standards (NORMAL 1990) by the Italian Ministry for Cultural Heritage and the Istituto Centrale del Restauro. The mandate of the committee was to develop a glossary of forms of alteration and degradation, with specification of graphic language for their representation. The first glossary issued was for paintings, soon followed by that for stone materials. These were the point of departure for a methodological transfer to the field of mosaics, leading up to publication of the Getty Conservation Institute glossary (Alberti *et al.* 2013), an essential instrument now translated in numerous languages.

For simplicity in recounting the development of the methodological "how" in mosaics-conservation documentation, we skip all stages of pre-computerization efforts in the 1980s (Nardi 1983) and go directly to the dawn of digital drawing techniques, taking the example of the CCA experiences in conservation of the Baths of the Cisiarii, at Ostia Antica, in 1994 (Albini *et al.* 1996).

In this case the intervention was preceded by on-site research, which involved recording data on the original techniques of execution and conservation status, including losses, imprints of tesserae, detachments and fractures. The documentation served in a detailed study of the mosaics and in planning the intervention, which was based on in situ consolidation with lime wash, applied by brush to the tesserae interstices, for surface consolidation, and infiltrated at depth using syringes for consolidation of the bedding layers. The documentation recorded all this, from as-found conservation status to the operations conducted, including the final systems for seasonal covering of the pavements, used for the first time at this site, and which for that period represented a quite innovative method.

The techniques involved transcription of data on scale drawings prepared during the on-site recording, or on drawings derived from photographs. The procedure was very slow and also resulted in schematic drawings, lacking in ability to convey all the characteristics of the original work. This limit was naturally closely linked to the scale of graphic representation of the original pavement: in mosaics, the scale of documentation is necessarily the tessera, rather than the iconography or particular unit of flooring. This was the critical factor in attempts at documentation during the 1980s and 1990s. Without resorting to 1:1 drawings on polyethylene, which among other considerations would be difficult to execute, archive and manage, the drawings and documentation were imprecise, closer to sketches than to true scientific documentation. The multiple attempts to resolve this limit gave rise to a list of procedural solutions. However, in the end, these attempts to identify an effective method, valid for all types of mosaics, in fact demonstrated the difficulties and technical limits of the documentary practices in use.

These same difficulties were also faced in the documentation systems for another project, in 2000, for the excavation and restoration of the mosaics of Zeugma, Turkey (De Felice 2002). This case presented serious practical problems, due to the great number of mosaics to be treated, covering nearly 1000 square meters of in situ and detached works, under difficult operational conditions and pressing deadlines. Given this, the documentary methodology played the role of the basis for all information management, and indeed the entire program, from the first day of work until project closure. The methodological development involved the use of both digital graphic techniques, applying AutoCAD software, and high-resolution digital photography. While this resulted in high-quality documentation, it also implied long and complicated operations, which in turn encountered a series of significant limits. For example, the initial planning underestimated the compatibility between the weight of files executed and the on-site computer technology available at that time, with subsequent difficulty in managing the great masses of computerized information, also occurring in laboratory and research stages (Fig. 1-2).

These limits essentially derived from the insufficient capacity of computers then available for on-site and laboratory work, a problem which receded over the years with access to more powerful and reliable portable devices. These could then be backed up by laboratory computers with capacities for high-volume archiving and rapid data processing. For example, by the final stage of the four-year Zeugma project, it had become possible to produce high-resolution digital photos, something that had been impossible at the outset (Fig. 3).

After the preceding experiences, in 2005 the CCA developed the documentation program for conservation of the Mosaic of the Transfiguration at the Monastery of Saint Catherine, Sinai. Two procedures

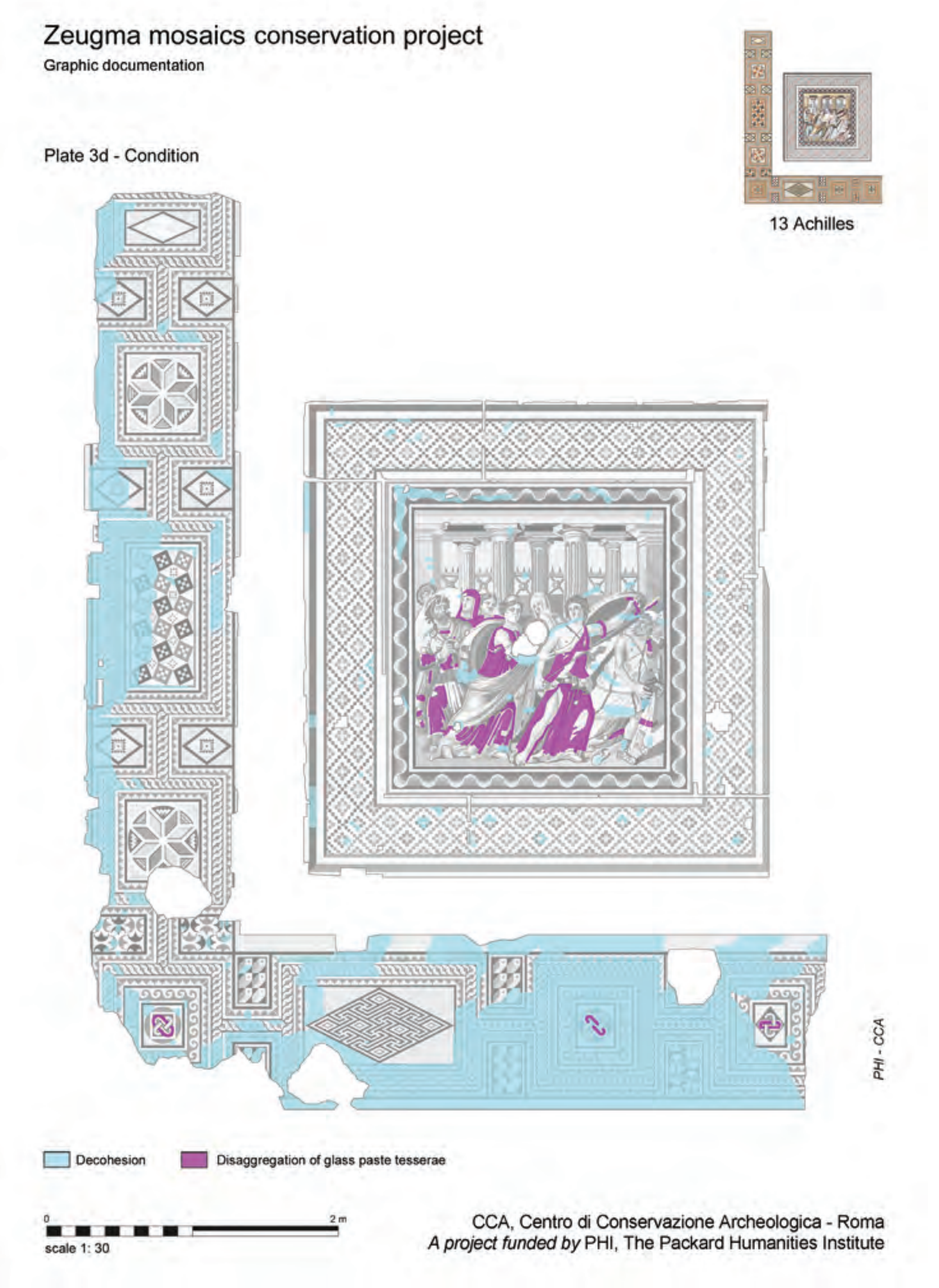

Fig. 1. Zeugma. Mosaic of Achilles on Skyros. The graphic documentation describing the deterioration of the tesserae: decohesion and disaggregation of the glass paste tesserae (drawing: G. de Felice)

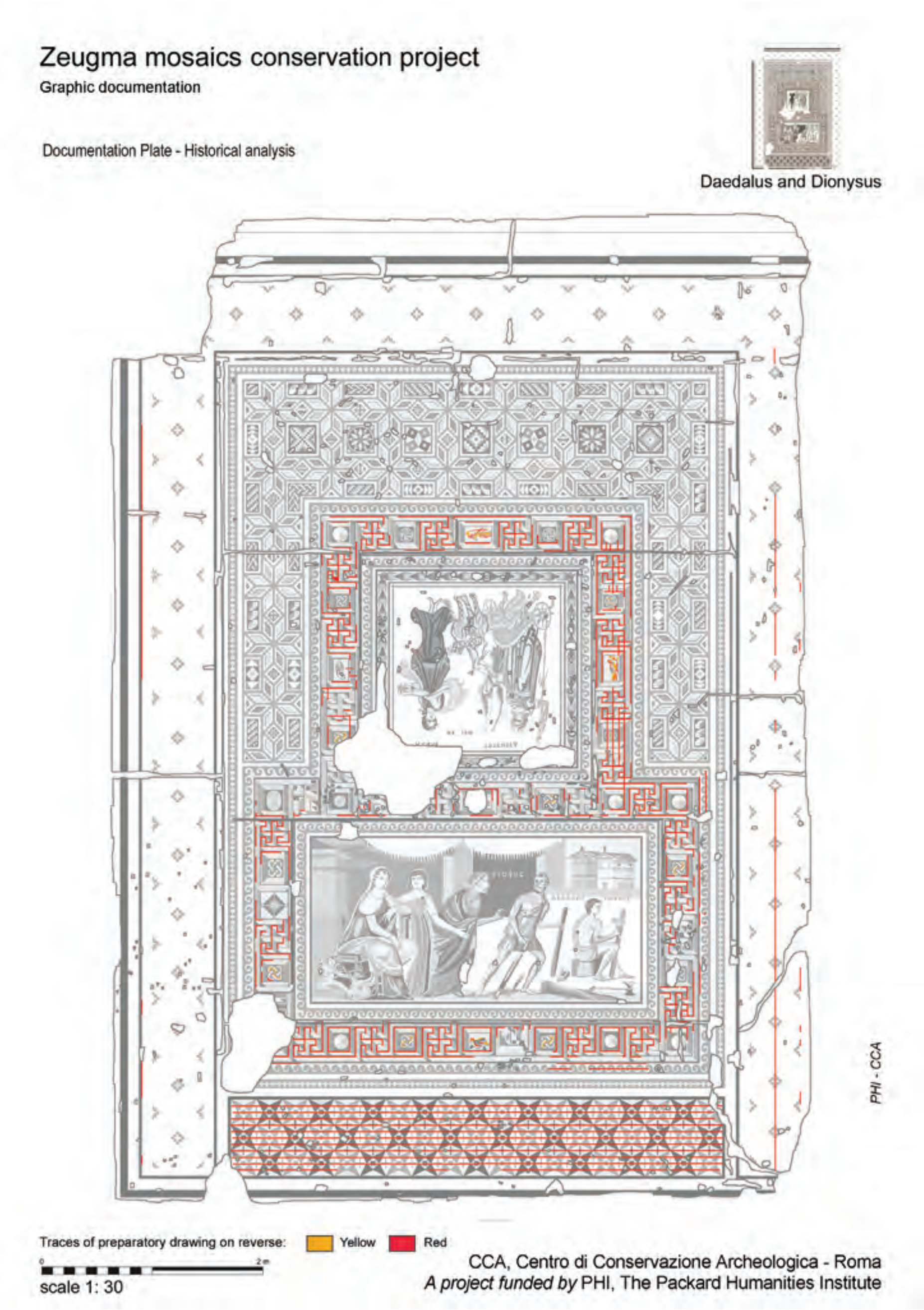

Fig. 2. Zeugma. Mosaic of Daedalus and Dionysus. The graphic documentation reporting the historical analysis with, in particular, the traces of sinopia (drawing: G. de Felice)

Fig. 3. Zeugma. Mosaic of Achilles on Skyros. Photograph in scale 1:1 by Araldo de Luca for CCA during the Packard Humanities Institute project 2000-2004

Fig. 5. Monastery of Saint Catherine, Sinai. Mosaic of the Transfiguration. Documentation was carried out directly at the worksite using a tablet computer and the Photoshop graphics programme

Fig. 4. Monastery of Saint Catherine, Sinai. Mosaic of the Transfiguration. Photograph in scale 1:1 by Araldo de Luca for CCA during the 2005-2009 conservation project

were put into place: a preliminary stage in which a professional photographer produced high-resolution base photographs, followed by a second one in which the conservator-restorers progressively transferred the data as acquired on the worksite. The photographer, Araldo De Luca, carried out a total of three documentary campaigns: before, during and at the close of intervention, using a Hasselblad digital camera-back with a complex flash setup minimising reflections from the gold tesserae. The base documentation of the Transfiguration mosaic, which covers the triumphal arch and apse, was executed at 1:1 resolution (Fig. 4). To avoid deformations deriving from the form of the apse, the individual image files for assembly of the photomontage were limited to a maximum of one square meter of surface coverage.

The photos resulting from this operation provided the basis on which the conservators executed the graphic recording of 25 fields of documentation, all recorded

Fig. 6. Monastery of Saint Catherine, Sinai. Mosaic of the Transfiguration. Moses removing his sandal in front of God by the Burning Bush. An example of 6 plates reporting the state of conservation of the mosaic and the treatment implemented. From top left: detachments; colours detected under the tesserae; materials composing the tesserae; deep consolidation; 1847 restoration; 2005-2016 restoration

during the intervention on a series of 25 "layers". This operation was carried out directly at the worksite using a tablet computer and the Photoshop graphics programme (Fig. 5). In this manner, the photographic and graphic documentations were connected, providing a method that responds perfectly to the needs of mosaics documentation.

Assigning suitable names to the layers or "fields" of documentation is a crucial step in ensuring good management of the system. Each layer in Photoshop has to correspond to a single characteristic under documentation, permitting individual management and variation of effects such as superimposition of colours, patterns, shadow or transparency, while the scale and above all the mosaic photography remain constant. In this manner, while viewing the documentary data, the mosaic also remains in view, because the graphic is simply overlain on the base photography, without interference from the further information inserted by the conservators. The mosaic photo is the background for the graphic data, and the data overlay the photography without interference or limitation. The operator retains the capacity to constantly access the iconography, the placement of tesserae, or any other technical characteristic recorded during the course of the intervention. It is notable that the recommendations from the UNI-Normal Committee still proved essential to these procedures, since they provide the fundament of clear and effective language (Fig.6).

The conservation-documentation project for the Mosaic of the Transfiguration also achieved interesting progress in the second area of technical concern, that of managing of the large quantities of information produced during an overall program. In fact, the unforeseen extension of the project, approved in 2001, funded and initiated in 2005, completed only in 2016 after the "Arab Spring", had the paradoxical effect of permitting access to great technical progress in the World Wide Web, for managing the documentation produced over the course of the intervention.

Through preparation of HTML files, all of the photographic, graphic and video documentation concerning the mosaic and the intervention could be "stored" on the Web. Drawing on a user-friendly management program, the user can travel within a digital reconstruction of the mosaic, in the original spaces, at 1:1 scale, while simultaneously and selectively drawing on all the information collected. The user can engage one or more layers of data, at the scale desired, using simple, readily understood menus (Fig. 7-8).

Documentation continues to employ methods that draw on different techniques, but its aims remain constant: to ensure adequate conservation and easy access to all data gathered. When the documentation methodology respects these principles, it will successfully fulfil its role. When documentation permits the further accomplishment of use of media channels as a means of communication, it achieves multiple objectives, beyond conservation: safeguard of the data, and also their communication. In this regard, the project for the apsidal mosaic of the Church of Monastery of Saint Catherine took full advantage of the technology, achieving equilibrium between the two objectives. A software to show a mosaic at 1:1 scale was developed, in a situation where the original was difficult to see, rendering every detail related of the mosaic tesserae but without losing sight of the whole, and thus

Fig. 7. Monastery of Saint Catherine, Sinai. Mosaic of the Transfiguration. User-friendly management program: the user can engage one or more layers of data, at the scale desired, using simple, readily understood menus

Fig. 8. Monastery of Saint Catherine, Sinai. Mosaic of the Transfiguration. Example of screen shot referred to the lacunae filled with tesserae during the treatment of 2005-2009. Documentation is accessible at 1:1 scale

showing the true appearance of the mosaic. The software was designed for input of the collected data, in graphic form using semi-transparent colours, thus permitting reading of the mosaic by a vast public, beyond those present on site.

Photography, along with video, graphics and three dimensional effects are the same means commonly used by the mass media to communicate their information to the public at large. In applying them we ultimately achieve the same function as for conservation documentation itself, meaning *communication*. This is an overused word, but the new frontier opened by digital technology in documentation lies exactly in this: our documentation can finally be communicated in a simple, clear manner, with the same instruments used by mass media, offering a unique occasion to transmit the fragility of cultural heritage. In documenting, we can simultaneously diffuse and communicate, no longer reaching an exclusively expert public, but a broader audience, composed of adults and children, tourists and students, travellers and stay-at-homes, experts and amateurs, youth and elders. Documentation is the collection of data and, at the same time, their divulgation; it is a virtuous process that initiates as an instrument of collection, becomes a means of research and diffusion, and completes the circle by itself becoming a vector of conservation of information.

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CONSERVATION AND MAINTENANCE OF MOSAICS IN CYPRUS

Maria Hadjicosti and Eleutherios Charalambous

Abstract

This paper presents a brief history of the research on ancient mosaics on the island of Cyprus along with the conservation and restoration program which was conducted by the Department of Antiquities of the Republic of Cyprus in collaboration with the Aristotelian University of Salonica. It explores the conservation problems which were faced and the methods and techniques which were used to address them. Conservation, documentation and dynamic protection of the mosaic pavements are the cornerstones of this conservation program.

History

Excavation work on the island of Cyprus over the last century has revealed a considerable number of mosaic pavements. These pavements are found in more than 16 archaeological sites, at least ten of which are accessible to visitors and four are located in the Turkish-occupied northern part of the island (Fig. 1). The political situation, created after the Turkish military invasion of 1974, led to the abandonment of excavated sites and scientific activity in the occupied areas, and to the increased rate

Fig. 1. Map of Cyprus showing the main archaeological sites with mosaics (E. Charalambous)

Fig. 2. Kourion, pebble mosaic under the "House of Eustolios" (photo: E. Charalambous/ Department of Antiquities of Cyprus)

of construction in southern Cyprus. This situation temporarily interrupted cultural activities and suspended the continuation of excavations even in the non-occupied part of Cyprus, where, in more recent times, scientific activity started again.

In the stores of the various district museums there is a small number of lifted floor mosaics, which do not exceed 15 in number. On the whole, there is evidence for the existence of a large number of mosaic pavements, including pebble mosaics (Fig. 2) and *opus sectile*. In fact, there are such finds in 49 locations all over the island and, more specifically, there are 240 mosaic pavements, excluding pebble floors (Michaelides 1992; Charalambous 2009), four of which were recently discovered during illegal excavations in the occupied village of Tympou. These floor mosaics cover an area of about 15 km^2 while there is evidence of yet more mosaics that have not yet been excavated. The existing pebble mosaics constitute an important part of the mosaic pavements of Cyprus. Eight of these bear decoration and cover an area of about 500 m^2, whereas a large number of plain pebble pavements is also recorded. In addition, the significant number of about 40 *opus sectile* floors, covering an area of more than 2.5 km^2 is also to be found in the numerous Early Christian basilicas that have been excavated all over the island. In total, over 18 km^2 of mosaic pavements have been exposed in Cyprus. According to the information gathered after the opening of the barricades towards the occupied zones of the island, bad maintenance conditions and major conservation problems in the monuments have been confirmed. The basilica of Saint Spyridon in the vicinity of the village of Tremetoushia is the only monument with mosaic pavements the present condition of which we ignore due to the fact that it is situated within a military area and it is thus impossible for anyone to visit it. In addition, a large number of wall mosaics are to be found in the following sites and monuments: in the Larnaca District: at the church of Panagia Angeloktisti at Kiti; in the Limassol District: a large part of the mosaics from the Early Christian basilica of the Kourion precinct, now kept in the Kourion Archaeological Museum at Episkopi; in the Famagusta District: at the archaeological site of Salamis, at the church of Panagia Kanakaria at Lythrankomi and at the church of Panagia Kyra at Livadia. Unfortunately, a large part of the last two has been destroyed or detached from the monuments and illegally exported abroad for selling.

Conservation Program

Over the past few years, an effort is being made for the creation of a program for the conservation and restoration of the mosaic pavements of the island. This program began in 2003 at the archaeological site of

Kourion with the cooperation of several specialists such as archaeologists, civil engineers, architects and conservators. For this program there was also a cooperation between the Department of Antiquities of the Republic of Cyprus and the Departments of Chemistry, Physics and Civil Engineering of the Aristotelian University of Salonica.

The program originally aimed at the evaluation of the results obtained from the chemical analyses of samples from ancient mortars and tesserae, with the ultimate intent of acquiring knowledge regarding ancient technologies and their potential application in conservation science and restoration. These results created a database that regards the consistency of stones and mortars, from which the conservator can draw information on how to choose the correct conservation method. The primary aim of these results is their use and application in the conservation and maintenance of the mosaics. The research had three main stages, each of which by itself and in relation to the others helped to arrive to the safest conclusions regarding the conservation of mosaic floors. The first stage consisted of chemical analyses using instrumental chemistry methods, which aimed at giving information on the elemental and mineralogical composition of the tesserae, their identification with the natural stones, their distribution in time and space, and information concerning their physical, mechanical and chemical properties (see Charalambous 2017). A database was created where all the elements concerning the composition of the stones were recorded. The second stage aimed at the chemical analysis of the mortars (see Charalambous 2017), which have been used in all the layers of the floors, in all of the periods under examination, with ultimate intention the gathering of information about the composition and the technology of their manufacture. This stage gave information regarding the composition and the characteristics of the technology of manufacture. The third stage dealt exclusively with the technology of the manufacture of the layer of tessellation, the development of the figurative and geometrical representations in time and the analysis of all those factors which influenced this development.

The combination of all this information helped significantly in the organization of the conservation program, the comprehension of the corrosions and the selection of conservation materials. After the chemical analyses, the other primary aim of this program was to confront the various problems that appeared in the mosaics with the ultimate intent of slowing down the degree of deterioration of the floor. To start with, the previously not-registered mosaic floors were documented and all the pavements that had received first-aid treatment were traced. The provision of first-aid was initially concerned with the unearthing, the mechanical cleaning and the fixing and grouting of the tesserae. Moreover, in some cases, the immediate protection and the taking of temporary measures for the removal of water were necessary. There were several instances where the Department of Antiquities decided to rebury the mosaic floors. Subsequently, considering the problems that appeared in the mosaics and the visitor flow in certain areas, the development of the program for facing the corrosion and the conservation of the works began. The main deterioration problems of the mosaics were mostly caused by previous conservation interventions, and this “phenomenon" occurred in almost all cases. The majority of floors had been broken into smaller pieces due to mechanical stresses; they had been lifted and repositioned using reinforced cement-mortar in the substrata, and in most cases the detached areas had not been repositioned. The cement-mortars that were used both as substrata and as a peripheral securement created serious problems in the conservation process. They had been used in almost all mosaics and were in the form of reinforced mortar. In many cases, the metal components had become rusty and caused some upturning of the mosaics while the peripheral securement caused problems of fragmentation and detachment. In order to address these problems, there was a collaboration among several specialists (archaeologists, conservators, civil engineers). The substratum was maintained, the peripheral cement-mortar as well as the rusty metal components were removed, whereas the remaining ones were insulated with cement-mortar that had a low degree of hardness. The maintenance of the two-millimetre lime-mortar substratum was of crucial importance as it enabled the tessellation stratum to remain unaltered by the cement-mortars. Lime-mortar was used to fill in the lacunae on the level of the mosaics due to the fact that its characteristics bring no consequences upon the works and are in accordance with the specifications that the research had defined. This program was applied in 2003 at the "House of Eustolios" at the archaeological site of Kourion, where the floors were restored and a maintenance program concerning both floor mosaics and their new shelter followed. Thus far, no noteworthy problems have occurred while a series of measures for the maintenance of these interventions is taken on a yearly basis.

The second major problem that the mosaics faced was their uplift and slide because of permanent vegetation roots and the underground presence of rusting metal components. Furthermore, the habit of some tourist guides to step on the mosaic floors during their guided tours maximized the problem. Initially, the pavements were protected, and later on, the lacunae underneath were secured and an effort was made to bring the mosaics, at least partially, to their original state of preservation. The third important problem was the high level of salts which were turning into crust, and the development of numerous biological accretions which were handled by chemical and mechanical means. Since 2003, the pavements are cleaned twice a year for monitoring purposes.

Documentation

All the works of the above program were documented in conservation reports, photographic records of all of the stages of the conservation and restoration, schematic representations (Fig. 3), maintenance diagrams that document the stratigraphy of the floors, and corrosion diagrams that document the most important corrosions and the corrosive factors. All of the mosaic pavements that have been conserved at the archaeological sites of Kourion, Amathous, Palaipaphos, Akrotiri and Agios Georgios at the village of Peyeia, are approximately 200 and for each one of them there is a separate file in which all of the elements of their identity, all the problems that occurred during maintenance, the methods and the materials used for their conservation, as well as all of the protective measures that were taken along those that should be

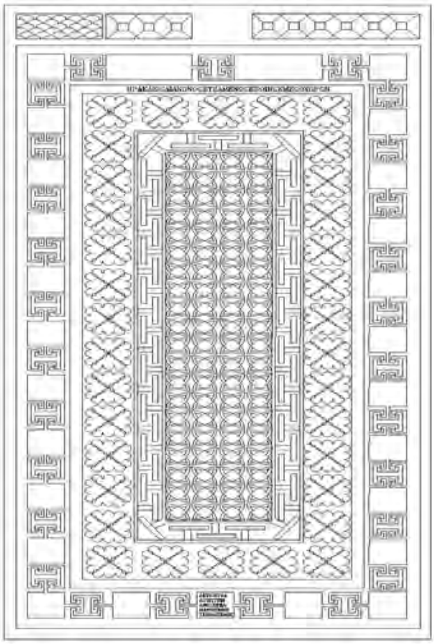

Fig. 3. Graphic representation of a mosaic floor from the Early Christian Basilica of Ayia Triada (E. Charalambous)

taken in the future are recorded. The corrosion diagrams played an important role in the conservation program because they form a useful tool both for detecting the problems and applying the proper measures, and for the improvement of the program. A team of experts inspects the mosaics and studies the conservation reports and the diagrams in order to evaluate the effectiveness of the measures taken and any problems that might have occurred due to the conservation procedures.

The conservation program did not present any originalities; it simply tried to follow all that conservation science advocates for the correct conservation and restoration of the mosaics. The program pays particular attention to the documentation of the proceedings, in order to develop, but also to help, the advancement of this discipline. This documentation is of great assistance to the long-term observation of the works, and to the changing of the maintenance provisions where this is necessary. Finally, part of the results of the research has been published (Charalambous 2009; 2007) and the other part will be published soon. They include countrywide results of all of the chemical analyses that provide information regarding the construction of the mortars. However, these results will be correlated with chemical analyses and the characterization of all the stones that have been used in the mosaic pavements of the island. This program will undoubtedly enhance the field of floor mosaic conservation. The archive for the preservation and maintenance of the mosaics of Cyprus has been digitized and will soon be registered in the database of the Department of Antiquities of the Republic of Cyprus. It is being developed and it will soon be available to every researcher. The conservation program is gradually being applied to all sites and, since the beginnings of March 2011, it is also applied in the "House of Dionysos" at Nea Paphos.

PROTECTION (SHELTERS)

It would be quite an omission not to refer to the shelters which were constructed above three *domus* that have mosaic pavements at the site of Kourion (Fig. 4). These shelters offer general protection from the main corrosive factors, climatic or other, which, however, should be improved in certain ways. Nonetheless, one needs to take into consideration the fact that a pioneering work of this type and scale has never before taken place in Cyprus and

Fig. 4. Kourion, the shelter over the "House of Eustolios" (photo: E. Charalambous/ Department of Antiquities of Cyprus)

thus, it is possible that it had weaknesses that should be judged accordingly. A first evaluation of the maintenance situation of the mosaics at the "House of Eustolios" according to the corrosion diagrams gives encouraging conclusions. Soon a second large project for the sheltering of the archaeological site of Nea Paphos (Fig. 5) will be initiated, where the vast majority of the mosaic floors will be covered. It is our belief that the problems occurring on this site will also be successfully dealt with. Another measure, that concerns the mosaic pavements that are not situated under the shelters, and is practised for the last two years by the Department of Antiquities, is the reburial of these floors (Fig. 6) during the winter period (see Charalambous and Lysandrou 2017). The reburial starts at the beginning of November and the uncovering at the beginnings of April, always depending on the weather conditions. Reburial protects the mosaics as much as possible, mainly from the frost and gives the chance to the team of experts to control and protect the pavements that are not buried during this same period. The aim of this reburial is to decelerate the corrosion procedure. The reburial consists of two layers: the first layer consists of a geotextile with a 90% covering, with which all the floors are covered. The purpose of this layer is to allow the drainage of the floor from rising humidity, to limit the excavated area from the protection layer and to obstruct, in a low grade, the development of vegetation. The second layer consists of ten to 20 centimetres of river sand; its function is to protect the monument from direct contact with and the action of rain water, to give stability to the work, to help it to adapt to the weather changes and to allow its drainage. An important factor in choosing the river sand is its purity. It should be without seeds and with low salt consistency. The Department of Antiquities has also reburied all the pavements that are located in archaeological sites that

Fig. 5. Nea Paphos, "House of Theseus", aerial photograph of part the the archaeological site that will be protected by the new shelter (photo: Department of Antiquities of Cyprus)

Fig. 6. Limassol, Akrotiri, Early Christian basilica, reburial of mosaic pavement (photo: E. Charalambous/ Department of Antiquities of Cyprus)

are not open to visitors and has also created temporary constructions to avoid floods during winter months. The Department of Antiquities gives particular importance to the conservation and maintenance of the mosaic floors and during recent years has developed important collaborations with other research centres that deal with research and diagnoses. Since March 2011, the program has been applied in the "House of Dionysos" at Nea Paphos, and the conservation of the mosaic floors, as well as the improvement and the aesthetic restoration of the shelter are due to be completed by the end of February 2012. This conservation program will also be applied to the remaining mosaic pavements of the Paphos archaeological site. Finally, particular importance is given by the Department to the third stage of the program, which regards the evaluation of the measures taken for the prevention of corrosions. Although there is still a long way ahead, we believe that we are on the right track.

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THE EMPÚRIES MOSAICS: FROM INITIAL RESTORATION TO TODAY'S NEEDS AND PROBLEMS

Sílvia Llobet i Font

Abstract

In the 6th century BC, traders hailing from Phocaea settled on the northern coastline of present-day Catalonia, founding the city of *Emporion*. This port would lend access to the first Roman incursion into Hispania in 218 BC. We may begin talking of a Roman city towards the beginning of the 1st century BC, which incorporated the earlier Greek settlement within its urban grid.

The enclave's systematic excavation commenced in 1908, and the presence of a large number of mosaics was documented early on. Their importance encouraged a conservational approach, as evidenced in the work conducted on the *Sacrifice of Iphigenia emblema* in the 1930s. From the 1940s onward, a series of campaigns focusing on the extraction and in situ re-laying of a large number of pavements was undertaken. Intermittent restoration work continued until the latter decades of the 20th century.

Taking a global look at all conserved mosaics, a project was drawn up in an effort to begin a new phase in the documentation, study and restoration of these highly complex monuments.

In an article such as the present, which discusses archaeological sites with mosaics, we believe that the Empúries site (Fig. 1) represents an extremely interesting example given its urban complexity, the number of preserved mosaics and the long archaeological tradition which began in 1908.

Empúries: From Phocaean Colony to Gateway of Romanization

In the early 6th century BC, traders from Phocaea established the first commercial settlement on the north coast of present-day Catalonia, which, by the mid-6th century BC, would become the city of *Emporion*. Today, this initial Greek nucleus is known as Neapolis. The first Roman incursion into Hispania took place in 218 BC, when troops led by Gnaeus Cornelius Scipio ventured inland to eliminate Hannibal's rear-guard. From this point forth, Empúries would become the gateway of Romanization of Hispania. Marcus Porcius Cato disembarked in 195 BC and set about controlling the territory. He later established a military settlement on a hill in the western part of the Greek city, from which he commanded the Empúries port and protected one of his initial ports of entry into Hispania. In the early 1st century BC, this initial camp became a planned city that incorporated the earlier Greek city, still an active harbour district, into its urban structure. The vast tract of land occupied by the Roman city was compartmentalized into an orthogonal grid plan based on rectangular insulae, forming an urban layout that, right from the beginning, earmarked a location for public areas.

Fig. 1. General view of Ampurias, Roman city (left) and Neapolis (right) (photo: MAC-Empúries Archives)

Only two of the residential insulae have been excavated, those known as *Domus* 1, 2A and 2B. That said, we must remember that, as of today, and despite the site's long archaeological tradition which began in 1908, only 20% of its urban area has been uncovered. The Roman city was gradually abandoned in the latter half of the 3rd century AD (Aquilué *et al*. 2012).

THE EMPÚRIES MOSAICS: A REPRESENTATIVE COLLECTION OF ROMAN MOSAICS FROM THE 2ND CENTURY BC TO THE 2ND CENTURY AD

Exhaustive archaeological excavations have unearthed a large number of mosaics dating between the 2nd century BC and the 2nd century AD. From the large collection of *signina* discovered in both Neapolis and the Roman city, most tesserae are arranged in geometric or floral patterns, while inscriptions and marble incrustations are also occasionally found. *Opus tessellatum* floors also abound. Prominent examples include the large collection of bichrome mosaics from the Roman city, as

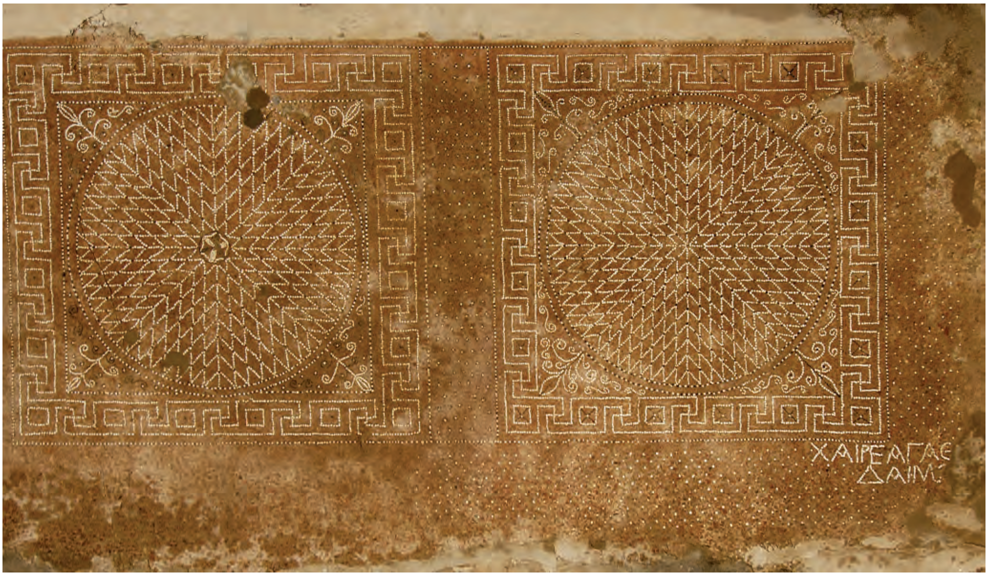

Fig. 2. *Opus signinum* from Neapolis decorated with geometric and floral designs in black and white tesserae and an inscription in Greek (photo: MAC-Empúries Archives)

well as the fewer examples of polychrome mosaics. Lastly, we must mention the *opus sectile* pavements (Pérez Olmedo 1996, 113-120) and the *emblemata* in *opus vermiculatum* (Balil 1962, 41-52).

We begin the descriptive itinerary by examining the surviving mosaics from Neapolis, where diverse types of housing dating to the final construction period, 2nd-1st centuries BC, have been documented (Aquilué *et al.* 1983, 134-135). In these simple buildings, the rooms are distributed around open-air centres structured like small courtyards. Prominent examples include simple buildings positioned around a small Tuscan atrium or tetrastyle portico, or other more complex examples, such as dwellings structured around larger porticoed courtyards reminiscent of Hellenistic houses with a peristyle (Santos 1998, 556-559; 1991, 20-21). While decorative remains from houses in Neapolis are scarce, 40 pavements still remain in varying degrees of conservation (Cortés 2009, 451). Examples include the *signina* decorated with black and white or, to a lesser extent, ceramic tesserae, arranged into geometric compositions or, on occasion, bearing inscriptions with greetings or good omens in Greek (Olmos 1989, 43-57; Mar and Ruiz de Arbulo 1989, 61-65) (Fig. 2). The same goes for *opus scutulatum* or *tessellatum* pavements combined with *signinum*, as is the case with the pavement from the Temple of Asclepius, dating between the late 2nd and early 1st century BC. In this case, we must note the recovery, in 1913, of the *emblema* known the "mosaic of the fish" (1st century BC), a remarkable example of the Hellenistic mosaic tradition. Moving to the Roman city, it should be pointed out that, of the total number of insulae occupied by dwellings, only three on the eastern flank have been studied so far. One of these insulae, the one known as *Domus* 1, contains a total of 30 surviving mosaics (Cortés 2009, 182-183), while the other two, *Domus* 2A and *Domus* 2B, have seven (Cortes 2009, 198) and 18 (Cortés 2009, 208-210) respectively. Much in the same manner as in Neapolis, these pavements display highly distinct degrees of conservation, based on their location, the time at which they were excavated and the conservation or restoration treatments performed over the years. The three *domus* were modified and enlarged in subsequent construction periods, as evidenced by the pavements which decorate the rooms (Santos 1991, 22-33; 1998, 559-565). The phases currently visible correspond, essentially, to two distinct periods (Mar and Ruiz de Arbulo 1993, 390-397). The first is fruit of a Republican Era (1st century BC) refurbishment, when the houses conformed to the Italic housing model with a central atrium. To this period date *signina,* with white or black and white tesserae arranged in geometric patterns, and also other types of mosaic, such as the *opus scutulatum* in the *impluvium* in *Domus* 1. Another prominent example dating to this period is the magnificent collection of *emblemata* from the latter half of the 1st century BC. These are Hellenistic-style copies, products of the same workshop, depicting a theatre mask, a cat attacking a bird, and a partridge picking a necklace out of a pyxis in its beak. Salvaged from *Domus* 1, they were set in white tesserae pavements with very simple black decorative strips (Balil 1962, 41-52) (Fig. 3). As well as these *emblemata*, we must also mention the famous *emblema* depicting a theatre performance of the Sacrifice of Iphigenia in Aulis (Fig. 4), discovered in a house in the Roman city that is yet to be excavated (Elvira 1981, 3-25). The second visible phase dates to the First Imperial Era (1st century AD), a time at which changes to the city's urban layout affect its domestic architecture. The more affluent houses, in this case *Domus* 1 and *Domus* 2A, build new wings and meeting rooms situated around porticoed areas with gardens. The decoration and techniques used on the pavements and mural paintings (2nd Pompeian style) represent the prevailing architectural trends of the day. *Domus* 1 is home to a significant collection of surviving bichrome mosaics (Fig. 4) from this period with diverse geometric designs (Tang 2005, 137-138), constituting one of the earliest examples of the influence that Italian black and white mosaics with geometric designs exerted on the western provinces. We can also mention other, less well-preserved examples of *opus sectile*, as well as polychrome *emblemata* with compass rose motives in the centre of *signina* pavements, from a phase postdating the 1st century AD. Other significant pavements from the Roman city can be found in Insula 30, half the surface area of which is occupied by a large public building: the city's thermae. The *apodyterium* is particularly remarkable and home to an *opus tessellatum* pavement with geometric designs from the late 1st century AD, dominated by a large central medallion depicting a triton and a dolphin (Aquilué *et al.* 2006, 208). To the south of this insula there is a Late Republican house with *signina* pavements in the atrium*, tablinum* and triclinium, all decorated with white tesserae and geometric designs. That said, the latter room also features plant motifs and a silhouetted dolphin. We conclude our tour of the Roman city in the Imperial Forum and,

Fig. 3. Close-up of area 23 of *Domus* 1, where the theatre mask *emblema* was discovered in situ in the 1940s (photos: MAC-Empúries Archives)

Fig. 4. Close-up of the Sacrifice of Iphigenia in Aulis *emblema*, discovered in the late 19th century in a Roman city *domus* yet to be excavated, and several preserved black and white mosaics from *Domus* 1 (photos: MAC-Empúries Archives)

more specifically, by exploring three of its *tabernae*. These establishments house three pavements from the late 1st or early 2nd centuries, two remarkably well-preserved *opus sectile* mosaics (Aquilué *et al.* 2004, 41) and an interesting polychrome *tessellatum* which depicts Silenus at a symposium and a krater with curved handles, among other motifs (Aquilué *et al.*, 1984, 93-97) (Fig. 5).

Fig. 5. The polychrome mosaic from the Forum in Ampurias: the new reinforced cement support installed in the 1990s; its condition after being re-laid in 2005; and a close-up of its decoration (photos: MAC-Empúries Archives, Sílvia Llobet)

The History of the Mosaics, from the initial, late 19th century discovery to today

In the first decade of the 20th century, a political and cultural movement called *Noucentisme* advocated a nationalistic and revivalist attitude towards Catalan society and culture and based its ethos upon two concepts: Classicism and "Mediterraneity". This premise prompted a number of significant cultural initiatives, including the Barcelona Museums Board's initial purchase of lands in Empúries in 1908, at a time when they were still privately owned. These events would spur the site's systematic excavation, a project headed by the architect Josep Puig i Cadafalch (1867-1956), a Catalan architect, historian and politician, who would become the director of the excavations, and the archaeologist Emili Gandia (1866-1939) (Oliveras and Santos 2008, 17-21), a Conservator from the Museum of Decorative Art and Archaeology of the City of Barcelona, who organized the workers and the site, launching a mammoth project that continues to this day. To keep accurate records and refrain from forgetting a single detail, Gandia started keeping excavation journals in 1908. These reports contain an exhaustive account of the archaeological progress that was made and the structures that were uncovered over almost 30 years and remain one of the most important documentary sources of information about Empúries.

That said, a series of non-scientific and uncontrolled excavations preceded this archaeological endeavour, as the site's relevance was patently obvious. The large number of mosaics that have been discovered since the early years (Oliveras and Santos 2008, 23; Monturiol 2008, 30-31) prompted the decision to launch conservation initiatives. For example, we know that, in 1851, a sturdy, enclosed shed was built in the room where the Sacrifice of Iphigenia in Aulis *emblema* was discovered in order to protect it from thieves and unauthorized access (Buscató and Pons 2002, 204). Furthermore, in 1905, excavations on private land unearthed part of the black and white mosaics from *Domus* 1 (Oliveras 2008, 16), a property not purchased until 1921. Several years later, in 1932, the *Museo de Arqueología de Catalunya* was founded in Barcelona, at which point regular restoration work at Empúries began. These efforts were directed by the Barcelona museum's conservator Francisco Font Contel (1893-1957) (Gracia 2002, 102), who engaged in on-site restoration until his passing away. Emili Gandia continued to organize the excavations until 1939. In 1935, he directed the excavation of several rooms in the northeast of Neapolis, salvaging a large number of *opus signinum* mosaics with tessera incrustations, one of which bore the Greek inscription *Xaire Agathos Daimon*; while in 1936, despite the armed conflict (Monturiol 2008, 28-29), he continued to work in *Domus* 1, where he discovered new *opus signinum* and *tessellatum* mosaics with remnants of central *emblemata*. With the outbreak of Civil War, the excavations came to a halt in 1937 and did not resume until the conflict ended. This same year, as a precautionary measure, all mosaics were covered and protected with earth, while the Sacrifice of Iphigenia in Aulis *emblema* was lifted and transferred to the *Museo de Arqueología de Barcelona*, where it was restored (Buscató and Pons 2002, 208; Barral 1989, 94-99). During the restoration, its original limestone support was replaced with a cement slab and the lacunae were reintegrated in a rather crude fashion. In the 1940s, the dictatorship's governing bodies named Martin Almagro (1911-1984) director of the *Museo de Arqueologia de Barcelona,* lending him complete control over Catalan archaeology (Tremoleda 2008, 34). Under his supervision, all discovered mosaics underwent a comprehensive restoration, with records showing that the

Fig. 6. Original condition and the lifting and re-laying (in the 1940s) of the mosaic from area 40 of *Domus* 1 in the Roman city (photos: MAC-Empúries Archives, Memorias de los Museos Arqueológicos Provinciales)

first mosaics were lifted in 1940 (Almagro 1941, Sheet XIV), an activity which intensified until the 1950s. The project was mainly concerned with the lifting, a common practice at the time, of virtually all preserved *tessellata* from the Roman city (Fig. 6). The workload forced them to hire, aside from the aforementioned Francisco Font, outside conservators. To the team were subsequently added three civil servants dependent on the *Dirección General de Bellas Artes* and the *Museo Arqueologíco Nacional* in Madrid: Adolfo Maragliano, Francisco Cruzado (Dávila and Moreno 1993, 159) and later Juan Antoni Díaz Pintado, a conservator at Mérida. These individuals formed part of a team of professional mosaic experts who travelled the peninsula lifting and restoring mosaics. We can, therefore, begin to talk about the professionalization of this profession at this time. Finally, in 1944, the team welcomed the site's first conservator, Domingo Gamito, who would work there until 1993. In 1950, Josep Calassanç Serra-Ràfols (1902-1971), archaeologist and curator of the Classics Department at the Archaeology Museum of Barcelona, published a fascinating article (Serra-Ràfols 1950, 48-53), in which he discussed the manner in which conservators should proceed and also the countless problems encountered in the course of their work, making reference to Font, Maragliano and Cruzado. Serra-Ràfols gave an account of how mosaics were lifted, a process that began with a "fairly aggressive" cleaning of the mosaic surface. The pavements were then faced with burlap and strong glue and lifted using the rolling technique or chisels. The instructions for the latter procedure are quite clear: remove only the layer of tesserae. The detached mosaics were then transferred to the workshops, where they were broken apart, if still in one piece, and consolidated on top of a new reinforced cement support. Yet, as described below, strangely enough the Empúries mosaics were not reinforced with metal elements. Actually, we know that F. Cruzado and A. Díaz Pintado worked on the Cosmological Mosaic in Mérida in 1968, which they lifted and re-laid in situ atop concrete with no metallic elements, and that they spread the bedding layer over a layer of lime and a small amount of cement (Lancha and Gago 1985, 46-47), a technique, as described below, that they had used at Empúries years earlier. The Empúries mosaics lifted at this time using the above-mentioned procedure were re-laid in their original location on new floors. In 2010, a series of sondages helped us determine the stratigraphy for the new supports on which the mosaics were re-laid, which display the following sequence:

<u>Layer A</u>: The bottom level consisting of a preparatory layer for levelling the ground with stones and sand.

<u>Layer B</u>: A middle layer of Portland cement and gravel with distinct grain sizes.

<u>Layer C</u>: The tesserae bedding layer consisting of Portland cement and lime mortar. A large proportion of lime was added to keep the mortar from setting too quickly and extend the work time.

Other restoration activities were also performed at this time. Reports indicate that in 1944, the *emblema* depicting the theatre mask, discovered in situ in a room of *Domus* 1, was lifted and restored in the Barcelona workshop (Almagro 1945, 110). The original limestone support, however, was preserved. The partridge, the cat attacking a bird and the fish *emblemata* – all discovered out of context, the first two in *Domus* 1 and the third in Neapolis – were also likely restored at this time, likewise preserving their original supports. In all the above instances, the lacunae were integrated with the same techniques that the Museum's Barcelona workshop, headed by Francisco Font, used on the Iphigenia *emblema*. Lastly, we must also mention that the majority of *signina* from the Roman city and Neapolis also underwent a treatment that included cleaning and consolidating and reintegrating missing parts with cement. The next documentary reference takes us to 1971, at which point the initial team had dwindled down to Adolfo Maragliano and Domingo Gamito. At this time, thanks to the latter's testimony and the significant photographic archives he provided, we know that several bichrome mosaics from *Domus* 1 were displaying signs of bulging and had to be treated. Aside from this, they used this occasion to integrate with tesserae lacunae that had been filled with Portland cement during the lifting and re-laying process. A new conservator from the Barcelona branch of the Archaeology Museum of Catalonia named José Pedro began working at Empúries in the early 1970s. He would work on a number of campaigns during

Fig. 7. Lacunae reintegration (in the 1970s) in area 9 of *Domus* 2A in the Roman City (photos: Mac-Empúries Archives)

his 40 years at Empúries and inherited his knowledge of mosaic restoration from the, by that point, aged Adolfo Maragliano. He continued to integrate the preserved bichrome mosaic from *Domus* 2A (Fig. 7) with tesserae, and lifted the polychrome mosaic from the Forum, the only mosaic with a new support reinforced with an iron mesh (Fig. 5). José Pedro coordinated the restoration works of the EMPORITON School and Workshop in 1994 and 1995. The course taught students how to document, restore and consolidate *tessellatum* and *signinum* pavements (Coma *et al.*, 1996, 45-46).

The current century has ushered in a new way of approaching the site's conservation; one in accordance with the new international policies promoted by organisms like the ICCM. Mosaic detachment is no longer an option. The use of natural materials that are compatible with the original materials will be staunchly upheld and new reintegration and museum conservation criteria established. We must briefly mention several interventions from the 21st century's first ten years, which adhere to these new policies, including interventions on the *apodyterium* mosaic from the public thermae, by the conservator Margalida Munar in 2003, the *opus sectile* pavements from the Forum in 2004 and the *signina* in the Late Republican *domus* in the south of Insula 30 in 2006, all carried out by the company Àbac. Conservació-Restauració, SL.

The Mosaics Today: State of conservation and short- and long-term action plan

In 2010, the Museum's team of archaeologists, in conjunction with the conservation company Àbac, debated the manner in which to approach the mosaics' conservation and the immediate and long-term steps to take. Over the past 15 years, this vast number of mosaics has not been subject to any kind of comprehensive restoration, maintenance protocol or intervention. To kerb this situation of idleness, we decided to launch a project aimed at introducing a new period of documentation, study and conservation for the entire collection of mosaics at Empúries.
To undertake these tasks in an efficient and orderly manner, we established a plan of action which outlines the work that needs to be performed with no set time frame, as this depends on annual funding. Conversely, our general principles have been clearly defined, as have the conservation processes which will ensure the safeguarding of this important collection, and underscore its value; principles which have also made us rethink museum conservation and encourage studies that spread and increase knowledge about these mosaics. We shall provide a general overview of the established protocol below, a number of phases of which are already underway.

a. Documenting and studying the state of conservation

We intend to produce an assessment on the state of conservation of each surviving mosaic. With regards to this process, data is currently being collected in situ using records which chronicle any existing pathologies or damaging agents.
Initial results reveal the serious condition evidenced by all bichrome mosaics in *Domus* 1, with obvious bulging problems resulting from microbiological growth (today in an advanced stage) caused by years of conservation stagnation and a high degree of moisture. One has to remember that the mosaics are exposed to harsh climatic conditions and are located near the coast. Aside from this, we have identified other commonplace pathologies among unsheltered mosaics in the open air, such as lacunae, detached tesserae and detachment between layers, which lead to structural instability, along with disaggregated tesserae and damage from earlier interventions, many of which have become obsolete or no longer serve a purpose. In addition to the latter, an analysis of the pathologies by professionals from other fields has also been performed. Although these assessments have already begun, they must be redefined as conservation moves forward. The initial analyses from 2011 have already provided us with a number of initial conclusions:

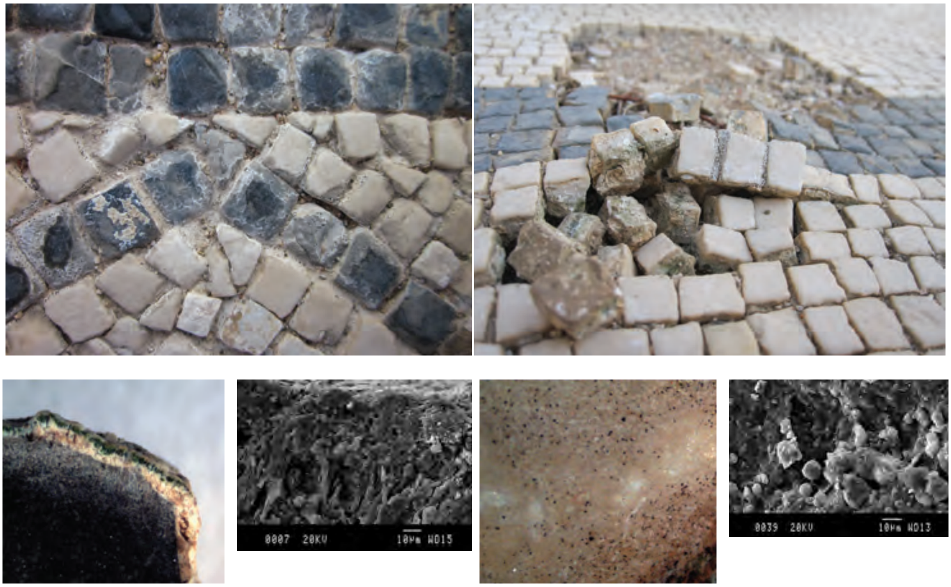

Fig. 8. Areas affected by microbiological growth and the resulting bulging issues; and close-ups of the microbiological growth and scanning-electron microscope photomicrographs of both a white and black affected tessera (photos: Sílvia Llobet, Patrimoni 2.0 Consultors SL)

Firstly, with Patrimoni 2.0 Consultors SL, we analysed four tesserae (two of white marble and two of limestone) from areas where bulges had been identified in *Domus* 1 (Fig. 8). In these cases, the mortar between the interstices and in the bedding layer has been colonized by microbiological organisms (fungi, algae and lichens). The mortar's microbiological growth also affects the tesserae, as the microbiological organisms secrete acids which attack the mortar and alter it through corrosion. With respect to the formation of bulges, which affect a large number of *tessellata*, we have confirmed that this phenomenon is induced by the stress that the growth process of the microbiological organisms (particularly lichens) exerts on the mortar between the interstices: given the large number of interstices, the sum of the stress produced in each joint is enough to expand the mosaic's surface, pushing the tesserae upwards. Secondly, we have analysed samples of black tesserae which show highly advanced disaggregation (Fig. 9). This highly porous sandstone contains variable amounts of clay. The clay content makes them susceptible to water, the cause behind this visible degradation. The distinct types of clay experience wet-dry cycles that lead to changes in volume, producing stress inside the stone which eventually causes granular disaggregation and material loss. Aside from studying and documenting the state of conservation, appropriate graphic documentation must be made during mosaic intervention. We plan on producing orthophotographs and tracings, which will form the basis for plotting data on maps and drafting a

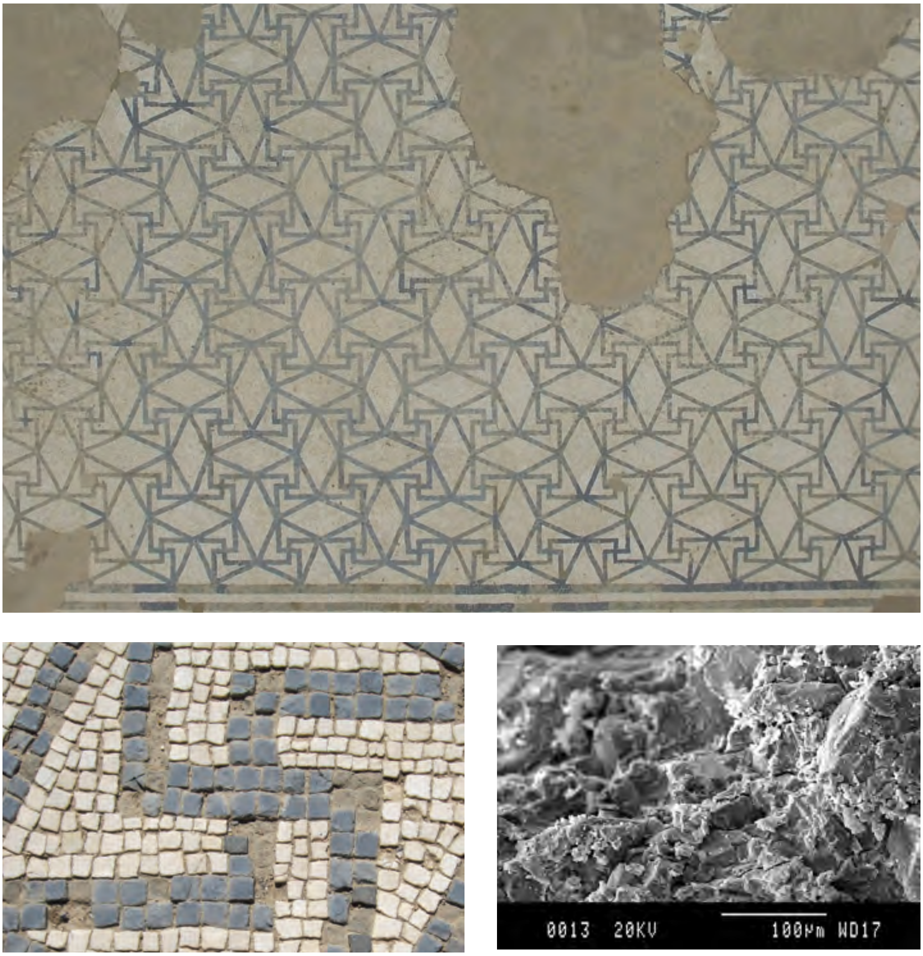

Fig. 9. Disaggregated sandstone tesserae from area 50 of *Domus* 1, and a scanning-electron microscope photomicrograph of one of the affected tesserae (photos: Sílvia Llobet, Patrimoni 2.0 Consultors SL)

historical study. In the summer of 2011, we took orthophotographs of the poorest conserved mosaics in *Domus* 1. We have since used these photographs to produce alteration maps that illustrate data such as state of conservation, earlier interventions and recent conservation efforts (Fig. 10). All of this collected data must be entered into a database that should become our primary assessment tool. This database has not yet been designed, as we are waiting to further our work and adapt it to our needs. It should be mentioned that in 2016, and since the presentation of this paper at the ICCM conference, the database has been completed and implemented.

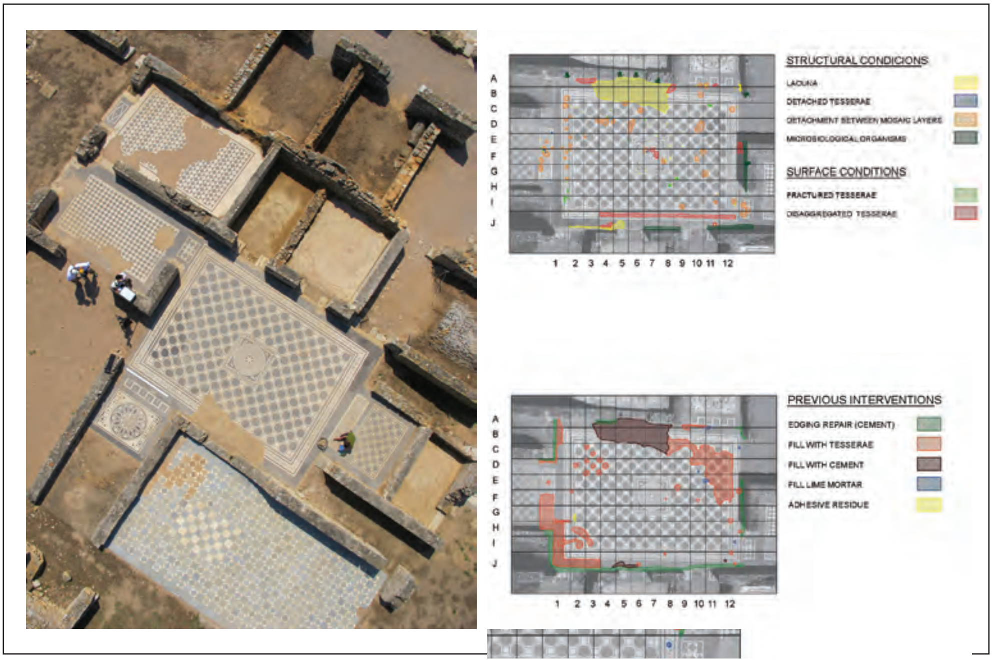

Fig. 10. Documentation work from 2011: orthophotographs and plans charting the original condition and previous interventions (photo: Des del aire)

b. Conservation and restoration initiatives

Due to progress made in assessing the state of conservation and the results from the analytical evaluations, the first emergency conservation initiatives were scheduled for 2011. These campaigns must be performed annually in the spring and summer, the time at which the mosaics are uncovered, since they are systematically covered during winter and autumn.

These initial initiatives included routine conservation and restoration, such as cleaning, biocide testing to deter microbiological growth, consolidating and resetting bulged areas with natural mortars (Fig. 11). It also involved the initial efforts to replace the repair cement from lacunae and edging with natural mortars, as this cement is in extremely poor condition and its appearance is highly questionable.

c. Maintenance initiatives: Following restoration, which is scheduled to last at least five years, we must introduce initiatives to maintain and monitor the state of conservation of each mosaic. From a conservator's point of view, conservation will be worthless without these initiatives. However, we are also aware that the reality of the situation does not always match these principles and that their safeguarding will depend on the funding the Museum provides for these activities; activities which are exceedingly important for the collection's conservation.

Fig. 11. Conservation work from 2011 on a black and white mosaic from *Domus* 1: application of a biocide, setting bulged areas with natural mortars and re-laying detached tesserae (photo: Sílvia Llobet)

d. Historical study

The study on the history of the mosaics, which was briefly touched upon in this article, must continue with collecting data, as it is tantamount to identifying the treatments each mosaic has undergone since its unearthing, and understanding the source of the current degradation. As is to be expected, the documentation on restoration from a considerable part of the 20th century is very sparse. Insofar as our project is concerned, our documentation comes mainly from archaeological publications, photographic archives and testimonies from the few participants who can still provide vital information through their accounts.

Furthermore, several members of the team involved in this project are scheduled to begin work on the Empúries mosaics corpus, which could prompt other studies that delve further into this collection. In fact, while exhaustive studies have been set in motion on several occasions (Barral 1980, 463-465), most of the preserved mosaics remain unstudied to this day.

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AN APPROACH TO THE MANAGEMENT OF MOSAICS THROUGH PRELIMINARY CONDITION AND RISK ASSESSMENT

John Stewart

Abstract

Condition surveys of mosaics are considered the responsibility of specialist conservators, who are indeed required to record and decipher complex conditions. However, other professionals responsible for archaeological sites can be trained in the survey process, specifically for preliminary regional surveys of mosaics or routine monitoring on site. This is also about empowering them in a measured way to make decisions that can preserve mosaics through simple and appropriate interventions, recognising problems and applying practical solutions.

Introduction

Condition surveys are acknowledged as an essential component of good conservation planning and management of archaeological sites. They are critical to the decision-making process. On sites or in regions with many mosaics, they are fundamental in establishing sound conservation programmes, based on accurate priorities of intervention.

Such surveys are usually understood as an activity undertaken by specialist conservator-restorers, and this is reinforced in professional publications. In this paper a complementary perspective is offered, in terms of preliminary or rapid condition surveys, undertaken by other professionals, such as archaeologists and those responsible for sites (curators, 'site managers') (Fig. 1). It reviews:

– levels of survey
– professional expertise and training
– complementary training components

Preliminary surveys are certainly undertaken elsewhere for understanding cultural heritage, as for historic buildings or museum collections. The methodology of the preliminary survey presented here has been developed by the author on projects in various countries, and on courses of ICCROM (International Centre for the Study of the Preservation and Restoration of Cultural Property, Rome) and The Getty Conservation Institute in association with the Institut national du Patrimoine of Tunisia. One of these courses was part of the MOSAIKON initiative (of ICCROM, the Getty Conservation Institute, the ICCM and The Getty Foundation), which aims to raise standards of mosaic conservation in countries of the eastern and southern Mediterranean (Teutonico and Friedman 2017; Dardes *et al.* 2010).

Managers of archaeological sites with mosaics face formidable challenges. How is one to cope with these complex and fragile features, particularly when they are very numerous? Often, the person responsible for a site (the 'site manager', or the like) does not have sufficient experience or confidence to

Fig. 1. The level or depth of inspection of a mosaic condition survey depends on specific circumstances and objectives. The amount of survey information previously gathered, the significance of the mosaic, its condition and risk environment all inform the level of survey that is appropriate for a particular case (© John Stewart)

make conservation decisions, or sometimes does not have the authority to do so. If foreign archaeological missions are present on a site, responsibility for technical decisions is usually devolved to them, particularly if they include a conservator-restorer of mosaics. However, parachuting foreign professionals into a site to deal with specific problems for a limited period of time is not, of course, a sustainable solution.

As a result there is usually a state of paralysis in the conservation of mosaics in situ. To move beyond this situation, some compromize is essential. This means accepting existing constraints, and working with them, in order to empower those responsible for sites as much as possible. Managers should be able to make basic conservation decisions and undertake simple interventions, with a sound understanding of mosaic conditions, their risk environment and their cost.

In some countries there may exist a published inventory, or corpus of mosaics, normally undertaken by archaeologists/art historians. If this is not the case, formation of a corpus may be in progress. Any such inventory of mosaics should form part of a country's *Sites and Monuments Record*, a record of national archaeological resources. The inventory assigns unique numbers to sites, buildings, rooms and specific features (as mosaics); such unique numbers can be employed for identification of mosaics in the condition survey. Where no such inventory exists, the condition survey will have to assign unique numbers to the mosaics inspected.

This paper addresses the survey of mosaics, but archaeological sites usually possess other pavements of importance that may be decorative (*opus sectile*) or utilitarian (*opus signinum*). These need to be inspected as well.

Levels of Survey

As previously stated, the condition survey of mosaics is associated with professional conservator-restorers, in terms of a very detailed inspection. In reality, there are several levels of survey or inspection, and each one requires different types of expertise. These can be represented conceptually by means of a simple inverted triangle, consisting, for example, of three levels of assessment: preliminary, detailed and specialist (Fig. 2). There is no standard nomenclature in cultural heritage for these different levels of survey, and indeed there are variations in terminology between different professions. All condition surveys of mosaics, irrespective of their level, normally distinguish between conditions on the surface (the *tessellatum*), and those affecting the structure (the mortar support).

Preliminary surveys are critical in collecting information for a large number of mosaics. They assist planning by:

- documenting global mosaic resources where such information has not yet been compiled, is outdated and/or incomplete
- identifying further survey requirements
- establishing conservation priorities

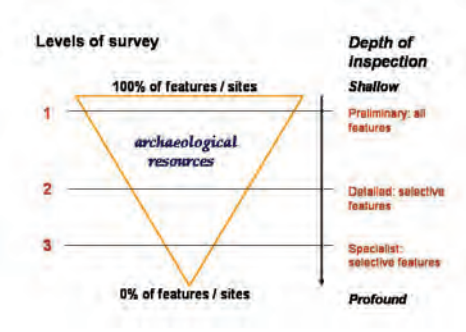

Fig. 2. A schematic representation of levels of condition survey, relating the depth of survey to the relative percentage of cultural features (e.g. mosaics) encompassed. At the top is the totality of features, all requiring preliminary inspection. More detailed surveys (moving down the triangle), where required, involve a diminishing number of features, greater depth of inspection, time, expertise and cost (© John Stewart)

They also identify urgent problems that can be resolved before undue damage to a mosaic can occur (such as closure of access, stabilization, support, reburial).

In order to encompass all mosaics of a site or region, preliminary surveys need to be *shallow* in depth, with little detail, so they can be completed in a cost-efficient and timely manner (*Level 1)* (Fig. 2). They can be undertaken by professionals with basic conservation training, as explained below. Complementary documentation can be by means of sketches or digital photographs. Any existing plans can be used as a graphic base to record specific conditions, but the preliminary survey should not require the execution of measured drawings or rectified photographs, as this is counterproductive to the intended economy and speed of the exercise.

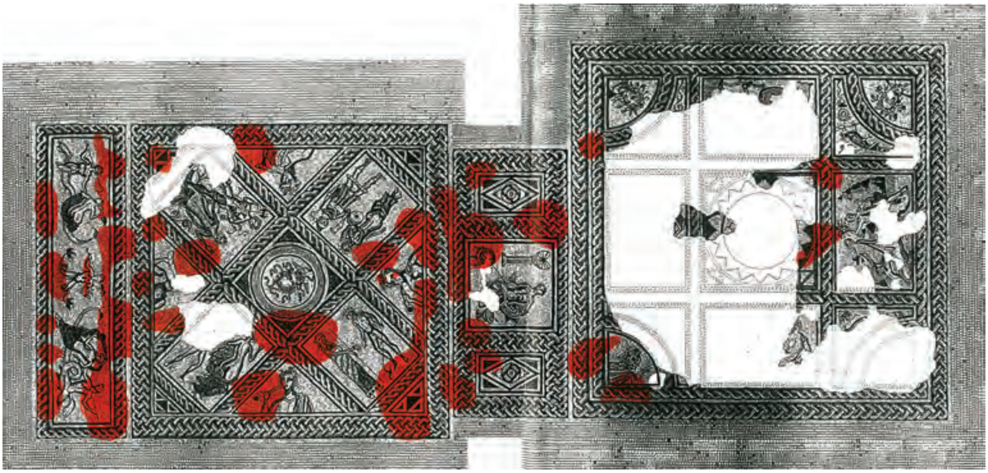

Fig. 3. A detailed condition survey identifies materials, past interventions and different forms of deterioration as precisely as possible, by visual inspection. Here, the location of bulges or detachment of the *tessellatum* is indicated in red. This requires methodical tapping of the entire mosaic surface, which, on a large mosaic as this, can take many hours, or even days, to record. Other forms of deterioration are also recorded with a graphic key to describe them. On a large mosaic with complex conditions, the execution of a detailed survey can easily take one conservator a week or more (© Historic England)

Preliminary surveys also identify mosaics that are of higher significance and whose condition requires more in-depth inspection (the 'detailed survey' *Level 2*) (Fig. 2 and 3). One model is the documentation methodology developed by The Getty Conservation Institute for training mosaic technicians of the Institut national du Patrimoine of Tunisia (Roby *et al.* 2008). The didactic materials are available in English, French and Arabic on the Getty's website (Getty Conservation Institute, 2011). The suite of condition survey forms consists of twelve pages.

Detailed surveys carried out by expert conservator-restorers are more time-consuming than preliminary surveys and they also require accurate graphic images (metric survey drawings or rectified photographs) on which to record observations. Therefore, they are much more expensive than the preliminary survey, and consequently should be undertaken where most needed, so that funds available are used prudently.

Of these significant mosaics subject to detailed survey, an even smaller number may be affected by very complex deterioration processes, and are at severe risk of loss. These require specialist diagnostic investigations (*Level 3*), as represented by the narrow base of the inverted triangle (Fig. 2), such as: material analysis; impulse radar investigation (to detect voids or discontinuities in masonry); or geological prospection of ground conditions. They are also expensive, but are only needed for a very small number of mosaics.

Both preliminary and detailed surveys should also include an analysis of existing and potential levels of risk specific to each mosaic, to define its 'risk environment'. This includes local climactic factors (seasonal flooding, fire, etc.), contextual factors (slope erosion, unstable perimeter walls, etc.) or human activities (abrasion by footfall, vandalism or theft, etc.). The condition of a mosaic, in association with its level of risk, ultimately defines its inherent *vulnerability* to deterioration and loss.

These assessments should also be underpinned by identification of the relative *significance* of each mosaic, which is usually defined by the rarity of its iconography, materials, technique or level of craftsmanship (e.g. the size and density of tesserae), within a geographical area. This may be obvious or may require expert art historical appraisal.

Vulnerability and *significance* assessments should form the basis for conservation decision-making and prioritization of interventions for large numbers of mosaics.

For data collection, all surveys benefit from the use of standardized terminology, so that the description of specific features of mosaics and forms of their deterioration is clear to current and future users of the survey data (Getty Conservation Institute, 2003). Similarly, the development and use of standard *pro forma* survey forms, using standard terminology, ensures that information is recorded consistently by different surveyors. Data can be classified in a meaningful way so they can be entered into a customized database, which can then be sorted to define conservation priorities and programmes of intervention.

Professional Expertise and Training

Conservation professionals, such as conservator-restorers, surveyors or architects move effortlessly between the preliminary and specialist survey levels in assessing cultural heritage. However, the engagement of other professionals responsible for sites to undertake preliminary surveys is a logical deployment of an untapped resource. Archaeologists, for example, are trained to apply acute powers of observation to physical phenomena; others, whether they be dedicated 'site managers' or curators, may have an intimate understanding of their site and its attendant risks (e.g. areas prone to seasonal flooding, visitor patterns and behaviour, etc). As deterioration and conservation of archaeological features (as mosaics) is not part of the curriculum of their university courses in archaeology, history or art history, this needs to be conveyed to them by other means. This is essentially about teaching them to read and understand the deterioration of archaeological remains through a different visual 'filter' (Fig. 4).

A methodology for the preliminary survey of mosaics was applied in courses of ICCROM's ATHAR programme, at Byblos, Lebanon (2005) and Amman – Madaba (2007), both attended primarily by archaeologists and architects (Fig. 5). On each course, participants undertook preliminary condition surveys of mosaics, each with distinct conservation problems. After the survey of the mosaics at Madaba, participants developed a prioritized programme of intervention for all the mosaics inspected, based on their significance, condition and the appropriate priority of intervention. Some participants expressed that this was the first time they had experienced a methodology that gave them an understanding of an entire site and a logical means to address conservation planning.

In 2009, a group of conservation professionals collaborated with Tunisian archaeologists, site managers and architects to formulate a preliminary conservation proposal for the site of Thyna in eastern Tunisia. This was an initiative of the Institut

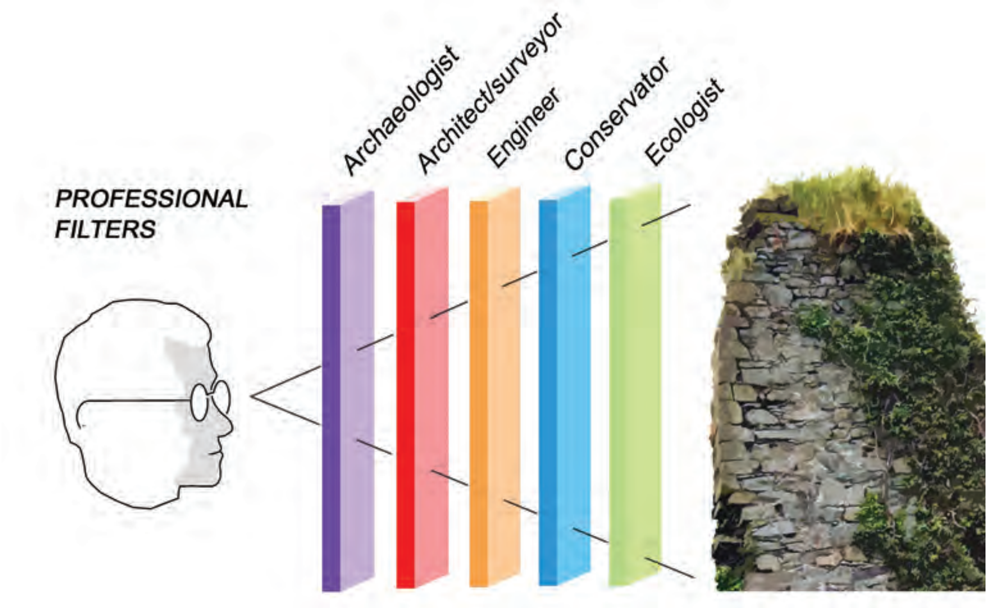

Fig. 4. Practitioners from different professions initially perceive a particular feature (e.g. a ruined wall) in terms of its basic materials and composite structure. However, training in one profession develops the reading of specific phenomena through an interrogative 'filter', distinct to the profession. An archaeologist seeks to determine phasing of construction and sources of materials; an architect or engineer assesses structural stability; a conservator its material condition and relative deterioration patterns, and an ecologist identifies flora and fauna. They all require keen powers of observation and deduction. By means of training, practitioners from one profession can learn to read different types of phenomena, at least at a basic level, through the 'filter' of another (drawing Iain McCaig, © Historic England)

national du Patrimoine supported by The Getty Conservation Institute. Over the course of eight days, preliminary condition surveys were carried out for all 18 structures of the site, many with mosaics. Interventions for each structure were subsequently proposed (Fig. 6). This was articulated into a programme of intervention, based on an understanding of significance and condition of each structure and its attendant risks. The urgency of intervention for each structure across the entire site was collectively discussed and agreed (Fig. 7). At the end of the workshop this information was collated by Tunisian colleagues to develop a general conservation proposal for the entire site. Obviously, such a proposal based on a preliminary survey is only a foundation for further detailed investigation and planning (including the costing of proposed interventions). However, this proposal is a significant accomplishment for a group of archaeologists, site managers and architects, with little or no previous experience in conservation planning.

As part of the MOSAIKON programme, a three-week course for site managers took place in Tyre, Lebanon in 2010. It began with lectures on mosaic materials and their composition, and the causes

Fig. 5. Participants on an ATHAR course in Madaba, Jordan, undertaking a preliminary condition survey of a mosaic. Group working promotes accurate assessments, through discussion and debate, during the early cognitive process of 'reading' the condition of a mosaic. Professional mentoring by instructors during the exercise also nurtures self-confidence of the participants ((© John Stewart)

and mechanisms of their deterioration. Participants then undertook preliminary surveys of mosaics with a range of conditions, working in small groups. The preliminary survey form consisted of two pages (Fig. 8). Each group was tasked to inspect four mosaics, being limited to 15 minutes for each pavement. Significance of mosaics and risk assessment were also addressed in this process. As an example of the additional benefit of this exercise, active deterioration was identified in the most important mosaic inscription on the site. It had not previously been detected.

Presentation of survey results by each group demonstrated that the participants had gained an accurate understanding of general conditions in a very short period of time, by comparing deterioration phenomena and variable conditions between different mosaics. Several participants stated that they found this a very instructive process (Fig. 9). They later undertook detailed condition assessments of mosaics as well, using the detailed survey forms of The Getty Conservation Institute, in which they showed increasing confidence in accurate assessment. At the end of the course, participants were tasked to collectively develop a preliminary conservation proposal for the entire site, as at Thyna, using components and skills developed over the previous two weeks. Costs of these interventions could not be estimated, as accurate data was lacking.

The exercise at Tyre shows the potential of preliminary surveys to quickly generate an

ACTION	IMMEDIATE	SHORT-TERM	MEDIUM TERM
Documentation: general	entire building		
Documentation: metric survey	walls and mosaics		
Condition survey: structure	vaults of frigidarium		
Condition survey: surfaces	mosaics of basins and wall paintings		
Structural stabilization: provisional			
Structural stabilization: definitive		walls of *frigidarium*	walls of all other rooms
Decorative surface stabilization: provisional			
Decorative surface stabilization: definitive	mosaics of basins and wall paintings		mosaics of the *caldarium* and other rooms
Protection of site border			
Reburial	mosaics of 2 basins of frigidarium		
Drainage			
Shelter			planning of the shelter
Monitoring and maintenance			
Legal protection			
Marine survey			
Liaison with planning authority			

Fig. 6. Results of the preliminary survey of the *Thermes des Mois*, at Thyna, Tunisia, identified a number of conservation interventions and programmed their priority, after a brief inspection lasting an hour or so. Similar tables were generated for all structures of the site (Courtesy of the Institut national du Patrimoine of Tunisia and The Getty Conservation Institute)

understanding of mosaics on a very large site. Using the course model of 15 minutes to survey each pavement, some 110 pavements at Tyre (including those of *opus sectile*), could potentially be surveyed by one person over a period of about one week. Data management and analysis of results obviously have to follow and this takes time as well. Preliminary surveys are clearly a manageable and economical task, forming the basis for sound conservation planning.

Complementary Training Components

In addition to condition assessment, there are several other components in teaching conservation and management of mosaics

ACTIONS	BUILDING/FEATURE NUMBER																		
	1A	1B	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Documentation: general	■			■	■		■	■	■	■	■		■						
Documentation: metric survey	■				■		■		■	■	■		■						
Condition survey: structure				■	■	■	■	■	■	■	■		■						
Condition survey: surfaces				■	■				■										
Structural stabilization: provisional								■											
Structural stabilization: definitive					■		■			■			■						
Decorative surface stabilization: provisional																			
Decorative surface stabilization: definitive	■								■		■								
Protection of site border																			
Reburial									■										
Drainage																			
Shelter																			
Monitoring and maintenance																■			
Legal protection																			
Marine survey																			
Liaison with planning authority																			

Fig. 7. Compilation of the surveys of 18 buildings at Thyna (Fig. 6), by their assigned number. In this table are identified the immediate actions that are considered necessary; other tables identify short- and medium-term measures. These provide an overview of conservation requirements across the entire site (Courtesy of the Institut national du Patrimoine of Tunisia and The Getty Conservation Institute)

MOSAIC PRELIMINARY CONDITION SURVEY				
Site:		Building:	Room:	Mosaic ID:
MOSAIC: GENERAL CHARACTERISTICS				
Dimensions (approx.)		Width:	Length:	Area (m2):
Materials	Surface	☐ Stone	☐ Ceramic	☐ Glass
	Support	☐ Lime mortar	☐ Cement mortar	☐ Iron reinforcement
Location		☐ Pavement	☐ Wall	☐ Vault
Integrity		☐ Original support	☐ Lifted and re-laid	☐ Detached panel
Decoration		☐ Plain	☐ Geometric	☐ Figurative
MOSAIC: OBSERVED PHENOMENA				
Accessibility		☐ Fully	☐ Partly	☐ Not accessible

Extent refers to **the percentage of surface area** affected by the phenomena:
Rate the extent by circling the appropriate number: **0 None, 1 (< 10%), 2 (10-30%), 3 (30-50%), 4 (> 50%)**

Severity refers to the **degree** to which the phenomenon impacts the physical integrity of the pavement:
Rate the severity by circling the appropriate letter: **A low, B moderate, C high**

SURFACE DETERIORATION		Notes
Deteriorated tesserae	Extent 0 1 2 3 4 Severity A B C	
Deteriorated mortar between tesserae	Extent 0 1 2 3 4 Severity A B C	
Detached tesserae	Extent 0 1 2 3 4 Severity A B C	
Efflorescence	Extent 0 1 2 3 4 Severity A B C	
Vegetation	Extent 0 1 2 3 4 Severity A B C	
Micro-organisms	Extent 0 1 2 3 4 Severity A B C	

STRUCTURAL DETERIORATION		Notes
Cracks	Extent 0 1 2 3 4 Severity A B C	
Bulges	Extent 0 1 2 3 4 Severity A B C	
Depressions	Extent 0 1 2 3 4 Severity A B C	
Tessellatum lacunae	Extent 0 1 2 3 4 Severity A B C	
Detachment between layers (voids)	Extent 0 1 2 3 4 Severity A B C	

DETERIORATION OF INTERVENTIONS		*Notes*
Deteriorated lacunae fills or edging repairs	Extent 0 1 2 3 4 Severity A B C	
Cracking/corrosion of metal reinforcement	Extent 0 1 2 3 4 Severity A B C	
Other:	Extent 0 1 2 3 4 Severity A B C	

MOSAIC: CONDITION
Evaluate all of the information above to provide an assessment of general condition. **Critical deterioration 1 2 3 4 5 Good condition**

PRESENT EXPOSURE AND GENERAL ACCESS CONDITIONS			
☐ In open air	☐ Under open shelter	☐ Under removable cover	☐ Barrier
☐ Walked on	☐ Under enclosed shelter	☐ Reburied	☐ Other

RISK ASSESSMENT			
Exposure and access conditons	☐ High	☐ Medium	☐ Low
Other (specify)			
Evaluate conditon with respect to all apparent current and potential risks and rate the level of risk **High risk 1 2 3 4 5 Low risk**			

RECOMMENDATIONS
☐ Immediate actions or interventions required. Explain and identify:
☐ Detailed condition survey required.

SUPPLEMENTARY INFORMATION		
Photo image numbers:		
☐ Other attachments Specify:		
Survey completed by:		Date:

Fig. 8. An example of a mosaic preliminary condition survey form. This is based on a longer survey form previously developed (with The Getty Conservation Institute and the Israeli Antiquities Authority; see Stewart 2008), which was modified for the Tyre MOSAIKON course, and further refined for this publication. It can be adapted for other forms of pavement (e.g. *opus sectile*). For large numbers of mosaics, condition data can be entered into a database that can then be developed into a prioritized programme of conservation treatments, across sites and regions (© John Stewart)

FIGURE 8 NOTES:

Mosaic: General characteristics
'Decoration' is an approximate assessment of significance.

Mosaic: Observed phenomena
'Accessibility' describes the intimate physical contact that is possible. Some mosaics may be within locked enclosures not accessible during the initial visit to a site. A subsequent 'recommendation' would be to gain access.

Surface/Structural deterioration
Deterioration is simplified into general categories. It uses standard terminology (The Getty Conservation Institute, 2003). Assessment of deterioration is by means of a graded scale to quantify the surface area affected, and severity of the phenomena. Combining these two parameters provides a rapid and useful means to classify the approximate condition caused by each phenomenon (e.g. a rating of **4C** is the most serious condition; one **1A** is the least serious, **0** is not applicable).

Mosaic condition
This is a relative scale that combines previous assessments of specific conditions (in the data field immediately above) into one rating. It takes into consideration the fact that some deterioration phenomena are more serious than others (e.g. rooted vegetation is more hazardous than the presence of micro-organisms).

Present exposure and general access conditions
These categories define aspects that influence the 'risk environment' of a mosaic.

Risk assessment
'Exposure and access conditions' is a relative rating of the combined factors identified in the data field immediately above. Evaluation of risk is a relative rating that considers general 'pavement condition' with respect to its 'risk environment'.

Recommendations
Immediate actions can be: repair of a damaged barrier to prevent access and damage by people or animals; use of lime mortar to stabilize loose tesserae of an inscription; or vegetation removal, etc.

at a basic level. These entail an explanation of: mosaic significance; materials and structure; deterioration processes (and the ability to distinguish between significant and less important signs of deterioration); risk; the types of intervention and their relative cost.
Training also needs to explain the range of interventions available, both preventive and remedial. Management of the vast majority of mosaics usually requires relatively simple interventions and regular maintenance. Two of the most effective preventive measures are regular maintenance, and reburial. Reburial of mosaics was addressed in detail on all of the courses cited above. The most common remedial treatment is stabilization of mosaics with lime mortar. At Tyre the materials and manufacture of lime mortars were also demonstrated, along with their use in basic mosaic repairs.

	Relevance of session to my work	Structure and clarity	Depth of material covered	Relevance of the practical exercises	Balance of theory and practice	Suitability of teaching methods	Interaction of the instructor	Quality of teaching matrials	Overall effectiveness/ use of time
High-Very good	9	7	6	8	8	6	7	5	6
Above average-good	2	6	6	6	5	5	5	7	8
Average	1	2	2		1	2	1	1	
Fair	1					1	1	1	
Low-poor									
Not Acceptable									

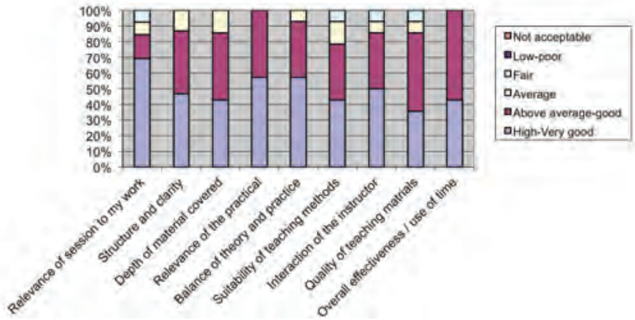

Fig. 9. Evaluation of the preliminary mosaic condition survey exercise by participants of the MOSAIKON course at Tyre, Lebanon (2010). This illustrates a high degree of satisfaction with the skills and confidence gained through the exercise (courtesy of ICCROM)

Another aspect of teaching mosaic management is the need to understand the roles and responsibilities of 'site managers', with respect to their functional organization as a whole. Rigid state bureaucracies, often with poorly defined responsibilities for their employees, conspire against effective management. By understanding constraints (such as limitations of responsibility), opportunities can be clarified (such as identifying professional competency and achievable objectives). At the course in Thyna these were explored in detail for each type of conservation action, to encourage those responsible for sites to better understand personal potential and limitations, to be creative and proactive. One example of the tangible outcome of this exercise demonstrates the application

of confidence and initiative. An archaeologist from one of the training courses in Tunisia submitted a proposal to her Director for a modest sum to carry out essential conservation work on the site on which she was based. She subsequently received funds and implemented the work proposed.
The most important output of such condition surveys should be a prioritized and budgeted plan of action. This requires an understanding of the cost of materials, transport and labour for a range of standard interventions (maintenance, mosaic stabilization and reburial). Conservation professionals in each country need to compile local data for such costs for the benefit of those locally responsible for implementing them. This translates conservation plans into realistic budgets for funding, and eventually into procurement of services and intervention.
Unfortunately, such costing of interventions is poorly developed for conservation of archaeological sites. One exemplar is a schedule of costs formulated by The Getty Conservation Institute and the Institut national du Patrimoine in Tunisia, for the conservation of mosaics in situ (Roby *et al.* 2014).

Conclusion

None of the methodology presented here is particularly novel. The intention, however, is to apply it in an effective way to the field of mosaic conservation where it is very much lacking. This short discourse is intended to demonstrate the potential of the preliminary condition survey in management of mosaics in situ. In summary:

- many mosaics can be adequately understood by preliminary surveys
- these create initial site-wide documentation where none exists
- they permit a rapid capture of condition – apparent risk that can later be expanded
- they identify mosaics/associated structures at real risk and simple interventions to prevent their loss
- they allow the prioritization of simple conservation interventions across a site and between sites, by means that can be costed and budgeted
- they identify the need for more detailed surveys or expertise where needed

Professionals responsible for archaeological sites can certainly be trained and entrusted to participate in the process of survey and understanding. This means de-mystifying aspects of deterioration and conservation, normally seen as the domain of conservation specialists. It is also about empowering them in a measured way to make decisions that can preserve mosaics through simple and appropriate interventions, recognising problems and applying practical solutions. However, understanding and calculating the costs of conservation treatment, and integrating these into realistic budgeted plans for implementation, remains a formidable challenge in training and site practice.

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POSTER

MOSAIKON REGIONAL SURVEY OF LIFTED MOSAICS IN MUSEUMS: A PLANNING AND LEARNING TOOL

Catherine Antomarchi and Karen Abend

Abstract

This paper provides an overview of the regional survey that was carried out in 2010 on the distribution and state of conservation of lifted mosaics housed and exhibited in museums and storerooms in the eleven targeted MOSAIKON countries: Algeria, Cyprus, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Syria, Tunisia and Turkey. Following a detailed discussion of the survey design, distribution, and data collection process, the paper focuses on the development of a user-friendly, web-accessible database that was created specifically for housing all the collected information. The database has been envisioned as an interactive and adaptable tool that can be used not only for sharing and updating information, but also to generate analytical graphs that visually communicate the results of the survey at the click of a button. Despite some noted discrepancies, the survey is considered to have been a success in having captured regional trends on statistics such as the countries with the largest collections of lifted mosaics, the percentage of mosaics exhibited indoors, outdoors, or kept in storerooms, and the amount of mosaics with no backing supports or in need of new ones.

Introduction

In the framework of the MOSAIKON programme (Teutonico *et al.* 2014; Teutonico and Friedman 2017), a pilot project for a regional course on "Saving Mosaics in Museums of the Southern and Eastern Mediterranean" was developed by ICCROM and the Getty Foundation. Scheduled to take place in Amman, Jordan, in the summer of 2012, the course aims to give museum professionals the opportunity to become part of an active regional network with the goal of improving the conservation and presentation of lifted mosaic collections in their institutions.

To help plan for the course and determine the situation of lifted mosaics in the region, a survey was launched in 2010 and carried out over a six-month period. While the conservation problems affecting lifted mosaics can be easily recognized, prior to the survey little was known about the extent of these problems. The survey focused on the most important collections of lifted mosaics currently stored and exhibited in the region's eleven targeted countries: Algeria, Cyprus, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Syria, Tunisia and Turkey (Fig. 1). In order to share the methods used and the general results obtained, this paper will first provide an overview of the survey process, with a critical eye directed towards the main challenges encountered during the project and how they were overcome. This will be followed by a discussion of an important

Fig. 1. Eleven out of 13 countries in the southern and eastern Mediterranean have participated in the MOSAIKON survey of lifted mosaics

result of the survey – the development of a web-accessible database that is a tool for collecting, analysing and sharing the survey data for use by the course participants and possibly an even larger MOSAIKON network in the future.

Designing and distributing the survey

The original objectives of the survey were quite ambitious. We wanted to be able to answer several important questions that could provide a clearer picture of the general situation of lifted mosaics in museums in the region: How many museums – public/private, national/regional, archaeological site museum/storage depots – in the MOSAIKON countries have collections of lifted mosaics? How big are these collections? What percentages of their lifted mosaics are in storage, on exhibit, outdoors, in galleries, supported, unsupported? What are their conditions? And who is in charge of these collections? It should be noted that a regional survey on mosaics in museums and archaeological sites open to the public is currently underway in the region of Southeast Europe within the SEE Mosaics project (see Frankovic and Lazarevic 2017; and www.seemosaics.org)

In the attempt to capture the type of information that could answer these questions, the survey questionnaire was carefully designed to be both straightforward and specific (see Annex 1). It would be necessary for surveyors to supply considerable data in the form of surface area measurements of the individual mosaic pavements or fragments in their collections. Only with these types of calculations would it be possible to convert these data into meaningful and comparable statistics at a later date, thereby creating a clearer picture about the situation of lifted mosaics in museums in individual countries and across the region. Thus, the main challenge of the survey we had in mind was that, unlike more traditional surveys, in this one surveyors would not be able to quickly go through a list of questions with pre-set answers that could be checked off; but rather they would have to commit to spending a day or more with their mosaic collections in order to make square metre calculations of the quantities of mosaics in the different locations and situations throughout their institutions (i.e., on exhibition indoors or outdoors, in storage, fixed to the walls or to the floors, re-laid on supports and using what materials, or unsupported).

To complement the numerical data, some more general types of questions were also asked in the survey. For example, surveyors were asked to assess the conservation conditions of their collections in the different museum locations, with a rating from excellent to poor. They were also asked to specify the responsibilities and professional backgrounds of the museum professionals responsible for their care.

To help overcome the potentially overwhelming challenge of distributing the survey questionnaire across such a large region, it was decided that the proper channel for proceeding with the survey was at the national level. Personal letters were sent by the Director General of ICCROM to the Directors General of each country's Antiquities Department to enlist their commitment to the project. At this time a request was also made to nominate an official 'survey coordinator' per country that would serve as our contact person. Because of the collaborative spirit of these Departments and the generous help of the reference people they designated, it was possible to widely distribute the survey questionnaire throughout the entire region. Personal contact was established with the survey coordinators by phone and email. The coordinators took over the responsibility of distributing the questionnaires to the most important museums with lifted mosaic collections in their country. To eliminate language barriers, the questionnaire was translated from English into French, Arabic and Turkish to satisfy the needs of all countries taking part in the MOSAIKON programme.

Processing the survey results

Surveyors were given one month to complete the questionnaire. To help meet this self-imposed deadline, maintaining close contact between the MOSAIKON coordinator and the individual survey coordinators was imperative. The rate of response was considered a great success, with a total of 64 institutions having completed the questionnaire at this stage.

Once the completed questionnaires were submitted to ICCROM, it was possible to begin the review process and to evaluate the strengths and weaknesses of the survey we had designed. For the most part, the surveyors were able to meet the challenge of measuring and recording their lifted mosaic collections and the distribution of their locations and support materials. However, as can be expected whenever mathematical calculations are required, some errors were found. For example, in theory, the total number of square metres of mosaic pavements housed in any one collection should equal the total amount of mosaics exhibited indoors + exhibited outdoors + housed in storage. Similarly, the total amount of mosaics with supports (concrete, aluminum honeycomb or other) + those unsupported should also equal the total square metres of mosaics housed in a collection. The review of the survey data was therefore mostly adding up sums of square metres to determine whether or not the figures given added up correctly. When they did not, it seemed likely that some measurements were inaccurate or that some mosaics were not measured in all of the required categories. It was also clear that institutions possessing vast quantities of lifted mosaics would be more challenged to accurately measure all of their pavements, and these are the cases where the greatest numbers of inconsistencies were found due to inaccessibility to materials or lack of time and manpower to undertake the required work.

Other minor discrepancies were evident in the collected questionnaires. These included unanswered questions, apparent confusion between in situ and lifted mosaics in cases of archaeological site museums, and in one case a reinterpretation of the survey questionnaire during translation which caused discrepancies in the information collected for that specific country.

Follow-up and finalization of results

To help visualize the inaccuracies in the square metre measurements and begin to analyse the information as a whole, all of the numerical data that had been collected were used to create a table summarizing the total square metres of lifted mosaics surveyed in each museum. When added together, these numbers gave the total number of lifted mosaics surveyed in each country. In turn, the total number of mosaics surveyed in each country could be added up to give a grand total for the whole region. In basic terms, this was a first snapshot of our present situation.

When viewing the data in these terms, the question of the future situation of the collections that had been surveyed was raised. The fundamental question of whether these collections are still growing, or if they can be considered as static, had not yet been asked. In other words, should we be taking into account future discoveries of mosaics that will be lifted from excavations and become part of growing museum collections when assessing the distribution and future needs of lifted mosaics in the region?

The finalization of this first round of data collection would therefore require several actions: 1) have each institution verify that the submitted data was correct; 2) have each institution correct any noted inaccuracies in the square metre calculations and/or supply any missing information; 3) collect information about the future situation of the surveyed mosaic collections.

Personalized letters were drafted to each country to first and foremost thank them for their contributions and share with them the preliminary results in the form of the summary table. We also took the opportunity to ask for corrections to be made to any noted inaccuracies in the original data, and asked them to answer a question about the expected future situation of mosaics in these collections (i.e., do they expect their collections to increase or remain the same in the next five years?). And finally, we asked for final recommendations of additional museums with mosaic collections in their respective countries that should be included in the survey. Once again, the follow-up letters were first distributed and then collected via the survey coordinators of each country, who yet again ensured that updated information could be received and any newly recommended institutions could be surveyed in a timely fashion. In fact, an ad-

ditional seven institutions were surveyed based on the recommendations made. This new information, together with corrections to the noted discrepancies and the new information provided on the expected future situations made possible a more complete tabulation of the results in the form of a summary table (Fig. 2).
Based on the original distribution of the survey questionnaire along with the follow-up activities, a total of 71 institutions from eleven countries have completed the survey, representing 32,867 m^2 of lifted mosaics! While it is clear that the collected data provide valuable insights into the state of lifted mosaics in the region, the overall process of conducting the survey has also been useful for garnering interest and direct involvement from the museum professionals themselves, as testified by the 98% rate of response and general spirit of cooperation.

Creating a tool for education, networking and planning: the database

To guarantee that the data are utilized to their fullest potential, a web-accessible database using the BraDypUS software system (an application developed by the consulting company of the same name, capable of creating and managing online databases) has been created to facilitate the storing, sharing, updating and analysing of the collected information (Fig. 3). Although the data entry form of the database was modelled after the original survey questionnaire, some additions were made in order to improve the quality of the collected information. For example, the degree to which the general condition rankings of the mosaics can be applied to the collection can now be specified (e.g., whole collection, majority of the collection, minor part of the collection, very small part of the collection). Also, sections on remedial conservation and restoration needs have been added to indicate the kinds of work the mosaics require. Other interesting features of the database include the possibility to upload digital images and to plot the geographical position of the surveyed institutions so that their locations can be visualized as points on a regional map.
Once the data are entered, its user-friendly interface (available in English, French or Arabic) allows users to add up, visualize and compare numerical data, and to generate pre-set graphs based on the square metre surface area measurements of the mosaics. In this way it is possible to determine, for example, how many square metres of mosaics have been surveyed in the region by country, the amount of the surveyed mosaics that are exhibited in galleries or housed outdoors, and the quantity of mosaics that have been re-laid on concrete or aluminum honeycomb-based supports (Fig. 4-9). In other words, it is now possible to make a global assessment of the problems concerning lifted mosaics throughout the entire region at the click of a button. Other pre-set graphs can be automatically produced to visualize the total square metres of lifted mosaics per country that are: fixed on the walls, fixed on the floors, in storage or currently unsupported. In addition, a simple-to-follow tutorial allows database users to customize graphs based on individual needs. Thus, the database is both a first, systematic inventory of lifted mosaics in museums in the southern and eastern Mediterranean, and also a strategic tool that has the po-

	Country	Museum	Total	PRESENT							FUTURE		
				Mosaics Inside			Mosaics Outdoors	Mosaics in Storage			Do you expect a substantial increase in the number of mosaics in next 5 years?		
				Wall	Ground	Total	Total	On support	No support	Total	Yes	No	Don't know
1	**ALGERIA**		**4384**	**2451**	**865**	**3316**	**955**	**81**	**32**	**113**			
1.1		Annaba	414	90	86	176	232	6	0	6			
1.2		Cherchell	230	208	17	2256	5	0	0	0			
1.3		Cirta Const.	154	113	31	144	1	9	0	9			
1.4		Djemila	1254	954	149	1103	134	0	17	17			
1.5		Guelma	75	51	24	75	0	0	0	0			
1.6		Mila	47	0	0	0	47	0	0	0			
1.7		Nat. Mus.	354	234	55	289	53	12	0	12			
1.8		Setif	239	18	97	115	76	48	0	48			
1.9		Tazoult	169	64	103	167	2	0	0	0			
1.10		Timgad	1141	626	277	903	232	6	0	6			
1.11		Tipasa	254	40	26	66	173	0	15	15			
1.12		Zabana	53	53	0	53	0	0	?	?			
2	**CYPRUS**		**266**	**3**	**74**	**77**	**84**	**50**	**55**	**105**			
2.1		Kouklia	80	1.5	74	75	0	5	0	5			
2.2		Larnaca	16	0	0	0	16	0	0	0			
2.3		Limassol	68	0	0	0	68	0	0	0			
2.4		Paphos	102	1.5	0	2	0	55	45	100			
3	**EGYPT***		**340**	**26**	**24**	**50**	**60**	**230**	**0**	**230**			

3.1		Alexandr.	340	26	24	50	60	230	0	230			
3.2		Marsa Mar											
3.3		North Co.											
3.4		Siwa											
4	**ISRAEL**		**367**	**93**	**73**	**166**	**153**	**48**	**0**	**48**			
4.1		Eretz Isr.	123	0	0	0	123	0	0	0			
4.2		Hecht	54	11	35	46	0	8	0	8			
4.3		Israel Mus.	160	82	38	120	30	10	0	10			
4.4		Maritime	30	0	0	0	0	30	0	30			
5	**JORDAN**		**688**	**107**	**353**	**460**	**120**	**108**	**0**	**108**			
5.1		Jerash	97	7	0	7	0	90	0	90			
5.2		Madaba M.	232	5	141	146	86	0	0	0			
5.3		Madaba P.	278	76	202	278	0	0	0	0			
5.4		Petra	10	0.3	10	10		0	0	0			
5.5		Salt	37	19	0	19	0	18	0	18			
5.6		Umm Qais	34	0	0	0	34	?	?	?			
6	**LEBANON**		**635**	**117**	**119**	**236**	**327**	**72**	**0**	**72**			
6.1		Beirut	300	20	21	41	204	55	0	55			
6.2		Beiteddine	335	97	98	195	123	17	0	17			
6.3		Bylbos											
6.4		Sidon											
6.5		Tyre											
7	**LIBYA**		**457**	**155**	**63**	**258**	**134**	**45**	**?**	**65**			
7.1		Jamahiriya	127	110	17	127	?	?	?	?			

7.2		Leptis Mag	330	45	46	131	134	45	?	65			
8	**MOROCCO**		**3032**	**32**	**3**	**?90**	**2719**	**0**	**223**	**223**			
8.1		Bansa	18	0	0	0	18	0	0	0			
8.2		Lixus	1	0	0	0	1	0	0	0			
8.3		Quasbah	20	20	0	20	0	0	0	0			
8.4		Rabat	10	10	0	10	0	0	0	0			
8.5		Tetouan	60	2	3	?60	0	0	0	0			
8.6		Volubilis	2923	0	0	0	2700	0	223	223			
8.7													
9	**PALESTINE**		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**			
9.1													
10	**SYRIA**		**3514**	**864**	**525**	**1389**	**390**	**1721**	**14**	**1735**			
10.1		Aleppo											
10.2		Apamea											
10.3		Damascus	130	34	5	39	90	1	0	1			
10.4		Dam Depot											
10.5		Deera											
10.6		Latakiya	9	9	0	9	0	0	0	0			
10.7		Maara	3334	800	520	1320	300	1700	14	1714			
10.8		Palmyra	41	21	0	21	0	20	0	20			
11	**TUNISIA**		**10221**	**3785**	**1964**	**5749**	**800**	**3658**	**14**	**3672**			
11.1		Bardo	5921	3058	1164	4249	0	1658	14	1672			
11.2		El Jem	4300	700	?800	1500	800	2000	0	2000			

tential to guide future efforts towards improving the care, conservation and display of lifted mosaics in the region.

Perhaps the most exciting aspect of the database is its intended interactive use within the course curriculum. In our plans, course participants will be both users of and contributors to the database. Given its accessibility through the internet, participants will be able to update and develop data collection from their home country and share results across the region. And, finally, if new needs develop as a result of the courses or based on input from the users, the flexible nature of the database will allow for improvements to be made so that it remains a relevant and useful tool into the foreseeable future. While at this time access to the database is limited only to those directly involved in the course, since it is still in the development phase, at a later date the MOSAIKON coordinators will reconsider how it might be utilized on a wider scale.

12	**TURKEY**		**4771**	**?**	**?**	**3062**	**361**	**?1348**	**0**	**1348**		
12.1		Buyuk Sar.	1872	?	?	1872	0	?	0	?		
12.2		Gaziantep	1550	?	?	550	0	1000	0	1000		
12.3		Hatay	1308	?	?	640	344	334	0	334		
12.4		Kharanam	41	0	0	0	27	14	0	14		
	GRAND TOTAL		**28645**	**7633**	**4063**	**14823**	**6103**	**7658**	**338**	**7719**		

***One survey form was used for four museums; numbers reflect totals for all four museums listed**

****In some cases, the totals do not correspond; numbers are listed**

Fig. 2. Summary Table: Square metres of mosaic surfaces in museums in the Middle East, April 2010

DISCUSSION OF THE SURVEY RESULTS

When reviewing the results of the survey with a critical eye, we are well aware that it could be argued that the numerical data collected are not accurate due to the possibility of human error. The process of distributing and collecting the survey questionnaires has illustrated that this kind of survey requires careful data checking on the part of the organizers, as well as follow-up correspondence in order to ensure that the data is as accurate as possible. The possibility of having good lines of communication between the surveyors and the coordinators is fundamental to this process. Also of great potential to the increasing accuracy of the

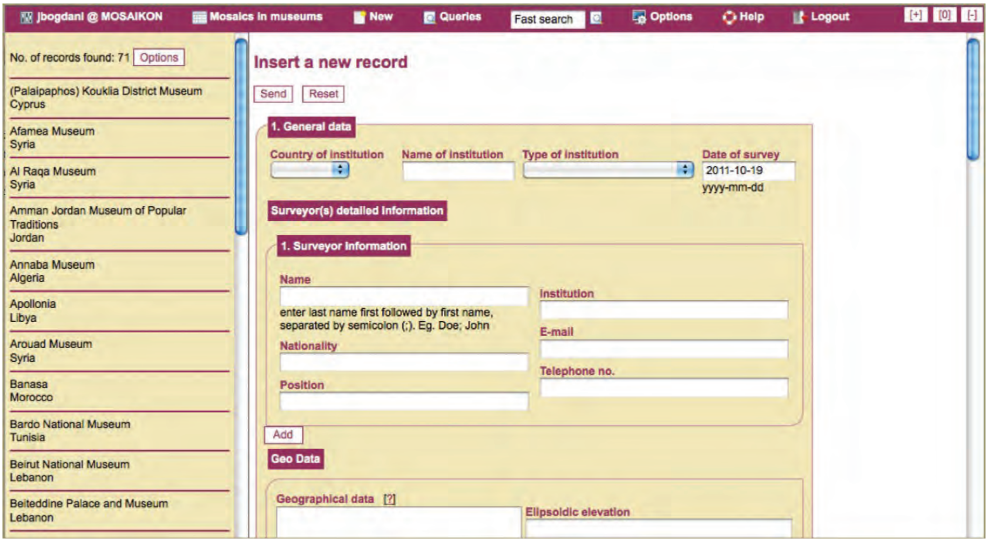

Fig. 3. Screenshot of the database. Museums have been catalogued in alphabetical order and by country

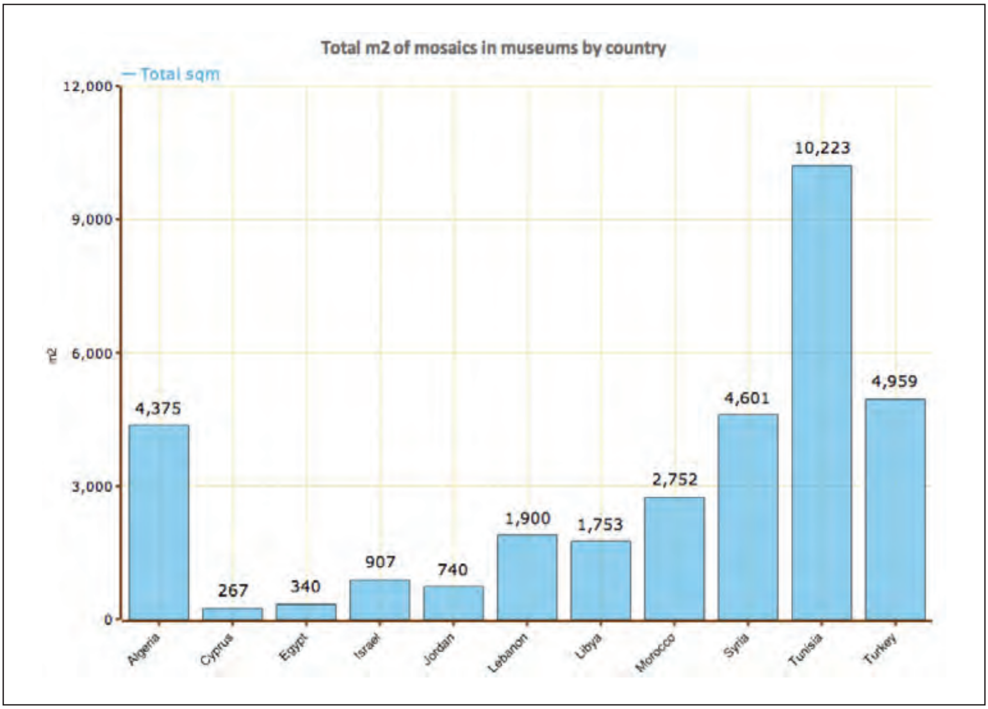

Fig. 4. Graph illustrating total of m^2 of mosaics in museums by country

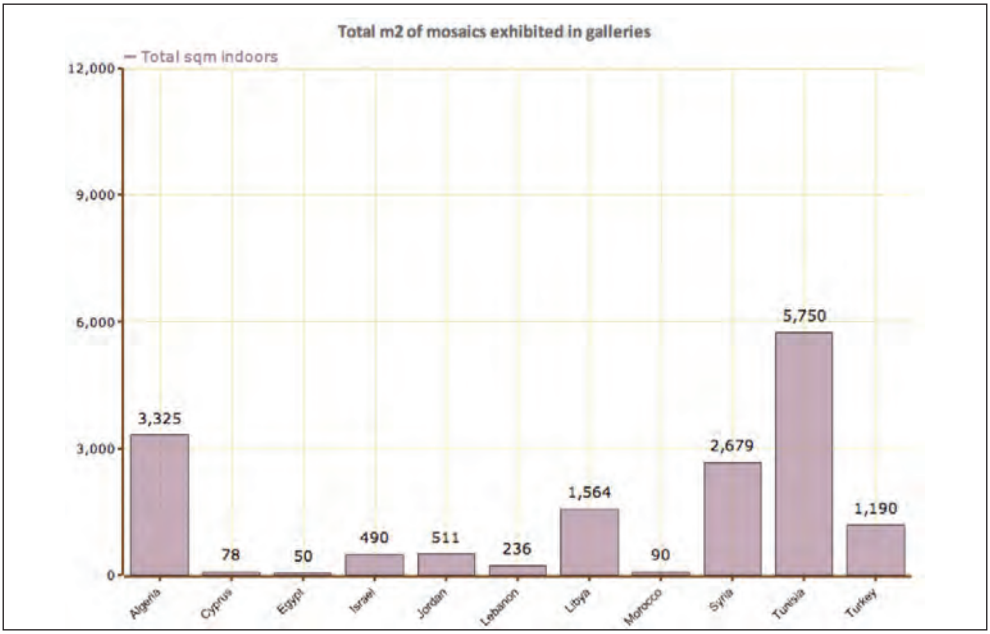

Fig. 5. Graph illustrating total of m² of mosaics re-laid on concrete-based supports

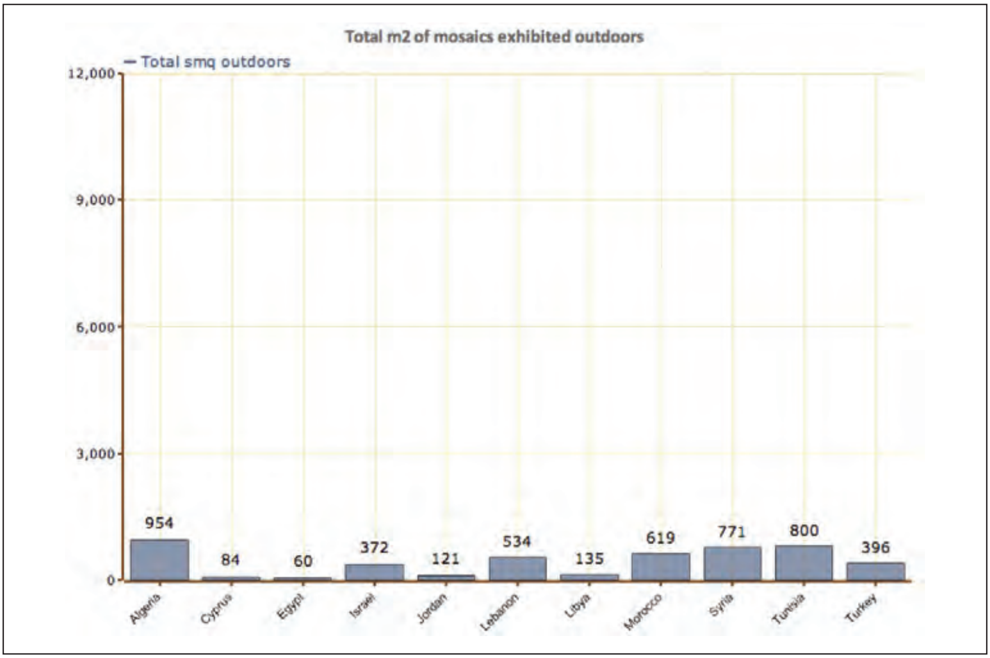

Fig. 6. Graph illustrating total of m² of mosaics exhibited in galleries

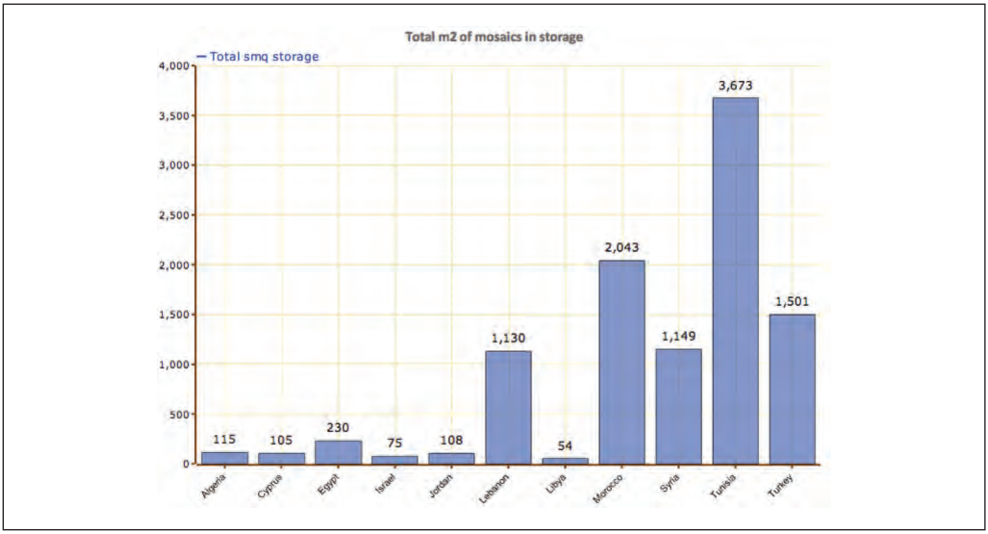

Fig. 7. Graph illustrating total m^2 of mosaics in storage (supported and unsupported)

collected data is the possibility of training future surveyors during interactive demonstrations and sessions focused on not only data collection, but also the use of the database, as part of the didactic activities of MOSAIKON courses.

However, on the topic of accuracy it should also be emphasized that our overall goal was not so much to have precise quantitative calculations, but rather to have an estimated, global understanding of the situation of lifted mosaics in museums in the region, and for this purpose we feel the survey has been a success. When the numerical data is visualized in tabular format, as in the summary table, or in bar graphs, like the database, the usefulness of this type of survey is immediately apparent. For example, by looking at the graph on Figure 4, which illustrates the distribution of mosaics in the region, we can clearly see that Tunisia is the country that currently has the largest collection of mosaics that have been lifted and removed from the original site, representing about 20% of what is exhibited in the entire region. This has created the fame of the Bardo Museum, but in the meantime has reduced the interest in the original sites. Regarding the location of the mosaics in the museums (Fig. 5 and 6: exhibited inside and outdoors), we also learn from the survey data that in the region nearly 66% of the mosaics that are housed in museums are exhibited, an important criterion to ensure their conservation, but more than one out of four are exhibited outdoors. If pavements are not brought indoors and are exhibited outdoors, regular monitoring is required. Instead, 34% of the lifted mosaics in the region are in storage (Fig. 7). Knowing the general conditions of the archaeological storerooms, they are probably not optimum for their conservation. Furthermore, their chances to be one day exhibited are probably minimal, even though 90% are on supports (Fig. 8 and 9). For the remaining 10%, which are still unsupported and glued on canvas, if urgent

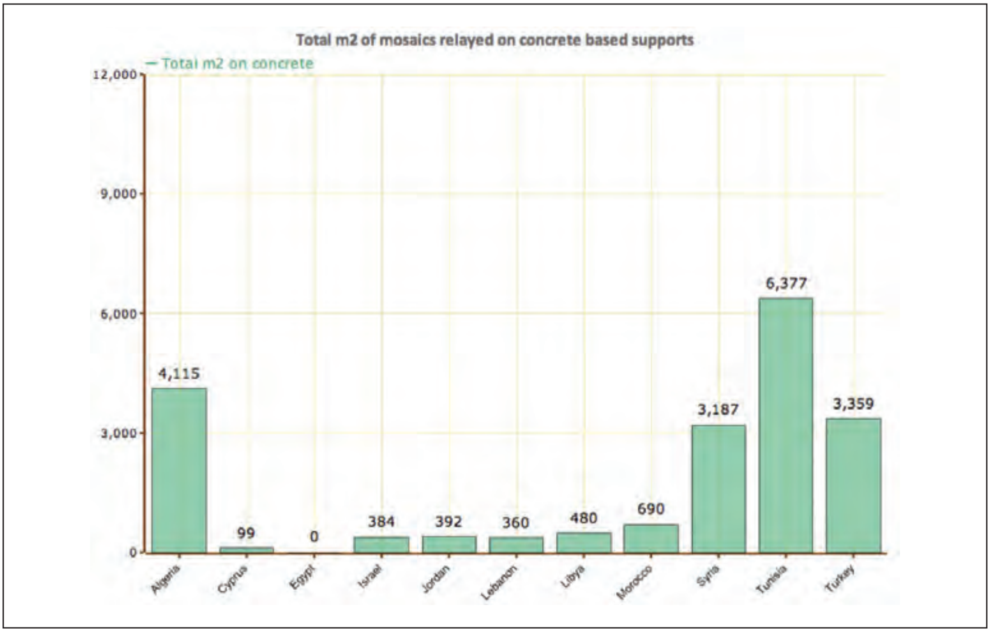

Fig. 8. Graph illustrating total m² of mosaics re-laid on concrete

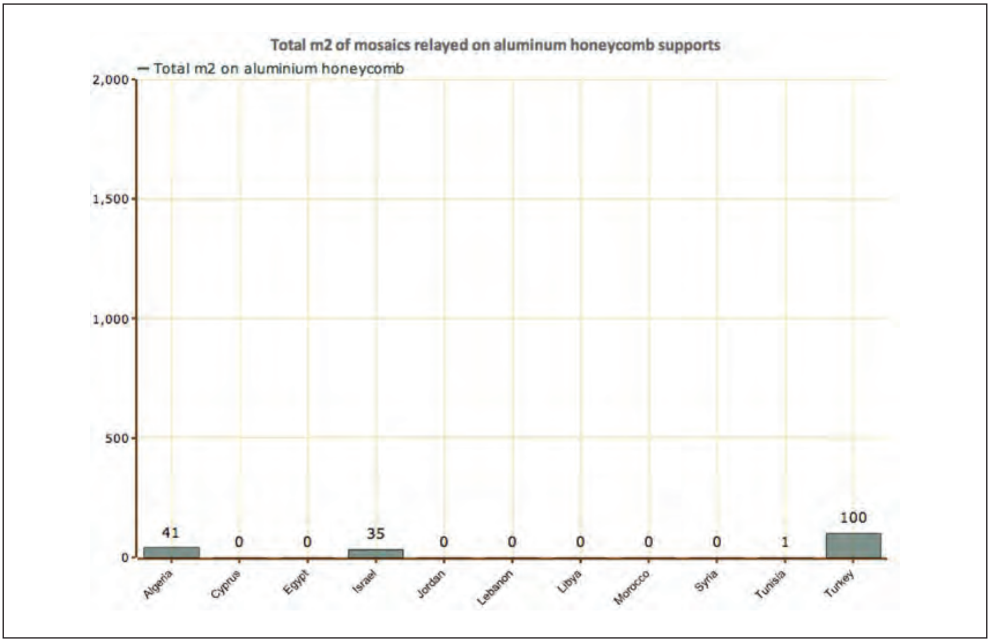

Fig. 9. Graph illustrating total m² of mosaics re-laid on aluminum honeycomb

interventions are not carried out they will probably be lost within ten years. Regarding the materials used for supporting the lifted mosaics, apart from Tunisia, where pavements have been re-laid on wooden panels and plaster, it can be said that in all other countries the totality of the pavements have been re-laid on reinforced concrete (Fig. 8). It is now accepted that reinforced concrete panels are not suitable for the conservation of works of art and specifically of mosaics. One day these pavements will have serious problems – if they do not have them already. Aluminum honeycomb panels, used for the first time in the 1960s in Germany and then later in France, are until now considered to be the best support for mosaics both for conservation and presentation purposes. Unfortunately, the high cost and the difficulty of importing them have prevented their introduction in the region.

Conclusion

Thanks to the 71 survey questionnaires carefully completed by museum professionals working with collections of lifted mosaics in museums in the southern and eastern Mediterranean, it has been possible to gather pertinent information regarding the distribution, state and conservation needs of these collections through the regional survey. Although some lingering discrepancies prevent the survey from being complete, and the expanded version of the questionnaire that has become the data entry form on the database still needs updating, we can say that the regional situation of lifted mosaics is no longer unknown. The development of a web-based database makes the survey data not only accessible, but also more meaningful and usable to all involved parties especially because of its analytical capabilities: regional trends or specific problems can now be automatically visualized at the click of a button. The upcoming pilot course will provide a first platform for sharing the database with the MOSAIKION community so that it can begin to become a relevant tool for the museum professionals directly working with collections of lifted mosaics in the region. In this way the database has a real potential for becoming a tangible networking tool and the regional identity of professionals seeking to improve the situation of lifted mosaics in the southern and eastern Mediterranean.

In conclusion, we would like to express our sincerest gratitude to the Departments of Antiquities who so generously agreed to participate in the survey, along with the museum professionals who completed the survey questionnaires, and the survey coordinators who made possible the distribution and collection of the data. Without their contributions, the survey would not have been possible. A final thank you goes to Gaël de Guichen who provided the vision for the project and generously agreed to review this article, offering invaluable insights on the data analysis.

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ANNEX 1: Survey Questionnaire

MOSAIKON

ICCROM

Preservation of mosaics in museum storage and exhibition

SURVEY OF LIFTED MOSAICS IN MUSEUM EXHIBITIONS AND STORAGE

In order to prepare a regional course for museum professionals dealing with the preservation of lifted mosaics in museum collections and exhibitions, we are collecting information on the situations and training needs in the different museums in the region.

We would be very grateful if you accept to help us in collecting information related to the situation of lifted mosaics in your museum by filling out the questionnaire blow.

The survey should take approximately one day of work. It will require you to tour the museum exhibition and storage areas. You will need access to your documentation files and/or a meter to estimate the approximate size of the different panels in your museum.

Thank you in advance for your collaboration!

Name of Institution: Name & TITLE of surveyor:
Date:

1. How many mosaic panels/pavements do you have exhibited indoors, outdoors, or in storage? (Please indicate the number of panels/pavements, and if possible, estimate the total surface area that it represents, in square meters).

	Number of panels	In total square meters
Exhibited indoors		
Exhibited outdoors		
In storage		

2. Where are the mosaics in your museum? Please, give your answer as an estimate in number of square meters (m^2).

	Number of m^2 fixed on the walls	Number of m^2 fixed on the floor (*)	Number of m^2 on movable supports
Exhibited indoors			
Exhibited outdoors			
In storage			

(*) When mosaics are fixed to the floor, can people (staff, visitors) walk on the mosaic pavement?
Yes ___ No _____

3. What material is used to support the mosaics in your museum? Please use an estimate of square meters in your answer (m^2).

	Mosaics on concrete (in number of m^2)	Mosaics on plaster (in number of m^2)	Mosaics on honeycomb (in number of m^2)	Mosaics on other supports* (in number of m^2)	Mosaics with no sup-port-stacks or rolled… (in number of m^2)
Exhibited indoors					
Exhibited outdoors					
In storage					

* What are the other supports, if any: Wood? Slate? Etc.?
Please specify here:

4. In your opinion, or from your observations, what is the overall condition of the mosaics in the museum? (put an 'X' where most appropriate in each of the 3 situations: exhibited indoors, exhibited outdoors or in storage)

	Excellent -----------good ----------------- poor---------------very poor
Exhibited indoors	
Exhibited outdoors	
In storage	

Please any other useful information:

5. Are there any international projects related to the conservation and exhibition of mosaics in your museum (recently, currently or in the near future)? Please, for each project, if possible indicate the purpose of the project, the dates, and the partners involved.

6. Are there publications regarding your mosaic collections?
Yes______ No _____
If yes, can you list the main publications?

7. How many staff members are in your museum?

Director	
Researchers	
Curators	
Assistants	
Guides	
Technicians	
Others	

8. Who is <u>the person in charge</u> of the mosaic collections and the display of the mosaics? (Please give the name and title. If there is more than one person, please add all the names and titles). For each staff member listed, can you briefly indicate education background?

Name	Title	Education background

9. When a mosaic on display or in storage is <u>in need of conservation treatment</u>, who does it? (Please give the name and title. Indicate if this person is a member of the museum staff or if he/she works for another institution/department).
For each staff member listed, can you briefly indicate education background?

Name	Title	Education background

Is there a specific space in your museum dedicated to the conservation treatment of mosaics?
Yes______ No _____

SESSION III:
CONSERVATION AND MANAGEMENT OF MOSAICS AT SITES

GUIDELINES FOR PLANNING OF SHELTERS OVER ARCHAEOLOGICAL SITES AND MOSAICS: APPROACHES FOR DEVELOPMENT OF A METHODOLOGY

Yael Alef and Jacques Neguer

Abstract

The planning of shelters over mosaics encompasses all the complexities of modern interventions in archaeological sites: conservation, interpretation and presentation. It requires professionals from different disciplines to envision creative solutions for the contradicting demands. This paper presents an approach for development of a framework for decision-making in the process of planning shelters. The methodology integrates conservation criteria based on a risk assessment, interpretation and presentation aspects and visitor and site management requirements.

Shelters over mosaics and archaeological sites have been a controversial issue and an ongoing challenge for well over a decade. This is no wonder, as shelters seem to encompass all the complexities of modern interventions in archaeological sites: conservation, interpretation and presentation. Our responsibility to protect the original fabric of ancient mosaics may in some cases, conflict with the demand to present those mosaics in the authentic context of the archaeological site. These two aspects, protection and presentation, already suggest different interests and different professionals concerned with the problem: whether to shelter and, if so, how to design the shelter. The need to form a common ground for the various professionals involved in conservation and presentation of mosaics, is then obvious.

The purpose of this paper, therefore, is to present approaches for development of a methodology for decision-making regarding the complicated issue of shelters over mosaics. These issues basically evolve around three questions:

1. How do we determine the need to shelter?
2. How do we design the shelter, its form and materials?
3. How do we develop the sheltering project? That is, the steps in the process of planning and construction of a shelter.

This paper builds on the collaborative research of the Getty Conservation Institute, English Heritage, and the Israel Antiquities Authority on the protective performance of shelters over mosaics (Stewart, Neguer and Demas, 2006). It started with a rapid assessment of existing shelters over mosaics (Neguer and Alef 2008). The results of the assessment showed that more than 30% of the mosaics under shelters in Israel are undergoing active decay and some have already been lost. In some cases the shelter itself (i.e. the microclimate it created) was the main cause of deterioration, indicating the need for better planning of shelters. From the rapid assessment the main factors affecting the condition of mosaics were identified (Neguer and Alef 2014). The outcome of this research would be the development of criteria and guidelines for modification of existing shelters and planning of new shelters.

Methodology

The broad context of the problem of shelters is mosaic conservation. As such, even if costly, shelters are only part of an overall approach for the site's presentation and management. After excavation and first aid treatment of the mosaic in situ, several options are possible: to conserve the mosaic in situ, lift the mosaic, or lift and relay the mosaic on a new support. Each choice will lead to different conditions and different interventions (Fig. 1). How then, do we choose the appropriate intervention? And when do we need to shelter?

The decision-making process that we suggest for shelters is based on Gaël de Guichen's flowchart. This is a simplified set of the questions regarding managerial issues such as cost benefit analysis, state of excavation, security and maintenance. These criteria guide the decision-making process in mosaic conservation (Fig. 2). Once a choice to present the mosaic on the site is made, we face the question whether to plan a shelter and set criteria for its design. The approach we are developing for the methodology continues with similar flowcharts of questions regarding the specific criteria required for the professionals concerned with the conservation and presentation of the mosaic, the shelter and its design.

The evaluation of the shelter's function revolves around the assessment of the effect of the shelter design on the condition and values of the mosaics. In other words, does the shelter enhance or damage the values and physical condition of the site? The answer lies in a combination of parameters. The different considerations are grouped into three categories:

1. Conservation needs (i.e. the protective function of the shelter)
2. The interpretation and presentation of the site and the mosaic
3. Visitor and site management

Conservation needs

The conservation criteria relate to evaluation of the efficiency of the three basic options for providing appropriate environmental conditions for the mosaic:

1. Leaving the mosaic exposed
2. Building an open shelter, or
3. Building an enclosure

There are, of course, many variations in between, such as temporary closures etc. In this paper, however, we will only present the general concept of the methodology.

When focusing on the issue of climate control we can start by asking if it is necessary to protect the mosaic from frost (Fig. 3). A 'yes' answer will lead us to consider erecting an enclosure, as in most sites in the UK for example (Stewart 2008). However, this is not the case for Israel, where we would ask if it is necessary to protect the mosaic from precipitation or sun radiation (SRD). A 'no' answer will suggest to consider the option of leaving the mosaic exposed. A 'yes' answer will suggest considering the option of constructing an open shelter.

Risk assessment

This is not as simple as it may seem because, how do we actually know if it is necessary to protect the mosaic from precipitation

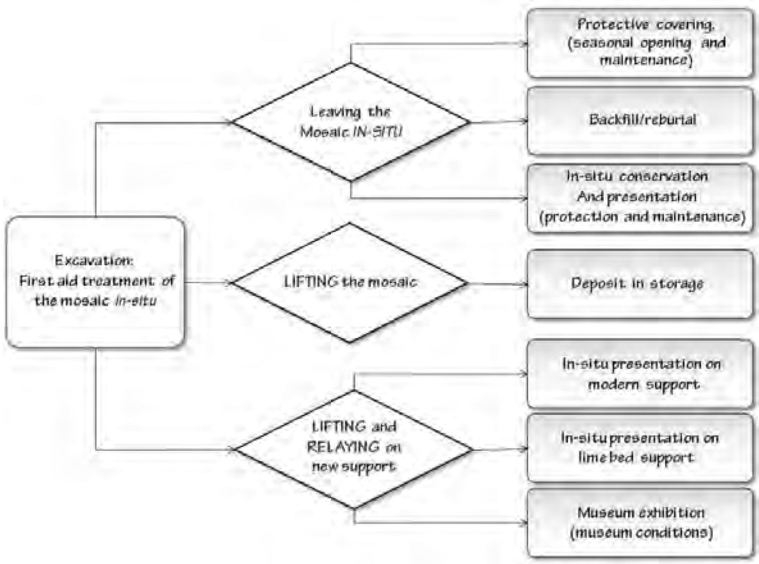

Fig. 1. Options for conservation flowchart: conserve the mosaic in situ, lift the mosaic, or lift and relay the mosaic on a new support

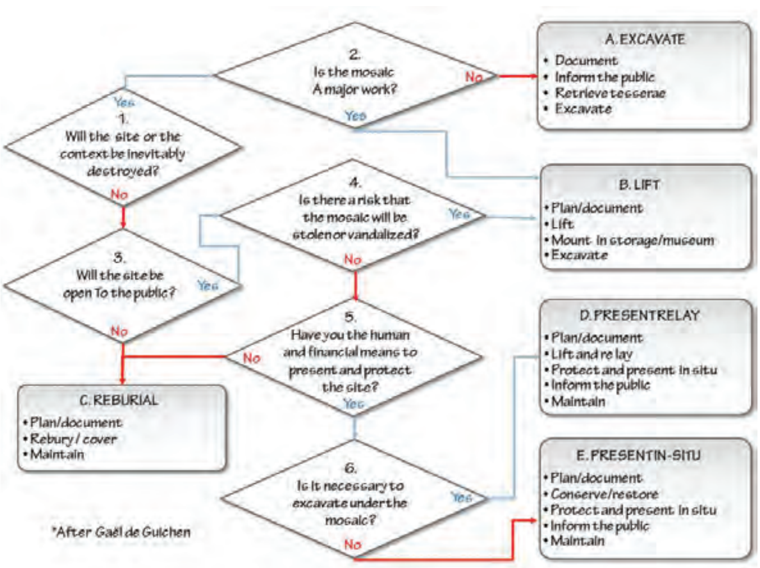

Fig 2. Decision making flowchart (after Gaël de Guichen) describing the rational for different interventions

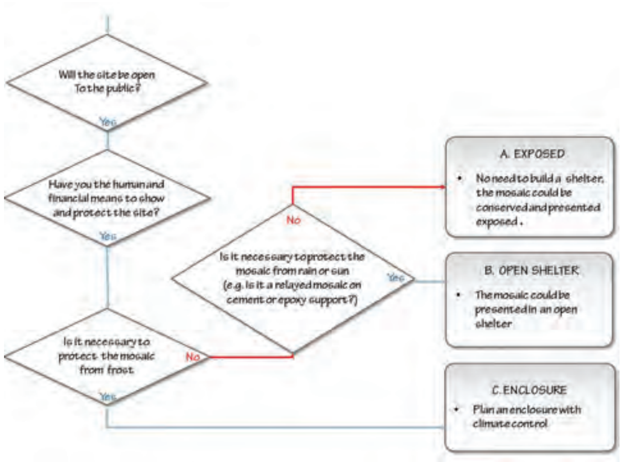

Fig. 3. The conservation criteria flowchart guides the choice between open shelter, enclosure or exposed mosaic

or sun radiation? And how do we answer the questions related to the environmental issues at large? That is, how do we define the conservation criteria? The conservation criteria are established by a risk assessment that is an assessment of the vulnerability of the material in relation to the risk factors. Risk assessment studies the nature of the material to be protected, against:

1. Environmental risk factors such as:
   a. Direct solar radiation (SRD)
   b. Rain, wind driven rain, rising damp, runoffs, lack of drainage
   c. Relative humidity and moisture content (condensation)
   d. Frost
   e. Wind
   f. Pollution: aerosol and deposits including dust and sand
2. Anthropic and biological risk factors include:
   a. Vandalism by humans
   b. Inappropriate use
   c. Invasive flora and fauna
   d. Bird droppings and animal dung
   e. The construction and maintenance of a shelter in the archaeological site (according to principles of reversibility and minimal interventions)
3. Geomorphological risk factors
   a. Seismic threats – earthquakes
   b. Floods, landslides, tsunamis

Each factor addresses specific questions in relation to the various conditions. Re-laid mosaics on cement or epoxy support, for example, are vulnerable to exposed conditions without the protection of a shelter, while in situ mosaics on lime-based support on the contrary, could be presented exposed (as long as they are conserved and maintained). On the other hand, the rapid assessment showed that, under the same shelter in Lady Mary, Beit She'an, re-laid mosaics were in better condition than in situ mosaics (Neguer and Alef 2008; 2014). An example from Caesarea will demon-

Fig. 4. Top: Aerial view of Caesarea after dismantling the bathhouse shelter and the Ibex mosaic shelter. Out of three permanent shelters constructed on the site, only the villa shelter remained. Courtesy of P. Gendelman, archaeologist; photography performed by Skyview (2010). Bottom: Photos taken during the dismantling of the bathhouse shelter. Photographer: A. Gilad (2010)

strate the need to establish a hierarchy of risks by a cause-effect analysis, with the aim of defining specific criteria for mitigating the risks. From this, performance expectations and design criteria could be established for the planning of the shelter. In the maritime environment of Caesarea, aerosols have been found to be a major risk for the mosaics. The aerosols are a greater risk than rain, which is usually regarded as a major risk factor in other environments. In fact, in the case of Caesarea, the rain actually washes and reduces the destructive effect of the aerosols that accumulate on the surface of the mosaics (Neguer and Alef 2008). This understanding, among other reasons, led to the dismantling of the shelter over the bathhouse nine years after

Fig. 5. The Dionysus mosaic, Zippori, interior view of the enclosure. The design responded to security concerns, emphasis on the artistic value, and human comfort needs. The mosaic is presented in museum conditions regarding lighting and climate control, isolating it from the architectural and archaeological context. Photographer: Y. Alef (2006) © IAA

its construction! (Fig. 4). Another option in a maritime environment may be the erection of an enclosure with a controlled air system to filter out the aerosols. In any case, the mosaics in those enclosures will probably need more maintenance than the mosaics left exposed in the open air in the maritime environment.

The Dionysus enclosure in the Zippori National Park is an example for security concerns in regard to risk of vandalism by humans. The Dionysus mosaic is of high technical quality of craftsmanship and artistic value. The richness of detail, the extent of the depictions, and especially the combination of the myth and the reality of the Dionysian cult in the same floor, make this mosaic unique, not only among the mosaics of Zippori, but among Roman art in Israel at large (Fig. 5).

Lary Belkin, the architect of the enclosure, recalls that the planning took place soon after the Tyche mosaic in Beit She'an was vandalized (Alef 2002). The alarming incident caused extra sensitivity to security matters in National Parks and in particularly over the "Mona Lisa of the Galilee". Security became a main priority in the planning of the shelter, and every measure was taken to ensure its efficiency. The north and west sides of the shelter are buried in the slope and the shelter has massive walls with only two openings for the doors that are locked overnight; windows and skylight were eliminated from the design. In the interior, elevated walkways were installed to separate the visitor from the remains (Fig. 6).

Fig. 6. The Dionysus shelter Zippori, exterior view of the enclosure in the archaeological context. Photographer: Y. Alef (2006) © IAA

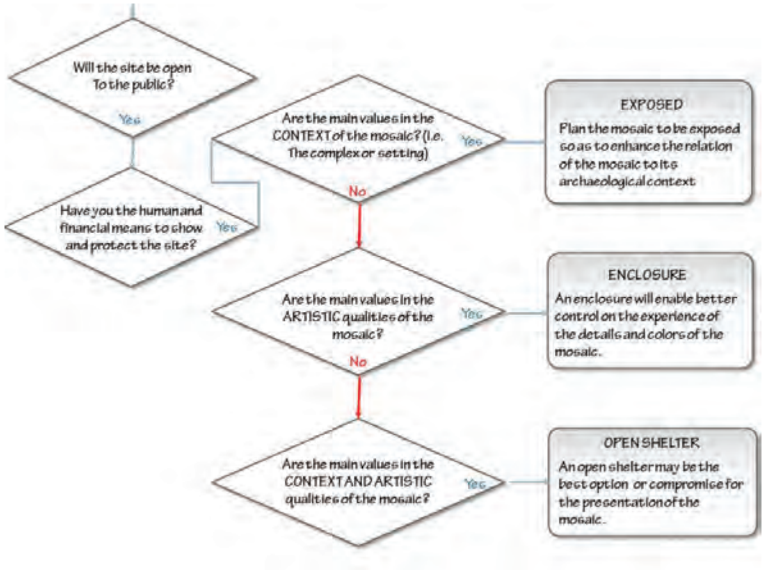

Fig. 7. Presentation and interpretation decision-making flowchart, guides the choice between open shelter, enclosure or exposed mosaic

Interpretation and presentation concerns

The effect of the shelter on the interpretation and presentation of the site and the mosaic will usually involve issues relating to its visual impact and, specifically:

1. The aesthetic qualities of the mosaic, site and landscape
2. The legibility of the mosaic in the urban and architectural context of the archaeological remains.

The following criteria could be used as general guidelines (Fig. 7). From the presentation aspect, the mosaic is better left exposed if its main values lie in the architectural, urban or landscape context. On the other hand, when the main values lie in its artistic qualities, an enclosure may enable better control (i.e. lighting and dust) of the experience of details, colours and the mosaic's composition.

Visitor and site management concerns

The function of the shelter in presenting the mosaics is closely linked to visitor management issues. These considerations have considerable effect on the overall experience and the attractiveness of the site. Visitor management includes issues such as:

1. Carrying capacity,
2. Human comfort,
3. Accessibility and
4. Visitor safety.

Integrated and multidisciplinary approach

In addition to the criteria it is necessary to define the stages of a planning process that will ensure an integrated approach. It is quite clear that a shelter alone cannot provide protection from all the risks and, at the same time, enable presentation of the site. Balancing the conflicting needs requires responsible risk management. In the face of these complexities it is quite surprising that the planning of shelters is rarely approached as part of an overall system for the site's protection and presentation. Even today the shelter is often planned as an ad hoc initiative, and "is often a response of an individual to a problem rather than a multi-disciplinary decision that benefits from the expertise and experience of many individuals. There is a need for multidisciplinary involvement from the beginning and throughout the process" (Teutonico 2001).

The decision to shelter, even if costly and dominant, is only one of the steps in planning the conservation and presentation of the site. The basic process proposed integrates the various issues of sheltering in the overall planning for the conservation and site management. Like most planning it is an iterative process that starts with:

1. Risk Assessment
2. Preliminary planning stage to set the design criteria including:
   a. Assessment of management needs,
   b. Conservation and environmental assessment,
   c. Interpretation and presentation of the site and the mosaic and visual impact assessment,
   d. Visitors control assessment,
   e. Assessment of constructions needs and specifications in the archaeological site.
3. Re-evaluation of shelter performance in response to:
   a. Risk mitigation and
   b. Cost–benefit analysis.
4. Final planning stage including preparation of:
   a. Maintenance plan for shelter and site,
   b. Monitoring plan for shelter and site,
   c. Planning of conservation and architectural supervision during construction.

Conclusion

The approach for the development of a methodology for shelter planning combines a structured process, which integrates design criteria for the various aspects involved:

1. Conservation Needs (Protective function)
2. Interpretation and Presentation
3. Visitor and Site Management

Each site poses unique conditions, and each shelter is a result of a unique response to those requirements. For this reason, it is difficult to draw simple conclusions from one site to another, and so mistakes are repeated again and again. It is necessary then, to form a systematic methodology for shelter planning that will enable the coordination of the different professionals and integrate the various and sometime contradicting demands. Shelter planning in archaeological sites always entails challenging problems and requires creative solutions. These are based on scientific knowledge and technical skill, as well as a critical and aesthetic activity in the cultural context of time and place.

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ECOLOGICAL ANALYSIS OF BIODETERIORATION OF MOSAICS IN OSTIA ANTICA (ROME, ITALY) AND CONSERVATION PROBLEMS

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Abstract

Some mosaic pavements in the archaeological site of Ostia Antica (Rome, Italy) were studied with the purpose of analysing, from an ecological point of view, the biodeteriogens that colonize mortar and mosaic tesserae. Particular attention was given to environmental and edaphic factors (chemical composition of the substrate, presence of shelters, inclination of pavements) as well as those anthropogenic ones which may affect the presence or absence of certain biological colonizations. The results obtained in 36 sampling areas, in ten different mosaic pavements and in seven sites, show that some factors are of extreme importance in influencing the growth of biodeteriogens. In fact, shelters show a big role in reducing biological growth, as does the inclination of the floor in reducing the colonization of algae and cyanobacteria. The chemical nature of the substrate does not seem to have an appreciable difference in relation to that growth, in contrast to the porosity and hardness of the substrate, although a sometimes synergistic or compensatory role exists among all these factors. The sampled microflora (lichens, cyanobacteria, algae and bryophytes) shows some qualitative and quantitative fluctuations related to seasonal trends, with behaviours of growth that differ within the different taxonomic groups.

Introduction

The archaeological site of Ostia Antica (the ancient harbour of Rome) preserves a high number of floor mosaics, mainly consisting of tesserae of two colours (black and white) where biodeterioration phenomena can often be detected. The growth of the photosynthetic microflora (algae and cyanobacteria) such as mosses, lichens and higher plants, not only interfere with the reading of the designs, but can also give rise to physical and chemical damage. Among the literature on conservation of cultural heritage, only few papers, mainly focussing on the cases of Roman pavements in Italy and Spain, analysed the problems of biodeterioration of mosaics (Monte Sila 1986; Seaward and Giacobini 1988; Garcia-Rowe and Saiz-Jimenez 1988; Gil and Saiz-Jimenez 1992; Altieri *et al.* 2003; Roccardi and Ricci 2006; Pietrini *et al.* 2008). These papers especially underlined the damage caused by the various organisms that can grow on the tesserae and on the mortars joining them; however the relationships between environmental factors and biological growth were poorly investigated. Nevertheless, the knowledge of the ecology of the biodeteriogens occurring in these conditions can have a great importance in preventing and controlling them. Therefore, the aim of this paper is to analyse some biodeterioration phenomena occurring in the site of Ostia Antica, in relation to the changes of environmental and edaphic factors, such as the chemistry and porosity of the tesserae and mortars, the presence of shelters or the inclination of the pavements, and also try to consider the further effects of anthropogenic factors.

The site: History, materials and current conditions

Traditionally, the foundation of the city has been attributed to Ancus Marcius, the fourth king of Rome, somewhere towards the end of the 7th century BC. The first urban settlement of which there is any certain knowledge, a *Castrum,* dates only to 350 BC, that is a little after Rome conquered Veii and gained control of the lower course of the River Tiber. After the 2nd century BC, when Rome had obtained dominance of the Mediterranean Sea, Ostia became an important naval base and the *Castrum* lost its original defensive role and took on a largely commercial one. During the Punic Wars (219-202 BC), Ostia increasingly developed as a commercial hub and centre of distribution for the wheat destined for Rome. After repeated attacks by pirates towards the end of the Republican period the need to build a defensive wall arose.

Under the Empire Ostia became a flourishing and highly populated centre, which welcomed many visitors, above all those occupied in commercial, administrative and activities associated with the port. This change of role for the city also carried with it an obvious transformation in terms of its social as well as its urban life. Augustus financed the building of monumental construction works like the theatre, which rendered Ostia worthy of its status as a *colonia.* Under Tiberius the forum was constructed, the number of *horrea* (warehouses) greatly increased and numerous luxury houses were built. Most importantly, a new aqueduct permitted the construction of hot baths. With the increase in the volume of trade, a new and more protected harbour was started by Trajan and completed in AD 110, in an area named *Portus*. This gradually increased in importance overshadowing Ostia, which at the beginning of the 3rd century entered a slow and steady decline. It is worth mentioning that Ostia was inhabited by a well-off middle class, constituting a homogeneous population, living in comfortable *domus,* which were not particularly luxurious, making up buildings in insulae, which were not very different from one another in respect to their monumental and artistic value. The floor mosaics in particular are quite similar to each other without having even a little touch of originality or character, a practice that evidences a decorative style typical of local artisans. Black and white tesserae are predominant in these mosaics: for the black ones the lithotype is a leucite lava composite from the volcanic regions around the Alban or the Sabine Hills, while for the white ones it is a fine-grained limestone majolica made up of 99% calcite ($CaCO_3$) (Becatti 1961). At the moment it is not possible to calculate the porosity differential of the tesserae, which seems to be very low in both cases. As regards the current climatic conditions, Ostia Antica falls entirely within the Mediterranean region's medium meso-Mediterranean thermotype and upper sub-humid ombrotypes. It is a mesoclimate with hot and dry summers, mild winter temperatures and rainfalls that are concentrated in the autumn and winter (Blasi 1994). As far as the level of rainfall is concerned, the average total reaches 898.4 mm/year. Ostia is characterized by a three-month summer with little rain (15.4 mm in July, the month with the least amount) and relatively high temperatures in August, the hottest month (23.7° C as the average of the maximum temperatures). On the other hand, in winter the rainfall increases tenfold (134.8 mm in November the wettest month) while the average temperature remains above zero.

Methods

Ten mosaic pavements distributed in seven areas were selected: (Insula dell'Invidioso; Terme dell'Invidioso; Caseggiato dei Lottatori; Mitreo di Felicissimo; Terme del Nuotatore; Terme delle Province; Terme di Nettuno) each representative of a characteristic ecological situation, which was sufficient to guarantee a significant population number for each sample area.

In order to assess the growth of both the biological patinas and phanerogams (seed plants), the same covering scale that was used for the phytosociological surveys (Braun-Blanquet 1964) was employed: + = isolated individuals; 1 = 1-5%; 2 = 5-25%; 3 = 25-50%; 4 = 50-75%; 5 = 75-100% of the surface. The central values are: 1 = 3%; 2 = 15%; 3 = 37:5%; 4 = 62:5%; 5 = 87:5%. The microflora samples were taken by removing the patinas on the substrate from at least two points in each station. As regards the phanerogamic component, a direct recognition of the species present in the field was carried out; samples were taken from the plants that needed a more accurate morphological analysis. The number of sample areas was established on the basis of the biological variability and ecology found in the sample zone, choosing an equal internal surface area to put in direct comparison. The ecological data was collected in the field; in order to discern the parameters for the "duration" of the solar radiation on surfaces, every area studied was photographed at regular intervals (once every hour) on the same day from 10 am to 3 pm, using a scale from a minimum of 1 to a maximum of 5 (the intermediate values were allocated according to a growing percentage of 25% of the solar radiation). The photosynthetic microflora, bryophytes and lichens were collected in the field, and then sampled; the taxonomic identification was controlled in the laboratory, and compared with the literature (Aleffi *et al.* 1997; Nimis *et al.* 1987; Pignatti Wikus and Giomi Visentin 1989). For the photosynthetic microflora reference is made to the monographs of Desikachari (1959), Bourrelly (1968) and John *et al.* (2002); and as regards the quantitative data, counts were carried out on each different taxon with an individual microscopic preparation in accord with the Rizzi Longo *et al.* method (1980). For the identification of the bryophytes the Cortini Pedrotti monograph (2001; 2006) was used and for the lichens, those of Nimis (1993) and Nimis and Martellos (2008). As regards the phanerogamic elements, species were determined using the *Flora d'Italia* (Pignatti 1982).

For the elaboration of the ecological statistics, the samples, obtained quantitatively, were organized in a matrix, then subjected to multivariate statistical analysis using the Podani Syn-Tax 2000 program (Podani 2001), which provided for the classification (chord distance algorithm and average link mode), along with the organization of the data.

Results and discussion

The 36 vegetation surveys carried out are presented here, after the organization of

Groups	A							B						C												D	E		F		G	H	I	
N° rilievi	1	4	3	10	14	15	16	2	19	20	21	22	24	5	7	8	34	9	11	12	27	29	25	30	31	26	17	18	32	33	28	23	6	13
area campionata (m^2)	0,651	0,133	0,651	0,254	0,651	0,651	0,133	0,651	0,062	0,062	0,24	0,25	0,25	0,062	0,206	0,651	0°	0,254	0,254	0,056	0,76	0,25	0,206	0,056	0,651	0,206	0,76	0,133	0,062	0°	0,76	0,33	0,062	0,056
Data campionamento	5.11.07	11.11.07	6.11.07	15.12.07	7.11.07	8.11.07	9.11.07	6.11.07	15.11.07	15.11.07	19.01.08	20.01.08	20.01.08	17.11.07	9.12.07	6.11.07	.	15.12.07	15.12.07	20.12.07	21.01.08	20.01.08	9.12.07	20.12.07	7.11.07	9.12.07	21.01.08	9.11.07	19.11.07	.	21.01.08	12.01.08	17.11.07	20.12.07
Pendenza	0°	0°	5°	0°	0°	0°	0°	0°	0°	0°	0°	10°	10°	0°	0°	0°	B/N	0°	0°	0°	0°	0°	0°	3°	0°	2°	0°	0°	0°	B/N	0°	12°	15°	0°
Esposizione	.	.	NW	.	.	.	.	.	.	.	.	NE	NE	.	.	.	1	.	.	.	.	.	.	NW	.	NW	.	.	.	4	.	NE	SE	.
Tipologia tessere	B/N	B/N	B/N	B/N	N	N	B/N	N	B/N	B/N	B/N	B/N	B	B/N	B/N	B	Sì	B	N	B	B/N	B/N	B	B/N	B/N	B/N	V	V	B/N	Sì	B/N	B	B/N	B
Ombra/luce	3	3	1	4	5	3	5	4	1	2	4	4	5	1	5	1	3,6	1	2	2	1	2	2	1	5	2	2	3	2	3,8	4	5	4	5
Presenza/assenza malte	No	Sì	No	Sì	Sì	Sì	Sì	Sì	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Sì	No	Sì	No	No	No	Sì	No	Sì	No	Sì	Sì
Distanza media fra le tessere (mm)	3	3	4,3	2,8	3	2,5	2,7	2	3,6	3,6	3,5	2	2,9	5	4,2	3,2	0	2,9	3	2,9	2,9	2,5	2	4	4,4	3,1	2	2,3	5	0	2,5	2	3	3
Coperto	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	.	No	No	No	No	No	Sì	No	No	No	No	No	No	.	No	No	No	No
Livello terreno	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	-1,3	-1,3	0	-1,3	0	-1,3	0	0	0	1	-1,3	0	0	0
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chroococcus lithophilus	2	2	2	1	1	2	3	.	.	2	.	.	.	1	2	2	1	2	2	2	3	2	.	.	1	.	2	3	1	.	1	.	.	2
Desmococcus olivaceum	2	1	.	.	.	1	.	1	1	1	+	1	1	2	2	2	2	1	2	2	2	1	1	3	1	2	.	1	+	1	.	1	.	.
Apatococcus lobatus	2	1	.	.	.	1	1	1	1	1	+	1	1	2	2	2	.	1	2	2	2	1	1	3	1	2	.	1	.	.	+	1	.	.
Tortula muralis	1	+	1	+	+	1	.	2	2	1	1	1	+	2	2	2	.	2	2	2	2	+	.	.	.	+	1	.	1	.	+	+	1	+
Gloeocapsa sp	1	2	.	.	+	+	+	.	1	.	.	.	.	.	+	1	.	.	.	+	1	.	.	.	.	+	.	.	.	.	+	.	.	.
Calothrix sp1	.	.	.	1	+	1	+	.	.	.	.	.	.	1	1	.	.	.	.	.	1	1	.	.	.	1	1	.	1	.	+	.	.	.
Verrucaria nigrescens	1	1	+	.	+	1	+	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	+	+	.	.	.	.	.	.
Aspicilia calcarea	2	2	1	1	1	2	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Catillaria lenticularis	.	+	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Caloplaca citrina	+	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Didymodon luridus	2	2	.	.	.	.	.	1	+	+	.	.	.	1	1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lecanora campestris	+	.	+	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lecanora dispersa	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Bryum sp2	+	.	2	.	.	.	.	.	.	.	.	.	.	3	2	1	.	1	.	1	1	.	.	.	.	.	.	.	.	.	1	.	.	.
Caloplaca flavescens	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Didymodon vinealis	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachythecium rutabulum	3	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lecidea fuscoatra	+	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aspicilia sp1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aspicilia radiosa	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gloeocapsa sanguinea	.	2	2	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	1	.	.	.	.	1	.	.	.	.	2	.	.	.
Collema tenax	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brachythecium veluitinum	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Placynthium nigrum	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Bryum torquescens	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	2
Barbula convoluta	.	2	1	.	.	.	.	.	.	.	.	.	.	2	.	1	.	.	.	.	.	+	.	.	.	2	.	.	.	.	.	.	.	.
Bryum sp1	.	3	1	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	+	3	.	1	.	.	.	.	.
Acarospora umbilicata	+	+	+	+	.	.	.	.	.	.	.	.	.	.	2	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bryum caespiticium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bryum capillare	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Acarospora sp1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1
Synechococcus aeruginosus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	2	.	.	.	.	.	.
Actinotaenium cucurbitinum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.
Navicula sp1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.
Oscillatoria sp	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.
Hantzschia sp	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	+	.	.	.
Bryum bicolor	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Bryum radiculosum	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
Pinnularia sp	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	1	.	.	.	.	.	.	.
Lecidea sp1	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chlorogloea sp	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.
Phormidium sp	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
Ulothrix sp	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Muriella terrestris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.
Protoblastenia sp1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
Trebouxia arboricola	.	.	.	.	.	+	1	1	1	1	1	1	1	1	.	.	.	1	1	1	.	.	.	.	.	.	.	1	.	.	3	1	.	.
Bryum sp3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	1	.	.	.	1	.	.	.	.	1	.	.	.
Lyngbya sp	.	.	.	.	.	.	+	.	1	1	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	2	.	1	.	.	1	.	.	.
Calothrix sp2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	1	.	.	.
Actinotaenium cucurbita	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Tortula sp 1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.
Nostoc sp	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	2	.	.	.	.
Klebsormidium flaccidum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	1	+	+	1	.	.	.	.	.
Trentepolia aurea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Coccomyxa sp	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Stichococcus bacillaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Pleurogaster lunaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Chlorella sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Navicula sp2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Lecanora muralis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.

Groups	A							B						C												D	E		F		G	H	I	
N° reliefs	1	4	3	10	14	15	16	2	19	20	21	22	24	5	7	8	34	9	11	12	27	29	25	30	31	26	17	18	32	33	28	23	6	13
Lecanora muralis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Candelariella vitellina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Characiopsis sp	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.
Caloplaca sp2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	+	.	.	.
Collema sp1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.
Fissidens bryoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.
Rhynchostegiella tenella	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Verrucaria sp1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lecanora sp1	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aspicilia sp3	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Candelariella aurella	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sarcogyne pruinosa	.	.	.	.	.	.	.	.	.	+	.	.	1	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acarospora sp3	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acarospora sp2	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aspicilia sp2	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Caloplaca sp1	.	.	.	+	.	1	.	.	.	.	.	.	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lecanora albescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
Caloplaca aurantia	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.
Caloplaca lactea	.	.	.	.	.	.	.	.	.	.	.	1	1	.	+	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.
Lecanora sp2	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Groups	A							B						C												D	E		F		G	H	I	
N° reliefs	1	4	3	10	14	15	16	2	19	20	21	22	24	5	7	8	34	9	11	12	27	29	25	30	31	26	17	18	32	33	28	23	6	13
Hantzschia sp	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	+	.	.	.
Bryum bicolor	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Bryum radiculosum	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.
Pinnularia sp	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	1	.	.	.	.	.	.	.
Lecidea sp1	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chlorogloea sp	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.
Phormidium sp	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
Ulothrix sp	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Muriella terrestris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.
Protoblastenia sp1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
Trebouxia arboricola	.	.	.	.	.	+	1	1	1	1	1	1	1	1	.	.	.	1	1	1	.	.	.	.	.	.	.	1	.	.	3	1	.	.
Bryum sp3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	1	.	.	.	1	.	.	.	.	1	.	.	.
Lyngbya sp	.	.	.	.	.	.	+	.	1	1	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	2	.	1	.	.	1	.	.	.
Calothrix sp2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	1	.	.	.
Actinotaenium cucurbita	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Tortula sp 1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.
Nostoc sp	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	2	.	.	.	.
Klebsormidium flaccidum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	1	+	+	1	.	.	.	.	.
Trentepolia aurea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Coccomyxa sp	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Stichococcus bacillaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Pleurogaster lunaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Chlorella sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Navicula sp2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Lecanora muralis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Lecanora muralis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Candelariella vitellina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Characiopsis sp	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.
Caloplaca sp2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	+	.	.	.
Collema sp1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.
Fissidens bryoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.
Rhynchostegiella tenella	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Verrucaria sp1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lecanora sp1	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aspicilia sp3	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Candelariella aurella	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sarcogyne pruinosa	.	.	.	.	.	.	.	.	.	+	.	.	1	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acarospora sp3	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acarospora sp2	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aspicilia sp2	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Caloplaca sp1	.	.	.	+	.	1	.	.	.	.	.	.	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lecanora albescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
Caloplaca aurantia	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.
Caloplaca lactea	.	.	.	.	.	.	.	.	.	.	.	1	1	.	+	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.
Lecanora sp2	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Candelariella sp1	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aspicilia sp4	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Protoblastenia incrustans	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 1. Biological colonization in the sampled area, following the order of cluster analysis

an ordered matrix following the order that arises from the cluster analysis (Table 1). Three main groups (A, B and C) can be distinguished; three groups each formed by two samplings (E, F and I) and finally three single reliefs (D, G and H) are associated to these.

Each group is characterized by some "guide species", which are found in most of the surveys taking part in a determined cluster. The classification results were confirmed by the arrangement, but the significance of Axes 1 and 2 are not high (16% and 10% respectively).

Effects of edaphic and environmental factors

As it is not easy to establish a hierarchy of influence of the ecological factors, which often interact with each other with synergistic or compensatory effects (Ortega-Calvo *et al.* 1991; Caneva and Ceschin 2005), we will try to highlight the importance of certain parameters, that it was possible to observe in the field, trying to extract the general trends. In general, we will show some cases in which the ecological variations were limited to no more than a pair of parameters, in order to test the possibility of establishing their relative importance.

Light vs nature of tesserae

In order to verify the influence of the constituent material of the tesserae on the biological colonization in the area of the Caseggiato dei Lottatori, samplings were taken from two areas composed exclusively of black tesserae (survey 11 and 14) and two areas consisting of white tesserae (reliefs 12

Fig. 1. Areas sampled in order to analyse the effects of light on the biological cover (photo: G. Caneva)

and 13), making sure that samples 11 and 12 came from an area in the shade for most of the day, and samples 13 and 14 from an area of the floor always in full sun (Fig. 1).

The data obtained (Table 2) show how the surveys with an equal index of light exposure are much more similar to each other, as compared to the findings with the same substrate; it seems that light here is more important than the type of substrate, probably in as much as it also affects more or less the water stagnation and in the end the xericity of the area. Also to help demonstrate this, no obvious differences in colonization can be observed in the white and black tesserae with the same light exposure in survey 1. Only in the "stanza dei ventagli", we could note how the lichen *Aspicilia calcarea* (L.) Mudd has a slight preference for black tesserae. Since it is not plausible that this is related to the chemical nature of the substrate (being a basophilous species, even if it is also true that the mortars are lime based) it is probable that this phenomenon is due to the more intense warming up of the black tesserae, which favours the xerophilous lichen species.

N° sampling	11	12	13	14	
Sampling sites (m^2)	0,062	0,062	0,062	0,062	
Sampling date	15.11.07	15.11.07	16.11.07	17.11.07	
Slope	0°	0°	0°	0°	
Exposure	.	.	.	.	
Types of tesserae	B	W	W	B	
Shade/light	2	2	5	5	
Presence/absence mortar	No	No	Yes	Yes	
Average space between the tesserae (mm)	3	2,9	3	3	
Cover	No	No	No	No	
Ground level	0	0	0	0	
Chroococcus lithophilus	2	2	2	1	
Gloeocapsa sp	.	+	.	+	
Calothrix sp1	.	.	.	+	
Nostoc sp	1	.	.	.	
Desmococcus olivaceum	2	2	.	.	
Apatococcus lobatus	2	2	.	.	
Trebouxia arboricola	1	1	.	.	
Verrucaria nigrescens	1	1	.	+	
Lecidea fuscoatra	.	1	.	.	
Candelariella aurella	.	.	.	+	
Acarospora umbilicata	+	+	.	.	
Acarospora sp1	.	.	1	.	
Caloplaca sp1	+	.	.	.	
Aspicilia radiosa	.	+	.	.	
Aspicilia calcarea	1	.	.	1	
Aspicilia sp1	.	+	.	.	
Tortula muralis	2	2	+	+	
Bryum capillare	.	.	+	.	
Bryum torquescens	.	.	2	.	
Bryum sp2	.	1	.	.	
Bryum sp3	.	1	.	.	

Table 2. Effect of Light vs Nature of tesserae in the biological colonization of mosaics

Fig. 2. Increase of the biological cover linked to a higher input of water and earth arising from a nearby shelter (photo: G. Caneva)

Shelters (water vs light)

The effect of a cover in inhibiting biological growth was particularly noted in the section of the Terme del Nuotatore, covered since a few decades by an opaque canopy, installed in order to protect some traces of frescoes and mosaics from the rain. Among the three samplings taken (surveys 25, 26 and 27), small spots of greenish deposits were found only in the third (consisting of the algae *Desmococcus olivaceum* Persoon ex Acherson and *Apatococcus lobatus* (Chodat) J.B. Petersen). This shows that humidity is the main limiting factor for biological growth, and that in the presence of a shelter, which prevents the rain from falling onto the mosaics, the biodeteriogens are virtually absent. The parallel effect of light reduction is to be considered negligible in as much as the more shaded but moist parts still showed growth of photoautotrophs. It should be observed that in areas adjacent to shelters the effects may increase biological growth, especially if there are clogged gutter drains, which can generate a local increase in the input of water and earth with synergistic effects on growth (Fig. 2).

Inclination (water vs light)

To evaluate the effect of the inclination of the mosaic surface on the development of the algae patinas, samplings were ta-

N° sampling	6	22	23	24	3	
Sampling sites (m^2)	0,651	0,056	0,056	0,056	0,651	
Sampling date	7.11.07	20.12.07	20.12.07	20.12.07	6.11.07	
Slope	15°	10°	12°	10°	5°	
Exposure	SE	NE	NE	NE	NW	
Types of tesserae	B/W	B/W	B	B	B/W	
Shade/light	4	4	5	5	1	
Presence/absence mortar	Yes	No	No	No	No	
Average space between the tesserae (mm)	3	2	2	2,9	4,3	
Cover	No	No	No	No	No	
Ground level	0	0	0	0	0	
Chroococcus lithophilus	.	.	.	.	2	
Gloeocapsa sanguinea	.	.	.	.	2	
Nostoc sp	.	.	.	.	+	
Desmococcus olivaceum	.	1	1	1	.	
Apatococcus lobatus	.	1	1	1	.	
Trebouxia arboricola	.	1	1	1	.	
Verrucaria nigrescens	.	.	.	.	+	
Lecidea fuscoatra	.	+	.	.	.	
Lecanora albescens	.	.	1	.	.	
Lecanora campestris	.	.	.	.	+	
Lecanora dispersa	.	.	.	.	+	
Lecanora sp2	.	+	.	.	.	
Candelariella sp1	.	+	.	.	.	
Sarcogyne pruinosa	.	.	.	1	.	
Acarospora umbilicata	.	.	.	.	+	
Acarospora sp1	+	.	.	.	.	
Acarospora sp3	.	.	.	1	.	
Caloplaca flavescens	.	.	.	.	.	
Caloplaca lactea	.	1	1	1	.	
Caloplaca aurantia	.	.	4	.	.	
Caloplaca sp1	.	.	.	1	.	
Aspicilia calcarea	.	.	.	.	1	
Aspicilia sp4	.	1	.	.	.	
Protoblastenia incrustans	.	+	.	.	.	
Collema tenax	.	.	.	.	1	
Tortula muralis	1	1	+	+	1	

Barbula convoluta	.	.	.	.	1	
Bryum bicolor	.	.	.	.	+	
Bryum caespiticium	.	.	.	.	.	
Bryum sp1	.	.	.	.	1	
Bryum sp2	.	.	.	.	2	
Bryum radiculosum	.	.	.	.	2	
Brachythecium rutabulum	.	.	.	.	2	
Brachythecium veluitinum	.	.	.	.	2	

Table 3. Effect of Inclination (Water vs Light) in the biological colonization of mosaics

ken from areas that have a slope that varies from 5° to 15° (Table 3). In these areas, it has been noted how cyanobacteria and algae are minimal, except in reliefs 22, 23 and 24, where green algae belonging to the species *Apatococcus lobatus* (Chodat) J.B. Petersen, *Trebouxia arboricola* Puymaly 1924 and *Desmococcus olivaceum* (Pers. ex Acherson) J.R. Laundon are detected, which, in any case, occur most frequently on the mosaics of Ostia. In relief 3 algae patinas are present containing *Chroococcus lithophilus* Ercegovic 1925, *Gloeocapsa sanguinea* (C. Agardh) Kützing 1843 and *Nostoc* sp., but here we are dealing with a particularly humid site with low brightness (because of shade). From what has been observed it can be inferred that a slope discourages the establishment of algae patina in as much as it promotes the flow of water, creating more xeric conditions, which are in turn less conducive to the growth of algae. Nonetheless, exposure cannot be overlooked especially when it is to the south, because of its analogous effect on potential drying (see survey, Table 3).

Degree of burial (water vs nutrients)

The Terme delle Province site, which is about 1.30 m above the average ground level of Ostia Antica, was selected to evaluate the effects of uneven gradients in the terrain (Fig. 3).
The five samples collected showed a similarity with others taken from areas

Fig. 3. High growth of algae and cyanobacteria in humid conditions (photo: S. Brignocchi)

with particularly high humidity, even if they were not underground as many of the others were. Once again water shows itself to be the determining factor. This, even if expected, reduces the potential influence of other factors, such as the nutrients, for example, which potentially could have an important role. No effects due to the eutrophication of the substrate were observed, except on one site (survey 23) where there is a conspicuous colonization by *Caloplaca aurantia* (Pers.) Hellb., a lichen species with a rather high eutrophication index, which can be explained by the close contact of this small section of the mosaic floor with the ground.

Fig. 4. High moss colonization in the interstices between the tesserae (photo: S. Brignocchi)

Interstices between the tesserae and the presence/absence of mortars

At Ostia Antica, the interstices between the tesserae range from a minimum of 2 to a maximum of 5 mm. In qualitative terms, these small variations do not have a great influence on the biological growth. Otherwise an influence is more evident from a quantitative point of view, when comparing the areas with minimum and maximum gaps between the tesserae. Where mortar is not present but deposits of earth are found, moss colonization is richer both qualitatively and quantitatively (Fig. 4). The presence of mortars, instead, permits the development of algae and lichen patinas, which in the absence of mortars, grow on the tesserae only.

Phenological aspects and dynamism of the biological colonization

The observed features of biological growth and quantitative fluctuations during the change of seasons present variations between the different taxonomic groups considered. In particular, both lichens and cyanobacteria show a stable morphology during the year; while, on the other hand, both the green algae and the mosses show evident phenological variations. The former have a mainly winter phenology, and the mosses, which in summer are dark in colour and camouflaged by the tesserae, from October to November start becoming more evident and spreading out, on some sites, into a dense bright green carpet.

As regards the dynamics of colonization the algae patinas, mosses and lichens must be dealt with separately. It has been observed how cyanobacteria often constitute biodeteriogens present in the early stages of colonization on a mosaic forming more or less dense blackish patinas which cover the surface of the tesserae; these patinas seem to grow equally as much on white tesserae as on black ones, where, however, they are less visible. In the case of more humid and shaded floors, such patinas proliferate in such a way as to cover the substrate and deface the mosaics.

In covered environments the role of pioneer organisms seems to be attributable to green algae (*Trebouxia arboricola* Puymaly 1924, *Desmococcus olivaceum* (Pers. ex Acherson) J.R. Laundon and *Apatococcus lobatus* (Chodat) J.B. Petersen). It should be noted that the patinas often begin by colonizing the outer margins of individual tesserae first and then gradually extending to the entire surface. By contrast, in most cases moss colonization takes place at the level of the mortar, because this material has high porosity, high permeability and an uneven surface. Furthermore, mortars undergo a progressive shrinking with time, which facilitates the accumulation of soil between the tesserae, an element that favours the growth of mosses. Another fact to highlight is that the mosses are found mainly in shaded areas that are rarely reached by direct sunlight.

Moreover, it may be interesting to note, that almost all of the mosses found in the sampling areas are acrocarps, while the pleurocarps are limited to only three species (*Brachythecium rutabulum* (Hedw.) B.S.G., *Brachythecium velutinum* (Hedw.) Schimp. and *Rhynchostegielle tenella* (Dicks.) Limpr.); these are found only in some sampling areas that are in the shade and always close to walls, where there are conditions conducive to higher humidity, since the acrocarps manifest a greater ability to adapt even under the most stressful ecological conditions while the pleurocarps require very stable conditions. On archaeological sites lichens often grow on mosaic floors that have a rocky substratum, and which are extremely stable and so lichen communities can develop undisturbed until maturity. This process occurs very slowly and since the pace of growth of the lichen thallus is so extraordinarily slow, it was in fact observed that many of the lichens in the areas studied are found only in small spots on individual tesserae. However, among the samples taken, there are examples of extensive lichen cover, such as *Aspicilia calcarea* (L.) Körber and *Caloplaca aurantia* (Pers.) Hellb., which often have a thallus of considerable proportions (in the order of a few centimetres) and which can even surpass the width of the interstices between the tesserae (Fig. 5).

The effect of anthropogenic factors, such as trampling, cleaning, restoration and maintenance are undoubtedly important, but their detailed effect has not been established due to the lack of quantitative data or certain temporal information which would make objective judgment possible.

Conclusions

Analysis and interpretation of the results obtained showed that the presence and growth of micro algae, lichens and bryophytes is influenced by very specific environmental factors, the principle one being water. Shade and the increase of the porosity of a material are factors which normally favour biological growth, just as much as water stagnation. Conversely and for the same reason, the increase of the inclination, especially in a southern exposure is often a limiting factor.

It was possible to verify how protective shelters represent a valuable means of protection of mosaics from the development of biodeteriogens. Among all the organisms studied, lichens and cyanobacteria resulted more tolerant to a low water content, while green algae and mosses developed only in quite moist conditions with,

Fig. 5. Extensive lichen cover (*Aspicilia calcarea* (L.) Körber and *Caloplaca aurantia* (Pers.) Hellb.), which sometimes can surpass the space between tesserae (photo: G. Caneva)

of course, a tolerance fluctuation associated with the different species. It should be noted how the state of preservation of the mosaic, and especially the presence of the mortars, condition the development of bryophytes, which prefer this type of substrate rather than the lithotypes used for the tesserae. For a more precise understanding of the phenomena of biodeterioration, which is of fundamental importance to the routine maintenance of archaeological sites, the development of various biological components, as well as environmental factors, must be correlated with the timing and the conservation work to be carried out.

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ARCHAEOLOGICAL SITES WITH MOSAICS IN TURKEY: MANAGING THE UNMANAGEABLE

Hande Kökten

Abstract

In situ preservation and display of mosaics at archaeological sites in Turkey is a major issue which causes risks, due to the lack of conservation professionals, as well as insufficient site management. The main causes of these risks can be summarized as follows, from the discovery of the mosaic floor to its reburial or display:

– Absence of professional (conservator or conservation technician) assistance during the discovery of a mosaic floor and the practice of inaccurate excavation techniques
– Lack of detailed documentation and condition assessment of the mosaic floor
– Lack of preventive conservation measures for stabilizing the condition of the mosaic floor
– Insufficient knowledge of first aid for the stabilization of the damaged mosaics
– Lack of standards for the re-burial of mosaic floors, as well as faulty practices (use of improper filling materials, plastic coverings, etc.)
– Improper lifting operations carried out by unauthorized and inexperienced team members
– Storage of lifted mosaics in unfavourable conditions and lack of maintenance in excavation depots
– Poor quality of sheltering and lack of maintenance for in situ preserved and exposed mosaic floors
– Lack of periodical control for the condition of exposed mosaics preserved in situ.

This paper will first discuss the issues that archaeologists and conservators face during the management of archaeological sites with mosaics in Turkey, and then present practical solutions for both professionals, by referring to a comparative study of two major ancient sites with mosaics in Anatolia, Erythrai and Sagalassos.

There are more than 90 archaeological sites with mosaics in Turkey, 83 of which date to the Classical, Hellenistic, Roman and Byzantine eras and are subject to systematic excavations undertaken by national and foreign expeditions. Due to the large number of mosaic floors that are discovered during these excavations, preservation issues are unavoidable. Assessing the causes of these problems seems to be the most direct approach to present practical solutions.

Absence of professional assistance during the discovery of a mosaic floor and practice of inaccurate excavation techniques

Even though the national legislation (no. 2863 for the “Protection of the Cultural and National Heritage”: http://teftis.kulturturizm.gov.tr/belge/1-41644/kultur-ve-tabiat-varliklarini-koruma-yuksek-kurulu-ile-.html (16.1.2012)) obliges the expedition to provide conservation for all movable and immovable archaeological finds unearthed during an archaeological excavation in Turkey, because of the lack of conservation planning and experienced professionals qualified in field conservation, the discovery of a mosaic floor often results in some degree of damage, depending on its condition. In many cases, conservators are called in for assistance when an excavator faces serious problems or irreversible damage caused by incorrect excavation techniques and improper stabilization methods and materials. Unfortunately, the need for first aid treatment, to be followed by preventive conservation measures, is often ignored by the archaeologists; and this affects the mosaic floor during the excavation in the short term, and later in the long term as it is re-buried with an inadequate fill for an indefinite period of time.

This situation is based on two major reasons:

– Although both the Legislation (see above, Article 45) and the "Code for the Research, Survey and Excavation of Cultural Heritage" (Article 9,e: http://teftis.kulturturizm.gov.tr/belge/1-41687/kultur-ve-tabiat-varliklariyla-ilgili-olarak-yapilacak-.html (16.1.2012)) hold the field director responsible for providing conservation and maintenance of the archaeological finds excavated, including the floor mosaics, there is no mention of guidelines that apply to their preservation. At the same time, archaeologists are lacking the necessary standards to judge the efficiency and compatibility of the conservation approaches taken by the conservator, especially when the conservation professional is not specialized in mosaics.
– In the absence of a qualified conservation professional, the scope of the archaeologist's responsibility expands in order to ensure the safekeeping of in situ floor mosaics by using preventative conservation measures and materials. However, neither field directors nor excavators have any degree of knowledge in preventive conservation to compensate the absence of a field conservator. The curricula of Archaeology and Art History Programs in Turkey very seldom include "preventive conservation" as a course, therefore archaeologists are not capable of using first-aid techniques during excavations (Çetin, 2009, 29-32).

Lack of detailed documentation and condition assessment of the mosaic floor

In Turkey, the condition and preservation state of the floor mosaics discovered during systematic archaeological excavations are often not documented in detail, even when there is a conservator on the site. Furthermore, the need to keep treatment reports for the mosaics conserved in situ are often disregarded. This situation is partly due to the insufficiency and irresponsibility of the conservation professional; as well as to the lack of standards that regulate the process. However, documentation has a crucial value for both the archaeologist and the mosaic conservator, as the mosaic floor is backfilled and thus becomes inaccessible for a long period of time. For instance, during the regular control of backfilled mosaics, it is necessary to have such documentation in order to test the success of the backfilling method and materials. On the other hand, as the field director will avoid removing the fill layer temporarily for a condition survey of the mosaic floor, this kind of information becomes the only source of information for the mosaic conservator to prepare a realistic conservation proposal.

Lack of preventive conservation measures for stabilizing the condition of the mosaic floor

As described above, lack of preventive conservation knowledge causes many serious problems and often irreversible damage during and after the excavation of a mosaic floor. Therefore, it is vital to provide guidelines for the excavator, to help him protect the newly excavated mosaics by taking the necessary steps. At this point, one has to understand and consider that preventive conservation of excavated floor mosaics should be classified under two major stages:

a. Basic preventative conservation methods that aims to control the environmental factors that affect the mosaic floor
b. Preventive conservation applications/ first aid for mosaic floors that require the intervention of the excavator

The excavator may need to act as a conservation technician for several reasons:

– An insufficient excavation budget for employing a conservation professional
– Unexpected mosaic discoveries
– The absence of a field conservator qualified in the conservation of mosaics
– The time constraints of the objects conservator for helping the excavator in the field.

Under these circumstances, the excavator should know how to stabilize the mosaic with reversible conservation materials and techniques. Extending the scope of the excavator's responsibilities to include interfering with the stabilization process is certainly a very dangerous matter; however, in many instances, it is the only solution that can prevent further damage.

Insufficient knowledge of first aid for the stabilization damaged mosaics

As discussed in the previous section, first aid for the stabilization of damaged mosaics can be classified as the advanced level of preventive conservation measures, preferably and primarily applied by conservation professionals or, in their absence, by the excavator. However, as observed at many archaeological sites in Turkey, this issue cannot be attributed only to the absence of conservators or conservation technicians, but also to the extent of their knowledge and liability. As a matter of fact, it is very sad but true that most of the destructive methods and materials have been applied by so-called "mosaic restorers". And thus it is obviously necessary to instruct the excavators and the government representatives about the principles of first aid treatment and materials, and to enable them to realize possible mistakes during the conservation work.

Lack of standards for the re-burial of mosaic floors, as well as faulty practices

As mosaic floors are mostly preserved in situ at archaeological sites, their long-term preservation becomes a major issue which has to be solved by the field director. In situ conservation and display usually requires a longer period for planning and design, as the national legislation (no. 2863, see above) obliges the expedition to obtain the approval of the Preservation District Board before building a roof or a protective structure in an archaeological site. Therefore, even for floors that will be displayed in situ, it is a standard procedure to backfill the mosaics. On the other hand, in many cases, back filling is the only option for the field director due to the high cost of protective structures.

Needless to say, one needs to remember that mosaic floors re-buried for long term may still be affected, depending on the method and materials used for re-burial, as well as the duration of the burial period and environmental factors (Podany, Agnew and Demas, 1994, 1-19). In many instances, the effectiveness of the chosen materials and method for backfilling is not discussed in detail and thus the mosaic floor is backfilled with whatever material is available at the site. For instance, in cases where the backfill layer is not solid enough, the *tessellatum* will be exposed to the effects of wind and rain, and thus will weather throughout the year. In the spring such an undesirable and improper display will become even worse because of the visitors. Unfortunately, such conditions are often observed at archaeological sites where a research project has been completed, and eventually these mosaics are under great risk.

Improper lifting operations carried out by unauthorized and inexperienced team members

In the national legislation for the Protection of the Cultural and Natural Heritage, no. 2863, Article 6 defines "floor mosaics" as an immovable archaeological property that should be preserved in situ· Article 20 of the same legislation, which classifies the lifting and removal of the immovable heritage, states that "*If there is a necessity to remove the immovable cultural property to a different location, or if its properties make this removal unavoidable, such an action can be taken by the Ministry of Culture and Tourism, after the approval of the District Preservation Boards and after necessary security measures are provided*". However, since receiving the permission of the District Preservation Board is a time-consuming process, the approval seems to be assigned to the government representative in order to speed up the process. In the meantime, legislation does not specify the "acceptable necessities for the removal of a mosaic floor from its original location" in detail, and thus decisions concerning the lifting of a mosaic floor are made after the proposal of the project director and the approval and permission of the government representative.

In this case, the obvious reason for the transfer of a floor mosaic proposed by an archaeologist is likely described as "the necessity to reach the earlier archaeological layers that are covered by the mosaic floor". There may be, according to the conservator, other reasons for lifting the mosaic floor:

- *Detached tesserae*: The great number of tesserae that have lost adhesion to the setting bed, due to the deterioration of the bedding layer
- *Deteriorated preparatory layers*: The loss of physical integrity within one or more layers of mortar supporting the *tessellatum*, due to ground water that cannot be prevented through drainage systems

- *Destruction of the supporting structures* (i.e. vaults, arches, shafts) below the mosaic floor, which results in the damage of both the preparatory layers and the *tessellatum*
- *Risk of destruction due to landslide and erosion* that is related to the original location of the mosaic floor (i.e. slopes, hillsides, waterfront).

However, as these causes are not clearly indicated in a code associated with the legislation, and in the absence of an experienced conservator, it may be that this important decision is made by the archaeologist and the representative who are not competent enough to evaluate the mosaic's condition. When the decision is made to lift the mosaic floor, there arises the even more difficult question of "how this complicated operation will be held and by whom?" There is no doubt that such a complex work will require the skills of an experienced mosaic conservator; however, as mentioned earlier, Turkey has very few professionals specialized in this field. Therefore, the lifting operations are often performed by conservation technicians and conservators who are not competent and experienced enough to exercise the lifting methods; and eventually the operation results in the destruction of mosaics (Kökten 2008, 131-135).

Storage of lifted mosaics in unfavourable conditions and lack of maintenance in excavation depots

After the lifting process, due to the space limitations in the excavation depots, sections of lifted mosaics are unrolled and stacked in layers either on the floor or on wooden platforms. There are also cases where the lifted mosaic panels are stored in field depots due to their accessibility. However, once they are placed in a remote corner of the depot, they will be forgotten for ever. The materials used during the lifting process are usually water-soluble glues and glue-based cotton facings which, over time, are susceptible to water damage and biodeterioration, especially when the storage conditions are not favourable for the long term preservation of the mosaics. Needless to say, the mosaics are vulnerable since they have been separated from their rigid substrates and are held together only by temporary facings.

As Kent Severson states "Storage conditions for faced mosaics should be given as much consideration as plans for more permanent disposition and should include factors that will ensure stability of the facing reinforcement and adhesive" (Severson *et al.* 2000, 10-11).

Poor quality of sheltering and lack of maintenance of in situ preserved and exposed mosaic floors

At archaeological sites that receive a large number of visitors during the peak season from May to October, the maintenance and monitoring of the mosaic floors displayed in shelters is a major concern, For this reason field directors and/or local museum authorities take this responsibility more seriously. However, at other sites the situation is far from acceptable as the detrimental processes are often neglected and not considered destructive until the mosaic floor is severely damaged.

Needless to say, it is vital to examine the roofs/shelters and their components (gutters, pipes, drainage systems, walls, ventilation shafts, etc.) regularly and to take the necessary measures immediately; and this assignment should be accomplished by the local museum, in the case of completed excavations (Aslan 2003, 89-97). The following questions still remain unanswered:

– Who will examine the condition of the shelters and how often will this examination take place?
– Who will be responsible for the maintenance of the mosaic floors?
– What are the intervention levels for in situ preserved mosaics?
– Who will treat the damaged mosaics again and to what extend take the necessary measures?

Lack of periodical control for the condition of exposed mosaics preserved in situ

It is not a common practice in Turkey to display mosaic floors at archaeological sites without sheltering; however, there are a few instances where ancient structures with exposed mosaic floors are open to visitors. Even though these mosaics have been treated and stabilized properly at the time of their discovery (Majewski 1973, 100-101), the weathering of the winter weather and the visitors walking freely on the floors imply their regular monitoring, as well as their maintenance and re-conservation. Unfortunately, these issues remain unsolved as expeditions often hesitate to spend their excavation budget for the maintenance of previously restored archaeological remains, as the cost of re-conservation reduces the area they can excavate. All these issues indicate that a great number of in situ mosaics unearthed at archaeological sites in Turkey are under severe risk and the major cause of this situation is the inadequacy of the "archaeological site management code" (http://teftis.kulturturizm.gov.tr/belge/1-44561/alan-yonetimi-ile-anit-eser-kurulunun-kurulus-ve-gorevl-.html (16.01.2012)). Hence, an extensive action program is recommended in order to resolve these issues before the mosaic heritage of Turkey is more severely and irreversibly damaged:

a. Establishing a reliable, illustrative and informative guide of preventive conservation for archaeologists, site managers and non-specialist conservators. This guide should include:
    1. The preventive conservation measures and materials to be applied during the excavation of a mosaic floor;
    2. First aid treatment methods and materials to be used on the newly excavated mosaics;
    3. The characteristics of an ideal backfill, as well as an illustrated description of the backfilling process; and
    4. Guidelines for an observation and maintenance program that will clarify the level and content of this assignment, as well as the qualifications of the keeper
b. The qualifications and competence of conservation professionals who will undertake conservation treatments of mosaics should be clearly defined. The field directors and authorities at the Department of Antiquities should be aware of these definitions and criteria in order to evaluate the suitability of the candidate for the conservation work.

    Conservation technicians and a non-specialist conservator should be able to:
    - Undertake excavation of the heavily damaged mosaics

- Document the physical condition of the mosaic floor
- Take the necessary precautions to protect the mosaic
- Apply basic post-excavation treatments to prevent further damage and to stabilize the *tessellatum*
- Assist the mosaic conservator during the interventive conservation procedures
- Supervise the workmen during the backfilling process
- Undertake the maintenance of the displayed mosaic floors

A specialist conservator should be able to:

- Supervise the archaeologists during the excavation of heavily damaged mosaics
- Prepare a condition report and conservation proposal for the mosaic
- Undertake the interventive conservation procedure
- Consult the excavation director about the backfilling of the mosaic
- Observe and document the condition of the in situ mosaics; treat them again if necessary
- Examine the sufficiency of the backfill method and the materials used

c. The code of archaeological site management should be revised by a commission of professionals, including field conservators and restorers, and it should be made available to site managers, field directors and archaeologists, as well as to the government representatives working at archaeological sites.

To contribute to the preservation of Turkey's mosaic heritage, the Ankara University Conservation Program prepared a guide of "Preventive Conservation for Mosaics", which will be distributed to the archaeological expeditions working in Turkey. A web site is also being designed for the same purpose in the hope of mutual support between archaeologists and conservators.
Turkey's mosaic heritage can only be saved with the collaboration of responsible field directors and qualified and experienced conservators under the protective shield of standards, codes and guidelines. As the knowledge of preservation is the most valuable source to share and distribute, especially among those who do not know how to gain it, conservation professionals need to think and work harder to provide as much information as possible, to improve the current situation of mosaics.

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TEMPORARY PROTECTING COVERING SYSTEM FOR MOSAICS IN ARCHAEOLOGICAL SITES

Alessandro Lugari

The methods of intervention for the conservation of mosaics in situ are well known, for this reason I will deal with the problem of maintenance of our work by temporary covering.

Before excavation there is a stable thermodynamic balance; during and after excavation, this balance is upset, and from that moment on the process of degradation begins. In a stable situation, there are constant parameters of temperature and humidity, and absence of light. In an unstable situation these parameters change and there is a rapid hygrometric and moisture variation as well as the presence of light. At this point, there are also some different issues that need to be faced: the main one is for the work to continue; and the secondary one is maintaining the visibility of the archaeological site and artefacts for the public.

The environmental parameters change very quickly and thus rapid evaporation must be avoided, the temperature range must be checked, as well as the presence of light and the growth of micro-organisms. The solution is to intervene on those parameters in order to reduce their effects on the ancient materials. Generally speaking, some kind of fabric is placed on top of the floor mosaic. One of the most commonly used materials is nonwoven fabric (Fig. 1 and 2), which is a good, short-term solution which, however, often, for not saying always, (for economic reasons) becomes permanent. In many cases, after conservation, the temporary covering is left for too long, which results in the growth of vegetation, the adhesion of the fabric to the underlying artefact, which makes it impossible to remove without damaging the mosaic (Fig. 3).

In the conservation project for the *Templum Pacis* (Temple of Peace) in the Imperial Fora in Rome (Lugari and Schievano 2010), during the excavation a nonwoven fabric was used, and every day the sections in which work had to be done, were uncovered, to be covered again at the end of the day (Fig. 4). Once the intervention was completed, the big problem to solve was how to preserve our hard and long work. So, we go back, for a moment, to the beginning of this paper, and mention that, at this point, we had an unstable thermodynamic situation with rapid variation of environmental parameters. There are many options for reducing the effects caused by these phenomena: The first, and perhaps the best, is the building of a shelter (Laurenti 2006) and, associated with this, the drawing up of a maintenance program. An alternative would be to cover the pavements at least seasonally and organize ordi-

Fig. 1. Covering mosaic floors with nonwoven fabric, Villa Fontana Amara, Rome (photo: A. Lugari)

Fig. 2. Covering mosaic floors with nonwoven fabric, Villa dei Quintilii, Rome (photo: A. Lugari)

Fig. 3. Condition after one year of covering with nonwoven fabric, Villa di Via Carciano, Rome (photo: A. Lugari)

Fig. 4. Daily covering with nonwoven fabric, Forum of Peace, Imperial Fora, Rome (photo: A. Lugari)

Fig. 5. Covering with Delta-Lite fabric, Forum of Peace, Imperial Fora, Rome (photo: A. Lugari)

nary maintenance when they are exposed. Other alternatives would be to do nothing or to rebury (this last option being the most common, mainly for economic and security reasons). All of these choices, excluding the last one, involve another big problem: money. At the site of the Imperial Fora building a shelter is a complex affair, firstly because of the impact on the landscape, and secondly because of the expense. It was decided not to rebury the pavement because of the importance of the monument and to apply an ordinary maintenance and, during the winter and the summer, use a temporary covering.

Since 1992, there is project ("Progetto Forum") for covering the floor in situ that has experimented with many possible solutions (Colombi 1995). After 20 years we can say that the best option for a temporary covering is gore-tex. The one and only, and the big problem with this material is its cost: it is very expensive (about 300 euros per square metre). Our research was to look for a material with the same characteristics as gore-tex (is waterproof, transpires, and is UV resistant) and, at the same time, cheaper. Eventually we found Delta-Lite, a material for construction works, used for the water-proofing of shelters. As an experiment, we tested it for covering the entire pavement (Fig. 5). When, after six months, we removed it in order to check the condition of the pavement, we got a surprise. The conservation of the floor was perfect, apart from small problems: the material was sold in rolls and at the junctions

Fig. 6. Condition after one year of covering with Delta-Lite fabric, Forum of Peace, Imperial Fora, Rome (photo: A. Lugari)

Fig. 7. Condition after one year of covering with Delta-Lite fabric, Forum of Peace, Imperial Fora, Rome (photo: A. Lugari)

Fig. 8. Covering with a 'single' sheet of Delta-Lite fabric, Forum of Peace, Imperial Fora, Rome (photo: A. Lugari)

Fig. 9. Covering with a 'single' sheet of Delta-Lite fabric, Villa dei Quintilii, Rome (photo: A. Lugari)

of the sheets there was some infiltration of water, but all the same the results were good (Fig. 6 and 7). To face this inconvenient we asked for a solution from the Delta-Lite factory. The expedient was the application by the factory itself of strong-glue stripes on the edges of every roll. Thus, a 'single' composite sheet is obtained (Fig. 8), which hinders water infiltration. Today, after five years of experimentation, we are completely satisfied with the Delta-Lite covering. It has the same characteristics as gore-tex, but costs only about three euros per square metre! A 'single' sheet is easy to apply and remove, and the conservation of the pavement is excellent; and we use it in many archaeological sites all over Italy (Fig. 9).

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SITE MANAGEMENT PLANNING: EIRENE ARCHAEOLOGICAL SITE, PLOVDIV, BULGARIA

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Abstract

Conservation of the Late Antique residential building EIPHNH (Eirene) with mosaic floors took place in 2004 through funding from the U.S. Ambassador's Fund for Cultural Preservation; these activities were presented at the ICCM conference in Palermo in 2008. Site management planning, envisaged as the third phase of the project, was funded separately by grants awarded by the Trust for Mutual Understanding and a private donor. Though the conservation was an important achievement that gained much attention, the site management planning project of 2005 and the interpretive planning projects that followed in 2007 and 2008 may have an even greater impact on the long-term preservation of the site. The aim of this paper is to report on the site management planning process, the achievements since the drafting of the plan and the challenges that remain.

Over the past two decades, a multi-phase program of conservation and planning has been undertaken in Plovdiv, Bulgaria, to preserve and manage the ancient Roman archaeological site known as the Eirene Villa. Since its discovery in 1983, the Villa has provided a unique forum for cooperative development among many stakeholders and supporters in Plovdiv, during a period of significant political and economic change for the city's population of more than 350,000 people. The initial stages of the project successfully addressed many aspects of preservation and site management, including stabilization of individual mosaics, site drainage, and construction of protective buildings. As public recognition of this precious resource grew, the project expanded in scope to include international educational exchanges and development of a broader site management plan. Most recently, a major public outreach campaign resulted in the establishment of a non-profit support organization, the Bulgarian Heritage Trails Association. Established in 2007, this new organization serves as a nexus for fundraising and grant administration, and has already implemented a pilot project in Plovdiv that has drawn attention to the Eirene Villa and many other of the city's cultural treasures (http://www.bulgarianheritagetrails.org/maps.htm).

History of preservation at the Eirene Villa Archaeological Site

The Eirene Villa has undergone many campaigns of restoration since its discovery during road construction in 1983-84. At that time, one of Plovdiv's central boulevards was being renovated to allow installation of a sewer main and construction of an under-

Fig. 1. The new pedestrian passageway follows the ancient pavement (photo: E. Kantareva-Decheva)

ground pedestrian crosswalk. During excavation, an ancient crossroad with sections of adjacent insulae was discovered. As a result, a new pedestrian passageway was built to conform to the archaeological site plan. It follows the ancient east-west street or *decumanus*, and now forms the pavement of the underground crosswalk (Fig. 1). Floor mosaics belonging to a peristyle residential building, now known as the Eirene Villa, were also discovered (Fig. 2).

The Eirene Villa occupied the larger part of an insula block located in the centre of the ancient city of Philippopolis at a major intersection. In addition to the street and façade wall of the Villa, four public rooms, an apse and a section of the inner courtyard

Fig. 2. Mosaics at the Eirene Villa (photo: E. Kantareva-Decheva)

have been excavated. The house was supplied with running water through a series of floor channels, leading from a branch of the city water main and terminating in an octagonal basin. The four excavated public rooms all have mosaic floors, as do the peristyle portico and the apse. The mosaics date to two separate construction periods: the second half of the 4th century and the mid-5th century AD (Bospachieva 2002).

In 1984-85, the state government erected a protective building around the mosaics. The ancient road immediately adjacent to the villa, with walls and foundations of the neighbouring ancient shops, remained exposed. Construction of the protective building required the removal of some mosaic fragments from the site. For the next 20 years, the mosaics were largely neglected and continued to degrade. As a result of poor vapour barriers in the roadway overhead, the mosaics were flooded more than once through leaks in the ceiling. The site is located at the lowest part of the underpass where the underground moisture level is generally very high. Water pooling and continued water movement resulted in extensive damage to the mosaics. Some restoration was begun, but due to lack of financing it was never completed and the mosaics and building were not opened to the public. Short-term and superficial restoration attempts may also have contributed to the deterioration.

In 2003, the Eirene Villa archaeological site was awarded a conservation grant by the U.S. Ambassador's Fund for Cultural Preservation. Site conditions were reported at a regional ICOM conference in Kladovo, Serbia, in 2006 (Kantareva, Bospachieva and Luk 2007) and details of the conservation activities were reported at the ICCM conference in Palermo in 2008 (Kantareva, Bospachieva and Luk 2014). Additional grant funds obtained by the Williamstown Art Conservation Center, Williamstown, Massachusetts, USA, supported cultural and professional exchanges, conservator travel and training, and a final phase of long-term planning. The continued support of two American charitable organizations, the Trust for Mutual Understanding and the Tiannaderrah Foundation made possible a series of cultural and professional exchanges that proved critical to site development.

In the same year, a concession license was granted for commercial development of the Eirene Villa site. The city-granted license permitted development of small shops, an art gallery and event space adjacent to the mosaics, in exchange for assumption of maintenance and security costs. Substantial energy and funds were invested into developing the archaeological underpass area, including the addition of 24-hour security, masonry repair, added rest rooms, finished walls, protective walkways, a reception desk and a performance stage with seating. A permanent conservator was hired to maintain the mosaics according to a conservator-designed maintenance plan.

While great improvements have been made, drainage at the site remains problematic. Renovations included installation of a culvert bebeath the ancient Roman passageway; construction there exposed the ancient Roman sewer system, which still functions to a limited degree. Since the Eirene site is situated at the very lowest elevation in Plovdiv, water runoff from three hills collects in and around the excavation. Unfortunately, the modern culvert does not prevent the entry of water and moisture in the Villa. The movement of moisture and soluble salts remains a grave problem.

Located in central Bulgaria, Plovdiv's climate is considered intermediate continental tending to Mediterranean. The average annual temperature is 10.5° C and the average annual precipitation is 630 mm. Summers are typically hot and dry, winters cold and damp.

Humidity and temperature variations at the unheated Eirene Villa were monitored during its first year after opening. Temperature was fairly stable over time, because the underground site is so heavily insulated. Changes occurred slowly as temperatures gradually dropped. Sudden jumps in temperature were attributed to special events. Surface humidity was found to average about 43%. Changes in humidity were sometimes sudden, usually due to heavy rainfall increasing the level of subsurface water. On a few occasions, most common in the summer and fall, humidity approached 60% or more when heavy rainfalls ocurred. These moisture levels typically normalized within two days of such rains, but not without posing risks to the mosaics.

Expanding commercial development is a continuing concern at the Eirene site. The licensee supplements Villa operating costs through the art gallery revenues and rentals for special events. A café and a museum shop have also been constructed on the ancient Roman foundations adjacent to the Villa. This commercial expansion, while financially supporting the complex, runs the risk of exposing the archaeological materials to misinterpretation, damage from casual use, and unauthorized alterations.

Site Management planning process

Site management planning in the broader sense began in 2002. Given limited financial resources and the urban location of the Villa, site planning needed to embrace income-producing commercial development. However, the preservation and protection of the physical site and particularly the vulnerable and spectacular mosaics always remained the paramount priority.

Between 2002 and 2005 a series of international exchange visits between Bulgarian and American conservators took place. Team participants made extended stays in Plovdiv, Bulgaria and Williamstown, Massachussetts, with briefer visits to other important Bulgarian and American locations. These visits were critical in revealing cultural priorities and obstacles, sharing information about a range of sites and material culture, training styles, and conservation materials and techniques.

The site management plan that resulted was intended to serve as a working document that assesses the numerous priorities of the various stakeholders and designs functional strategies for achieving and compromising on these goals. As the needs of the site develop and change, these goals and strategies will be revisited; the original plan of 2006 is even now being revised.

Stakeholders

The unique nature of the Eirene Villa resulted in a large number of interested parties and stakeholders. Each has specific functions, with some overlapping areas of activity. The collective goals of the stakeholders were taken into account while drafting the final site management plan.

Although government-owned and located on municipal property, the Eirene site is privately leased. The individual who leases the site continues to provide funding for preservation and public access to the site. This experimental structure of ownership has proven to be an important means of allowing private and foreign subsidies to benefit a site.

The Villa site and the in situ mosaics are the property of the Bulgarian state. As such, they must be cared for according to protocols designed and supervised by the National Institute of Immovable Cultural Heritage. The ancient road and shops are also designated as significant cultural monuments and belong to the state. There are limits on new construction: only old backfill can be removed, and no deep foundations can be installed. Because it is assumed that these limitations prevent the site from being altered, no other inspections or preservation protocols are required.

Ancient artefacts are regulated differently from archaeological sites, with different custodians. Artefacts that have been excavated and removed from the site, including detached mosaics, are the property of the Archaeological Museum of Plovdiv. The Ministry of Culture and the Municipality of Plovdiv, under the authority of the Mayor, administer the museum.

Because of the great wealth of ancient sites in Plovdiv, an additional stakeholder is the *Oblast* or Province of Plovdiv. In 2006, the only source for conservation expertise and analysis was in distant Sofia, therefore the *Oblast* had a vested interest in developing better conservation facilities for the Plovdiv region. A regional support centre that serves all state and provincial monuments is under consideration, and a state-owned building in the Old Town has been proposed as the location of a regional conservation laboratory. Other urgent priorities for the *Oblast* include the conservation and development of the ancient Roman archaeological site known as the Large Basilica, located in the city centre and the Archaeological Museum of Plovdiv.

Strategic long-range planning

The strategic planning process was initiated in 2005 when Eirene Villa conservators and site archaeologist travelled to the United States to identify potential long-term strategies. The visit included touring exemplary U.S. archaeological sites, meeting with archaeologists, curators, park supervisors, researchers, interpretive planners, and others. This exhaustive research tour provided a wealth of ideas for the management plan.

Following this tour, but while still in the United States, a preliminary planning meeting was held to consider a number of options, ranging from “no action” to “optimum action”. In the ‘minimal’ plan, only the Eirene Villa and the archaeological underpass were addressed, while in the ideal, ‘maximal’ plan, all the ancient sites in Plovdiv were considered. A list of target changes was developed.

Additional meetings were held in Bulgaria to develop the plan further, including an important meeting with the Vice Governor of Finance of the regional government of Plovdiv, who advocated that the Large Basilica archaeological site dating from the 4th-6th centuries AD, and containing two mosaic floor layers, be slated for the next major improvement plan.

Attention was also focused on the Archaeological Museum of Plovdiv. The museum contains a vast store of priceless cultural treasures, yet it has been closed to the public due to financial and structural weaknesses. Initial efforts to assist with new building designs ultimately stalled, as funding and political support lagged. Efforts to promote the concept of a regional conservation laboratory. have also been slow, due to financial and political challenges in the region.

The planning meetings defined three strategic target areas. First, a list of immediate recommendations for the Eirene Villa was developed, to sustain momentum there and to preserve the many gains made at the site. For mid-range plans, the Large Basilica site was agreed upon as an excellent target for improvement, but this target was eventually replaced with conservation efforts now in progress at the Small Basilica site, another site in Plovdiv's city centre which dates to the 5th-6th century AD and contains mosaic floors.

Another mid-range goal, the advocacy for a regional conservation facility within Plovdiv continues. However, the Archaeological Museum has been impressively renovated with improved exhibition spaces (Fig. 3), climate controlled storage and the setting up of a new conservation laboratory.

Long-term strategies, broader in scope and less specific in action, reflect the understanding that for maximum effectiveness, all of Plovdiv's ancient sites will be considered as a whole, and always within the context of regional and national tourism plans.

Cultural Context

Bulgaria finds itself in a unique position as a possessor of extraordinary cultural heritage from the ancient world. Western scholars have often overlooked the history of Thrace, an advanced civilization with close ties to Classical Greece. The most famous Thracian gold treasures have been published and exhibited internationally, but the much larger body of tomb paintings, architectural materials, and artefacts have not been sufficiently researched.

Evidence of Bulgaria's extensive Thracian and Roman heritage survives to an astonishing degree. Plovdiv is built directly over the ancient city of Philippopolis, a major city on the land route to Byzantium, named after Philip of Macedon, the father of Alexander the Great. Architectural remains of the late antique period are evident everywhere in the city, mingled with modern urban architecture.

Many significant sites survive from later periods as well. Examples remain from the Medieval period including several important Ottoman sites. Plovdiv's Old Town is included in the elite list of Bulgarian Monuments of Cultural Significance, in recognition of its unique collection of 18th and 19th century National Revival buildings.

The Bulgarian Heritage Trails Association

One of the most significant achievements that resulted from the site management planning process was the formation of the Bulgarian Heritage Trails Association, a non-governmental, non-profit organization, registered in Plovdiv in January 2007. The B.H.T.A. team includes conservators, an archaeologist, a tourism expert, an architect, an educator, and highly skilled artists. The Association's mission is to preserve Bulgaria's cultural heritage through various activities, including promoting public appreciation for Bulgaria's cultural heritage by working with municipalities to install heritage trails.

In 2007, the entire B.H.T.A. team participated in an interpretive planning research project that focused on natural and cultural heritage sites in the United States. Classroom-like sessions led by National Park

Fig. 3. The renovated building of the Archaeological Museum of Plovdiv (photo: E. Kantareva-Decheva)

Service staff were particularly useful and reinforced the idea that interpretation encourages public interest and appreciation for cultural and natural heritage which, in turn, leads to public support for activities that will ensure the preservation of such sites.

To better understand the challenges of running a cultural heritage foundation, particularly one with similar aims as the B.H.T.A, meetings were scheduled at the Freedom Trail Foundation, Boston. The Freedom Trail originated in 1951 to help visitors find Boston's historic sites and to boost tourism. Now, various private and public organizations maintain and promote the trail, including the City of Boston, the Commonwealth of Massachusetts, the National Park Service, and the Freedom Trail Foundation. Together these organizations have made the Freedom Trail an exciting, historical adventure. More than 1.5 million people walk the Freedom Trail every year, discovering Boston's Revolutionary past within a modern urban environment.

From these meetings action plans were developed on which funding and grant applications were based. These efforts led to the implementation of the B.H.T.A.'s pilot project in Plovdiv. The Association developed three itineraries corresponding to three periods in Plovdiv's unique history; the trails are named "Antiquity", "Middle Ages" and "Revival", and each trail has an obvious icon for easy identification.

Fig. 4. The signage for the Peristyle building Eirene, 4th-5th century (photo: M. Bospachieva)

Brochures published by the Bulgarian Heritage Trails Association contain trail itineraries and maps, with text describing each of the three historical periods, and more text describing the history of each site with photographs. These brochures are available at the Tourist Centre, and elsewhere, for self-guided touring, and are also printable from the B.H.T.A. web site. The Municipality of Plovdiv manufactured and installed signage according to Association designs. Trail visitors may choose one of the three trails, follow icons on street banners leading to specific destinations, with or without trail maps, and read informational signage describing each site. The Eirene Villa is prominent on the Antiquity trail, and attracts numerous visitors (Fig. 4).

Conclusions

Resurrected after years of neglect and decay, the transformed Eirene Villa Archaeological Site formally opened to the public in October, 2004. This festive event celebrated the successful collaboration between national and international sponsors, between non-profit and for-profit entities, and between advocates for business and culture. It is an outstanding example of what international and interdisciplinary cooperation can achieve in the area of cultural preservation.

Fig. 5. The Eirene site in 2011 (photo: E. Kantareva-Decheva)

Since then, much has been achieved, especially in the area of interpretive planning. With the formation of the Bulgarian Heritage Trails Association and its pilot project in Plovdiv, the Eirene Villa Archaeological site has gained global attention. The project was highlighted at the EU forum Open Days 2008 at a tourism inovations workshop.

Visitorship at the Eirene site has increased yearly. The total number of visitors in its first year after opening was 5,882. Site staff now claim visitors average 600 persons per day, including attendance at musical performances at the Villa performance stage adjacent to the mosaics.

Despite huge public success, nothing has been more satisfying than witnessing new interest displayed by the local citizens of Plovdiv toward the cultural treasures in the city. While challenges remain, the development of the Eirene Villa site showcases the enormous opportunities available, and the desire and determination of many stakeholders to make such projects a success (Fig. 5).

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TOWARDS A METHODOLOGY FOR A VISITOR MANAGEMENT APPROACH AT SITES WITH MOSAIC FLOORS: THE CASE OF HERCULANEUM

Niki Savvides

Abstract

This paper presents a methodological framework for managing visitors at sites with mosaic floors. The framework was developed as part of my doctoral research, which examined the sustainability of visitor access using the archaeological site of Herculaneum as the main case study; and this methodological framework has evolved to what was included in the final doctoral thesis submitted in 2015 (Savvides 2015). Drawing upon the discourse of sustainability, a methodology is presented for thoroughly assessing the visitor-mosaic relationship within the broader context of managing access and conservation. The results of the assessment form the basis for developing recommendations to control the impacts of access to the mosaics through the use of visitor management and preventive conservation measures. These concerns are applied at the archaeological site of Herculaneum, which forms the main case-study of the research.

Introduction

Increasing visitor numbers at archaeological sites, although much desirable, not only for the income they generate but also for gaining broader public support, are at the same time one of the main threats to their preservation. This is particularly true for sites with mosaic floors with enabled direct access. Uncontrolled influxes of visitors to the floors lead to excessive and repetitive load and pressure on their surface and can have a destructive effect on their integrity, particularly in the presence of other factors of active decay (Fig. 1).

Traditional responses to this phenomenon (uncontrolled access) aim at the prevention of direct access to in situ mosaics through the use of raised walkway platforms and/or barriers, particularly in cases where mosaics do make the site of which they are a part. Although these solutions may be successful in this type of sites, they cannot be used as a one for all solution, particularly in cases where mosaics are only one aspect of the preserved archaeology. Furthermore, guided primarily by the need to preserve the fabric, these decisions are not always placed within the broader context in which conservation occurs, a vital requirement for sustainable management, and thus they do not consider holistically the issue of access. As Hall and McArthur argue (1993, 13) traditional management that has focused on the heritage resource is deficient because it takes inadequate account of the significance of visitors. It is essential to consider the visitor experience and how it may be impacted by conservation interventions, as this will ensure a more successful approach to the in-

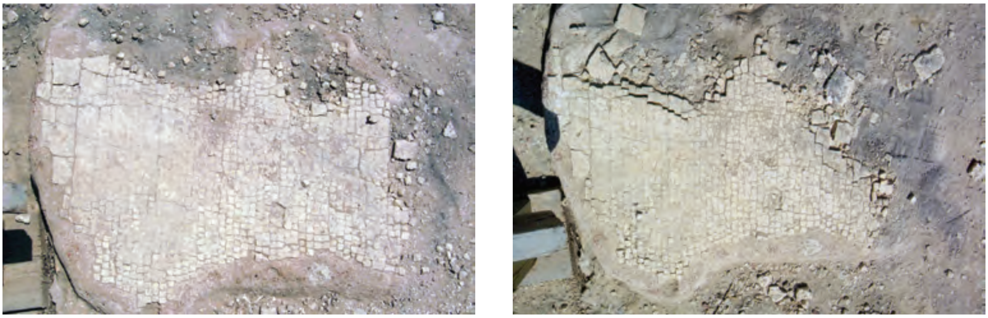

Fig. 1. Mosaic fragment from the site of Caesarea, Israel, showing how rapidly loss can occur to in situ mosaic from visitor foot traffic. The mosaic was photographed on April 21, 1999 (left) and May 13, 1999 (right) (photos: Rand Eppich)

terpretation and presentation of sites, and consequently a deeper appreciation and public support for conservation.

The field of mosaic conservation is yet to fully embrace the developments in the broader sector towards sustainable site management. Hence, issues such as the intangible benefits deriving from direct physical contact with the mosaics to the experience of visitors and to the spirit

Fig. 2. The archaeological site of Herculaneum, facing northeast, with the modern town of Ercolano in the background (photo: Niki Savvides)

of place have not yet been explicitly addressed, particularly at sites where mosaics constitute one element among other well-preserved features, such as full standing buildings and other types of architectural decoration.

This paper presents a holistic approach to managing visitors at sites with mosaic floors, which considers the sense of place stemming from direct physical contact with mosaics, and strives to find a balance between the need for preservation and the benefits from access. The site of Herculaneum is used as the main case study, where it has been deduced through visitor interviews as part of my doctoral research, that direct physical access to the mosaics does contribute to an authentic experience and to a sense of place. The suggested approach consists of a thorough assessment of the role of access to the mosaics to their physical integrity and their values, within the broader context of access and mosaic conservation at the site.

The site of Herculaneum

The site of Herculaneum, located at the foot of Vesuvius in Campania, South Italy, is extraordinary for the degree of preservation of its Roman townscape (Fig. 2), a result of the excellent conditions created by the eruption of Vesuvius in 79 AD. Excavated in the open air in the 19th and 20th centuries, the site consists of 45,000 square meters of remarkably intact, multi-storey buildings, complete with precious architectural features, decorative surfaces and organic materials.

Fig. 3. Plain bi-chrome, black-on-white mosaic, *tablinum*, Casa del Tramezzo di Legno, Herculaneum (photo: Niki Savvides)

The mosaics

Among these features are the mosaic floors, which decorate the houses and public baths of the Forum, along with other types of flooring such as *opus sectile* and *battuti*. Made predominantly with volcanic, calcareous stone and marble, their surfaces have plain (Fig. 3) or geometric decoration (Fig. 4 and 5) except for the two figural mosaics in the baths (Fig. 6). A total of 34 mosaics are currently directly accessed by thousands of visitors every day (Fig. 7). Their numbers peak in the months of March to May, when most school groups come to the site, along with organized groups and independent visitors (Fig. 8). Visitor numbers have been on the increase at the site, and they are expected to continue doing so as more areas re-open to the public in the near future. This is partly due to the Herculaneum Conservation Project (HCP), which improved the state of conservation of the site since 2001 (Court, Thompson and Biggi 2011). The Herculaneum Conservation Project is a Packard Humanities Institute initiative in collaboration with the Soprintendenza Pompei (at the time

Fig. 4. Geometric bi-chrome black-on-white mosaic, *tepidarium*, Terme Centrali Femminili, Herculaneum (photo: Niki Savvides)

Fig. 5. Geometric polychrome mosaic, vestibule, Casa dei Cervi, Herculaneum (photo: Niki Savvides)

Fig. 6. Figural bi-chrome black-on-white mosaic, *tepidarium*, Terme Centrali Femminili, Herculaneum (photo: Niki Savvides)

Fig. 7. Mosaics at Herculaneum open to public access and included in the visitor impact assessment (image: Herculaneum Conservation Project)

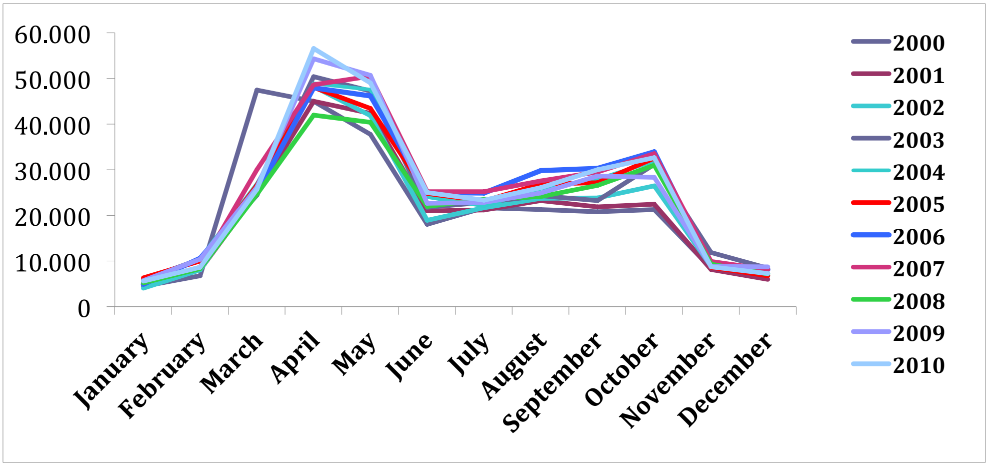

Fig. 8. Monthly visitor numbers to Herculaneum for the last ten years. Based on data from the Soprintendenza Speciale per i Beni Archeologici di Napoli e Pompei www.pompeiisites.org

Soprintendenza Speciale per i Beni Archeologici di Napoli e Pompei) and the British School at Rome. This public-private initiative for the conservation of the site of Herculaneum was launched in 2001 (see www.herculaneum.org).

Foot traffic has been acknowledged by the HCP team as one of the factors causing damage to the mosaics, especially in cases where the floors are affected by deterioration processes and lack of regular maintenance (Pesaresi and Martelli Castaldi 2007, 223). In the light of future increases in visitor numbers, the necessity for more effective management of visitor movement and their effects on site becomes of critical importance.

The intangible benefits of access

Despite the possible negative effects on the fabric of the floors, visitor access does contribute in fostering a sense of place at the site. Direct physical access to the mosaics enhances the feel of the place acquired by being inside the full-standing buildings of the ancient town. Visitors can just be and feel the domestic and urban spaces of their interiors, which contribute to the significance of Herculaneum and to the inscription of the site, together with Pompeii and Oplontis, on the UNESCO World Heritage List in 1997. The justification of the inscription was based on criteria iii, iv, v considering that the "impressive remains of the towns of Pompeii and Herculaneum and their associated villas, buried by the eruption of Vesuvius in AD 79, provide a complete and vivid picture of society and daily life at a specific moment in the past that is without parallel anywhere in the world" (http://whc.unesco.org/en/list/829/).

Walking on the mosaics makes these spaces "more real", through the physical contact with the ancient floors. Hence, visitors are immersed into the Roman past without any physical barriers usually used at archaeological sites, that "distance the past from the present" (visitor 010, interviewed in 2010). This quality of Herculaneum was noted by many visitors, who were pleasantly surprised by the fact that they were able to walk on the mosaics. The findings from the interviews (see introduction), suggest that the freedom to experience the site and its buildings like its original users, contributes to an authentic experience and a better appreciation of the site.

An alternative approach to the management of visitors

How should the benefits of direct physical access be considered when managing visitors at the site? Such a task requires a different stance to the conflicting relationship between access and conservation. It necessitates an approach that transcends the access-preservation dichotomy, and instead uses conservation to allow access in the best possible way, thus protecting the intangible values associated with it.

The concept of sustainability is ideal for guiding this approach, which is also the main philosophy of the Herculaneum Conservation Project. Although the term, which derives from environmental conservation, has been increasingly used as a broader guiding approach to managing heritage resources (English Heritage 2008; Fairclough 2003; Throsby 2002). Its use is associated with "sustainable development" as defined by the Brundtland report of the World Commission on Environment and Development (WCED 1987, 8): "development that meets the needs of the present, without compromising the ability of future generations to meet their own needs". In the context of heritage conservation, sustainability argues for the careful use of resources in the present, while having a long-term view in the future and delivering economic, social and environmental benefits (Clark 2008, 82).

Sustainability requires a different outlook to conservation, one that does not focus solely on protection of the fabric, but instead focuses on how best to manage change that occurs from the past, to the present and to the future. Such an approach "sidesteps the pitfalls of fossilization and what might be called museumification and it takes a healthy, as well as an archaeological view of the inevitability and inherent interest of change" (Fairclough 2004, 59). This outlook considers not only physical change, but also how change affects the values ascribed to archaeological sites by various groups with an interest in them. Values are the qualities of heritage places, defining what is important about them (in this case archaeological sites). Although not always explicitly stated, values have always been at the heart of conservation (Demas 2002, 35). The increasing shift in conservation and management planning towards values-based approaches (De la Torre and Mac Lean 1997; Mason and Avrami 2002), has made pertinent the clear and broader articulation of the values ascribed to a place and how these are affected by various processes (environmental, social, economic), while ultimately striving for the best solutions to their protection.

A prerequisite for sustainability is a thorough understanding of how change occurs. As Matero (2003, viii) comments, "unless we understand how cultural heritage is being lost or affected and what factors are contributing to these processes, we will not be able to manage it, let alone pass it on".

At the same time, sustainability acknowledges the finite, non-renewable nature of mosaics, and how their loss would be detrimental to the site's integrity and authenticity. Controlling change is paramount to the sustainability of the resource: not all or any change is acceptable. As Fairclough (2003, 24) suggests, two questions should guide the approach to managing change: "…How to reconcile minimising loss with the needs of the present, and how to ensure that the balance we strike does not reduce future generations options for enjoying and using their inheritance".

Towards a methodology

Guided by these theoretical concerns, the rest of the paper presents an approach to decision making on how to best manage visitor access at Herculaneum, while at the same time ensure the best possible preservation of the mosaics. The overall aim of the assessment is to understand and ultimately control more effectively unwanted change that has yet to occur from wear-and-tear. More specifically, it aims to assess the vulnerability of mosaics to uncontrolled foot traffic and behaviour stemming from current access patterns and to identify the factors that contribute to this vulnerability. The results of the assessment will form the basis for developing visitor management and mitigation strategies for visitor impacts.

Wear and tear has been acknowledged by the HCP team as one of the factors exacerbating the decay of mosaics. As the outcome of the continuous and recurrent motion of visitors' feet (Lloyd and Lithgow 2006, 56), this becomes significant in the case of mosaics in a poor condition and/or subject to other factors of active decay. These effects are inevitable in the long-term even on the most robust and stable floor. They manifest at different rates and scales of severity, such as surface abrasion to surface loss, depending on their resistance to mechanical damage. Although these effects have been acknowledged as a cause of decay for in situ mosaics, as Piqué *et al.* (2008, 36) point out, there is little documentation of this process.

The assessment consists of the following phases:

1. Mosaic vulnerability assessment;
2. Mosaic values assessment;
3. Assessment of visitor access, with particular focus on access to the buildings with mosaics;
4. Integration of the three assessments.

These variables are assessed using a range of qualitative and quantitative methods, drawn from the fields of mosaic conservation, the built environment, museum studies and ethnography. A Geographic Information System is used for the analysis and spatial correlation of quantitative data at Herculaneum.

Mosaic vulnerability assessment

The concept of vulnerability is introduced as it provides a framework for assessing potential change stemming, among other causes, from foot traffic. Vulnerability acknowledges the archaeological context of mosaics, which, having passed through the phases of burial and excavation, are exposed to conditions different to the original ones (for example without any roofs). They are thus susceptible to an array of agents of deterioration, stemming primarily from their interaction with the environment and human action. Changing weather conditions and variations in relative humidity and temperature are key environmental causes of deterioration for mosaics. Similarly, inappropriate previous interventions, using materials now considered damaging (Bassier 1978; Gambogi, Fontanelli and Tuccino 1998), or lack of maintenance (Nardi 2003; Zizola 2005; Roby, Alberti and Ben Abed 2005), have been identified as equally significant deterioration-inducing factors. Deterioration processes affect the condition of mosaics and lead to the gradual loss of the original properties of their constituent materials and to the separation of their components. Thus, they become particularly vulnerable to foot traffic.

The level of severity and extent of foot traffic impacts also depends on the inherent properties of the mosaics' constituent materials, such as hardness, mineral composition and porosity, which determine their robustness and thus resistance to mechanical damage, especially gradual cumulative damage. For example, tesserae made with soft, porous stone are more susceptible to abrasion and surface loss than tesserae made with harder and more resistant stone, such as marble. Finally, the exposure of mosaics to a context that favours mechanical damage from foot traffic, such as the presence of gravel, is another factor contributing to their susceptibility to this hazard.

The magnitude of visitor impacts depends on the severity and distribution of mosaic conditions in relation to visitor access patterns, but also in relation to the volume and load of visitors. A detached area, although a significant vulnerability indicator, is less so if it is located away from a main access route, than one that is found on a frequently visited access route.

Stemming from the above and drawing upon the definition of vulnerability by the United Nations International Strategy for Disaster Reduction (UNISDR 2009, 30) as "the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard", the assessment examines the role of condition, inherent properties of materials and context in determining mosaic vulnerability to foot traffic.

The methodology of the survey consists of the following phases:

1. Preliminary research

This entails the compilation of existing written and graphic records related to the history of condition and past interventions to the mosaics. Unfortunately, due to the scarce amount of visual and written documentation available on past interventions since the excavation of the site, most information comes from the recent documented interventions by the Herculaneum Conservation Project, since 2001.

2. Site survey

This part constitutes the core of the assessment and entails a broad evaluation of mosaic condition and context. This is achieved through the mapping of extent and quantitative evaluation of severity of condition and the systematic recording of context.

The mosaic glossary developed by the Getty Conservation Institute and the Israel Antiquities Authority (Getty Conservation Institute and Israel Antiquities Authority 2003) was used to assist in the definition of each condition recorded (Fig. 9). The

Mosaic Conditions	Phenomena suggesting foot traffic impact	Phenomena suggesting vulnerability to foot traffic
Surface	Earth deposits/Soiling Abrasion	Gravel deposits
Structural	Loss of tesserae (lacunae) Loose tesserae Loss of interstitial mortar Mortar repairs as indicators of tesserae	Bulging with a void Cracks (wide) Detachment Deterioration of preparatory layers Lacunae Loose tesserae Loss of interstitial mortar Subsidence (severe)

Fig. 9. Recorded conditions for the vulnerability assessment of the mosaics at Herculaneum

extent of each condition was mapped on a 1:50 m scale maps for each mosaic. Severity was measured using nominal values from “insignificant” to “high”. These were assigned a numeric score: Insignificant=1, Low=2, Moderate=3, High=4. The rating was based on the degree to which each condition affects the physical integrity of the mosaics. For some conditions severity was not rated, as it was not seen as necessary for the assessment. Only their extent was mapped to indicate their incidence, whether they are present or absent on the mosaic. These conditions are the gravel, loose aggregates and earth deposits, loose tesserae and lacunae.

A template form was used for compiling information related to condition and mosaic, based on the form created by the collaborative project between the Getty Conservation Institute, English Heritage and the Israel Antiquities Authority on the assessment of the effectiveness of the protection of shelters over mosaic floors (Neguer and Alef 2008; Stewart 2008). The form (Fig. 10) records, in a tick-box format, the following: 1. Materials and structure of the mosaic; 2. Presence or absence of roofing over the mosaic and type; 3. Presence and evidence of effectiveness of roof and floor drainage (if any); 4. Evidence of water pooling (if any); 5. Type of adjacent surface area.

All collected information was transferred onto the GIS of the site where the vulnerability assessment was carried out.

Values assessment

The values chosen for the assessment were the archaeological values, identified and assessed by the Herculaneum Conservation Project in 2009 (Esposito and Imperatore 2009). The assessment was done as part of the overall assessment of the archaeological value for each room in all buildings, based on their uniqueness in terms of architectural typology within the Vesuvian area (Esposito and Imperatore 2009). Using a rating scale of 1-10, mosaics were assessed in terms of decorative

MOSAIC VULNERABILITY: CONTEXT AND MOSAIC CHAR/S DATA COLLECTION

Date of survey:	Survey undertaken by:
MOSAIC SITE:	BUILDING NAME
Mosaic No:	HCP CODE:

MOSAIC CHARACTERISTICS

Dimensions	Width: Length:
Mosaic type:	☐ Bi-chrome black on white ☐ Bi-chrome white on black ☐ Polychrome, white background ☐ Polychrome, black background
Materials	☐ marble ☐ Other- describe ☐ volcanic stone ☐ limestone, calcareous stone
Notes	
Integrity	☐ On original bedding ☐ Lifted and re-laid ☐ Indeterminate
Notes	

MOSAIC GENERAL CONTEXT

Protection

Present exposure conditions	☐ In the open air ☐ Enclosed (mosaic is in a structure with roof and no open sides) ☐ Partially enclosed (mosaic is in a structure with a roof and open sides) Comments:
Roof Construction	☐ Original ☐ Modern (Date of construction:)

Drainage

Roof Drainage	☐ Downpipes ☐ Gutters Location:	☐ Combination ☐ Other (specify)
Is roof drainage effective?	☐ YES Comments (evidence of drainage malfunction if any):	☐ NO

Floor Drainage	☐ Drains Location:	☐ Other (specify)
Is drainage effective?	☐ YES Comments (evidence of drainage malfunction if any):	☐ NO
Access		
Access to the mosaic	☐ Open to access ☐ Partially open to access	
Type of Barrier used for controlling access	☐ Raised pathways ☐ Rope on mobile wooden posts ☐ Mobile metal barrier ☐ Other	
Is barrier effective?	☐ YES Comments	☐ NO

Information on maintenance – obtained from site manager/ conservator	
Type and frequency of previous interventions	
Type and frequency of maintenance	

Fig. 10. Template form for the collection of data on mosaic context and characteristics

typology, their state of conservation and their contribution to the archaeological value of the room of which they are part.

Visitor access assessment

The visitor access assessment aims to get a holistic understanding of the visitor dynamics onsite, particularly in relation to mosaic floors. By understanding how the site is used by various visitor groups, and by identifying the volume of visitors to buildings with mosaics, it evaluates how current access patterns correlate with mosaic condition. A broader aim is the identification of the wider issues related to access that determine directly or indirectly visitor impacts. This was achieved by using a mixed method approach for the collection of data: structured and unstructured observations and interviews with guides, custodians and personnel from the ticket office.

1. Structured observations
Structured observations of visitor movement at the site level were undertaken aimed at understanding site use and at evaluating visitor volume per group type in each building with mosaics open to access.
1.1. Macro-level observations
Observations were used to assess both volume and flow of individual throughout the site, as this method provides an objective account of their behaviour (Vaughan and Stutz 2001, 32; Yalowitz and Bronnenkant 2009). It is an unobtrusive technique, which provides an accurate representation of the actual movements of visitors as they experience the site. Different types of visitors were followed around the site and their route was recorded on an A4 size site map. Each route was described using a form in a tick box format, in terms of visitor type and numbers, starting and exit points, start and end time. A total of 120 routes were recorded, consisting of 40 routes per group type: independent visitors, schools and organized groups.
1.2. Micro-level observations
This method recorded visitor movement within selected buildings with mosaic floors with a layout that allows more than one circulation route. Similar to macro-level observations, these were carried out to identify movement patterns as per visitor type and how these correlate with the distribution of mosaic condition. The recording was carried out twice in each building. During one-hour time-slots, one subject was observed and his/her route was recorded on A4 size building plans. Notes and photographs were also taken of particular phenomena related to visitor behaviour. To comply with ethical considerations when carrying out research with human subjects, a notice was put at the entrance of the site ticket office notifying visitors that people were being followed onsite for research purposes.

2. Unstructured Observations
Unstructured observations were conducted with the intention of gaining a better understanding of visitor dynamics onsite, but also of identifying any particularities related to access, with the potential to cause damage to the mosaics. These were recorded through note taking and photography.

3. Interviews with relevant interest groups
Interviews with the custodians and a number of guides were also carried out to gain a holistic perspective of the broader issues related to access and how these may have a direct or indirect effect on the mosaics,

Fig. 11. Map of Casa del Salone Nero (map: Studio Brizzi/Herculaneum Conservation Project, with additional modifications by Niki Savvides)

which can explain why certain phenomena occur and thus contribute to the development of effective mitigation strategies. Following the collection of data, all quantitative data were inserted in separate layers in the GIS platform. Although their spatial analysis has been completed, the association of the three assessments was at the time of the conference ongoing and hence, an example is presented below to demonstrate the applicability of this method.

The House of the Black Salon (Casa del Salone Nero)

The house, located in insula VI, has an atrium and a peristyle and its main entrance is on the *Decumanus Maximus*, with a secondary one on *Cardo IV Superiore* (Fig. 11). It was excavated in the late 1930s to early 1940s (Maiuri 1958) and has been open to the public since then. The mosaics, all on their original bedding, pave the corridors of the peristyle and the rooms around it; they constitute the most visited part of the house. All mosaics are covered with roofs except the south, east and partial west sides of the peristyle (Fig. 12). The main attraction is the black salon from which the house takes its name, decorated with wall paintings of a black background. Access to this room is currently restricted due to the poor state of conservation of the decorative wall and floor surfaces.
Macro-scale observations suggest that the main visitor type coming to the house is independent visitors (24 groups either as individuals, dyads, small groups/families), followed by organized groups (18 groups),

while schools are the lowest (7 groups). Most visitors enter from the *Decumanus Maximus* and exit from *Cardo IV*, although independent visitors and organized groups also use either access point to enter and exit the house (Fig. 15).

Micro-scale observations further confirm this pattern (Fig. 15) as the majority of visitors recorded in the two-hour slots in 2011 are independent visitors (27 groups) followed by organized groups (2 groups). The access and exit patterns suggest that the majority enter and exit from the *Decumanus Maximus*, with a lower use of Cardo IV for entering or exiting the building.

Unstructured observations further suggest that additional pressure is placed on the peristyle mosaics, especially on those on corridor 19, which is used as a resting point during the hottest hours of the day.

The large mortar repairs recorded on mosaics 16, 17 and 19 (see Figure 13) date to the time of their excavation, as indicated by the limited post-excavation visual documentation, which, unfortunately, due to poor resolution cannot be used as a basis for defining the increase of losses since then.

The tesserae of the peristyle are extensively abraded as opposed to mosaics 4, 5 and 9, where this condition affects mainly the borders made with volcanic stone (Fig. 12). The peristyle mosaics are further affected by soiling (Fig. 19). All peristyle floors have extensive mortar repairs (Fig. 13). These exhibit severe decay on mosaics 8 and 18 (Fig. 16 and 17). Other structural conditions recorded on these floors are detachment and to a lesser extent lacunae and loose tesserae along their central panels and their borders towards the peristyle (Fig. 12 and 13 respectively).

Detachment of low severity on mosaics 4 and 5 was recorded along their west borders, off their main access areas (Fig. 12). Subsidence was recorded on mosaic 4, at the entrance to the room (Fig. 13). No cracks are present, however, to suggest high susceptibility to damage from visitor loading.

Gravel and loose aggregates deposits on mosaic 16, and especially on areas recorded with lacunae (Fig. 18), suggest that gravel may contribute to the instigation and possible growth of existing losses. Their source is the deteriorated *battuto* of the *tablinum* that connects the peristyle with the atrium.

The uneven morphology of the peristyle mosaics 16 and 19, allows rain water to accumulate on their surfaces (Fig. 12), thus contributing to deterioration and to making the mosaics vulnerable to foot traffic effects.

Overall, the peristyle mosaics appear more vulnerable to foot traffic than those in the surrounding rooms. Most vulnerable areas are the areas recorded with severe erosion and losses of mortar repairs. Their vulnerability is further accentuated by the nature of their materials, being primarily made with volcanic stone, and also by the fact that they are totally or partially exposed to the environment.

Visitor movement observations (Fig. 15) suggest that the peristyle mosaics receive more visitors than those in the surrounding rooms. Finally, the archaeological value of the mosaics (Fig. 14) suggests that access control measures to mosaics 5, 8, 18 and 19 should be prioritized, as these have high values (equal to 8). Pertinent is the control of access to mosaic 18, as due to the nature of the material of its *tessellatum* and the severity of the recorded conditions, appears the most vulnerable to visitor access.

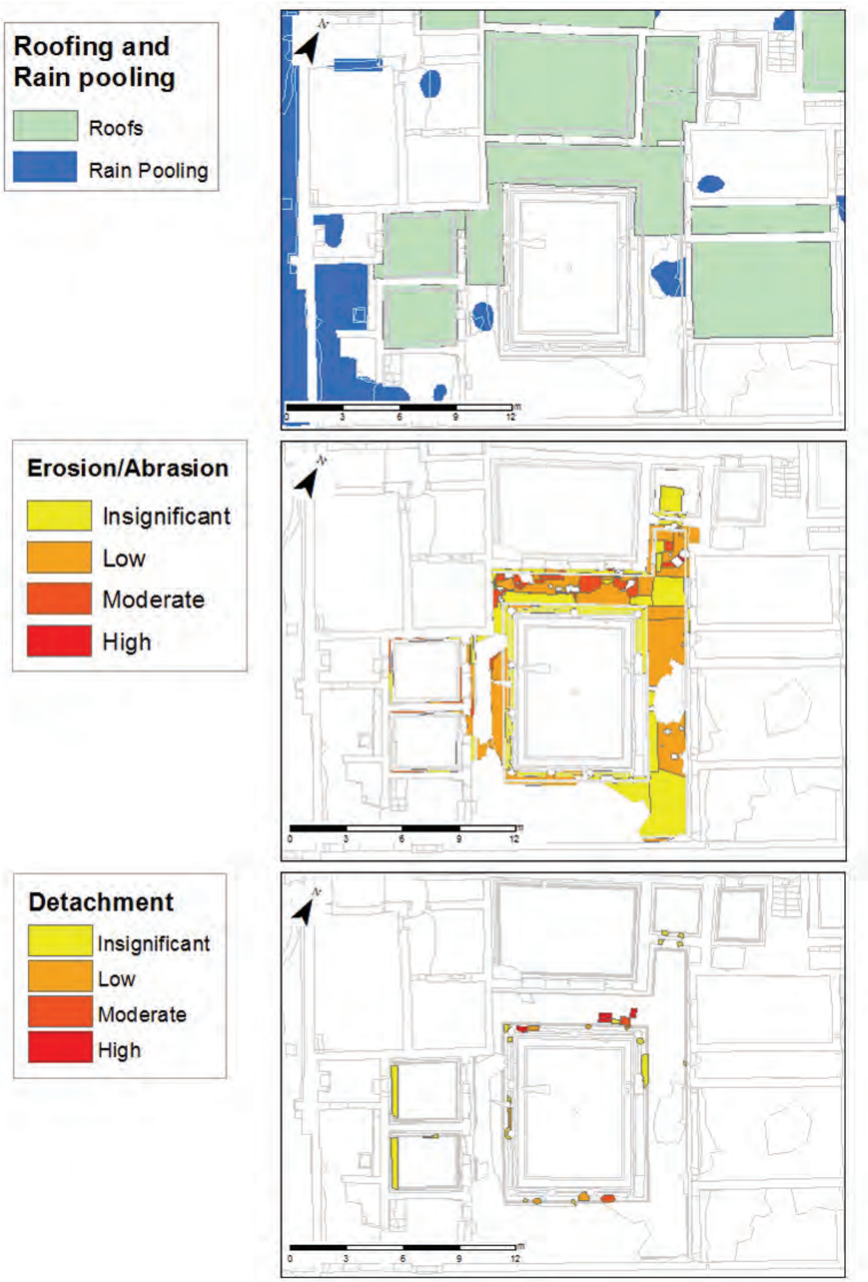

Fig. 12. Map showing roofs and water pooling (top) (Data: Herculaneum Conservation Project); erosion/abrasion conditions (centre) and detachment (bottom) on the mosaics in the Casa del Salone Nero (map: Herculaneum Conservation Project)

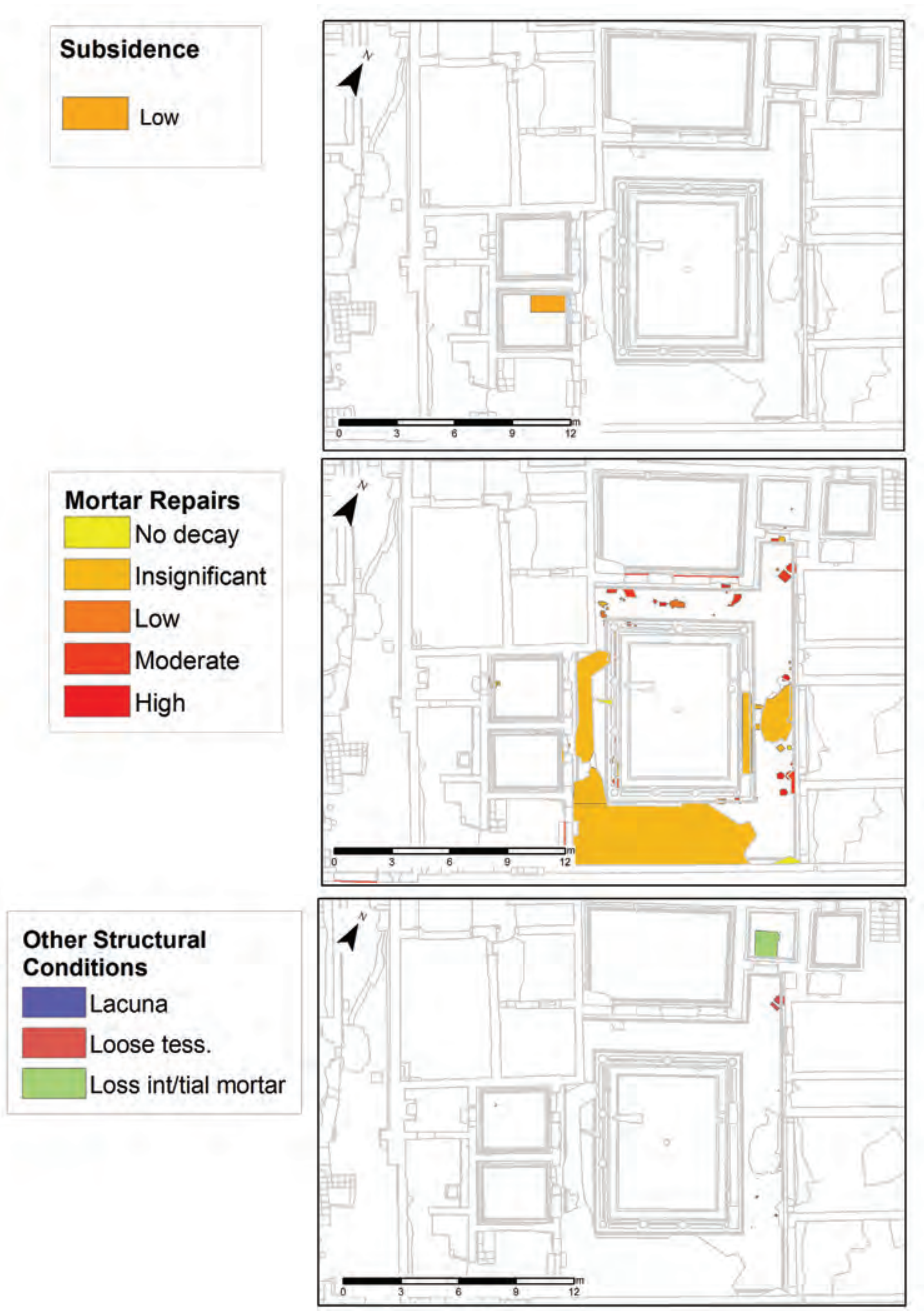

Fig. 13. Map showing subsidence (top); mortar repairs (centre); other structural conditions (bottom) (map: Herculaneum Conservation Project with added layers of conditions by Niki Savvides)

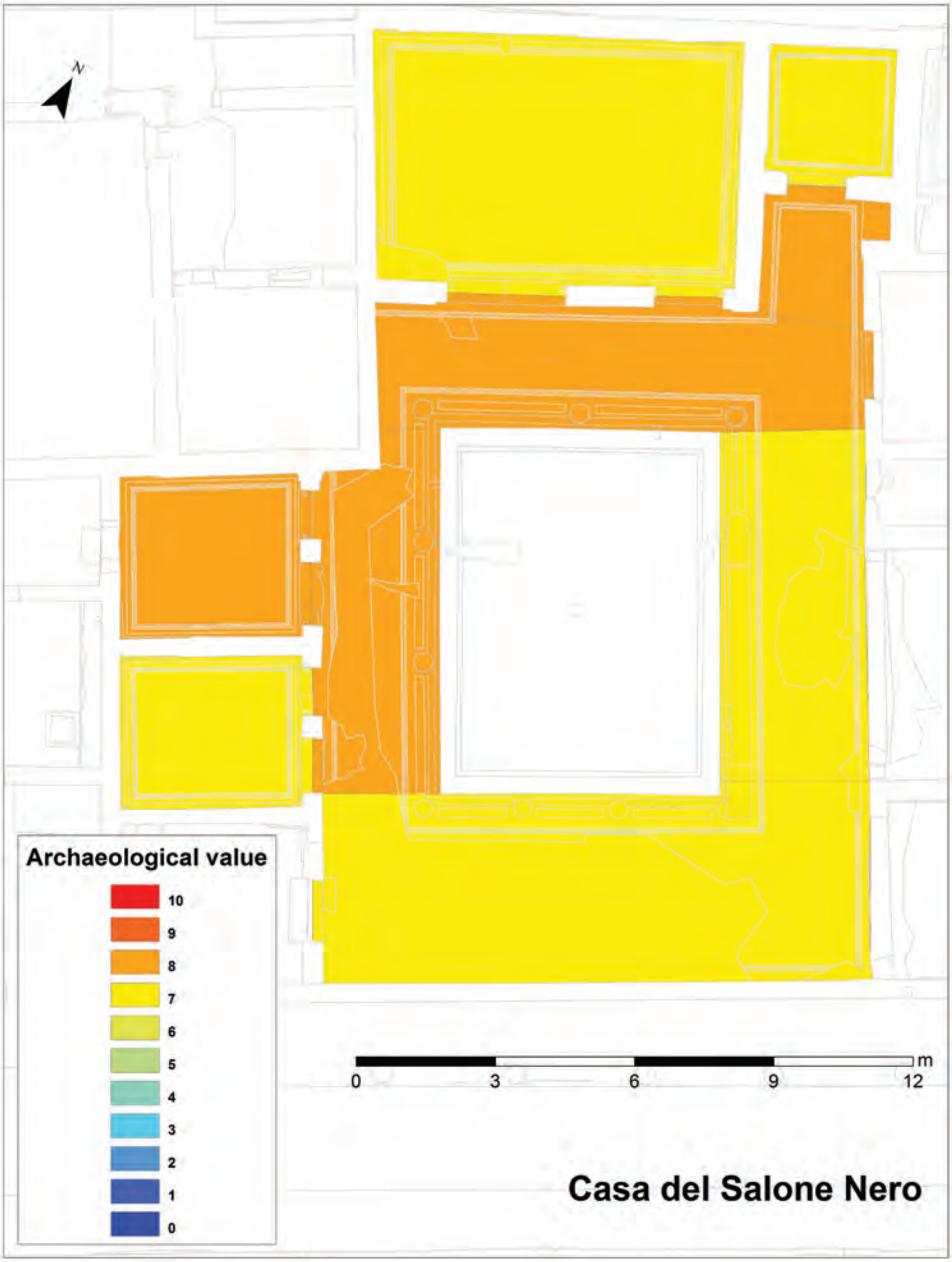

Fig. 14. Map of the Casa del Salone Nero, Herculaneum, with the mapped archaeological values for the mosaics (photo: Sosandra/Herculaneum Conservation Project)

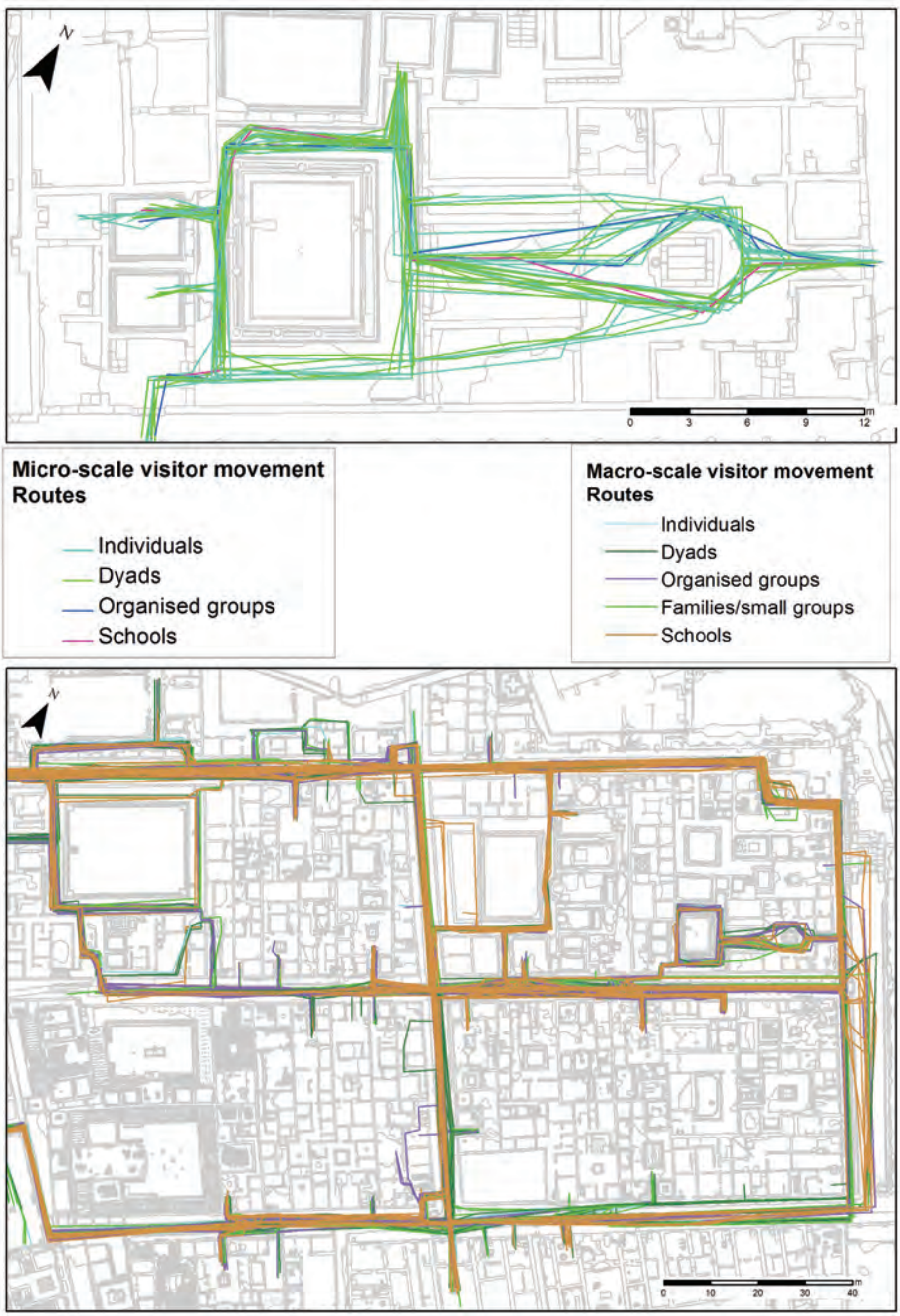

Fig. 15. Map showing recorded visitor routes at the micro- (top) and macro-level (bottom) for the Casa del Salone Nero, Herculaneum (map: Herculaneum Conservation Project)

Fig. 16. Mosaic floor of the peristyle corridor 18 with extensive abrasion and mortar repairs, Casa del Salone Nero, Herculaneum (May 2011) (photo: Niki Savvides)

Fig. 17. Mosaic floor of corridor 8 with extensive abrasion and mortar repairs, Casa del Salone Nero, Herculaneum (May 2011) (photo: Niki Savvides)

Although it is necessary for the site-wide assessment to be completed for making decisions on how to tackle these issues holistically, potential recommendations could include the following options:

1. Carry out remedial interventions to stabilize the mosaics and surrounding surfaces (the *battuto* in *tablinum* 11, the floors in rooms 10 and 14). This, in fact, is being carried out as part of the public-private joint programming between the HCP partners: a major mosaic conservation campaign planned by the HCP (Puglisi, Volta and Simeti 2010) and commissioned by the Soprintendenza Pompei (at the time known as Soprintendenza Speciale per i Beni Archeologici di Napoli e Pompei) with works at the time of the research in progress.
2. Limit visitor numbers in the peristyle area, especially the north and west sides, by designating special openings, daily, monthly or weekly, during off-peak hours, by allowing only independent visitors to have access, and by prohibiting group visits, so as to limit visitor pressure through control of visitor volume. At the same time, provide alternative interpretation, on-site or off-site, for the areas that are not constantly accessed, to compensate limited access to the building.
3. For the rest of the opening hours of the site, establish one-way itineraries to and out of the building by using both access points, so that visitor flow is controlled and less pressure is placed on tessellated areas (Fig. 20). The suggested itinerary considers the original access point into the house, which would enable visitors to get a better understanding of the function of the house in antiquity.
4. Establish a routine maintenance plan for the mosaics, especially before, during and after the peak-visiting season. Maintenance should be more frequent for the mosaics made with volcanic stone. This is being introduced by the HCP, as part of the follow-up to the major mosaic conservation

Fig. 18. Lacuna on peristyle corridor 16, Casa del Salone Nero, located close to the *tablinum* with a deteriorated *battuto*, from where gravel is transferred onto the mosaic and may be related to the losses affecting the floor (May 2011) (photo: Niki Savvides)

Fig. 19. Soiling affecting the surface of the peristyle mosaic 16, Casa del Salone Nero, Herculaneum (May 2011) (photo: Niki Savvides)

Fig. 20. Suggested itineraries for the Casa del Salone Nero for controlling visitor access

campaign (Puglisi, Volta and Simeti 2010).
The implementation of these measures requires the local heritage authority to adopt a strategy for controlling organized groups through modifications of their itineraries onsite, and ideally through the collaboration with tour guides. In addition, preventive measures through interpretation towards educating the public about the vulnerability of the mosaics will raise public awareness about the fragility of the floors, and will positively affect changes in their behaviour.
The results from this house, in combination with preliminary results from the on-going data analysis point to the following factors as significant to the vulnerability of mosaics against foot traffic at Herculaneum:
1. Materials
Mosaics made predominantly with black volcanic stone are softer and more porous and thus more susceptible to mechanical damage from foot traffic, as opposed to limestone and marble.
2. Exposed vs sheltered mosaics
Mosaics fully or partially exposed to the elements appear to be more vulnerable to foot traffic as opposed to roofed mosaics, as they are affected by a range of conditions indicating deterioration, such as water accumulation on their surface, deteriorated tesserae, detachment. Thus, they require more frequent maintenance and control of visitor numbers.
3. Adjacent surface areas
The presence of gravel and loose aggregates on adjacent areas, either as a preventive measure to prevent soil erosion from foot traffic on unpaved areas, or as a result of deterioration of adjacent paved floors, is a factor contributing to mosaic vulnerability.

Lack of frequent maintenance

Preliminary research into past conservation interventions especially in the recent years of 2008-2011 suggest that lack of systematic maintenance has contributed to the increase of losses of mosaics.

Conclusion

Few sites are able to evoke the sensation of exploring the streets and houses of 2,000 years ago in the way that Herculaneum does. This authentic experience is greatly attributed to the way the site has been preserved and presented all these years, allowing free movement and close contact with the archaeological fabric. Direct access to the mosaics and limited modern installations contribute greatly to this experience and to the site's sense of place.
The issue of controlling visitors over mosaics at sites like Herculaneum, becomes a great challenge, and ultimately a dilemma between preservation and use. The approach presented here offers a framework for seeing this dilemma as not necessarily a choice between one and the other; it offers the alternative of having both: continuing to use wisely while managing change, which is the ultimate scope of conservation.

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THE ARCHAEOLOGICAL SITE OF SIRMIUM, SREMSKA MITROVICA, SERBIA: CONDITION SURVEY AND DEVELOPMENT OF A CONSERVATION AND MAINTENANCE PROGRAM FOR THE MOSAICS

Nemanja Smičiklas, Marijana Protić and Aleksa Jelikić

Abstract

The paper will present the results of the condition survey, as well as the development of a conservation and maintenance program for nearly 300 m^2 of mosaics from the 4th century AD imperial palace in the archaeological site of Sirmium, in the town of Sremska Mitrovica. The site was excavated during the 1960s, and around 200 m^2 of mosaics were conserved (lifted and re-laid on reinforced concrete support) in the 1970s. Around 50 m^2 of mosaic from the earlier layer were lifted in 2006-2007, and stored. The conservation of these fragments was used as a pilot project for developing the conservation program. The rest has never been conserved. A shelter project, executed in 2010, allows mosaic presentation, for the first time after almost 30 years. The survey consists of the condition assessment of the mosaics and environmental monitoring. Its objective is to contribute to the creation of a conservation and maintenance program in order to prepare the mosaics for presentation and to ensure their conservation under the new conditions.

Fig. 1. The excavation in late 1950s (photo: Institute for the Protection of Cultural Monuments of Sremska Mitrovica)

Fig. 2. The excavated mosaics after conservation (photo: Institute for the Protection of Cultural Monuments of Sremska Mitrovica)

Historical overview

The town of Sremska Mitrovica has grown over the remains of Roman Sirmium, one of the capital cities of the Roman Empire during the late 3rd and early 4th century. Our understanding of the remains of the imperial palace site in Sirmium has been limited by the space available for archaeological excavation, given that it is situated in the centre of modern Sremska Mitrovica (Werner 2009; on the palace, see also Jeremić, M., 2002; 2009).

The remains of the imperial palace were first revealed by a salvage excavation in 1957 in preparation for the construction of an apartment building near the modern centre of Sremska Mitrovica (Fig.1). Work was halted on the construction project, at first temporarily and then permanently, when a complicated arrangement of radiant heating ducts, draining channels and mosaic pavements were revealed (Fig. 2). Additional excavations were conducted in 1974 and 1976. At that period, some of the revealed mosaics were conserved and restored. The mosaics are made in *opus tessellatum* and most of them consist of polychrome geometric designs, which are characteristic of the Late Empire and of urban and rural buildings of the upper classes (Werner 2009; Brukner1982-1983). Figurative motives are rare, and the most important one represents the god Mercury (Fig. 3). After the excavations, the archaeological site was left exposed but the mosaics were covered with a thin layer of sand. Considering that the site had no proper maintenance for over four decades, and that it is located in the centre of town (Fig. 4), there were lots of agents that contributed to its degradation, starting with temperature oscillations, vegetation growth, the building of a "perfect" shelter for public toilets, and a few car crashes ending with cars upside down in centre of the palace. Due to all these problems, it was necessary to start conservation work at the palace. This took place from 2003 to 2004 mainly on the walls. The mosaics were simply exposed and then covered

Fig. 3. Mosaic of the god Mercury (photo: Institute for the Protection of Cultural Monuments of Sremska Mitrovica)

Fig. 4. Presentation of imperial palace in the open air during the 1980s (photo: Institute for the Protection of Cultural Monuments of Sremska Mitrovica)

Fig. 5. View on the archaeological site after conservation treatment in 2003-2004 (photo: Institute for the Protection of Cultural Monuments of Sremska Mitrovica)

Fig. 6. Archaeological excavations in 2006-2007 – the north escarpment (photo: Institute for the Protection of Cultural Monuments of Sremska Mitrovica)

with a new layer of sand (Fig. 5). Since the imperial palace is of high value and importance for the town of Sremska Mitrovica and Serbia as a whole, we had to find the way for a more permanent solution for its preservation and presentation. It was decided that an 'Archaeological Site 1a' should be covered completely with a permanent building rather than a slight shelter. In order to complete such a task it was necessary to make some additional archaeological excavations, and these were conducted during two long campaigns from August to December 2006 and from February to June 2007. The investigations were supervised by Zorka Pejović assisted by Biljana Lučić, archeologists from the Institute for the Preservation of Cultural Monuments, Sremska Mitrovica. Excavations were limited to the sections which defined the edges of the previously exposed architectural remains (Fig. 6). The mosaic pavements uncovered in the recent excavations all belong to the imperial palace phase of the site. In some of the rooms of the palace there were multiple layers of mosaics, which all date to the late 3rd and 4th century when the palace was in use. The multiple layers are indicative of the successive phases of remodelling which the palace rooms underwent. Most of these mosaics also consist of geometric decorations characteristic for the Late Empire.

The shelter project

The project for covering of the imperial palace is significant as it is the first systematic program for the protection and presentation of the archaeological site of Roman Sirmium. The concept of the sheltering project is to cover the entire archaeological site, with an average surface of 2680 m^2 (Fig. 7). The architecture of the new building fits the urban surrounding; it is functional as well as satisfying the need for the protection and presentation of the site (Fig. 8). The visitor centre has three levels. The upper one is the gallery. The main floor consists of the entrance –

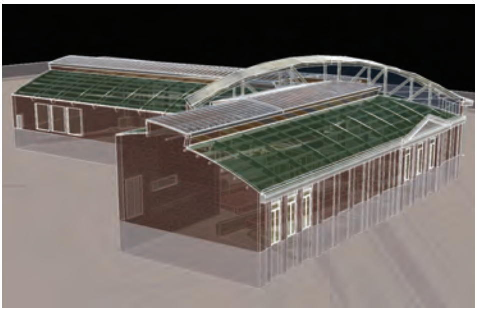

Fig. 7. Model of shelter for covering the entire archaeological site (Institute for the Protection of Cultural Monuments of Sremska Mitrovica)

Fig. 8. Model of the external appearance of the building (Institute for the Protection of Cultural Monuments of Sremska Mitrovica)

a visitors' area with a souvenir and a coffee shop, the purpose of which is to give financial support for the maintenance of the archaeological site. Walkways on ramps allow easy access to the lower level (Škorić 2008) (Fig. 9 and 10). Visitors are allowed to walk not only on the ramps but also to go down and walk through the

Fig. 9. Final appearance of the interior (photo: Institute for the Protection of Cultural Monuments of Sremska Mitrovica)

Fig. 10. Panoramic view on the archaeological site (photo: Institute for the Protection of Cultural Monuments of Sremska Mitrovica)

entire '1a Site'. Therefore, the mosaics are still covered with sand, with only small sections presented since this is all at an experimental phase (Fig. 11). The project was funded by the Ministry of Culture, the Ministry of Economy and Regional Development and the city of Sremska Mitrovica. The main contributors were experts from the Regional Institute for the Protection of Monuments Sremska Mitrovica under the direction of Ljubiša Šolaja. The design and presentation were prepared by the architects Adrijana Škorić and Ivan Filipović.

Fig. 11. View of the mosaic presentation (photo: Institute for the Protection of Cultural Monuments of Sremska Mitrovica)

Fig. 12. Development of micro-organisms and certain types of low vegetation (photos: N. Smiciklas, Institute for the Protection of Cultural Monuments of Serbia, Belgrade)

The microclimate

Despite the fact that the sheltering project was carried out very carefully, with the cooperation of experts from all fields of heritage protection, it led to inevitable changes in the microclimate within the building. This was caused by the failure of the ventilation system of the palace, which, for technical reasons, could not be repaired for over one year. During that, period there was only natural ventilation which was not enough. The surfaces of the walls and the mosaics, showed alterations characteristic of micro climate change, such as incrustations, which indicate a rapid drying out, and a greenhouse condition that is very suitable for the development of micro-or-

Fig. 13. Examples of rising damp (photos: N. Smiciklas, Institute for the Protection of Cultural Monuments of Serbia, Belgrade)

ganisms and certain types of low vegetation (Fig. 12). A second problem is rising damp, which was not visible before the covering of the site. This appears to be localized in the area of the wells that were dug in order to drain water during the period when the site was open. As the site is located very close to the river Sava, all high rainfall and rising water levels impact directly the balance of moisture in the imperial palace (Fig. 13). The alternation of dry and rainy periods also has an impact on the state of the microclimate in the imperial palace. In order to determine the real situation and to take adequate steps to solve this problem, it was decided to conduct detailed physical, chemical and biological tests. At the time of writing this paper there was no significant budget for carrying out serious research. We can only partially rely on our personal, very subjective observations, founded on many years of experience with similar projects. We also had the results of a brief preliminary analysis and the data collected by the hydro-meteorological station Laćarak, in the territory of Sremska Mitrovica (Fig. 14).

Analyses

Testing microclimatic parameters

Data collection was performed with an infra-red thermometer with hydrometer module TESTO 845. Temperature was recorded at selected wall remains and so were other microclimatic parameters such as relative humidity and air temperature, while the calculation obtained computational parameters such as dew point, surface moisture

AVERAGE MONTHLY TEMPERATURE IN °C

	An annusl average 1948-1986	10-year interval 1998-2007	10-year interval 2000-2009
April	11.5	12.3	12.3
May	16.4	17.6	17.9
Jume	19.5	20.7	20.6
July	20.8	21.9	22.0
August	20.4	21.8	21.9
September	16.6	16.4	16.2
October	12.2	12.4	12.03

AMOUNT OF RAINFALL (MM)

	An annusl average 1948-1986	10-year interval 1998-2007	10-year interval 2000-2009
April	51.0	46.6	45.5
May	61.0	61.4	56.1
Jume	89.0	88.8	84.6
July	66.0	63.6	46.2
August	53.0	61.4	62.4
September	42.0	58.7	54.6
October	42.0	65.1	60.7

Fig. 14. Hydro-meteorological data for a ten-year interval, with annual average (Institute for Hydro-Meteorology of Serbia, Belgrade)

and dew point spread The measurements were carried out for about 30 minutes.

The data collection was performed during the sunny period. Relative humidity was 48.1% (48.6% outside) with a slight tendency to increase (due to the temperature drop at the end of the day outside and the termination of heating through the roof by solar radiation). The average temperature was about 20.2º C (17.6 outside); while, the temperature of the wall surface was 155º C. Computational parameters such as dew point, surface moisture and dew point spread show that, at the time of measurement, there were absolutely no condensation processes because the dew point spread was about 6.7º C. While surface moisture is measured from 0-1.0 (0 = dry, 1.0 = very damp) a measured value of 0.65 confirms that at the measuring moment it was not sensitive to microbial growth (Fig. 15 and 16). It should be not-

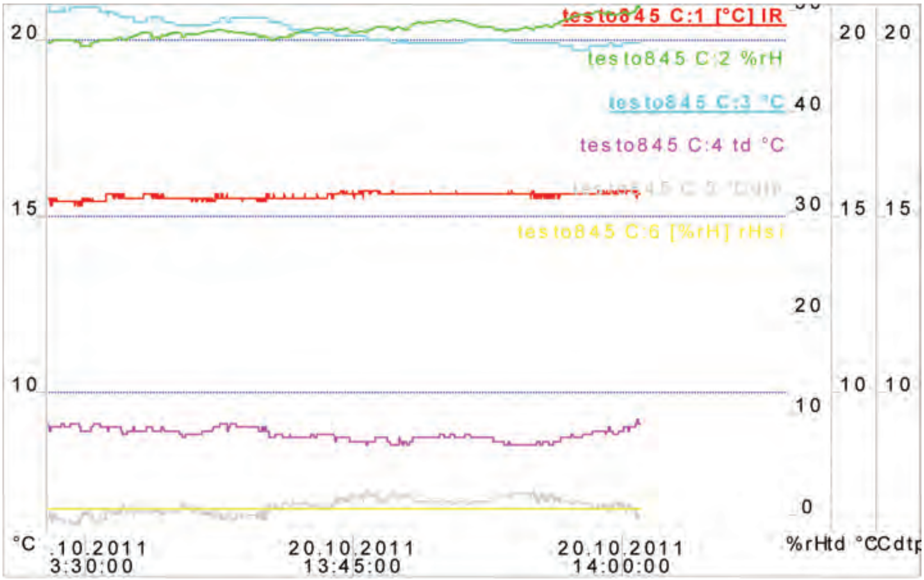

Fig. 15. Diagram of movement of microclimatic parameters during 30 minutes inside the enclosed space of the imperial palace (A. Jelikić, Institute for the Protection of Cultural Monuments of Serbia, Belgrade)

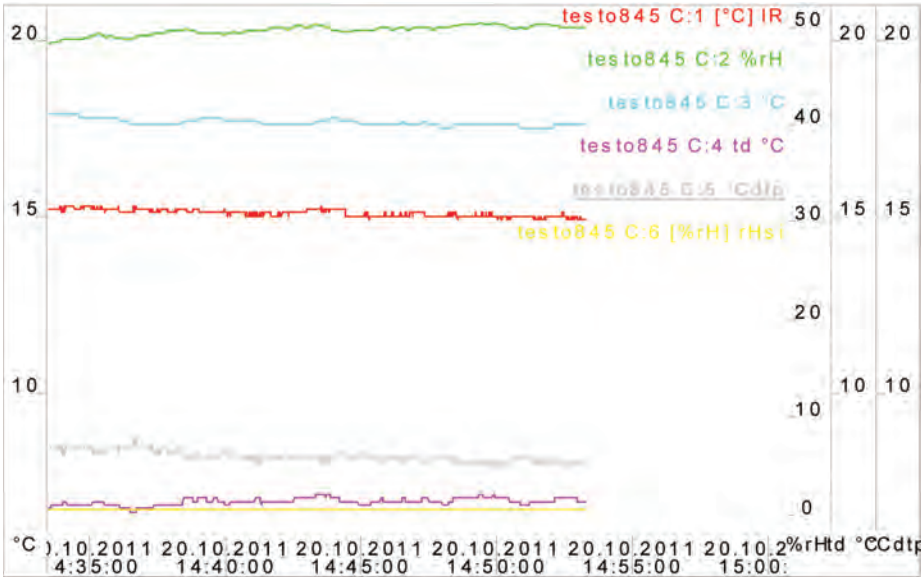

Fig. 16. Diagram of the movement of the microclimatic parameters during 30 minutes outside the imperial palace (A. Jelikić, Institute for the Protection of Cultural Monuments of Serbia, Belgrade)

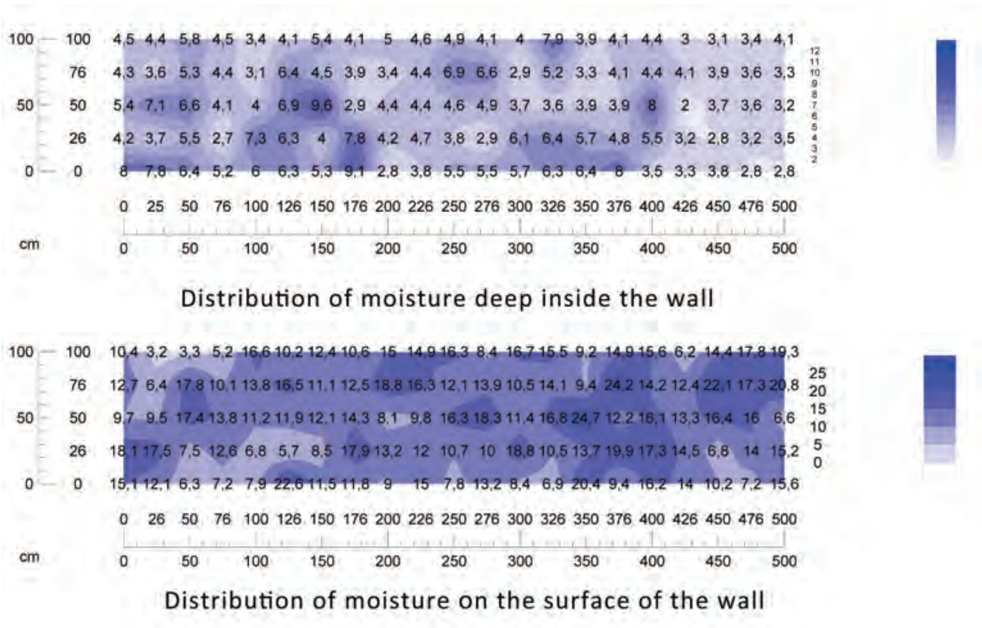

Fig. 17. Testing moisture content in wall remain (A. Jelikić, Institute for the Protection of Cultural Monuments of Serbia, Belgrade)

ed that this is a very short period of time, which does not allow us to make relevant conclusions. This kind of study requires a minimum measuring frame of at least a year, which includes a complete ambient monitoring, not only physical but also chemical and biological.

Testing moisture in the wall remains

Research into solving the problems of biological growth in the imperial palace consisted in measuring the moisture content of part of one of the wall remains, with the goal of determining the state of the wall humidity in depth and on the surface; that is, the mapping and detection of the origin and quantity of moisture coming from diverse sources. These data provide a better understanding of the condition and appearance of the wall structure.

Moisture measurements were taken using the microwave, non-destructive method, which allows measurement and comparison of the results for water on the surface and deep inside a given wall.

The measurement is based on the principle of reflection, i.e. the microwaves that are reflected back from the material, dependent of the water content in it, are measured. The method was used on a brick wall. The measurements were taken on one side of the wall surface to a depth of 5 and 30 cm, at identical points of a 25x25 cm grid. The measurements were taken at a wall height of 100 cm, and an identical pattern was applied to all the

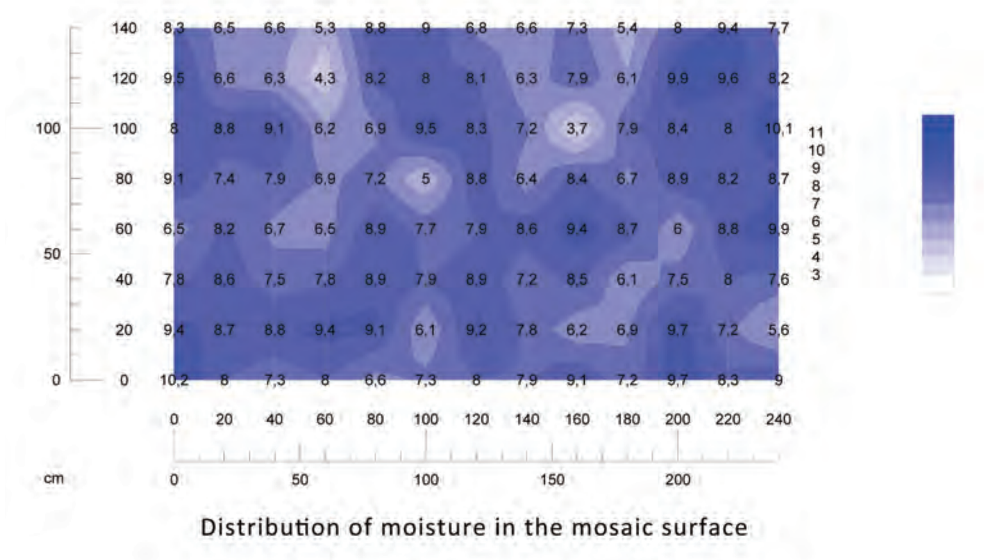

Fig. 18. Testing moisture content on a mosaic (A. Jelikić, Institute for the Protection of Cultural Monuments of Serbia, Belgrade)

surfaces. The results are then processed with moist analyses software (Fig. 17).

The same measurements were conducted on the mosaics. The deep measurements show a pattern indicating a steady supply of water through rising damp. The measured values on the surfaces are higher than the deep ones everywhere, something that indicates rising damp or hygroscopic moisture, which may be due to the visible microorganisms that retain moisture in its structure. The large disparity between the in-depth and the surface values of the wall indicates the adsorption of water from the air. Measurements on the mosaic surface were performed for the limestone rock in a grid of 20 cm (Fig. 18). The values recorded on the surface at a depth of 5 cm are much lower than those measured on the walls. The relatively uniform distribution of water content, without major deviations and moist areas, is remarkable. Values average about 7.5%.

Condition of the mosaics

Since 1960 and up to 2009, the mosaics were presented in situ, outdoors. Throughout the last 50 years they were exposed to atmospheric influences that led to their faster deterioration and devastation. The current condition of the mosaics is very bad. Their whole surface is covered with a thick layer of dirt and incrustation, which make them difficult to see. Also there are many other types of alteration, such as colour alteration of tesserae, deteriorated tesserae, deteriorated preparatory layers, detachment between mosaic layers, incrustation, cracks, lacunae, etc. (Fig. 19).

The mosaic floors of the imperial palace are made in the *opus tessellatum* technique, and with clay tiles, and are decorated with a variety of geometric patterns. The size of the variously coloured stone tesserae ranges between 0.5 and 1.5 cm (Fig. 20, 21 and 22), and the brick tiles are hexagonal. During the1970s, over 200 m^2 of mosaic revealed at that time were conserved. In rooms 14, 16, 23, 2-upper level and 34, the mosaics were lifted and placed on reinforced concrete supports. For the main bearing layer of the previously cleaned segments of mosaics, a 3-4 cm thick mortar was made as follows (the amounts given are for about 10 m^2):

– lime (hydrating) 102 kg
– cement (Beočin M-250, Portland) 32 kg
– opalska breča (volcanic tuff)12 kg
– sand (Venčac 1x grained) 306 kg

The fragments were re-laid after treatment and joined with cement mortar. This cement mortar surfaced through the lacunae and the edges where the mosaic was cut into pieces, and covered tesserae in these areas. After this major intervention was performed, only minor maintenance took place (change of the protective layer of sand and removal of vegetation) which revealed more and more defects in the underlying layer of mosaic, where tesserae were deteriorating and separating from the substrate. The lacunae are filled with cement mortar to the level of the tesserae, which, over time has become darker and cracked, and thus spoils the whole visual impact and stability of the tesserae, and also undermines the mosaic as a whole. The edges of the lacunae and the mosaics are extremely unstable, and the tesserae are detached and fall out of their sockets. Minor damages are retouched with tesserae of inappropriate colour, size and tone, which, instead of being functional, impair the visual experience of the mosaics. Given the weight of the fragments after the conservation and restoration of the 1970s, which used reinforced concrete in some places, the soil has settled, cracking and deforming the original hypocaust (*suspensura*) and its supporting pillars (*pilae*). Consequently, bumps and cracks are visible on the entire mosaic surface. The network of cracks spreads mainly through joints, but individual tesserae are also damaged. The surface of the mosaic itself is covered with a thin layer of incrustation and salt efflorescence. This greatly affects the visual impact, since the incrustation appears as a light coating on the tesserae. The efflorescence found especially in the interstices between the tesserae appears as a white crystalline powder. Given that this is a product of efflorescence, it is very destructive. Salt crystallizes in the micro-cracks of the mortar and the tesserae, and with expansion leads to cracking and major damage to all layers of the mosaic. This occurs because of the ability of concrete to attract and retain moisture. Visual inspection of the tesserae established various types of damage. On the larger mosaic surfaces there are traces of disaggregation, loss of adhesive properties and pulverization, and lamination of the tesserae. Many of them have separated from the underlying layer of mortar, but are still in their original place, although there are some parts of the mosaic where they are lost. A large number of broken tesserae are still in their proper place, complete or in fragments. Although, after conservation and restoration the mosaics

Fig. 19. Current condition of the mosaics (photos: Institute for the Protection of Cultural Monuments of Sremska Mitrovica)

Fig. 20. Upper level mosaic pavement in Room 1 (photo: I. Filipović, Institute for the Protection of Cultural Monuments of Sremska Mitrovica)

Fig. 21. Lower level mosaic pavement in Room 1 (photo: I. Filipović, Institute for the Protection of Cultural Monuments of Sremska Mitrovica)

Fig. 22. Lower level mosaic pavement in Rooms 21 and 24 (photo: I. Filipović, Institute for the Protection of Cultural Monuments of Sremska Mitrovica)

were covered for protection with a layer of sand, about 20 cm thick, this did not keep them entirely safe, given that the site was not covered or guarded. Despite the protective layer of sand, grass has grown and its roots have devastated the mosaic foundation. Residues and other changes are visible on the mosaic surface, incurred as a result of many years of exposure to outside agents, such as rain, frost, vandalism and animal droppings. All these have greatly affected the integrity of the fragments of mosaic, as well as their present appearance. This is best seen in places where there has been alteration in the colour of the tesserae, as well as in surfaces covered with microorganisms. In the joints and the surface of individual tesserae there are visible remains of the old *colletta* (animal glue), which was not completely removed after the lifting, conservation and restoration of the mosaics. The entire surface of the fragments is covered with sediment-contaminated dirt. Also, a number of cavities have formed under the tesserae.

Conservation and restoration works on the mosaics

The conservation and restoration of the mosaics at archaeological "Site 1a", the imperial palace at Sirmium, presents a complex and delicate procedure that aims to prevent further progression of the negative processes that may lead to the damage or complete loss of certain parts of the mosaic. In order to create the conditions for the longevity of the mosaics, it is necessary, first of all, to eliminate the effects of all those agents and influences that have led to the current damage; lift the fragments and reset them on an adequate new substrate; and remove the cement mortar that was used for filling the lacunae. There is a strong justification for the project which will employ modern methods of mosaic conservation on a stratified, stable and lightweight base, which will give structural stability to the fragments, enable their mobility and separate them from the influence of surrounding factors. It was decided to start with the conservation and restoration of lifted fragments in order to establish methodologies for the rest of the mosaics revealed during the excavations of 2006-2007 that are currently on the site. The conservation and restoration project aims to:

– ensure the structural stability of the mosaic fragments in the new microclimatic conditions
– improve their presentation and the understanding of their context
– use materials that are compatible with the original ones, and that can be purchased locally.

Some of the mosaics, mainly the large fragments, are lifted using conventional *colletta*, while the smaller ones are lifted using Movilith. Using such methods is dictated by the weather conditions that have adversely affected the traditional drying of *colletta*. After lifting, the back of the fragments is cleaned of sediment contaminants, with care being taken to preserve, where possible, the stability of the original, ancient mortar (Fig. 23). After cleaning, a layer of mortar made using quartz sand and hydraulic lime is applied. A second layer is made of lime mortar reinforced with glass fibre and plastic mesh. A glass fabric

Fig. 23. Conservation and restoration work on mosaic fragments (photo: N. Smičiklas, Institute for the Protection of Cultural Monuments of Sremska Mitrovica)

is glued with epoxy resin to the back side of the fragment. Thus prepared, the fragments are placed on custom-made trays of a reinforced aluminium honeycomb grid. The panel surface which is in contact with the mosaic, as a finishing layer, is coated with a special film that increases the quality of the connection between the panel and the mosaic fragment. Bonding was made with the use of an epoxy resin with the addition of fillers. We thank the team of the COMPOSITE TECHNOLOGY TEAM DOO and the BG Model Shop, which developed and improved panels for our purposes. Their experts helped in testing different types of epoxy resins and fillers in order to choose the best combination for our needs. Along with that, adhesives based on polyurethane were tested as an eventual replacement of epoxy. We look forward to our further cooperation in the field of promoting materials for conservation and restoration.

During restoration, the facing is removed from the fragments using a steamer. The face of the tesserae and the joints are then thoroughly cleaned of sediment impurities, and the lacunae are filled with lime mortar in neutral tones, up to 2-3 mm below to the tessera level. Considering that there is no place to exhibit the fragments in situ, since they were pulled out from escarpment on which there are now the walls of the building, a proper place for their presentation is yet to be found within the new shelter. A project for treating the mosaics that were conserved in the 1970s was prepared by experts from the

Institute for the Protection of the Cultural Monuments of Serbia, in Belgrade, and is already in motion. This project provides for the removal of the concrete supports, and their replacing with lime mortar on a light but strong support like honeycomb, using the methodology already tested on the fragments. Mosaics conserved in this way are going to be returned in situ and presented accordingly.
The approach consists of the following:

- Removal of the protective layer of sand from the surface of the mosaics
- Preparation for photo documentation, drawings and 1:1 tracing
- Physical, chemical and mycological analysis
- Controlled drainage of the fragments up to the moisture concentration at which it would be possible to conduct further work without fear of side effects
- Preventive consolidation and tessera fixing
- Edging repair and filling of lacunae where necessary
- Preventive consolidation of the bedding layer in areas where it is needed
- Chemical treatment of the mosaic in order to eliminate the devastating impact of microorganisms
- Setting the appropriate facing on the mosaics in layers
- Surveying and setting elevations for the return of fragments of mosaic to the site
- Lifting fragments of the mosaics
- Cleaning the back, removal of the reinforced concrete layer and the mortar, and preliminary work for setting up a new base
- Setting up a new, firm, stable and light base
- Removal of facing from the mosaics
- Cleaning and additional consolidation of the tesserae
- Sealing existing damage, filling-in the lacunae
- Retouching with original tesserae found on the site, only where there is the necessary evidence
- Applying a protective UV layer
- Development of the necessary supporting documentation
- Photo and video documentation of the complete work flow
- Making presentations on a variety of public media
- Restoration of the fragments in situ and presentation of the treated fragments
- Organizing lectures with themes about conservation and restoration of mosaic fragments
- Training technicians working at the palace for further monitoring of the mosaics

Conclusion

After all that has been described above, we can conclude that monitoring the state and the maintenance of mosaics are key processes in their conservation. Without continuous monitoring and gathering data – something that takes years – it is not entirely possible to propose precise and safe methods of conservation and restoration.
As we were not able to carry out all the necessary tests, we can only hope that the methodology that we have chosen fits the needs of the mosaics in this surrounding. When selecting the approach to the problem of conservation and restoration, we relied on our practical experience as well as that of others. It is up to us to continue monitoring the condition of the mosaics as well as the archaeological site, and to hope that our

work was not been in vain. It is up to us to set as a goal the raising of awareness about the necessity of continuous monitoring and data collection, so that we do not find ourselves in a similar situation again. We need to raise the awareness of the relevant institutions and individuals, particularly those on which financing depends, who do not understand the problems of conservation and its needs. We will continue maintenance and research at the palace, as well as conservation and restoration work on the mosaics in the best way possible.

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RÉUSSITES, DIFFICULTÉS ET COÛTS DE LA CONSERVATION D'UN SITE ET DE SES MOSAÏQUES

Denis Weidmann

Résumé

Les analyses de situation et le développement des méthodes d'intervention spécifiques mises en œuvre pour la villa gallo-romaine d'Orbe (Suisse) ont été régulièrement présentées dans les colloques ICCM. La démarche de conservation entreprise depuis 1974 visait au maintien in situ de neuf mosaïques, constituant le plus grand ensemble visitable en Suisse.

La préoccupation de conservation et d'entretien des pavements s'est rapidement élargie au maintien de l'intégrité du site archéologique, menacé par des projets routiers et par l'exploitation agricole. La stratégie d'intervention sur les mosaïques a été redéfinie dans un programme général comprenant l'exploration et l'étude archéologique complètes de la *pars urbana*, la conservation des vestiges dans le sol, l'acquisition des terrains du site par les collectivités publiques, les détournements routiers, l'arrêt de l'exploitation agricole dommageable, un plan d'urbanisme définissant la protection légale et les aménagements possibles pour la mise en valeur et l'exploitation.

Alors que tous les autres objectifs ont été atteints, la mise en œuvre de l'aménagement connaît des difficultés et atermoiements, pour des raisons politiques et financières. Dans ce long parcours, les mosaïques conservées effectivement in situ, par leur attractivité, constituent la motivation et la justification permanente de l'entreprise.

Les engagements financiers pour le site d'Orbe sont donnés, et notamment le coût du traitement des mosaïques et des installations de protection, et de leur entretien.

Huit mosaïques ont été mises au jour fortuitement et progressivement, dès 1841, dans les champs proches de la ville actuelle d'Orbe (Canton de Vaud, Suisse) (Fig. 1). La plupart d'entre elles ont été heureusement protégées dès leur apparition sous des abris construits en maçonnerie, ouverts à la visite publique pendant la saison favorable.

Fig. 1. Position de la villa (carré de 400x400 m) dans la campagne au nord de la ville d'Orbe (extrait carte nationale au 1 : 25,000)

Fig. 2. Le site, vu de l'ouest en 2000, a été ménagé lors des travaux routiers. Le terrain sombre, au centre, contient la *pars urbana* et ses mosaïques (cliché : Archéologie cantonale VD)

Nous avons présenté aux Conférences ICCM 4, 7, 8, 9 et 10 les différentes études, analyses et méthodes de traitement effectuées, pour assurer la conservation de ces pavements in situ (Bakirtzis et Mastora 2011, 22, 31, 34, 40, 43). Une neuvième mosaïque ayant été mise au jour en 1993 lors des fouilles archéologiques entreprises à Orbe, cinq pavements restent aujourd'hui maintenus sans dépose sur leur support d'origine, alors que trois autres ont dû être placés sur des matériaux modernes (une mosaïque, détruite en 1845, ne subsiste qu'en fragments).

La conservation du site

Bien que l'ensemble d'Orbe soit le plus important pouvant être visité en Suisse, dûment classé en qualité de monument historique, il n'a été l'objet d'aucune fouille archéologique avant les années 1970. Ainsi, la nature exacte du site, son plan et son extension restaient indéterminés, bien que l'étude des mosaïques par V. von Gonzenbach (1961, 173-199) ait clairement démontré que ce riche programme ne pouvait appartenir qu'à une importante résidence privée de campagne, et non pas à divers bâtiments d'une agglomération urbaine.

C'est le projet de construction d'une autoroute (route nationale) traversant le périmètre du site répertorié qui a ouvert la voie aux recherches, au début des années 1970. Notre service, chargé de la protection du patrimoine archéologique régional, devait alors se déterminer sur le projet routier et fixer, le cas échéant, les conditions auxquelles les travaux de construction à venir devaient satisfaire, pour prendre en compte les éventuels vestiges archéologiques touchés.

Des sondages géoélectriques ont été tout d'abord réalisés, pour tenter d'appréhender l'extension du site dissimulé sous les terres arables. La compréhension du site a été opportunément accélérée par des photographies aériennes prises en juin-juillet 1976, suite à la fameuse sécheresse printanière, qui ont révélé l'ensemble des structures conservées à peu de profondeur sous la surface cultivée, de ce fait très arasées par les labours. Le plan d'ensemble de l'organisation a pu être tracé et interprété, s'étendant sur une surface de 16 hectares (Weidmann 1978, 84-86 ; Francillon et Weidmann 1983, 2-14 ; Weidmann et May Castella 1994, 20-21). Il a été ainsi confirmé que les mosaïques ornaient les sols de la *pars urbana* de la plus grande villa gallo-romaine construite en milieu rural au nord des Alpes.

Ces constatations ont confirmé que les mosaïques ne pouvaient désormais être dissociées de l'ensemble architectural, de manière à préserver les potentialités de futures mises en valeur du site. Nous avons dès lors recherché et mis en œuvre toutes les mesures allant dans ce sens. En premier lieu, le tracé de l'autoroute a été corrigé, évitant toute atteinte au périmètre de la villa. Le raccordement à l'autoroute de la route locale, traversant la *pars urbana* depuis l'époque médiévale, a été également redéfini de façon à contourner le site (Fig. 2). Le démontage de l'ancien tracé et des chemins de dévestiture agricole qui oblitéraient le plan de la villa a été requis, dans le cadre des travaux de réaménagement des abords de l'autoroute. Ces interventions ont été réalisées par un programme de fouilles archéologiques méthodiques intégrées dans le financement de la construction routière.

Nous avons confié les investigations à l'Institut d'archéologie et d'histoire ancienne de l'Université de Lausanne (Prof. D. Paunier), en les limitant à un dégagement et à un relevé du dernier état des vestiges, excluant toute destruction ou percement des sols pouvant être présentés dans l'état de leur mise au jour. Les structures ont ainsi été systématiquement remblayées au terme de 18 campagnes de fouilles-école réalisées de 1986 à 2003, couvrant une surface totale de près de 27,000 m^2 (Fig. 3). Les recherches visaient également à établir l'état de conservation de l'ensemble des vestiges et à définir les mesures de protection nécessaires.

Les sols et murs de l'édifice (et donc les mosaïques) se sont révélés n'être recouverts que de 20 à 30 cm de terre, et ils avaient subi de nombreux impacts des engins de labours, dont la puissance et l'efficacité s'étaient progressivement accrus au cours des dernières décennies. La première mesure de protection urgente a donc consisté à interdire les labours dans l'emprise de la *pars urbana* et à limiter leur profondeur dans le reste du site.

L'identification progressive des diverses parties de la résidence et l'évaluation de leur intérêt ont orienté le programme des investigations, qui ont été étendues à l'ensemble de la *pars urbana* et à quelques secteurs de la *pars rustica*, permettant de

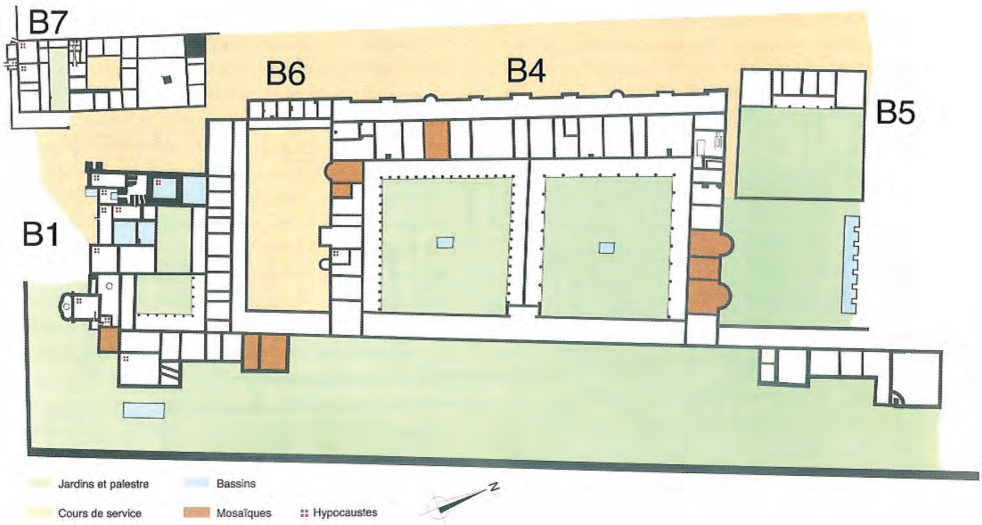

Fig. 3. Les fouilles archéologiques ont déterminé les fonctions des divers secteurs de la *pars urbana*. En foncé, emplacement des sols mosaïqués (dessin : IASA-Uni Lausanne)

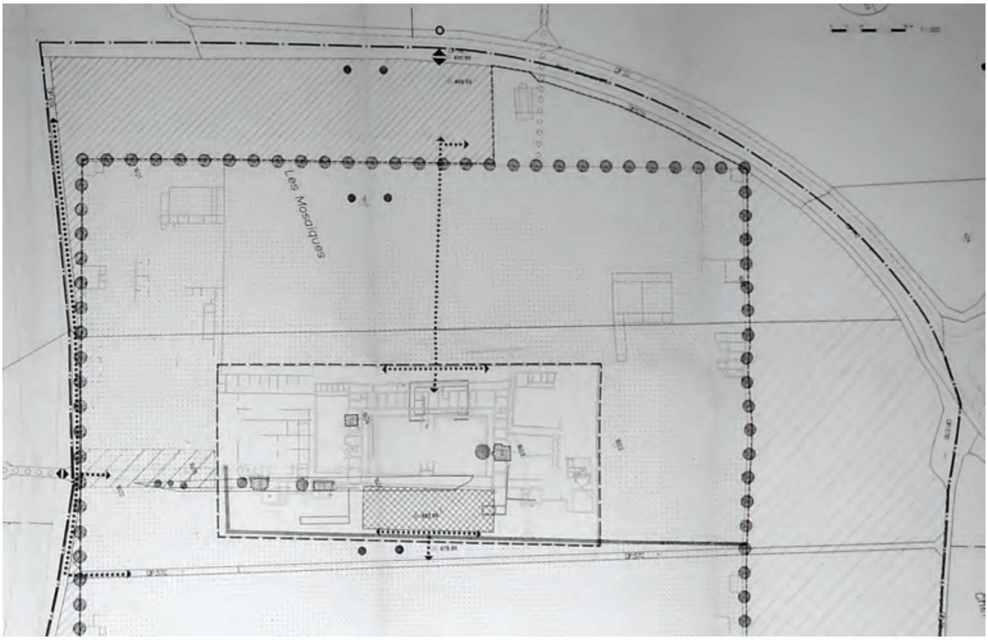

Fig. 4. Une partie du plan d'urbanisme (2000) qui définit les différents secteurs du site, les affectations et aménagements possibles

préciser la compréhension du plan général (Paunier et Luginbühl 2016).
Il est vite apparu que la densité des vestiges dans le sol et la nécessité de leur conservation annonçaient des contraintes nouvelles pour la gestion des terrains sus-jacents, difficilement compatibles avec le statut de propriété privée qui prévalait jusqu'alors. Nous avons alors saisi l'opportunité de l'opération de remembrement des terres agricoles aux alentours de l'autoroute pour proposer – et obtenir – l'attribution des 16 hectares de la villa, en partage entre la Commune d'Orbe (qui possédait déjà une partie des terrains) et le Canton de Vaud (déjà propriétaire de trois des mosaïques, qui prit en charge l'entier de la *pars urbana*). La Commune était intéressée par le développement d'un point d'attraction touristique dans son territoire et l'Etat avait une large expérience de la gestion de monuments archéologiques importants.
L'étape suivante vers une mise en valeur du site a été l'élaboration d'un plan d'affectation (plan d'urbanisme), constituant simultanément un plan directeur des aménagements à venir dans le périmètre de la villa. Il était en effet nécessaire de soustraire les terrains de la zone agricole, statut qui interdisait toute construction ou aménagement. Ce document et son règlement ont été établis sur la base du plan archéologique issu des investigations. De même, la définition des hauteurs constructibles (le cas échéant, pour la réalisation d'abris sur les vestiges, ou de bâtiments de service) a été donnée par l'étude de reconstitution architecturale de la villa (Paunier et Luginbühl 2016, vol.1, 273-277). Dans la mesure du possible, les accès et circulations de visite ont été fixés selon les parcours antiques. Le plan fixe également les mesures de protection des diverses parties du site. Le plan d'affectation « Les Mosaïques » a été légalisé en 2000, ouvrant la voie à des projets et réalisations concrètes (Fig. 4).
L'étude de divers projets d'aménagement a dès lors été abordée par un groupe de travail réunissant les instances intéressées, à savoir les représentants des nouveaux propriétaires, l'association locale gérant la visite des mosaïques, notre service et un mandataire privé. Une série d'avant-projets a été esquissée et évaluée dans ses coûts, en 2002, allant du simple marquage des vestiges en surface à la mise sous abri de vastes surfaces des vestiges remis au jour, incluant toutes les mosaïques, avec espace d'accueil et d'information, présentation muséographique, parkings … La fréquentation annuelle du site, actuellement de l'ordre de 5,000 visiteurs, était évaluée jusqu'à 50,000, selon l'ampleur des aménagements proposés. La planification de mesures d'économie budgétaires pour les constructions cantonales, notamment dans le domaine culturel, a malheureusement bloqué toute perspective de réalisation cohérente à court terme, si bien que les projets restent dans les cartons.
Par les démarches effectuées, le site d'Orbe a tout au moins acquis une protection satisfaisante, et les conditions nécessaires sont dorénavant réunies pour la mise en œuvre de nouveaux aménagements. Ainsi, en 2009, une première application a consisté en la mise en place d'un vaste pavillon d'accueil à l'entrée du site, où les visiteurs reçoivent une information générale avant la visite des différentes mosaïques.

La conservation des mosaïques

Les mosaïques restent le principal attrait du site d'Orbe et les seuls objets visibles,

Fig. 5. La mosaïque no 8, dite des Divinités, mise au jour en 1862, après les récents travaux de conservation (cliché : Fibbi-Aeppli, Grandson)

et ceci depuis le milieu du XIXe siècle, en dépit des efforts récemment déployés pour leur assurer un cadre plus satisfaisant. Les huit pavements, partiellement ou totalement visibles dans les bâtiments de protection construits au XIXe et au XIe siècle, sont classés comme monuments historiques depuis l'année 1900, et ils ont été périodiquement entretenus et restaurés, avec des fortunes variables. Le constat de leur état de conservation très alarmant, dans les années 1970, nous a fait rechercher les solutions envisageables pour leur sauvegarde.

Nous avons ainsi sollicité en 1978 l'expertise de Claude Bassier, de Périgueux, qui a proposé une dépose générale et le transfert sur des supports indépendants des sols. Cette solution, alors couramment pratiquée en France dans les situations de découvertes nouvelles, était relativement économique et séduisante, car elle résolvait de manière durable la conservation. Elle venait cependant en contradiction

SITE DE LA VILLA GALLO-ROMAINE D'ORBE - 9 MOSAÏQUES *IN SITU*, 16 HECTARES
EVALUATION DES COÛTS 1976--2008

	Francs suisses	Euros
– Entretien et amélioration des bâtiments de protection, infrastructures, installationsd'alarmes	640.000.-	533.000.-
– Présentation muséographique, balisage	100.000.-	84.000.-
– Conservation des 9 mosaïques, y compris études et analyses	1.256.000.-	1.046.000.-
– Fouilles archéologiques, relevés, élaborations de publications, y compris remblayages et protections des vestiges dégagés	5.800.000.-	4.830.000.-
– Etudes et procédures pour protection et mise en valeur, projets	115.000.-	96.000.-
– Nouveau pavillon d'accueil (2009)	300.000.-	250.000.-
Total	**8.211.000.-**	**6.840.000.-**

FINANCEMENT	National (Confédération)	env. 67 %
	Cantonal (propriétaire)	env. 28 %
	Communauté locale	env. 5 %

Fig. 6. Tableau de l'évaluation des coûts du traitement du site d'Orbe, de 1976 à 2008

avec la tradition locale de maintien *in situ* des vestiges, observée ici depuis 1841, et avec le constat plus récent (1976) de la présence d'un environnement archéologique exceptionnel, susceptible d'être protégé dans son entier. Nous avons alors opté pour la voie du maintien *in situ* la plus complète possible, tout en restant conscient des nombreuses incertitudes de la démarche.

Les différentes communications publiées dans les actes des conférences ICCM (Bakirtzis et Mastora 2011, 31, 34, 40, 43) rendent compte des analyses de situation et des méthodes de traitement mises en œuvre pour les pavements « anciens », et pour l'amélioration des climats de conservation dans les abris. Ces travaux sont aujourd'hui achevés pour l'ensemble du site, et ils permettent la visite de mosaïques entièrement restaurées (Fig. 5).

La mosaïque dite d'Achille à Skyros (Paratte 2005, 211-222), neuvième du site, localisée en 1993 lors des fouilles méthodiques, a donné lieu à une démarche différente, prenant en compte les constats effectués dans le reste du site et cherchant à éviter une évolution défavorable. Le pavement n'a été dégagé qu'après avoir été mis sous abri fermé, sommairement documenté et aussitôt maintenu à l'abri de la lumière, dans des conditions déterminées d'humidité et de température. Aucun traitement n'a été opéré, dans l'attente que les dispositifs mis en place au voisinage (drainages approfondis, suppression des infiltrations, évacuation des eaux) établissent les conditions nécessaires pour une conservation sur le support d'origine (Weidmann *et al.* 2003, 173-174, 183-184). L'évolution constatée a permis dès 2008 de procéder par étapes à des consolidations et nettoyages du *tessellatum* (Fischbacher et Krieg 2017), tout en maintenant un taux d'humidité maximal en surface pour éviter la formation et migration de sels. Cette neuvième mosaïque, la plus grande de la villa, est dans l'attente de la construction d'un abri permettant une visite publique et garantissant les conditions climatiques nécessaires.

Evaluation des coûts

Nous donnons ici (Fig. 6) le résumé des coûts des différentes études, interventions et travaux conduits entre 1976 et 2008, qui ont été évoqués ci-dessus. La répartition des postes peut paraître arbitraire, mais elle cherche à rendre compte d'activités très diverses, réparties irrégulièrement sur plus de 30 années. Les montants sont donnés à titre indicatif en Euros, calculés au taux de 1 Euro = 1.2 Franc suisse. Les spécificités de l'organisation de la conservation du patrimoine en Suisse sont mises en évidence dans le cas particulier d'Orbe, notamment par la très grande part des recherches archéologiques liées à la construction de l'autoroute. Organisées par le canton concerné, elles sont dans ce cas financées par l'Etat fédéral (Confédération), ce qui explique la part prépondérante de la Confédération au financement global. En réalité, le soutien fédéral à la conservation du patrimoine d'importance nationale propriété des cantons (c'est le cas à Orbe) n'est que subsidiaire, et se limite au subventionnement de postes tels que les travaux de conservation. On notera enfin que le tableau n'évalue que les prestations réalisées par des mandataires (Université, laboratoires, ateliers de restauration, architectes, entreprises…). Les prestations des services responsables de la conduite des opérations ne sont pas incluses (parts aux études, gestion générale, administration).

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CONSERVATION, MAINTENANCE AND DISPLAY OF THE MOSAICS IN PERGE – TURKEY

Şehrigül Yeşil-Erdek

Abstract

The excavations carried out by Istanbul University in Perge since 1946 revealed a great number of mosaic pavements. Unlike many sites in Turkey bearing mosaic pavements, the Perge mosaics have been preserved in situ, which ascribes to them a special value. During the archaeological analysis of the mosaic pavements decorating the Southern Baths, the *Macellum* and the *Porticus* east of the Late Antique Square of the city, ca 3,000 m² of mosaic have been uncovered, documented by photogrammetric methods and consolidated. All stabilized mosaic pavements have been reburied, which made it impossible for them to be appreciated by visitors.

There is an ongoing attempt to devise a conservation management plan for the Perge mosaics which is the first initiative of its kind in Turkey and which will potentially constitute a model for other sites. The ultimate goals of the project are to create a plan for the maintenance of the mosaics, to display a limited part of the panels seasonally and thus contribute to the tourism of the region, and to enable the long-term continuation of conservation activities.

Perge was one of the major cities of ancient Pamphylia, a region on the southern coast of Asia Minor (Pekman 1989, 3). It is situated on the east of Attaleia (modern Antalya) and 11 km inland from the Mediterranean. The city, where the earliest findings date back to the Late Chalcolithic Period, provides evidence of settlement up to the Seljuk and Ottoman Periods (Özdizbay 2012, 6-20). Mosaic finds in the city date from the Roman Imperial Age and the Early Christian Period (Işıklıkaya 2010, 52-60). The excavation and preservation works in Perge have been carried out by Istanbul University, Department of Classical Archaeology, since 1946. Today, Perge is one of the most attractive historical sites, visited by over 300,000 tourists per year and is currently on the "Tentative List" for World Heritage Sites in Turkey.

In Perge, a vast number of mosaic floors have been excavated, all of which are preserved in situ. In 2008, it became essential to devise a new maintenance and display project that would be integrated into the Site Management Plan already in progress.

There are three main objectives to the project, which are to build a plan for the maintenance of the mosaics, to display a limited part of the mosaic panels seasonally and thus contribute to the tourism of the region, and to enable the long-term continuation of conservation activities.

Building a plan for the maintenance of the mosaics

In Perge, mosaic floors are known to exist (Fig. 1) in:

– the basilica on the acropolis
– the residential area in the northeast part of the lower city
– the galleries on both sides of the colonnaded street
– the *Macellum*
– the South Baths
– the East Portico of
– the Late Antique Square
– and at least in two grave monuments in the western necropolis of the city.

All of these have been preserved in situ, which renders Perge even more valuable with regard to its mosaics. The first phase of the project will be conducted in the mosaic area of 3,000 m^2 in the Southern Baths, the *Macellum* and the East Portico of the Late Antique Square. Based on the results to be obtained at this stage, we intend to extend the project to cover all the other mosaic areas in the city. The maintenance program is intended to prevent the factors damaging the mosaics, in advance, or as soon as they appear. It concerns all practical and technical measures that should be taken in order to maintain the mosaics in a proper order within a continuous process. In order to facilitate continuity, a well-established plan and full documentation is of vital importance.
The main objectives of maintenance project can be summarized as:

- Ensuring the systematic and periodical maintenance of the mosaics on the site
- Making the maintenance procedure a part of conservation plans
- Understanding the factors leading to deterioration in mosaics in situ with the help of maintenance processes
- Training personnel responsible for the monitoring and maintenance of the mosaics
- Ensuring systematic and accessible documentation during this working process
- Preparing the ground for continuous conservation.

In order to achieve these six main objectives, the maintenance of the Perge mosaics is planned to be carried out according to a program consisting of four main phases. These phases are:

a. Archaeological assessment and documentation of the mosaics
b. Preparation of conservation documentation and materials required for maintenance, and making these accessible
c. Determination of the causes of deterioration
d. Training and involving conservation technicians that will carry out the maintenance

a. Archaeological assessment and documentation of the mosaics

A considerable number of mosaic pavements was unearthed in different areas of the city, especially in the 1970s and 80s (Mansel 1975; Abbasoğlu 2004; Işıklıkaya 2008) and the first systematic archaeological research on mosaics was initiated; it could not, however, be completed. These mosaics were conserved and partially documented with valid methods of the time and then reburied. In accordance with the practice of that time, the team conducting the restoration works on site did not leave any detailed documentation of their

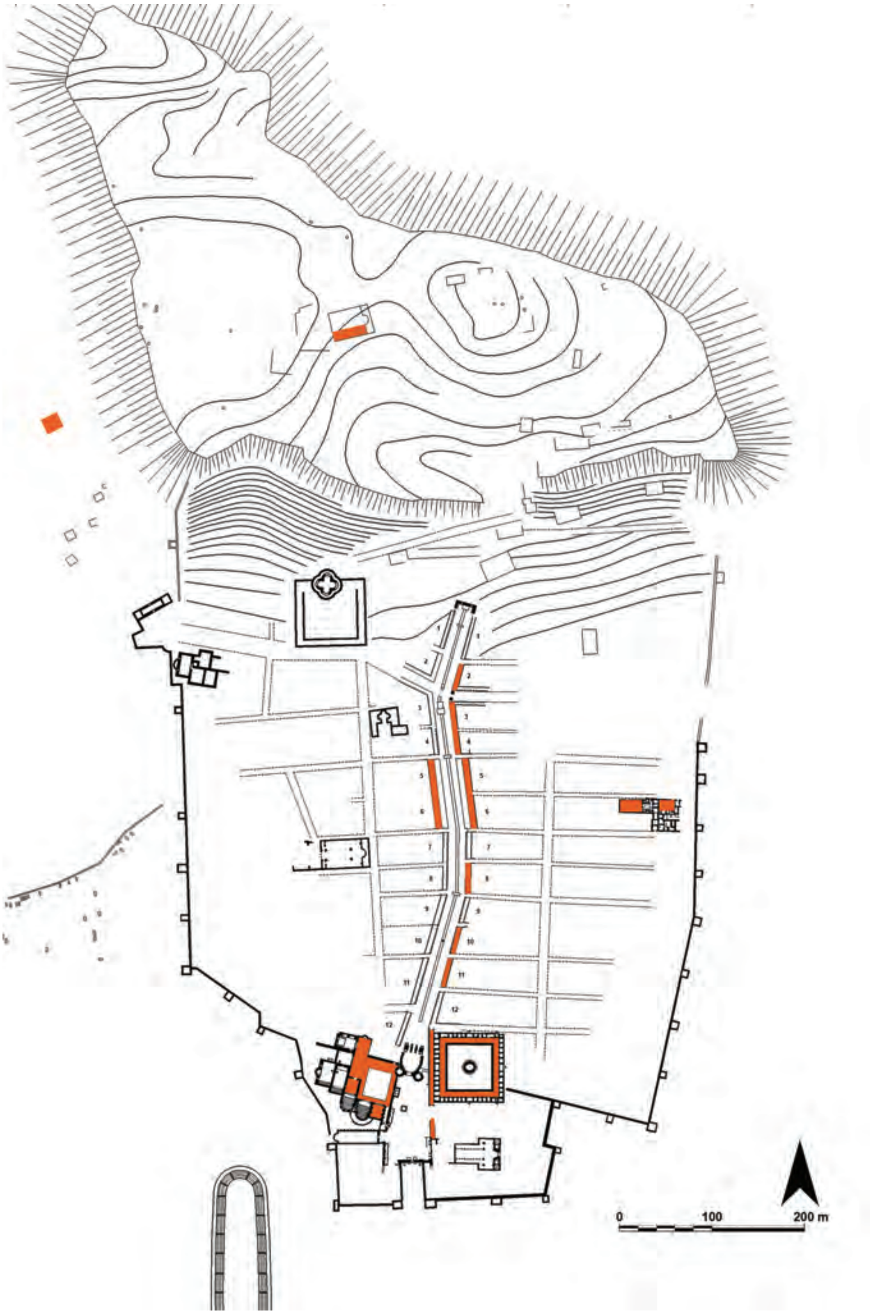


Fig. 1. General plan of Perge. Areas in the city where mosaic pavements are known to exist are marked in colour (drawing: A. Şakar, from the Perge Archives, İstanbul University. Courtesy of Prof. Dr H. Abbasoğlu)

Fig. 2. Reburied mosaics in Perge (photo: I. Işıklıkaya, from the Perge Archives, İstanbul University. Courtesy of Prof. Dr H. Abbasoğlu)

work. We have some photographs, a few hand drawings, excavation reports, and a limited number of publications regarding their restoration from the treatment in the 1980s (Işıklıkaya 2010, 53). Between 2004 and 2010, a dissertation was conducted concerning the archaeological study of the mosaics by Dr Işıl Işıklıkaya-Laubscher (Işıklıkaya 2010). During this process, almost 3,000 m^2 of the mosaic pavements in the *Macellum*, the South Baths and the Portico east of the Late Antique Square of the city were systematically documented, archaeologically studied, and partly conserved. This process rendered the comparison of the current condition of the preservation of the pavements with the archive photos possible. What is more, in some areas it has been possible to reveal new mosaic pavements that had not been excavated in the previous years. Within this wide-ranging study, mosaics were catalogued, together with brief remarks on the previous and current restoration interventions, according to both archive studies and current observations. The mosaics were documented by photographs and drawings. At the end of the field documentation, the pavements have been reburied with geotextile and river sand (Fig. 2). The documentation with measured drawings was carried out using photogrammetric methods as an accurate way for this great number of mosaics (Işıklıkaya 2008, 360). The floors

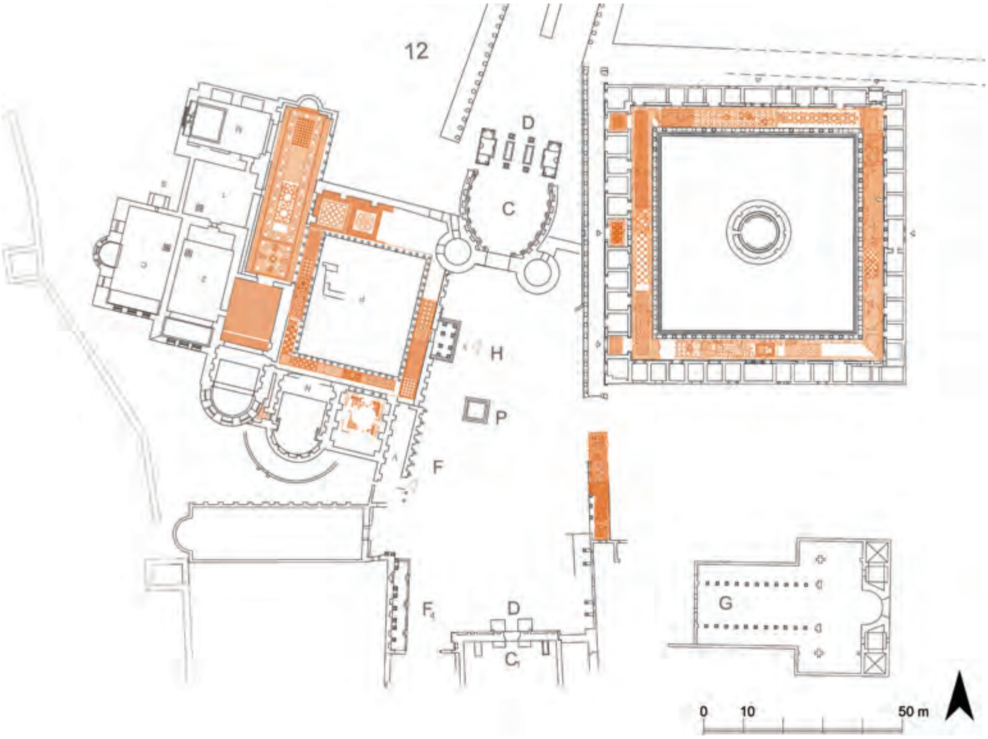


Fig. 3. Plan of the South Baths, the *Macellum* and the East Portico of the Late Antique Square of Perge (plan: A. Şakar and Ü. İzmirligil; Mosaic drawings: the author, from the Perge Archives, İstanbul University. Courtesy of Prof. Dr H. Abbasoğlu)

were photographed in small panels of between 1x1 and 2x2 m, their corner points were then rectified according to the measured coordinates which finally provided a scaled bird's-eye view of the pavements. The drawings of the panels were then made in AutoCAD, and their possible restitution concluded this initial stage (Fig. 3).

b. Preparation of the conservation documentation and the materials required for maintenance, and making these accessible

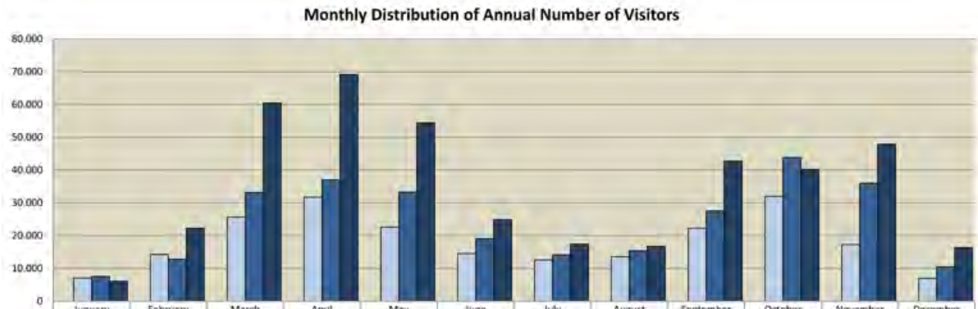
The next step was to prepare the conservation documentation and the materials required for the maintenance and to make these accessible. In order to create a common vocabulary for all the project participants, a common terminology in Turkish for different types of mosaic pavements, various preservation situations, as well as the deterioration types (such as structural, superficial and biological) and possible interventions, has been devised based on the "*Illustrated Glossary for Mosaic in Situ Project*" developed by Getty Conservation Institute and Israel Antiquities Authority (*Illustrated Glossary* 2003). Subsequently, the materials required for the documentation of the maintenance have been prepared. The planned conservation and maintenance works will be documented in written, graphic and photographic form. The

Fig. 4. Plant intrusion on the reburied mosaic in the South Baths (photo: I. Işıklıkaya, from the Perge Archives, İstanbul University. Courtesy of Prof. Dr H. Abbasoğlu)

examination on the field will be registered in digital forms using File Maker database program. The digital storage of the information will enable us to oversee and regulate the monitoring processes conducted on site. All previous treatments had to be documented before starting the maintenance processes. A catalogue displaying the present-day condition of the mosaics has been prepared by taking several catalogues prepared for the archaeological work as the base material, and by extending them with categories such as materials used, application method and current condition. The catalogue has been digitalized and thus made easily accessible and updateable. Furthermore, all former applications have been shown on the drawings.

c. Determination of the causes of deterioration

The permanent maintenance and conservation process depends on an understanding of the causes of deterioration, which forms the third phase of the maintenance plan. Within the scope of the above-mentioned dissertation, material characterization analyses have been carried out, which provide us with the characterization of materials and also some of the causes of deterioration. The causes of deterioration will surely appear more clearly during the maintenance process. However, microbiological organism and plant intrusion are two of the most important causes of deterioration of mosaics whether conserved or not (Fig 4). Therefore, the investigation of the bio-diversity is of extreme of importance for the maintenance processes.



	January	February	March	April	May	June	July	August	September	October	November	December
2009	7.052	14.287	25.669	31.754	22.602	14.511	12.560	13.593	22.288	31.984	17.298	6.928
2010	7.579	12.832	33.171	37.035	33.305	19.065	14.156	15.367	27.576	43.830	35.982	10.522
2011	6.053	22.292	60.438	69.136	54.424	24.886	17.428	16.754	42.745	40.198	47.884	16.348

Table 1. Monthly Distribution of Annual Number of Visitors according to the Antalya Archaeological Museum records

d. Training and involving conservation technicians

One of the most challenging phases of the project is to train and involve conservation technicians that will carry out the maintenance. In order to select the technicians who will take part in the project, three different options have been considered: 1) local workers who have participated in several of the previous conservation works on the site; 2) conservation technicians who have been hired to carry out the work; and 3) students who are attending a vocational school, which offers a two-year education program in the area of conservation.

It was finally decided to carry out the project with the students attending the restoration program of the Serik Vocational School, situated approximately 20 km east of Perge, and our request to start a joint project was positively accepted by the school director. The two important reasons for considering this school are its proximity to Perge, which would enable the students to participate in the field work without interruption, as well as their awareness of the basic principles and ethics of conservation. Although no courses on mosaic conservation have been offered so far, and the students do not have any practical knowledge on the subject, the basic training which has been offered at the institution still constitutes a major advantage for the needs of the maintenance project. A training handbook will be prepared in order to support the theoretical knowledge of the technicians on documentation of the current situation of the mosaics as well as deterioration and simple maintenance tasks. This handbook, which will be used throughout the training and maintenance process, will clearly define the boundaries of these tasks and introduce the tools to be used. The person who will carry out the maintenance interventions will learn the process under the supervision of highly-trained conservators and will be periodically overseen by them.

Displaying a limited part of the mosaic panels seasonally

The conservation, maintenance and display program devised for Perge regards the appreciation of the mosaics by the visitors of utmost importance, especially after considering the data on the number of annual visitors to the site (Table 1). According to the data acquired from the Antalya Archaeological Museum, Perge received a total of 220,525 visitors in 2009, 290,420 in 2010, and 418,586 in 2011, which means a total increase by almost 130,000 between the years of 2010 and 2011. These figures constitute one of the most fundamental reasons why exposing the mosaics has become essential. The increasing number of visitors has motivated us to improve the already existing potential in the area, and therefore contribute to the tourism of the region. However, a permanent display of such great number of mosaics, considering the necessary precautions against climate factors and visitor damage, is not possible. It is obvious that the construction of a shelter could not be a proper solution in this site, either. Taking all these factors into account, this project offers a seasonal and partial exposure and maintenance program, which means opening certain parts of the Perge mosaics for both monitoring and display purposes, in an annually alternating manner. While devising this partial and seasonal arrangement, we have taken two main issues into consideration: the monthly distribution of the number of visitors, and the climate conditions in the region. As can be seen on Table 1, the months March through May and October to November are the ones with the greatest number of visitors. However, it must also be considered that during October and November the region receives a remarkable amount of rain. Therefore, this project proposes to uncover certain parts of Perge between March and May, rebury them after this period and open a different part in the mentioned months of the following year. Through this project, we aim not only to ensure the appreciation of the mosaics, together with the surrounding environment and the architecture, by the visitors, and thus increase the interest towards both the architecture and the mosaics, but also to help the visitors access more detailed and accurate explanations and information. Direct contact with the mosaics will also be prevented by devising new walking routes via footpaths and bridges.

Long-term continuity of conservation

We intend to organize the conservation and maintenance work to be done in the future campaigns in the colonnaded street and other areas in accordance with the results of the preliminary examination carried out in this section of the city. Believing that the success and continuity of any conservation attempt depends on the improvement of the awareness of visitors and local people, we are planning to implement several awareness-raising projects involving the participation of local people. The first target group for this plan involves the teachers and students of the nearby Aksu High School, some non-governmental organizations working in the area, and the staff of the municipality.

Conclusion

To preserve mosaics in situ and make them accessible for future generations in a site with such a vast number of pavements as Perge is a highly difficult and complex issue. However, the mainte-

nance and exposure of mosaics in their original setting is important both for cultural and economic reasons. The preparation of comprehensive but applicable maintenance and display projects seems to be the only way to find a satisfying solution for all parties.
Despite some difficulties about budget and permission processes (not only at the Perge excavations but also at most of the excavations in Turkey), an outstanding level of resources for the maintenance of mosaics is presently being created. This initial project for the maintenance and seasonal and partial exposure of the mosaics in Perge will hopefully form a model for Turkey as the first example of its kind.

Acknowledgement

The author would like to thank Prof. Dr Haluk Abbasoğlu, Director of Perge excavations, for his permission to study the conservation of the mosaics in Perge and his invaluable support during the process. The author would also like to thank Mr Thomas Roby from GCI and Mrs Livia Alberti for their insightful remarks.

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POSTERS

ARCHAEOMETRIC STUDIES ON THE HALEPLIBAHÇE MOSAICS IN TURKEY

Ali Akin Akyol and Yusuf Kagan Kadioglu

Abstract

Şanliurfa (ancient Edessa) is located in the south-eastern part of Anatolia. During an urban infrastructure project in 2006, extraordinary mosaics were discovered by chance in the Haleplibahçe region and the rescue excavations project directed by the Şanliurfa Museum started immediately in 2007. In the years 2008 and 2009 primary and complementary conservation projects were also performed by Ankara University.

During the conservation project of 2009, representative tesserae and related mortars, including the setting bed, the *rudus* and *nucleus* layers of the mortars of the mosaics from ten rooms of the so-called Amazons Villa were collected so as to be characterized.

The samples were first visually examined, photographed and coded. For the analysis, the aggregate and binder parts of the mortars were determined separately. The thin sections of each sample were prepared so that all parts could be examined petrographically under an optical microscope. The elemental composition of the samples was determined using PED-XRF technique. The results of the archaeometric studies showed that the tesserae are mostly made of limestone. The combined elemental and petrographical examination of the mortars also showed that the original binder materials have high hydraulic character and the mortars are mainly a mixture of lime and clay. In general, the aggregate part of the mortars reflects the local rock formation. The brick particles are also observed in the aggregate part of all the layers of the mosaic mortars.

Key Words: Haleplibahçe, mosaics, archaeometry, mortars, tesserae.

Introduction

Şanliurfa (ancient Edessa) is located in the south-eastern part of the Anatolia (Fig. 1). During an urban infrastructure project in 2006, extraordinary mosaics were discovered by chance in the Haleplibahçe region and the rescue excavation project directed by the Şanliurfa Museum started immediately in 2007. In the years 2008 and 2009 primary and complementary conservation projects were also performed by Ankara University. The mosaics from the Amazons Villa of the Haleplibahçe archaeological area (Fig. 2) began to be examined archaeometrically as a preliminary study in 2009. Within these studies on the Haleplibahçe mosaics, a restoration group has been formed by Assoc. Prof. Dr Y. Selçuk Şener from Başkent Vocational School of Ankara University. The mosaic mortar and tesserae samples taken from the mosaics of the Amazons Villa were brought to the Ankara University Başkent Vocational School Material Research and Conservation Laboratory and Ankara University Earth Sciences Research and Application Center and their analysis has begun.

During the restoration activity at the Amazons Villa, 18 mortar samples from different layers (*rudus* and *nucleus*) of the mosaics

Fig. 1. Location of the Haleplibahçe Archaeological Area (Şanliurfa, Turkey).
(Map on left and middle: General Directorate of Highways www.kgm.gov.tr/Sayfalar/KGM/SiteTr/Root/Uzakliklar.aspx; Map on right: Google Earth < www.googleearth.com >)

Fig. 2. Rooms with mosaics in the Amazons Villa in the Haleplibahçe Archaeological Area (Photos: Gazi University, Faculty of Fine Arts, Department of Conservation and Restoration of Cultural Properties Archive – Designed by Selçuk Şener)

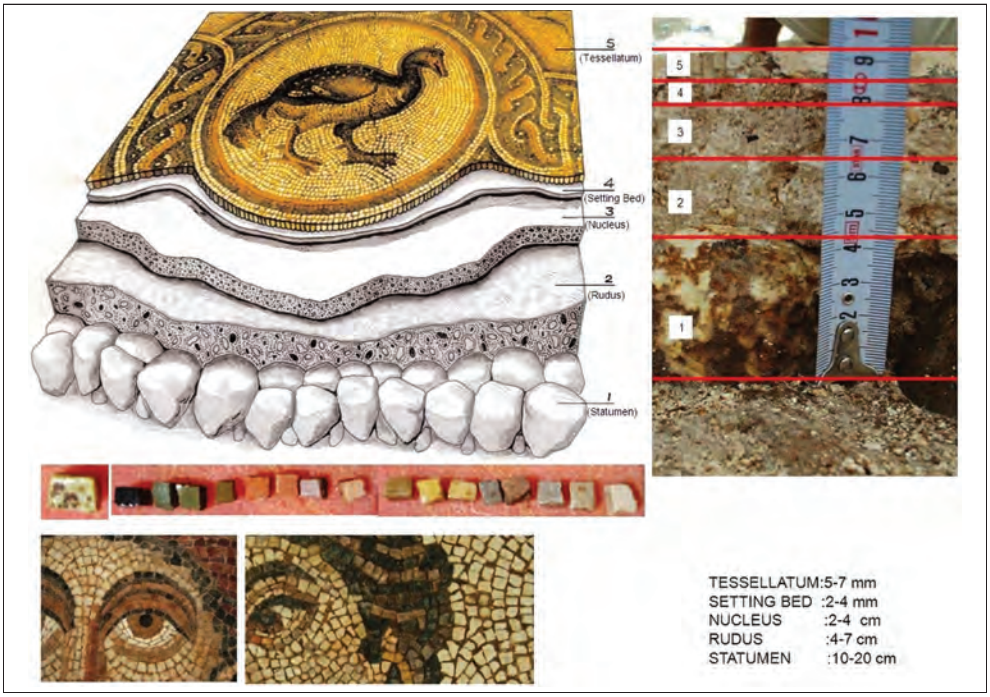

Fig. 3. Description of the mosaics with their layers (Top left photo: *Illustrated Glossary*, 2003, 2; Remaining photos: Gazi University, Faculty of Fine Arts, Department of Conservation and Restoration of Cultural Properties Archive – Designed by Selçuk Şener)

from ten rooms and 24 stone tessera samples of the mosaics from six rooms of the villa were collected to be analysed (Fig. 3-5).

The tessera and mortar samples of the mosaics were first examined visually, and then photographed, documented and coded (Tables 1, 2 and Fig. 3-5). The rock types of the tessera samples were defined petrographically (Table 3 and Fig. 8, 10). Aggregate/binder ratio determination analysis (Fig. 6a, 6c), distribution of aggregate particle analysis (aggregate granulometry) (Fig. 6b, 6b, 7), optical microscopy analysis of thin sections (Tables 3, 4 and Fig. 8-10) and element analysis (PED-XRF) were carried out on mosaic mortar (*nucleus* and *rudus*) samples, (Tables 5, 6). The lime types of the mortars were evaluated by their Cementation Index values (Tables 7a-7c).

Methods and experiments

Such knowledge, about the constructive and decorative materials, can be acquired by archaeometrical studies. Mosaic samples were examined to get their raw material characteristics, mineralogical and chemical compositions, and microstructural properties using various analytical techniques such as aggregate/binder analysis, optical microscopy, and PED-XRF.

In the aggregate/binder analysis, 18 mortar samples (12 of *nucleus* and six of *ru-*

Fig. 4. Tessera samples from the mosaics of the Amazons Villa in Haleplibahçe (Photos: Gazi University, Faculty of Fine Arts, Department of Conservation and Restoration of Cultural Properties, Historical Material Research & Conservation Lab Archive – Ali Akın Akyol)

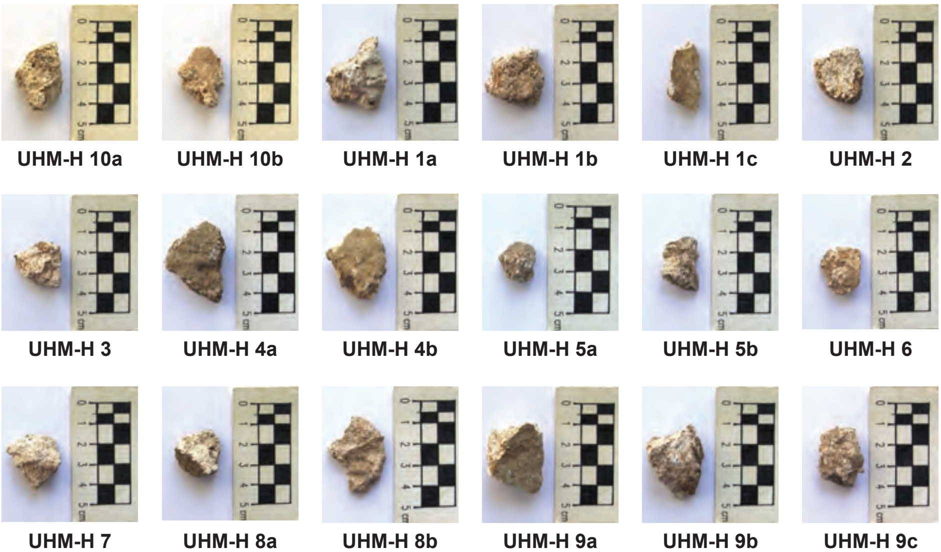

Fig. 5. Mortar samples from the mosaics of the Amazons Villa in Haleplibahçe
(Photos: Gazi University, Faculty of Fine Arts, Department of Conservation and Restoration of Cultural Properties, Historical Material Research & Conservation Lab Archive – Ali Akin Akyol)

dus), coming from ten different rooms of the Haleplibahçe Amazons Villa, were first weighed dry to determine the rates of aggregate and binder parts. Then, dilute acid (%5 HCl) was used on these samples in order to separate them from

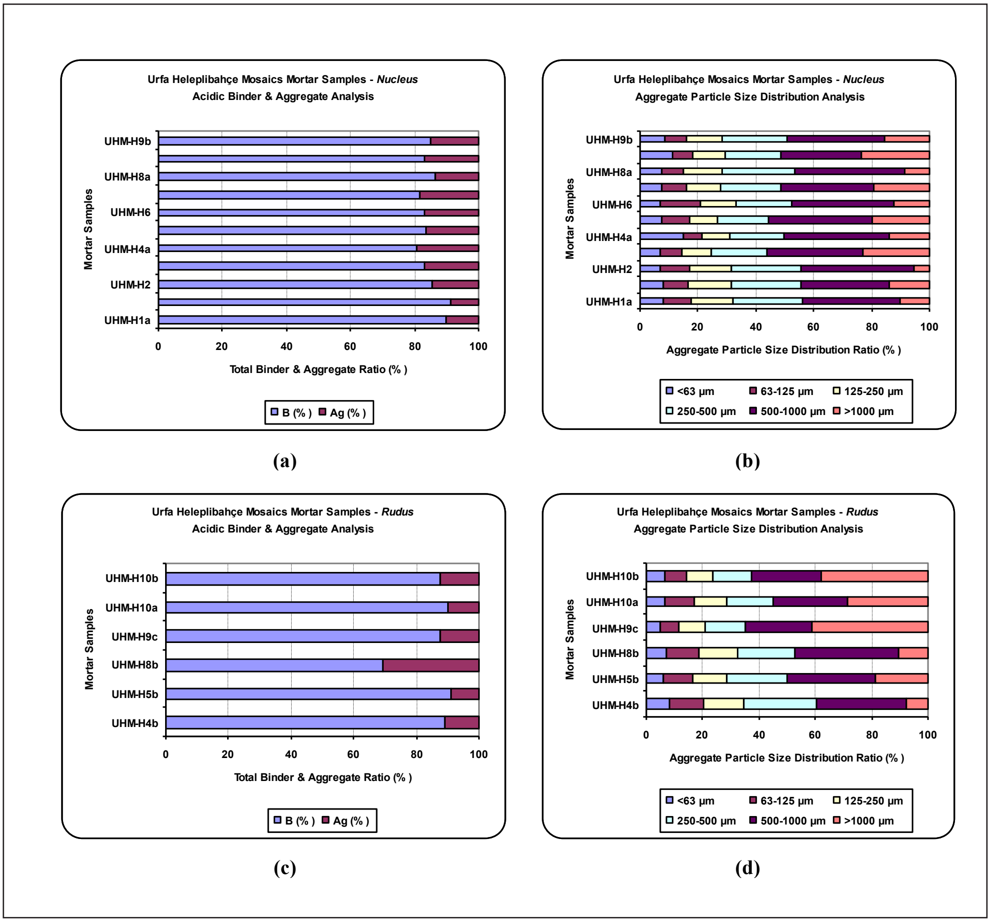

Fig. 6. Acidic aggregate and binder analysis (a,c) and granulometric analysis of aggregate/aggregate particle size distribution (b.d)

their binder contents. The mortar samples were separated from all carbonate content (as binder), and their aggregate parts were taken out after the acidification (by 5% HCl), filtering, washing and drying steps. Then, the samples were dried at room temperature and weighed again so their total binder (dissolved) and aggregate (%w/w) amounts were determined (Fig. 6a, 6c). Systematic filtering was applied on the aggregate parts of the samples (for this purpose sieves between 63-1000 µm were used) and aggregate particle size grain distributions (analysis of aggregate granulometry) were determined separately for each of the *nucleus* and *rudus* layer of the mosaics (Turkish Standard; TS 3530 EN 933-1/April 1999) (Fig. 6b, 6d, 7). Thin sections were prepared for all samples and examined under optical microscope (Tables 3, 4 and Fig. 8-10). Thin sections of rock (tessera) samples were

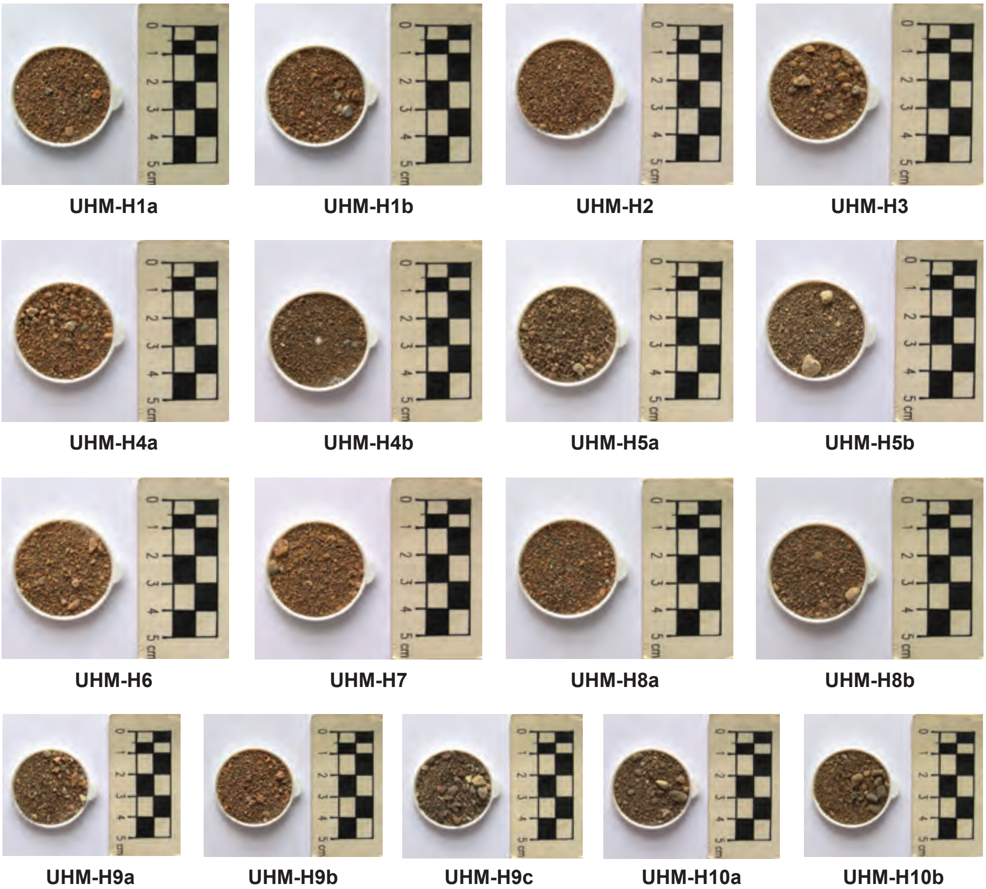

Fig. 7. Aggregates (noncarbonate) of the mortars after acidic agregate and binder analysis (Photos: Gazi University, Faculty of Fine Arts, Department of Conservation and Restoration of Cultural Properties, Historical Material Research & Conservation Lab Archive – Ali Akin Akyol)

prepared directly from the outside to the inside in order to show all the layers, and the thin sections of mortar samples were prepared by hardening with a proper resin. During the thin section observations, a Leica polarizing DMLP Model optical microscope was used. Moreover, photography was carried out using a Leica DFC 280 Digital Camera (by single and cross Nicole imaging) and a Leica Qwin Digital Imaging Program was used for evaluation. Rock and minerals that form the aggregate structure in mortars were determined by using the Pointing Counting Program (Kerr 1977; Rapp 2002).

In addition, the X-Ray Fluorescence Polarized Energy Dispersive analysis method (PED-XRF) was used to determine the elemental compositions of the mortar samples (Tables 5, 6). There are spectroscopic devices in the Petrography Research and Application Laboratories of the Research

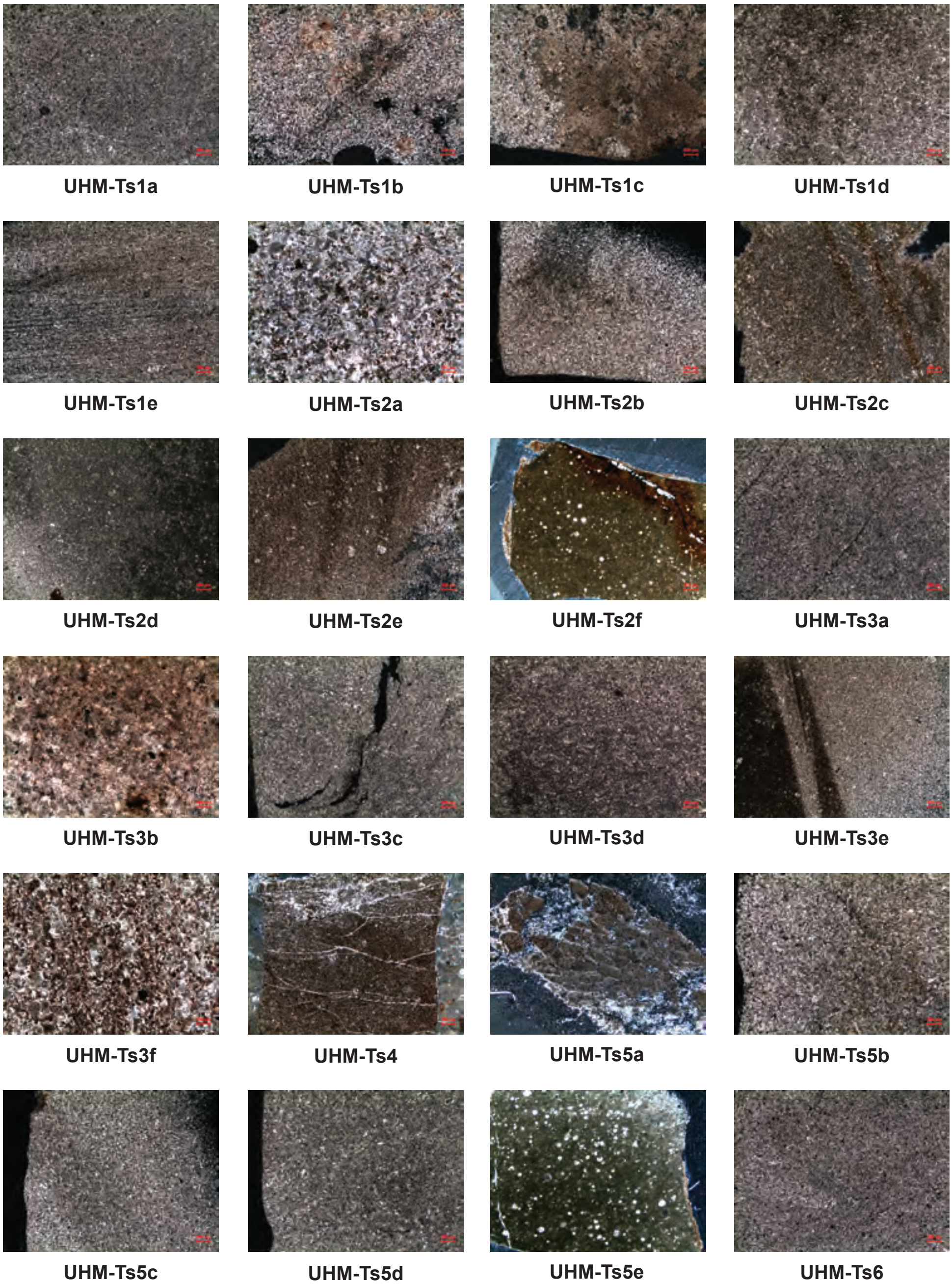

Fig. 8. Microphotographs of the tessera samples by thin section optical microscopy (Photos: Gazi University, Faculty of Fine Arts, Department of Conservation and Restoration of Cultural Properties, Historical Material Research & Conservation Lab Archive – Ali Akin Akyol)

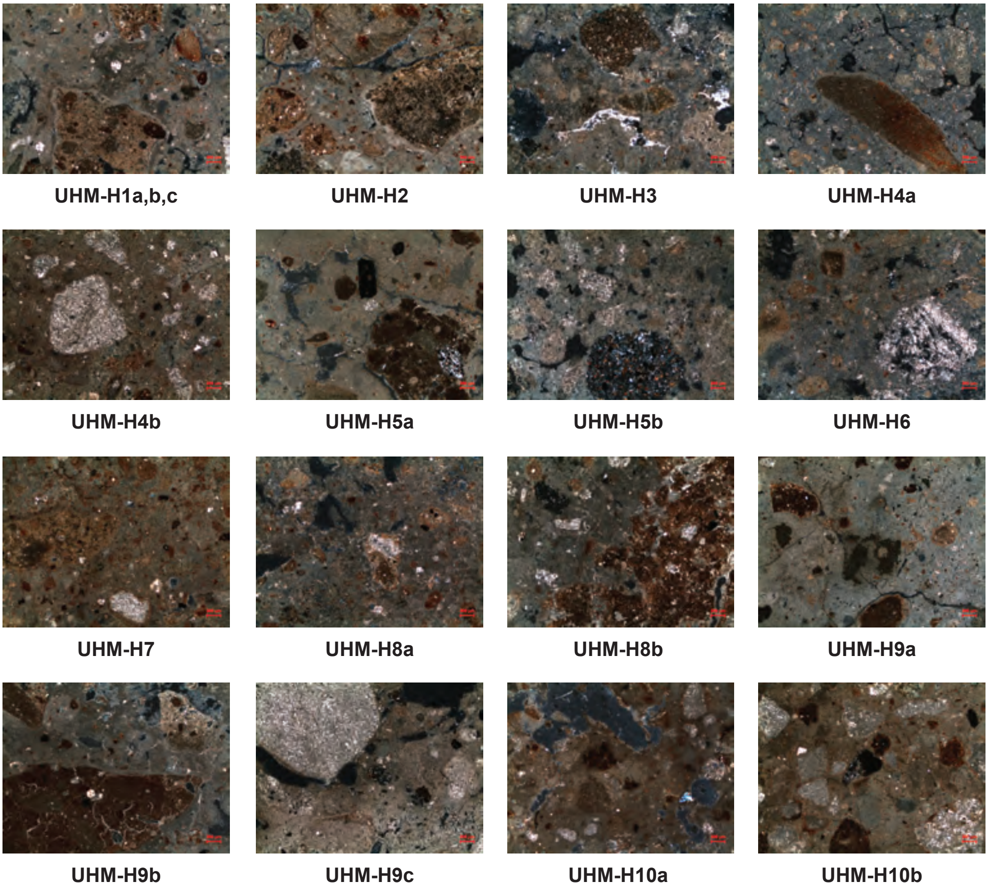

Fig. 9. Microphotographs of the mortar samples by thin section optical microscopy (Photos: Gazi University, Faculty of Fine Arts, Department of Conservation and Restoration of Cultural Properties, Historical Material Research & Conservation Lab Archive – Ali Akin Akyol)

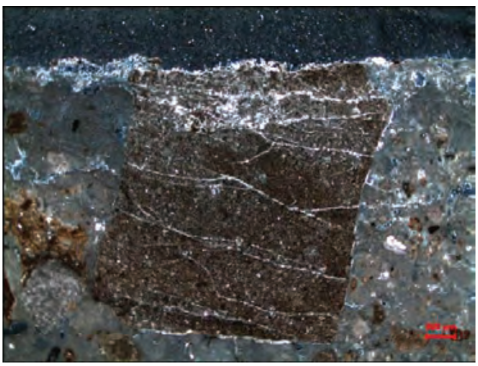

Fig. 10. Microphotographs of the tessera samples in the lime mortar of setting bed (Photos: Gazi University, Faculty of Fine Arts, Department of Conservation and Restoration of Cultural Properties, Historical Material Research & Conservation Lab Archive – Ali Akin Akyol)

Samples	Locations (Colours)
UHM-Ts1a	Tesserae from Room 1 (White)
UHM-Ts1b	Tesserae from Room 1 (Red)
UHM-Ts1c	Tesserae from Room 1 (Yellow)
UHM-Ts1d	Tesserae from Room 1 (Grey)
UHM-Ts1e	Tesserae from Room 1 (Black)
UHM-Ts2a	Tesserae from Room 2 (White)
UHM-Ts2b	Tesserae from Room 2 (Red)
UHM-Ts2c	Tesserae from Room 2 (Yellow)
UHM-Ts2d	Tesserae from Room 2 (Grey)
UHM-Ts2e	Tesserae from Room 2 (Black)
UHM-Ts2f	Tesserae from Room 2 (Green)
UHM-Ts3a	Tesserae from Room 3 (White)
UHM-Ts3b	Tesserae from Room 3 (Red)
UHM-Ts3c	Tesserae from Room 3 (Yellow)
UHM-Ts3d	Tesserae from Room 3 (Grey)
UHM-Ts3e	Tesserae from Room 3 (Black)
UHM-Ts3f	Tesserae from Room 3 (Claret Red)
UHM-Ts4	Tesserae from Room 11 (Yellow)
UHM-Ts5a	Tesserae from Room 12 (Red)
UHM-Ts5b	Tesserae from Room 12 (Yellow)
UHM-Ts5c	Tesserae from Room 12 (Grey)
UHM-Ts5d	Tesserae from Room 12 (Black)
UHM-Ts5e	Tesserae from Room 12 (Green)
UHM-Ts6	Tesserae from Room 13 (Yellow)

Table 1. Location and colour descriptions of tessera samples at Amazons Villa in Haleplibahçe

and Application Center of Earth Sciences (YEBIM), which is directed by the Archaeometry group of Ankara University. These devices are used for archaeometric research on materials used in historical properties. Moreover, these devices are used in order to define the minerals and rocks, to identify the geochemistry of the rocks, and the mineral chemistry. For the analysis, a SPECTRO X-Lab 2000 model PED-XRF Spectrometer was used. This spectrometer has the speciality to analyse the elements from sodium (Na), whose atomic number is 11, to uranium (U) with atomic number 92. Besides, this device has a sensitive limit and this allows it to measure the heavy elements down to 0.5 ppm and the light elements to 10 ppm. Approximately three grams of pulverized sample pellets were prepared and analysed in its original sample holder (Pollard and Heron 1996).

Samples	Locations (Mortar Type)
UHM-H1a	Mosaic Mortar from Room 1 (*Nucleus* – Top)
UHM-H1b	Mosaic Mortar from Room 2 (*Nucleus* – Middle)
UHM-H1c	Mosaic Mortar from Room 3 (*Nucleus* – Bottom)
UHM-H2	Mosaic Mortar from Room 2 (*Nucleus*)
UHM-H3	Mosaic Mortar from Room 3 (*Nucleus*)
UHM-H4a	Mosaic Mortar from Room 5 (*Nucleus*)
UHM-H4b	Mosaic Mortar from Room 5 (*Rudus*)
UHM-H5a	Mosaic Mortar from Room 8 (*Nucleus*)
UHM-H5b	Mosaic Mortar from Room 8 (*Rudus*)
UHM-H6	Mosaic Mortar from Room 9 (*Nucleus*)
UHM-H7	Mosaic Mortar from Room 10 (*Nucleus*)
UHM-H8a	Mosaic Mortar from Room 11 (*Nucleus*)
UHM-H8b	Mosaic Mortar from Room 11 (*Rudus*)
UHM-H9a	Mosaic Mortar from Room 12 (*Nucleus* – Top)
UHM-H9b	Mosaic Mortar from Room 12 (*Nucleus* – Bottom)
UHM-H9c	Mosaic Mortar from Room 12 (*Rudus*)
UHM-H10a	Mosaic Mortar from Room 13 (*Rudus* – Top)
UHM-H10b	Mosaic Mortar from Room 13 (*Rudus* – Bottom)

Table 2. Location and layer descriptions of mortar samples at Amazons Villa in Haleplibahçe

Results and discussion

The rock type of stone tessera samples of the Haleplibahçe Amazons Villa was determined petrographically (Table 3 and Fig. 8, 10). Aggregate/binder ratio determination analysis, the aggregate particle size distribution analysis (aggregate granulometry), thin sections optical microscopy analysis and elemental analysis (PED-XRF) were applied on the samples of mosaic mortar (*nucleus* and *rudus* layers) separately (Tables 4-6, Fig. 6, 7, 9, 10). The results of the archaeometrical studies carried out on the tessera and mortar samples are shown below.

According to the results of thin section optical microscopy analysis, one of these 24 tessera samples was defined as clay-stone (UHM-Ts5a; hardness in Mohs 2.5-3) and the remaining samples were related to two different types of limestones: sparitic and pelagic limestone (Table 3 and Fig. 8). In terms of their mineral contents and phases, different coloured limestone tessera samples (white, grey, black, yellow, green, red, claret red) could be assembled into sub-groups (Table 3). Pelagic limestones were composed of three groups; one which underwent hydrothermal alteration (under pressurized conditions with hot water) and contained iron hydroxide minerals (such as limonite); one with clay/carbonate; and another, which had a more fine-grained matrix structure (hardness 3-4 in Mohs). Similarly, sparitic limestones consisted of

Tessera Rock Groups	Tessera Rock Types	Hardness (Mohs)	Descriptions
Rock Gr1*	Clay Stone	2.5 – 3.0	Clayey matrix
Rock Gr2a	Pelagic Limestone	3.0	Hydrothermal alterations in iron oxide matrix, calcite, limonite and opaque minerals
Rock Gr2b	Pelagic Limestone	3.0 – 3.5	Clay/Carbonate matrix, fossils (radiolaria)
Rock Gr2c	Pelagic Limestone	3.5 – 4.0	Quartz accumulation in micro cracks
Rock Gr3a	Sparitic Limestone	3.0	Calcite matrix
Rock Gr3b	Sparitic Limestone	3.0	Mainly calcite and opaque minerals in the matrix

(*) Groupping of Tessera Samples;
Rock Gr1 : UHM-Ts5a
Rock Gr2a: UHM-Ts2a
Rock Gr2b: UHM-Ts2d, UHM-Ts2e, UHM-Ts3b, UHM-Ts3f
Rock Gr2c: UHM-Ts2f, UHM-Ts5e
Rock Gr3a: UHM-Ts4, UHM-Ts8a
Rock Gr3b: UHM-Ts1a, UHM-Ts1b, UHM-Ts1c, UHM-Ts1d, UHM-Ts1e, UHM-Ts2b, UHM-Ts2c, UHM-Ts3a, UHM-Ts3c, UHM-Ts3d, UHM-Ts3e, UHM-Ts5b, UHM-Ts5c, UHM-Ts5d, UHM-Ts6

Table 3. Thin section optical microscopy determination of the tessera rock types and their petrographical properties

two groups which basically contained a thin and coarse calcite matrix (hardness 3 in Mohs) and whose micro fractures/cracks were filled with fine quartz crystals (Fig. 8). The rock types of all tessera samples reflected the local limestone rock formation.

The aggregate and binder contents of the mosaic layer samples of the Amazons Villa were determined. It is not possible to learn the aggregate and binder rates of mortars by using only acidic aggregate/binder analysis, because all materials with carbonate content dissolve during the acidic analysis. Therefore, all materials with carbonate content, which were dissolved by acid at the end of the process, were declared as “binders” and the remaining undissolved part was named as “aggregate”. The aggregate/binder ratios of aggregates revealed by the acidic process were calculated by using the following formula;

% Aggregate = [(Ms – Mag)/Ms] × 100
% Binder (dissolved) = 100 – % Aggregate
Ms: Sample weight
Mag: Aggregate weight

When the results of this acidic analysis on *nucleus* and *rudus* mortar samples were evaluated, it was determined that the total content of the *nucleus* layers would change from 8.75% to 19.26% (average 15.14%), and this rate could be between 8.77% and 30.78% (average 14.18%) for the *rudus* layers. It was also seen that, according to average values, the total aggregate/binder rates were similar for the *nucleus* and *rudus* layers (Fig. 6a, 6c).

When the distribution of aggregate particle in mosaic mortar samples from different rooms in the Amazons Villa was considered, the results showed that the coarse-sized aggregate (>1 mm) rate in the *nucleus* was between 5.32% and

Mortar Groups	Bn (%)	Ag (%)	Matrix Binder Composition (%)				Matrix Aggregate Composition (%)		
			L	MP	Cm	Clay	Rocks & Minerals*	BP	Org
Mortar Gr1**	77	23	65	-	-	35	65 (Ls,Ch,Op)	35	-
Mortar Gr2	85	15	25	-	-	75	85 (R,Ch,Op)	15	-
Mortar Gr3	82	18	95	-	-	5	92 (Q,Ch,O,B,S)	8	-
Mortar Gr4	75	25	85	15	-	-	90 (Ls,Q,B,Op)	10	-
Mortar Gr5***	79	21	100	-	-	-	94,5 (C,Op,S)	5,5	-

(*) **Ag:** Aggregate, **BP:** Brick Particles, **C:** Calcite, **Ch:** Chert, **Cm:** Cement, **B:** Basalt, **Bn:** Binder, **Ls:** Limestone, **L:** Lime, **MP:** Marble Powder, **O:** Olivine, **Op:** Opaque Minerals, **Org:** Organic Particles, **Q:** Quartz, **R:** Radiolarite, **S:** Serpantinite

(**) Groupping of *Nucleus* Layer Mortar Samples;
Mortar Gr1: UHM-H1a, UHM-H1b, UHM-H1c, UHM-H2, UHM-H3, UHM-H4a, UHM-H6 and UHM-H9a
Mortar Gr2: UHM-H9b
Mortar Gr4: UHM-H5a, UHM-H7, UHM-H8a

Groupping of *Rudus* Layer Mortar Samples;
Mortar Gr1: UHM-H8b
Mortar Gr3: UHM-H4b, UHM-H5b, UHM-H9c
Mortar Gr4: UHM-H10a, UHM-H10b
(***) Mortar – Setting Bed Layer around UHM-Ts4

Table 4. Thin section optical microscopy determination of the mortars and their petrographical agregate and binder properties

23.61% (average 15.01%); and the rate in the *rudus* could vary between 7.87% and 41.04% (average 24.11%). Also, the rate of clay/silt-sized grains (<63 μm) was measured and according to the results, this rate in the *nucleus* layer was between 6.79% and 15.04% (average 8.64%) and in the *rudus* it could vary from 4.68% to 8,21% (average 6.51%). Silt/sand-sized grains (63-1000 μm) completed the structure in mortars (Fig. 6b and 6d).
After the aggregate particle size distribution analysis, it was seen that the *rudus* samples contained larger-sized grains in aggregate (>1000 μm). However, it was observed that the aggregates in the *nucleus* were formed mainly with the grain sized between 500 and 1000 μm. The mortars that were examined after the results of the aggregate particle size distribution analysis were evaluated by taking into account the Wentworth aggregate particle size classification (Wentworth 1922). According to this classification, it was determined that eleven samples of the *nucleus*, except for one, UHM-H9a, contained coarse sand-sized aggregates (500-1000 μm). The aggregate structure of UHM-H9a samples, which had different structure from other samples, was formed by very coarse sand-sized particles (>1000 μm). When six *rudus* samples were analysed in terms of their aggregate structure, it was understood that three of these samples (UHM-H4b,

Element	UHM-H4a	UHM-H5a	UHM-H8a	UHM-H9a	UHM-H9b	Ave.**
Na_2O	0,079	0,079	0,078	0,210	0,080	0,079
MgO	0,166	0,403	0,476	0,591	0,414	0,365
Al_2O_3	1,741	2,573	2,466	4,825	2,947	2,432
SiO_2	17,74	20,69	21,46	30,47	22,40	20,57
P_2O_5	0,177	0,204	0,207	0,524	0,180	0,192
SO_3	0,129	0,191	0,207	0,395	0,279	0,201
Cl	0,029	0,081	0,017	0,077	0,082	0,052
K_2O	0,241	0,461	0,382	0,686	0,418	0,375
CaO	54,19	48,47	48,80	24,00	46,24	49,43
TiO_2	0,140	0,238	0,194	0,327	0,217	0,197
Cr_2O_3	0,009	0,013	0,012	0,001	0,009	0,011
MnO	0,033	0,040	0,039	0,001	0,038	0,038
Fe_2O_3	1,125	1,830	1,607	0,438	1,789	1,588
LOI*	24,70	24,77	24,87	37,93	24,7	24,76

(*) LOI: Loss on Ignition at 950°C, (**) average except UHM-H9a

Table 5. The results of PED-XRF analysis of *nucleus* mortar samples

Element	UHM-H4b	UHM-H5b	UHM-H8b	UHM-H9c	UHM-H10a	UHM-H10b	Ave.
Na_2O	0,078	0,079	0,076	0,076	0,082	0,080	0,079
MgO	0,160	0,623	0,800	0,265	0,239	0,139	0,371
Al_2O_3	1,933	3,291	4,323	2,235	2,188	2,156	2,688
SiO_2	18,45	24,39	27,13	19,47	19,22	17,87	21,09
P_2O_5	0,149	0,252	0,334	0,223	0,129	0,127	0,202
SO_3	0,096	0,475	0,453	0,115	0,327	0,241	0,284
Cl	0,024	0,077	0,022	0,029	0,024	0,022	0,033
K_2O	0,434	0,610	0,617	0,330	0,307	0,356	0,442
CaO	50,83	43,72	43,34	47,01	48,38	50,11	47,23
TiO_2	0,206	0,299	0,318	0,194	0,215	0,242	0,246
Cr_2O_3	0,011	0,015	0,019	0,012	0,013	0,013	0,014
MnO	0,028	0,057	0,049	0,029	0,031	0,032	0,038
Fe_2O_3	1,479	2,600	2,510	1,589	1,589	1,850	1,936
LOI*	26,74	23,88	20,73	28,64	27,85	26,99	25,81

Table 6. The results of PED-XRF analysis of *rudus* mortar samples

Mortar Lime Type	Notations	Cementation Index Value
Fat Lime	FL	Close to zero
Weakly Hydraulic Lime	WHL	0.30–0.50
Moderately Hydraulic Lime	MHL	0.51–0.70
Eminently Hydraulic Lime	EHL	0.71–1.10
Cement/Natural Cements	C/NC	1.11–1.70
Cement	C	1.70 <

Table 7a. Cementation index value and the lime type of the mortars

Nucleus Mortar Samples	CI	Lime Type
UHM-H4a	0.97	EHK
UHM-H5a	1.28	C/NC
UHM-H8a	1.30	C/NC
UHM-H9a	3.67	C
UHM-H9b	1.45	C/NC
Nucleus Ave.	1.73	C

Table 7b. Cementation index value and lime type of the *nucleus* mortars

Rudus Mortar Samples	CI	Lime Type
UHM-H4b	1.08	EHL
UHM-H5b	1.67	C/NC
UHM-H8b	1.87	C
UHM-H9c	1.24	C/NC
UHM-H10a	1.19	C/NC
UHM-H10b	1.08	EHL
Rudus Ave.	1.35	C/NC

Table 7c. Cementation index value and lime type of the *rudus* mortars

UHM-H5b and UHM-H8b) were coarse sand-sized like in the *nucleus*; two of them (UHM-H9c and UHM-H10b) were very coarse sand-sized and one (UHM-H10a) had both coarse and very coarse sand-sized particles (Fig. 6b, 6d).

The thin sections of the mortar samples were examined petrographically under an optical microscope and these samples were classified into five different mortar groups according to their binder/aggregate types, their aggregate distributions in the matrix and their alteration/decomposition properties (Table 4 and Fig. 9). The *nucleus* and *rudus* samples were assembled into three groups; two of which were similar (Mortar Gr1 and Mortar Gr4) and one (Mortar Gr2 and Mortar Gr3) was different. For 13 mortar samples, the binding contents were formed by different rates of lime/clay (Mortar Gr1, Mortar Gr2 and Mortar Gr3) and for five of them it was formed by lime/limestone/marble powder (Mortar Gr4). The setting-bed mortar of UHM-Ts4 tessera sample was discovered by chance (Fig. 10). The setting-bed mortar, determined during thin section analysis (and not coded as a different sample), contained solely lime mortar (as Mortar Gr5) differently from other examples (Table 4 and Fig. 9). Limestone, basalt, radiolarite and serpentine rock fragments and calcite, chert, quartz, olivine and opaque minerals constituted the aggregate form of mortars (Table 4 and Fig. 9). In addition, to increase the strength, brick particles were added to mortars at rate charges between 5.5% and 35% of total aggregate (Table 4 and Fig. 9, 10).

The chemical compositions of the mosaic mortar samples were determined by PED-XRF analysis. Also, through this analysis, major (>1%), and trace element (<%1) combinations of the mosaic mortar layers were defined (Tables 5, 6). The basic elements of the mosaic mortar layer samples in their chemical combinations are as follows: for the *nucleus*, calcium (CaO) at a rate ranging from 24.00% to 54.19% (average 44.34%); silicon (SiO_2) from 17,74% to 30,47% (average 22.55%); aluminium (Al_2O_3) from 1.74% to 4,83% (average 2.91%) and iron (Fe_2O_3) from 0.44% to 1,83% (average 1.36%). Also, for the *rudus* samples, calcium (CaO) from 43.34% to 50.83% (average 47.23%); silicon (SiO_2) from 17.87% to 27.13% (average 21.09%), aluminium (Al_2O_3) from 1.93% to 4.32% (average 2.69%) and iron (Fe_2O_3) from 1.48% to 2.60% (average 1.94%). The *nucleus* and the *rudus* samples both had a homogeneous elemental structure among their own groups. The UHM-H9a sample among the *nucleus* mortars was noteworthy not only among its own group, but also among all mortar sample groups with its own different elemental structure. In this sample, there was less calcium (24.00%), but more silicon (30.47%) (Table 5) when compared with other samples. The different content of this sample could be seen in the trace element composition too. As we saw already, on the mortar samples the calcium rate of the *nucleus* mortars (without UHM-H9a sample) was higher than the *rudus* ones and at the same time, the silicon rate was lower on mortar samples (Table 6).

The lime type and compositional properties of the analysed mortars were evaluated with the cementation index (CI) data:

$$CI = \frac{[2.8\,(SiO2\%) + 1.1\,(Al2O3\%) + 0.7\,(Fe2O3\%)]}{[(CaO\%) + 1.4\,(MgO\%)]}$$

The cementation index on hydraulic lime mortars is expressed with the rate of the soluble part in acid to the soluble part in base (Boynton 1980; Holmes and Wingate 1997; Akyol and Kadioglu 2008). The mortars containing lime can be separated into two groups: as fat lime mortar (FL) and hydraulic lime mortar (WHL, MHL and EHL) in terms of their aggregate content and type (Table 7a). Fat lime mortars that have less than 5% of total aggregate content are the mortars with a high rate of lime, namely CaO. Moreover, the mortars that have over 5% of total aggregate content are the ones with a hydrolytic feature. The rate of aluminium (Al_2O_3), silicon (SiO_2) and iron (Fe_2O_3) is high in this type of mortar combinations. The CI values of mosaic mortars, whose elemental composition was determined with XRF analysis, are shown on Table 7b and 7c.

It was seen that the mortar samples generally had quite a high level of CI values (clay/sand aggregate with natural cement property is dense in content). The UHM-H4a samples of *nucleus* mortars and the UHM-H4b samples of *rudus* mortars and the UHM-H10b samples are lime mortars with hydraulic property; other samples with their high silicon, aluminium and iron contents are the mortars at natural cement structure and have high strength (Fig. 7b, 7c).

Conclusions

In this study, the Amazons Villa mosaics in the archaeological area of Haleplibahçe in the city of Şanlıurfa were discussed archaeometrically. As a preliminary study, archaeometric researches were done on a small-scale, sample group; tessera and mosaic mortar layers were analysed using different types of analytical methods, the data about them were evaluated. The results of the archaeometric studies showed that the stone tesserae are mainly limestone. The combined elemental and petrographical examination of the mortars also showed that the original binder material giving the high hydraulic character of the mortars is mainly lime and a mixture of lime and clay. In general, the aggregate parts of the mortars reflect the local rock formation. The brick particles are also observed in the aggregate part of all the layers of the mosaic mortars in order to regulate the humidity in the matrix. Thus, all mosaic materials in the Haleplibahçe Amazons Villa were described, and an archaeometrical approach was presented, which would support the restoration works planned to be carried out later.

Archaeometric studies with their interdisciplinary properties can provide important contributions to many steps such as conservation of historical areas and buildings, doing necessary restorations and transmitting them to the future in the right conditions. To make the material research works in Haleplibahçe more efficient, for later stages of work, archaeometrical studies will be increased proportionally to the number and type of materials and this will accelerate the conservation process.

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SUITABLE RESTORATION MORTARS FOR THE CONSERVATION OF MOSAICS IN ARCHAEOLOGICAL SITES

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Abstract

The decay of mosaics in archaeological sites depends on different causes (physical, chemical and mechanical), however, an important role in the conservation of mosaics is related to the composition and structure of the mortars in which the tesserae are embedded. These mortars, in fact, may contribute to the release and transport of soluble salts, transport of water and detachment of the tesserae themselves.

In this project, related to problems of conservation of mosaics at the archaeological site of Villa Romana delle Paduline, 1st-2nd century BC (Castiglione della Pescaia, Grosseto, Italy), three different repair mortars for embedding tesserae were prepared and their performances tested. In particular, the behaviour of these mortars during their preparation, hardening and artificial ageing has been checked. The colour changes of the mortars during hardening and ageing (determined by a chromatic test), the water vapour permeability, the cohesion properties (by the Drilling Resistance Measurement System) and the durability to artificial ageing (thermo-hygrometric changes in the presence of water or salt solution uptake) were determined.

Introduction

An important role in the conservation of mosaics in archaeological sites is played by the decay of the mortars, particularly those into which the tesserae are embedded. The decay of mortars may depend on their composition and structure, humidity changes, capillary rise, biological growth, type of substrate, etc. (Pecchioni *et al.* 2008).

The present project shows a methodological approach in the selection of suitable restoration mortars to be used as substitution and integration of original mortars. In particular, this research focuses on the identification of repair mortars for the archaeological site of the Roman Villa delle Paduline (1st-2nd century BC) in Castiglione della Pescaia (Grosseto, Italy) (Fig. 1). This is a part of a wider archaeological site that was inhabited between the 3rd century BC and the 4th century AD. The Roman Villa delle Paduline, dating back to the period of transition between the Republican and Imperial age, was a luxury residence with decorative mosaics, frescoes and thermal buildings. It is located in a slightly elevated position with respect to the right bank of the Bruna River, near the ancient port-channel structure, and is subjected to continuous exposure to decay agents. In the 1960s, 70s and late 80s, some interventions were carried out in the archaeological area in order to save mosaics and structures. In particular, repair mortars were applied along the outer edges of the

Fig. 1. The archaeological site of the Roman Villa delle Paduline at Castiglione della Pescaia (Grosseto, Italy) (1st-2nd century BC) (Photo: Pasquino Pallecchi)

mosaics in order to fix the tesserae in their original position (Fig. 2). After more than 20 years since the second intervention, the state of conservation of the mortars (original and restoration) seems good in some cases, while in others it is rather precarious. The reasons are the capillary rise of more or less salty water, the bulging of the substrate made of sandy clay, and the biological growth (Fig. 3a, 3b, 3c).The main goal of this work was the formulation of

Fig. 2. The interventions carried out in the past (20th century) (Photo: Pasquino Pallecchi)

Fig. 3a, b, c. The different decay phenomena observed in the mosaic of the archaeological site (Photos: Mara Camaiti)

new repair mortars for the mosaic to be used for the replacement of the original and old repair mortars. To achieve this, the original mortars and the traditional repair mortars used in the past interventions were studied. It was decided to prepare new mortars with the same basic composition of the original ones and to study the influence of some organic compounds added to this basic mixture. The physical and mechanical parameters (i.e. resistance to drilling, water permeability) of these new mortars and their behaviour during accelerated ageing have been investigated. The accelerated ageing consisted in subjecting the mortar samples (kept in fresh water/salty solution capillarity uptake – see below) to thermo-hygrometric cycles. This procedure was adopted in order to evaluate the stability and durability of the mortars in conditions similar to those affecting the mosaic of Villa delle Paduline.

Materials and methods

The original mortar (MO) in which the tesserae are embedded was studied under optical microscopy at different magnification, using an AxioScope A.1 Zeiss polarized microscope equipped with a high resolution camera, in order to evaluate the composition of the binder and the aggregate, and their ratio.

Repair mortars were prepared by adding two synthetic organic compounds: Acryl 33 (acrylic resin) and Peoval 33 (polyversatic ester-*co*-vinyl acetate) to a mortar similar to the original one. These hydrophobic products were added to MO in order to reduce the water uptake and to increase the “elasticity”. The composition of the mortars is shown on Table 1. The three types of mortar (MO, MO + Acryl 33, MO + Peoval 33) were cured for 16 months at room conditions.

Taking into account that the main problems of decay in the archaeological site of the Vil-

MO	MO Ac	Mo Pe
Tot. 100 g	MO + 3 % Acryl 33 in water	MO + 3 % Peoval in water
Binder/aggregate = 1/1	(dry residue 46 %)	(dry residue 42 %)
Lime 50 g	6.72 g	7.36 g
Aggregate:		
– 70 % *cocciopesto* 0 µm < Ø < 100 µm 35 g		
– 30 % sand 100 µm < Ø < 160 µm 15 g		

Table 1. Composition of prepared mortars.

la delle Paludine are caused by capillary rise of more or less salty water, the mortar samples were aged in two different ways:

– maintaining them in fresh water capillary uptake;
– maintaining them in salty water (NaCl – 3.5 g/L) capillary uptake.

During fresh and salty water uptake, the samples were subjected to 50 cycles of artificial ageing. The thermo-hygrometric conditions of each cycle are reported in the Fig. 4.

The following tests were performed on the mortar samples, before and after ageing:

- cohesion properties (determined by the Drilling Resistance Measurement System: Tiano *et al.* 2000) with the following operative conditions: drilling bit type Fisher SDD, diameter 5 mm, speed rotation 200 rpm, penetration rate 40 mm/min, penetration depth 10 mm;
– water vapour permeability realized according to NORMAL 21/85: 1986;

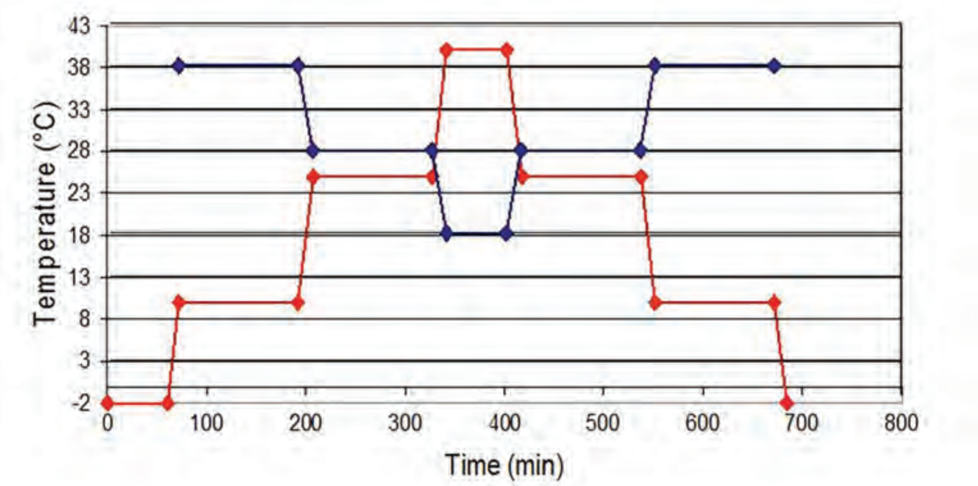


Fig. 4. Thermo-hygrometric changes corresponding to one cycle (Mara Camaiti, Emma Cantisani, Fabio Fratini)

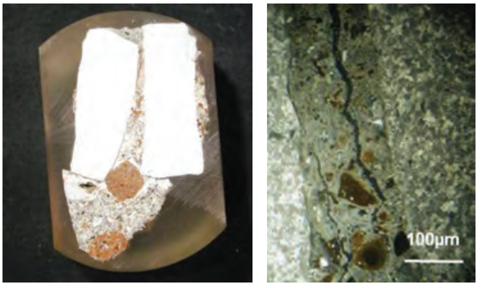


Fig. 5a. Cross section of the mortar lying under and between two limestone tesserae.
Fig. 5b. Image of the same mortar in thin section (XPL) (Photo: Mara Camaiti, Emma Cantisani, Fabio Fratini)

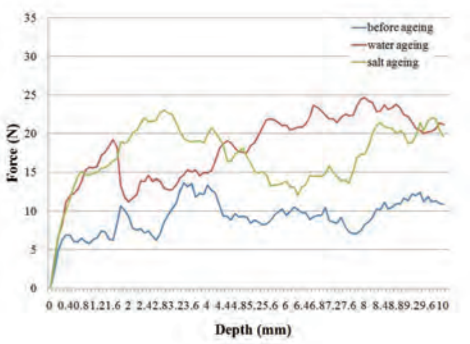
– colour changes (determined by chromatic tests and expressed as ΔL^*, Δa^*, $\Delta b^*$and $\Delta E^* = (\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2})^{1/2}$ in accordance to NORMAL UNI EN 15886: 2010.

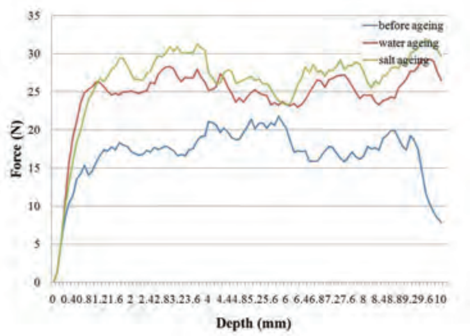
RESULTS AND DISCUSSION

The minero-petrographic observation carried out under optical microscope revealed that the original mortar used under and between the mosaic tesserae was made using an air hardening lime binder mixed with fine grained *cocciopesto* and some occasional quartz. The ratio binder/ aggregate is about 1:1 (Fig. 5a and 5b).
On the basis of this result, samples of mortar with this basic formulation and added Acryl 33 and Peoval 33 have been prepared and after a cure of 16 months, assuming a complete carbonation, the samples have been subjected to the ageing tests. The mechanical properties of the MO samples and MO with added Acryl 33 and Peoval 33 are shown on Table 2. It is clear that the addition of synthetic organic products determines, before ageing, an increase of the drilling resistance, and Peoval 33, in particular, gives higher hardness than the acrylic resin. After ageing (50 cycles), an increase of the drilling resistance can be observed, mainly for the mortar samples without additive. This can be due to the complete carbonation of lime, favoured by ageing in the presence of water, or to some processes of dissolution and re-precipitation of the carbonatic binder during the ageing test. This behaviour is partly displayed by the results obtained from the mortar treated with Acryl 33 (MO Ac) and Peoval 33 (MO Pe) resins, in which we can observe a lower increase of drilling resistance with respect to the values reached for the mortar without additive. These resins are normally used by restorers as waterproofing agents, in order to prevent or reduce the water absorption in natural or artificial materials. This waterproofing effect reduces the amount of water in the mortars and, consequently, leads to a lower carbonation rate or fewer dissolution/precipitation phenomena.

SAMPLE	BEFORE AGEING	SALT AGEING	WATER AGEING
Original mortar (MO)	9.45 N	17.62 N	18.27 N
MO with acrylic resin	17.44 N	27.49 N	25.53 N
MO with Peoval resin	29.22 N	33.30 N	36.09 N

Table 2. Drilling resistance of mortars before (after 16 months at room conditions) and after 50 cycles of ageing with salt and water uptake





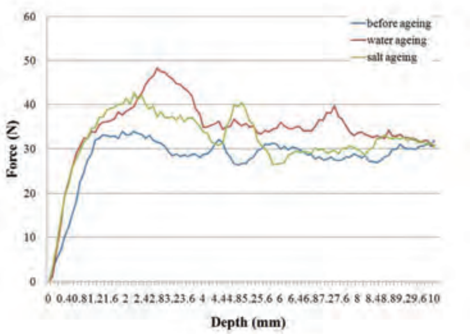
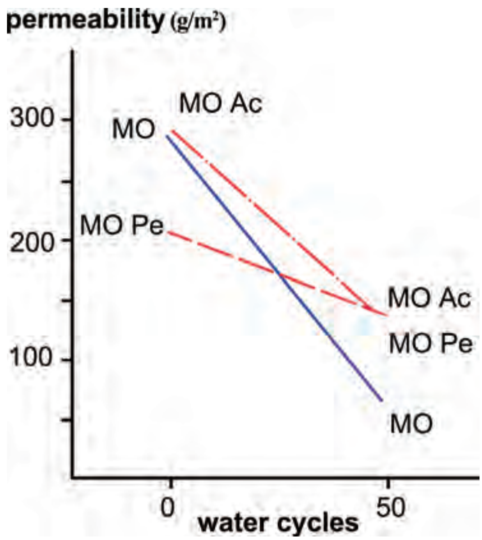


Fig. 6a. Original mortar (MO): drilling profile before and after ageing with water and salt uptake (Photo: Mara Camaiti, Emma Cantisani, Fabio Fratini)
Fig. 6b. Original mortar with Acryl 33 (MO Ac): drilling profile before and after ageing with water and salt uptake (Mara Camaiti, Emma Cantisani, Fabio Fratini)
Fig. 6c. Original mortar with Peoval 33 (MO Pe): drilling profile before and after ageing with water and salt uptake (Mara Camaiti, Emma Cantisani, Fabio Fratini)



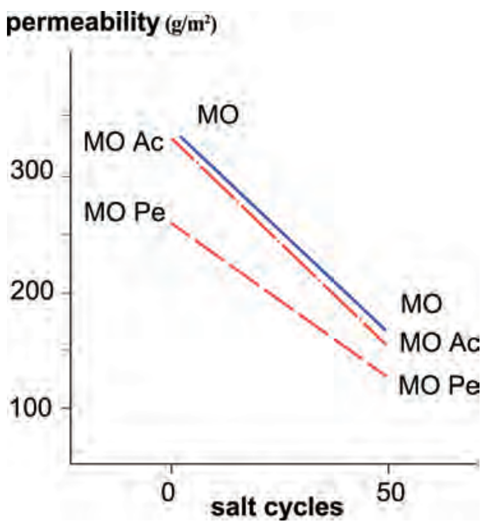


Fig. 7a. Water permeability of the mortars before and after 50 cycles of ageing with water uptake (Mara Camaiti, Emma Cantisani, Fabio Fratini).
Fig. 7b. Water permeability of the mortars before and after 50 cycles of ageing with salt uptake (Mara Camaiti, Emma Cantisani, Fabio Fratini)

	Ageing with salts				Ageing with water			
	ΔL*	Δa*	Δb*	ΔE*	ΔL*	Δa*	Δb*	ΔE*
Original mortar (MO)	0.45	-0.56	-1.25	1.44	0.47	-0.82	-0.77	1.22
MO with Acryl 33	-0.28	-0.3	-0.77	0.87	2.16	-1.75	-1.69	3.25
MO with Peoval 33	-1.24	-0.6	2.46	2.82	-0.44	-1.5	2.64	3.07

Table 3. Colour changes of mortars after 50 cycles of ageing with salt and water uptake

This may explain the reduced increase of drilling resistance of MO Ac and MO Pe samples with respect to MO samples. Figures 6a, b and c show the curves of the drilling resistance up to a depth of 10 mm. The first observation is that these graphs, which are the curves obtained for each treatment from the average values of the drilling resistance (Force) found during the drilling of three areas on the same sample, show an indented trend: this is due to the heterogeneity of the mortar samples (carbonatic binder, *cocciopesto*, carbonatic rock fragments). The second important observation is that the profiles of MO samples before and after ageing, both with fresh water and with salty water, are much more irregular than the MO Ac and MO Pe samples; the MO Pe profiles in particular show the lower variability, which is probably due to the greater thermo-hygrometric stability of the mortars treated with this organic product. These results are in accordance with the data obtained by the permeability tests (Fig. 7a and b). The water permeability, before ageing, of MO is similar to that of MO Ac and higher than that of MO Pe, but after ageing, and in particular in the case of ageing with fresh water capillarity uptake, the permeability of MO usually decreases much more than that of MO Ac and mainly that of MO Pe. This behaviour may be justified by the slowing down (or modification) of the curing process caused by the synthetic compounds that do not assist the carbonation process of the mortar or prevent the processes of dissolution and precipitation of carbonatic binder. In Table 3 the colour changes of the mortar samples aged with fresh water and salty water uptake are reported. The ΔE* is generally less than 3 (considered as the detection limit for the human eye) except for mortars with added Acryl 33 and Peoval 33, and subjected to water uptake ageing (ΔE* of 3.25 and 3.07, respectively). As regards the MO Ac samples, the most relevant changes have been witnessed in the L* parameter (+2.16), while for the MO Pe samples in the b* parameter (+2.64).

Conclusions

This paper contributes to the research on materials to be used in the restoration of mosaics, taking into account the mortars in which the tesserae are embedded, often considered as a material to be sacrificed, capable of "receiving the decay" and not passing it on to the mosaic. The paper emphasizes the need to know the original mortars used in the mosaic, in order to formulate compatible mortars, but also highlights that the addition of organic compounds, normally used by restorers for the treatment of natural stones, should be carefully evaluated. The addition of organic compounds (Acryl 33 and Peoval 33) determines an improvement of the mechanical properties and a reduction of water permeability of the mortar before ageing. After the artificial ageing (tests performed on samples subjected to thermo-hygrometric changes during fresh water and salty water uptake), the same samples show fewer changes in mechanical (drilling resistance) and physical (vapour permeability) properties, and, consequently, a greater stability to the ageing conditions. However, it is important to bear in mind that this is a preliminary study and that the number of ageing cycles must be increased in order to confirm the trend observed. It would also be very important to repeat these tests on small portions of mosaic in order to highlight the behaviour of the complex system of mortar/tessera.

Acknowledgments

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LA SAUVEGARDE DES MOSAÏQUES *IN SITU* DANS LE SITE ARCHÉOLOGIQUE DE BULLA REGIA EN TUNISIE : BILAN PRÉLIMINAIRE

Moheddine Chaouali

Résumé

Lorsqu'on déambule à Bulla Regia, on est rapidement frappé par la somptuosité et la richesse des mosaïques in situ. Après avoir fait état des principaux risques auxquelles elles sont confrontées, je présenterai les solutions possibles envisagées par l'Institut National du Patrimoine de Tunis (INP) en collaboration avec le Getty Conservation Institute (GCI) afin de les protéger et les transmettre intégralement aux générations futures sans altérations supplémentaires à celles dont elles ont été déjà victimes.

Le site archéologique de Bulla Regia situé au Nord-Ouest de la Tunisie à 150 km à l'ouest de la capitale Tunis se singularise par de nombreux monuments de différents types, dont des mosaïques *in situ*. Cependant on n'a pris récemment conscience du fait que ses pavements émergeant du sol, dans lequel ils avaient été enfouis pendant plusieurs siècles, pouvaient être la proie d'une dégradation accélérée.

Au début des années 2000, l'Institut National du Patrimoine de Tunis (INP) s'est associé au Getty Conservation Institute (GCI) dans une collaboration pour sauver, restaurer et mettre en valeur des milliers de mosaïques en Tunisie. Après plusieurs mois de formation, les techniciens étaient répartis dans les sites archéologiques bénéficiant d'une riche collection de mosaïques *in situ* comme les sites de Dougga : *Thugga*, El Mdeina : *Althiburos*, El Jem : *Thysdrus*, Hammamet : *Pupput,* El fahs : *Thuburbo maius* etc. Le site archéologique de Bulla Regia riche de ses 300 pavements de mosaïques allant de la période romaine à la fin de la période byzantine fait partie de cette stratégie nationale.

Depuis septembre 2008, une équipe pluridisciplinaire réunissant d'un côté archéologues, techniciens et conservateurs de l'INP et de l'autre côté des spécialistes du Getty Conservation Institute (GCI) s'est penchée sur l'état des pavements et sur les solutions nécessaires pour assurer une conservation à long terme des mosaïques et un projet de mise en valeur du site archéologique de Bulla Regia.

Pourquoi faire de Bulla Regia l'objet d'un tel intérêt ? Pour le comprendre, il faut savoir que ce site est l'un des plus remarquables de la Méditerranée et que ses nombreux monuments, dont les 300 pavements de mosaïques mis au jour, sont exposés à des risques divers sans oublier les mauvaises restaurations remontant à plusieurs décennies.

Fig. 1. Etage souterrain de la Maison de la Chasse, Bulla Regia (cliché : Moheddine Chaouali)

Hormis les monuments publics de tout genr : théâtre, amphithéâtre, temples (Capitole, temple d'Isis, temple d'Apollon, temples géminés, temples anonymes…), basilique civile, citernes, thermes memmiens, forum, marché, bibliothèque ?, *Augusteum*, fortin byzantin, basiliques chrétiennes… le site de Bulla Regia comporte plusieurs demeures. Certaines d'entre elles étaient munies d'un étage souterrain (Maison de la Chasse (Fig. 1), Maison de la Nouvelle Chasse, Maison de Vénus appelée aussi Maison d'Amphitrite, Maison du Trésor, Maison des Mosaïques, Maison du Paon…) considérées par les historiens et les archéologues comme le joyau de l'architecture domestique d'Afrique du Nord puisqu'aucune ville du monde romain n'a adopté ce parti architectural de manière aussi systématique. La plupart de ses monuments publics et privés étaient ornés de mosaïques, exposées aux outrages du temps et au vandalisme.

Les mosaïques de Bulla Regia sont exposées à trois types de risques : humains, biologiques et naturels.

En premier lieu les risques humains : le site de Bulla Regia est victime de sa réputation internationale. Son succès universel est responsable des altérations et dégradations multiples entrainées inévitablement par l'afflux de dizaines de milliers de visiteurs tout au long de l'année. Effectivement, la simple circulation quotidienne de milliers de visiteurs sur des sols mosaïqués entraine une dégradation considérable des pavements. Les insouciances et indélicatesses de certains visiteurs sont complétées par des actes

Fig. 2. Végétation qui pousse autour des mosaïques, Augusteum, Bulla Regia (cliché : GCI)

de destruction volontaires parfois irréparables qui consistent notamment à l'arrachement de tesselles.
Ensuite les risques biologiques : l'une des sources importantes de dégradation des mosaïques de Bulla Regia sont les micro-organismes (mousse, lichens…). Les végétations qui poussent autour des mosaïques (Fig. 2) et les animaux (vaches et moutons) sont responsables de beaucoup de détériorations.
Enfin les risques naturels : les mosaïques de Bulla Regia subissent une alternance de phases humides et de phases sèches favorisant la formation de sels en surface et provoquant des décollements des tesselles. Gorgées d'eau en hiver, ces mosaïques sont de plus en plus sensibles au gel pendant la saison froide et au développement de lichens au printemps (Fig. 3).

Les pavements de mosaïque de Bulla Regia étaient endommagés dans l'Antiquité. Curieusement, on dénote quelques tentatives de « restaurations » remontant à l'Antiquité tardive (VI^e siècle) dans la Maison de la Nouvelle Chasse. Cette intervention antique montre bien une nette différence entre les parties originelles et celles qui avaient été refaites témoignant du peu de souci accordé alors à la préservation de la beauté originelle du pavement.
Avec la redécouverte de la ville au milieu du XIX^e siècle, beaucoup de mosaïques ont été abondamment mis au jour. Les découvertes des pavements (estimés aujourd'hui à presque 300) s'échelonnaient de la fin du XIX^e siècle jusqu'aux années 1990. Depuis 2008, l'INP est conscient qu'il faut à tout prix remédier aux faiblesses et parfois incohérences des restaurations anciennes

Fig. 3. Gorgées d'eau en hiver, les mosaïques sont de plus en plus sensibles au développement de lichens au printemps, Maison de la Nouvelle Chasse (cliché : GCI)

(Dr Carton, M. Boulouednine, M. Zaiani, M. Laâbidi, équipe franco-tunisienne) qui s'avèrent aujourd'hui néfastes reflétant parfois un esprit novice. Sachant que beaucoup de pavements avaient été déposés et transposés sur différents types de supports, notamment en mortier de ciment armé puis remis à leur emplacement original. Avec l'avancée des sciences et méthodes de la conservation archéologique, il est devenu urgent de commencer les travaux de restauration des tableaux de mosaïques *in situ* afin de pallier tous les dommages, selon un projet élaboré au préalable.

Comment protège-t-on les mosaïques ? Par la documentation, la restauration et parfois le réenfouissement.

Une documentation exhaustive d'une mosaïque se fait en remplissant des fiches, en dessinant des plans et en prenant des photos. La documentation doit être divisée en trois phases qui sont : étude, programmation et intervention.

Les interventions sur les pavements conservés *in situ* sont multiples : nettoyage du pavement qui consiste à retirer les poussières, concrétions et micro-organismes en vue de rendre au pavement sa lisibilité (Fig. 4), protection des bords, consolidation des matériaux et supports avec le renforcement de l'adhérence des tesselles aux couches préparatoires par injection de mortier liquide, bouchage des lacunes etc. Toutes les opérations de stabilisation nécessitent obligatoirement l'usage des mortiers à base de chaux. Plusieurs œuvres ont ainsi pu faire l'objet d'un traitement complet dans les maisons de la Chasse, la Maison des Poissons et les basiliques chrétiennes. Pour des raisons financières autant que déontologiques, les restaurations doivent être légères, les plus discrètes possibles. Mais il nous arrive parfois aussi d'opter pour le réenfouissement certains panneaux de mosaïques mis au jour depuis des décennies sont au-

Fig. 4. Intervention sur un pavement conservé *in situ*, Bulla Regia (cliché GCI)

Fig. 5. Réenfouissement dans la Maison no. 9), Bulla Regia (cliché : Moheddine Chaouali)

jourd'hui de plus en plus fragiles. Leur état de dégradation s'accentue sensiblement. Le choix est alors porté sur des actions de réenfouissement (opération menée récemment, par exemple, dans la Maison no. 9) (Fig. 5). Faute de moyens financiers et humains, l'équipe est obligée de recourir à une telle solution qui assure une protection temporaire.

En guise de conclusion, notons d'ores et déjà que toutes les interventions que nous menons respectent l'authenticité du pavement conformément aux principes actuels de la discipline.

La conservation conduite sur quatre années nous a permis de restaurer et de mettre en valeur cinquante mosaïques dans leur intégrité dans les maisons de la Chasse, de la nouvelle chasse, de la pêche, du trésor, dans les basiliques chrétiennes.

L'Institut National du Patrimoine tente par divers moyens de sauvegarder les mosaïques antiques de Tunisie, considérées parmi les plus beaux exemples de l'art de la mosaïque romano-africaine, afin de les transmettre intégralement aux générations futures sans altération supplémentaire à celles dont elles ont été déjà victimes. Le souci accordé au riche répertoire des mosaïques *in situ* du site archéologique de Bulla Regia s'intègre parfaitement dans cette stratégie patrimoniale nationale.

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GEOLOGY AND THE USE OF MORTAR IN THE CONSERVATION AND MANUFACTURE OF CYPRIOT FLOOR MOSAICS

Eleftherios Charalambous

Abstract

The paper presents and summarizes the author's doctoral study on the manufacturing technology of Cypriot mosaics (tesserae, mortars, tessellation, stone cutting methods and techniques for tesserae), from the 2nd to the 7th century AD. This research also explored the use of mosaic floors in the wider geographical area of Cyprus. Furthermore, it focused on stones used for cutting tesserae for floor mosaics, and the identification of their sources. The doctoral thesis was written at the Aristotle University of Thessaloniki, under the supervision of Professor Ioannis Stratis, Department of Chemistry (Charalambous 2009; published in 2012). The examination of the parameters in the manufacturing technology of mosaics, such as the preferred geological sources and specific rock types, the cutting techniques, the tesserae and mortar manufacture, lead to significant conclusions regarding ancient technologies and preferable and long-lasting conservation methodologies. This research forms a reference-database for young scholars and also serves as a manual for the maintenance, restoration and conservation of mosaics. It was prepared with the help and, often, the determining contribution of several collaborators from various disciplines. It reconsiders and re-establishes the basis upon which research regarding this subject can be carried out.

Introduction: The role of geology in Cypriot mosaics

The geological peculiarity of Cyprus is one of the most important factors in the development of the art of mosaic on the island. The large colour gamut of the stones, along with their mechanical properties, gave the opportunity to the local mosaicists to experiment towards the creation of significant works of art. A series of complex and unique geological processes have made Cyprus a geological model for the earth scientists of the entire world. Cyprus is probably one of the few countries in the world, whose geology was the primary factor in the creation of the natural environment (Constantinou *et al.* 1997, 1-13). The uniqueness of this geology has played an important role in the course of history and helped significantly the cultural and socio-economic growth and development of the island.

One of the most important geological complexes of the island is found in the district of Paphos. This is the Mamonia complex, named after the main village in the area (Fig.1). The Mamonia complex is an assemblage of indigenous rocks dating from the Triassic to the Cretaceous period, which were thrust onto the southern part of Cyprus through a series of geodynamic processes. The Mamonia complex includes sedimentary rocks such as cherts and siltstones, ophiolitic rocks such as serpentinites and pillow lavas,

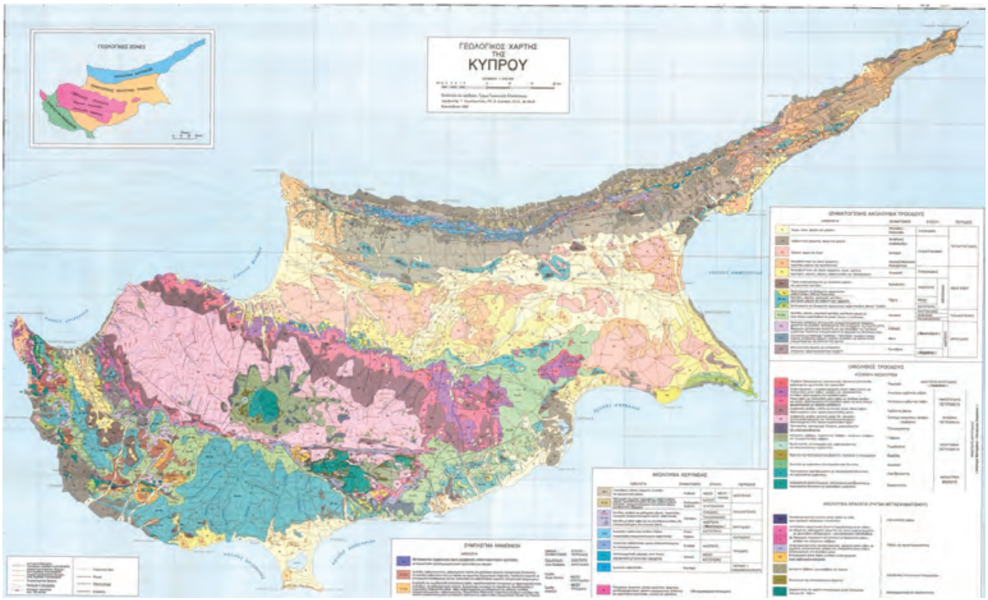


Fig. 1. Geological map of Cyprus (Geological Survey Department, Republic of Cyprus)

and metamorphic rocks such as amphibolites, phyllites, schists and marbles. The recrystallized shales, known as 'Petra tou Digeni' formation, and the lavas exposed within the cliffs of the bay with the same name, are actually alien rocks in the Mamonia area. The complex geology of this region includes mainly colourful limestone and is considered the main cause of landslides in this area. The alien rocks found within the Mamonia complex are generally considered to have derived from the partial precipitation of the Troodos Ophiolite complex during the collision of the African and Eurasian plates during the Maastrichtian period, seventy million years ago.

This particular geology-geomorphology of the island, along with other factors, played an important role in the development of floor mosaics. The abundance of several kinds and colours of rocks, including limestone, offered an extraordinary palette to mosaic artists, allowing them to develop this form of art and produce outstanding works. The research showed that the Mamonia complex was the main source of stones for the ancient artistic productions. Mamonia, and particularly the formation of Fassoula, has also been a primary source of stones for mosaicists until recently. The colours, which are prevalent in the area, attract visitors to observe them and admire this geological phenomenon, which itself can be described as a work of art.

Stones-Tesserae

My research took into consideration the geological complexity of the island and initially sought to identify the sources of the stones which were used for the mosaics. It considered the use of stones and their localization a significant element of this technology. After a thorough land survey, two sites were identified as probable sources of raw materials. These are very far apart from one another: one is located in the Paphos District: Mamonia/Fassoula cluster and the other in the Nicosia District: Analiontas/Kokkinovounaros. The rocks from the latter area did not present the basic requirements for cutting tesserae, because they were not homogeneous. Furthermore, they were too distant from the great centres of mosaic manufacture (Nea Paphos, Kourion, Palaipaphos). Moreover, subsequent chemical analysis of tesserae corroborated our initial suspicions (Charalambous 2006, 152-171) and confirmed the Mamonia area as the source of rocks for tesserae. Focusing on the Mamonia complex, almost all of the rocks that constitute the sample were traced and identified visually; firstly by a team of modern mosaicists (including the author), and then confirmed by Nikos Kantiranis, Professor of Geology (Aristotle University of Thessaloniki). Therefore, my research firstly classified all of the different kinds of rock used for the creation of mosaic tesserae. Then, it identified potential sources for each type of rock. These sources were mainly traced in the Mamonia complex and especially within the Fasoula Formation. It is worth noting that the majority of the stones, which have been used, are mostly calcareous since their properties favour their use as tesserae, while other stones, whose properties do not favour such a use, are not used at all, or, in some cases where it was necessary, they were used in small quantities. I made a table for every kind of rock separately – a total of 63 tables – including geological and archaeological information regarding every type of rock individually (Charalambous 2009, 23-108; 2012, 25) (Fig. 2). These tables form a database for research and conservation of mosaics and stones in particular.

The study of the mineralogical composition of the samples was carried out with the method of X-ray Diffraction. Diffractometers of the type PHILIPS PW1820/00 were used, equipped with a microprocessor PW1710/00, Cu tube and Ni filter to obtain CuKa radiation, and the area scan angle 2θ was 3-63 ° and the scan rate of 1,2 ° /min. Prior to the samples being x-rayed, the sensitivity and accuracy of the diffractometer was checked, with a special template of pure silicon. Samplers and conditions of scanning were exactly the same for the method of preparation of randomly oriented samples. The quantification of the mineralogical phases was based on enumerations of specific reflections. The specific reflections were not affected by any other random reflection. This process took into account the density and mass absorption rates of the mineralogical phases. Corrections to the rates of minerals that were identified, were made with the use of external standard mixtures of several minerals included in the examined samples. The determination of the petrographic type of limestones and dolomitic rocks was based on Harben's chart (1992, 148).

Experimentation was also a significant component of this research. A team of mosaicists (including the author) using cutting tools, after several trials and tests, confirmed the potential for all of these rocks to be used in the production of tesserae. The experimentation conducted by this team included several tests for rocks to be cut without the use of modern in-

- **Ερυθρωπός ασβεστόλιθος**

Έργα στα οποία χρησιμοποιήθηκε το πέτρωμα: Νέα Πάφος/ Οικία Διόνυσου, Νέα Πάφος/ Οικία Θησέα, Νέα Πάφος/ Οικία Αιώνα, Κούριο/ Οικία Αχιλλέα, Κούριο/ Οικία Μονομάχων, Κούριο/ Ρωμαϊκή Αγορά/ Δημόσια Λουτρά, Κούριο/ Ιερό Απόλλωνα Υλάτη/ Δημόσια Λουτρά, Άλασσα/ Ρωμαϊκή Οικία, Νέα Πάφος/ Οικία Ανατολικά οικίας του Διόνυσου, Παλαίπαφος/ Οικία Λήδας, Παλαίπαφος/ Ιερό Αφροδίτης, Παλαίπαφος/ Οικία Κάτω Αλώνια, Κούριο/ Οικία Ευστολίου, Νέα Πάφος/ Παλαιοχριστιανική Οικία ανατολικά της Οικίας του Διόνυσου, Νέα Πάφος/ Παλαιοχριστιανική Βασιλική Χρυσοπολίτισσας, Κούριο/ Επισκοπική Βασιλική, Άγιος Γεώργιος Πέγειας/ Βασιλική Α΄, Άγιος Γεώργιος Πέγειας/ Λουτρώνας, Ταμασσός/ Παλαιοχριστιανική Βασιλική Αγίου Ηρακλειδίου, Ακρωτήρι Λεμεσού/ πιθανόν Παλαιοχριστιανική Βασιλική, Ακάκι/ Παλαιοχριστιανική Βασιλική Αγίου Αρτέμονα, Άλασσα/ Παλαιοχριστιανική Βασιλική.

Ιστορική περίοδος έργων που συναντάμε το πέτρωμα: Υστερορωμαϊκά ψηφιδωτά, Παλαιοχριστιανικές Οικίες, Παλαιοχριστιανικές Βασιλικές.

Αύξων αριθμός δείγματος: 5

Χρωματικός χαρακτηρισμός ψηφίδας
σύμφωνα με τον κώδικα Munsell: 8,1YR6,7/3,3

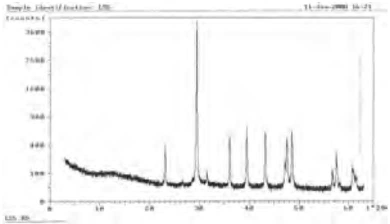
Χρωματικός χαρακτηρισμός μητρικού πετρώματος
σύμφωνα με τον κώδικα Munsell: 5,6YR5,9/3,4

Δειγματοληψία: Ψηφίδα επιδαπέδιου ψηφιδωτού .

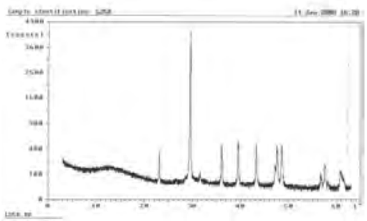
Περιγραφή δείγματος: Το πέτρωμα χαρακτηρίζεται ως ερυθρωπός ασβεστόλιθος και το συναντούμε στην περιοχή του συμπλέγματος των Μαμωνιών και ιδιαίτερα στο σχηματισμό της Φασούλλας. Επίσης μπορεί κάποιος να το συναντήσει υπό μορφή βοτσάλου στα ποτάμια της περιοχής καθώς επίσης και στις παραλίες που βρίσκονται στην περιοχή.

Σύσταση	Ασβεστίτης	Χαλαζίας
Ψηφίδα	99%	1%
Μητρικό πέτρωμα	99%	1%

Παρατηρήσεις: Υπάρχει απόλυτη ταυτοποίηση του πετρώματος της ψηφίδας με αυτό του μητρικού πετρώματος. Το πέτρωμα αυτό χρησιμοποιείται κυρίως στα σαρκώματα και έτσι μπορούν να αποδοθούν τα πλασίματα και τα χαρακτηριστικά καλύτερα.



Φάσμα XRD ψηφίδας



Φάσμα XRD μητρικού πετρώματος

Φωτογραφική τεκμηρίωση (θέσης δείγματος): Φωτ.1 (φωτογράφηση του δείγματος), Φωτ.2 (Στερεοσκοπική παρατήρηση), Φωτ. 3 (φωτογράφηση μητρικού πετρώματος).

Fig. 2. Sample of table containing all characteristics and general information regarding individual tesserae and their provenance

English Translation of legends on Fig. 2:

- Reddish limestone

Artwork in which this stone was used: Nea Paphos: House of Dionysos; Nea Paphos: House of Theseus; Nea Paphos: House of Aion; Kourion: House of Achilles; Kourion: House of the Gladiators; Kourion: Roman Agora, Public Baths; Kourion: Temple of Apollo Hylates, Public Baths; Alassa: Roman House; Nea Paphos: House East of the House of Dionysos; Palaipaphos: House of Leda; Palaipaphos: Temple of Aphrodite; Palaipaphos: House at Kato Alonia; Kourion: House of Eustolios; Nea Paphos: Early Christian House East of the House of Dionysos; Nea Paphos: Early Christian Basilica of Chrysopolitissa; Kourion: Episcopal Basilica; Ayios Yeorgios Peyias: Basilica A; Ayios Yeorgios Peyias: Baths; Tamassos: Early Christian Basilica of Ayios Herakleidios; Akrotiri: probable Early Christian Basilica; Akaki: Early Christian Basilica of Ayios Artemon; Alassa: Early Christian Basilica.
Historical periods during which the stone was used: Late Roman Mosaics, Early Christian Houses, Early Christian Basilicas
Sample number: # 5
Tesserae Munsell color code: 8, 1YR6, 7/3,3
Rock Munsell color code: 5, 6YR5, 9/3,4
Sample provenance: Floor mosaic tesserae
Sample description: The stone is reddish limestone found in the area of the Mamonia complex, and particularly in the Fassoula formation. As a pebble, it also occurs at the rivers and beaches of this area.

Consistency	Calcite	Quartz
Tesserae	99 %	1 %
Stone	99 %	1 %

Notes: 100 % identification of the tesserae with the rock. This kind of rock is mainly used in the depiction of the flesh so that the individual characteristics are better presented.

Chart of Tesserae XRD – Chart of stone XRD

Photographic record: Photo 1. Photograph of the sample, Photo 2. Stereoscopic observation, Photo 3. Photograph of the rock

struments, and concluded on the easiest and most efficient ways of cutting rocks, which would have had the best results producing the dimensions of tesserae. These experiments also confirmed that in antiquity, an entire team of specialists would have been needed in order for a mosaic workshop to have successfully functioned: specialists who would have known the sources of the rocks and possibly would have been involved in the quarrying process would have been needed; artisans who would have been knowledgeable of the stones' properties and how best to cut them in the desirable dimensions would also have been employed; experienced craftsmen would also have been needed to cut the stones into tesserae, and who may or may not have been the same people as the artists, who would have chosen

Room 1 Scylla	Room 2 Narcissus	Room 3 The Four Seasons	Room 4 The Central Hall	Room 5 Geometric pattern	Room 6 Phaedra and Hippolytus
0,9Y3,2/0,8	9,6YR5,6/3,8	0,7Y7,2/3	0,7Y6,6/3,1	1Y6,5/3,2	1Y6,4/4,5
1,8Y3,9/1,6	0,5Y5,6/3,2	3Y5,3/1,2	4,4Y2,8/0,4	3,6Y3,8/1	6YR4/2,2
3YR3,9/2,3	0,6Y4,7/2,6	8YR4,5/2,2	3,9YR4,2/3	1,4Y5,2/2,4	6,3YR4/2,1
2,6Y6,9/2,6	6,4YR4,8/2,2	7,5YR5,5/4,2	1,4Y4,3/1,7		3,9Y3,2/0,6
	6,9YR4,2/1,8	1,8YR3,9/2,8	8,8YR4,1/1,9		6,8Y5,2/2
	9YR3,5/0,8	0,6Y4,2/3,4	0,1Y6,4/4,1		6,4YR4,4/2,7
	9,6YR6,8/3,3	7,2YR3,1/0,8	9,5YR5,3/3,3		8,6YR6,1/4,4
	6,8YR6,2/4,9	2,9Y5,3/2,5	3,7YR5/4,3		6,2YR5,4/4,6
	5YR6/3,7	0,5Y6,1/4,9	8YR5,8/5,3		8,2YR5,7/5,4
	7,5YR5,3/2,3	9,3YR4/1,7	0,6Y5,9/2,7		0,8Y5,2/2,6
	3,6Y5,6/1,3	0,4YR4/3,8	6Y3,8/1,2		
	1,3YR4/3,5	1,3Y7,5/1,5			0,2YR3,8/4,1
	8,8YR6/4,8	1,5Y5/2,4	4,2YR5,6/6,9		9,6YR4,1/0,6
	1,6Y7,6/1,2	5Y7,1/0,5	8PB3,3/1,3		5,5YR4,8/6,4
			7,2PB4/1,4		
	7,5YR5,4/5,4	7,2YR3,1/0,8	0,8BG4,5/3,9		
		8,8Y4,8/2	1,6GY4,6/2,9		
		8,3B3,3/2	8,4Y6/4,7		
		1,3BG3,6/2,2	0,6Y6,8/2,6		

Fig. 3. Example of chromatic table. Measurements taken from the "House of Dionysos" at Nea Paphos

the appropriate stone-colours for the final composition of a mosaic floor.
Lastly, the creation of a colour database was considered of great importance (Fig. 3). This database, on the one hand adds a new aspect of data in our research field, and on the other, helps us understand the chromatic choices that the artists made for the creation of mosaic pavements. The portable spectrophotometer, which was used for the measurements of the colour of the samples, was model CM-2600d of KONICA MINOLTA. The measurements of the samples were made using the Munsell color chart. These measurements were made on all of the mosaics, which were easily accessible and which were not covered for preventive maintenance. In this way, a significantly large proportion of the rocks used in the mosaic floors underwent chromatic recording. The colour database, in conjunction with the petrological ana-

lysis and the database of the rock-types can be used as a manual for every kind of research regarding floor mosaics. It could also help to arrive at informed conclusions regarding the technology and development of mosaics.

Colour-coding within the tables of my thesis, indicated black for stone tesserae and orange for glass. Firstly, in the House of Dionysos at Nea Paphos, eleven different colour hues were identified for the rocks used in the mosaics, while in some rooms more colours were attested too. It was not possible, therefore, to distinguish between the most ancient and more recent conservation interventions and to arrive at safe conclusions regarding the original colour selection. The glass tesserae, which were also recorded, are part of modern maintenance interventions, like those seen in the pavements of the House of Theseus. In this house, about eight stones of different hues were used, while on the mosaic floors with figural representations the number of colours used increased. The mosaic of Aion also has approximately eight different colour hues, while in the central hall of the same building, House of Aion, which shows representations of human and mythological figures, the number of colour hues used is larger. Generally, the same stones were used also in the urban *domus* of Nea Paphos. Depending on the needs and the desired final result, the number of rocks of different colour hues used increased as shown in several tables of the thesis database.

A similar number of stones is observed in the mosaics with geometric themes, depending on the significance of the site and the complexity of the thematic repertoire. At the archaeological site of Kourion, in the House of the Gladiators and the House of Achilles, similar observations can be made as for those at Nea Paphos. In both *domus*, the number of rocks of different colours used in floor mosaics which include human figures was larger than that used in floor mosaics with geometric representations. In the House of the Gladiators the geometrical repertoire is simpler, while at the House of Achilles it is more complex.

The floor mosaics, which are located in the Early Christian basilicas and in the Early Christian houses/buildings, are of particular interest. Although not a large number of Early Christian houses has been excavated on the island, which would allow us to draw secure conclusions, the complexity recorded in mosaic floors is certain. Several times this complexity was achieved with the use of a small number of stones of different hues, allowing us to witness the chromatic perception and the virtuosity of the craftsmen who created these works. Sometimes, the selection of the perfect stone for the perfect place, the accuracy of the patterns, the impeccable tessellation, combined with specific colours are fundamental parameters for these excellent results.

This research showed that the physical properties of the selected stones were exploited in accordance to the needs and requirements of the mosaic production. The durability of the rocks in time played a crucial role in the creation of a mosaic. As a result, the choice of the rocks was made according to the original conception of creating a pavement that would have looked like an imperishable carpet. Regarding the white tesserae, which were used largely in the background of the panels, but also in the emergence and development of the peripheral geometric zones, they were made of a selection of local white limestones, which, from region to region and depending on the impurities, present weaknesses and many conservation problems. In the area of Kourion, limestone is characterized by its better quality unlike that of the Paphos area; so, in the mosaic floors located in the area of Akrotiri and Kourion the white tesserae do not present particular problems of maintenance, contrary to the floors of the Paphos area. This is probably one of the main reasons why the use of white stone in the background of the mosaics of Paphos was abandoned in antiquity, and the use of green predominated. In some cases where limestone from the area of Kourion is used in the floors of the Paphos area, these are modern maintenance interventions rather than an ancient use of the rock. Lastly, one observes the use of all kinds of limestone. Depending on the purpose of their use, the shades of the colours of limestones were fully exploited, and in some cases they were used to denote depth. Some stones, like red jasper, which show no special properties for use as tesserae due to their hardness, were used on a small scale, mainly where their particular hue was needed.

he findings of this research are intended to lay the groundwork for archaeometric research on this subject and to contribute to the disciplines of archaeology, history of art and especially conservation and maintenance of works of art. The main objective of these conclusions is their appropriate application in the maintenance and preservation of mosaics. The chemical and mineralogical

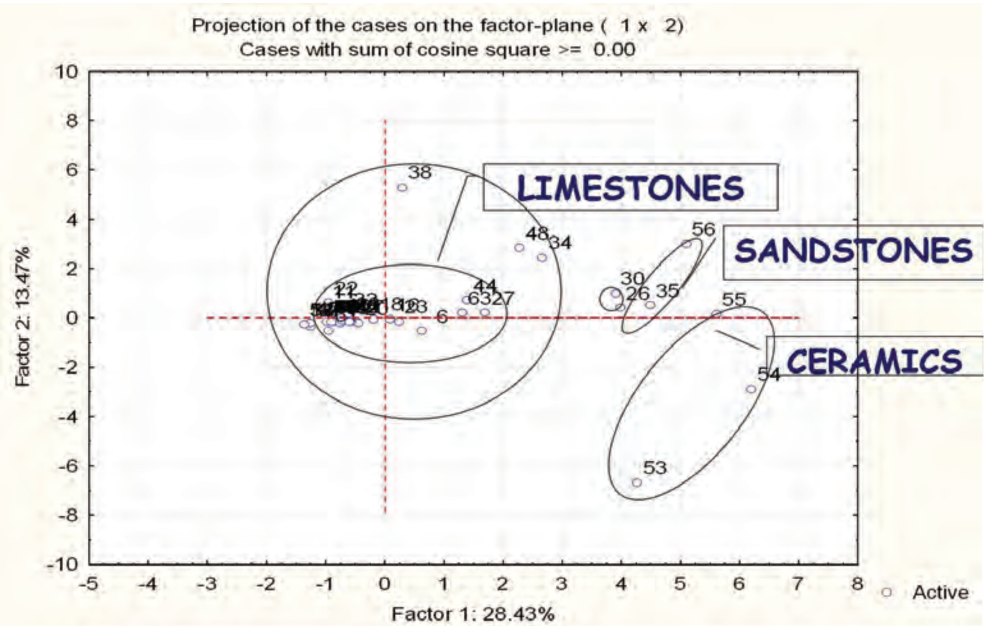


Fig. 5. Diagram showing the mineralogical composition of the rocks and their identification to bed rock (PCA)

analysis by instrumental methods, aimed to provide information about the elemental and mineralogical composition of the stones (Fig. 4), their identification with the bed-rock, their movement in time and space and their natural, mechanical and chemical properties. It is expected that this kind of information would also serve excellently the conservation and preservation of this extraordinary form of ancient art, the mosaics.

Mortars

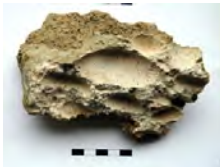
The research on the composition and the technology of the mortars gave important information on the development of floor mosaics. A large number of samples were collected from several regions in view of covering the entire range of Cypriot floor mosaics chronologically as well as geographically.

Scanning Electron Microscope type Jeol JSM-840 of the laboratory of electron microscopy of the Aristotle University of Thessaloniki, equipped with a system of energy dispersion analysis (EDS) LINK 10000 AN, was used for the study of the mortar samples. The operating conditions of the instrument were 15 kV, electron beam intensity <3 nÅ diameter of 1 mm, while the measurement time was 60 sec. Corrections were made using the program ZAF-4/FLS provided by LINK. The characterization of the colour of the mortars was made with a spectrophotometer. The portable spectrometer used for measurements of the colour of the samples was a KONICA MINOLTA model CM-2600d. The measurements and colour classification of the samples were made according to the Munsell chart scales (Munsell color notation). The spectrometer is located at the Laboratory of Analytical Chemistry of the Aristotle University of Thessaloniki.

This part of the research aimed at the collection of information on the composition and manufacturing technology of the mortars used in all of the stratigraphic levels of mosaic floors, throughout this period of time (2nd to 7th century AD), with the use of chemical and physicochemical measurements and microscopic observation (Charalambous 2009, 114-185) (Fig. 5). The results of the chemical analysis of the mortars regarding the manufacturing technology of mosaics led us to conclude that limestone mortar with an increased percentage of ash was predominantly used to such an extent that these mortars can be described as lime-pozzolan. Also observed is the use of aggregates of different sizes collected from around the areas where these mortars were used, since the resources are plentiful. The existence of some organic materials, such as straw and occasionally charcoal was also recorded (Charalambous 2007, 307). This can have derived either from the carbonization of some organic substances or residues which remained in the ash used for the mortar manufacturing. It is worth noting that the use of ash gradually increased the more superficially a layer was located. Lastly, on the floors, which date to the end of the period under examination, the use of gypsum-limestone mortars was recorded since, in this period of time, this type of mortar was also used in masonry.

The study of the mortars concluded that this technology remained unaltered through the years, with small variations and minor deviations from the Hellenistic type of mortar, which was the basis for mortar manufacturing. The roof tile-*kourasani* (a type of ancient mortar,

ΔΕΛΤΙΟ ΔΕΙΓΜΑΤΟΣ Ι



Προέλευση: Κύπρος/ Ακρωτήρι/ Καταλύματα Πλακωτών/ Βοτσαλωτά/ Βοτσαλωτό Ι.

Κωδικός αριθμός κονιάματος: Δείγμα Ι

Ημερομηνία Δειγματοληψίας: Ανασκαφική περίοδος, Αύγουστος 2007.

Χρωματικός χαρακτηρισμός σύμφωνα με τον κώδικα Munsell: 1,5Y6,8/1,3

Καιρικές συνθήκες (Θερμοκρασία, υγρασία): Καλοκαίρι 40 C?, Σχετικά υψηλή υγρασία.

Είδος κονιάματος (δόμησης, επίχρισμα, επίστρωση, πλήρωση, άλλο): Υποδομή Βοτσαλωτού δαπέδου (Πλήρωσης λιθοδομής- υπόστρωμα).

Θέση δειγματοληψίας (ύψος από το έδαφος, οριζόντιο/ κάθετο, εσωτερικό/ εξωτερικό, προσανατολισμός, βάθος που πάρθηκε, με επίχρισμα/ χωρίς επίχρισμα, κάτοψη/ όψη): Δάπεδο βοτσαλωτού περίπου 5cm το οποίο βρέθηκε κατά τη διάρκεια της ανασκαφής.

Επαφή με (πλίνθο, λίθο, μέταλλο, άλλο): Επαφή με κεραμικά και βότσαλα, τα οποία βρίσκονταν κατά την διάρκεια της ανασκαφής ανάμεσα σε στρώμα καταστροφής.

Στοιχείο κατασκευής(τοιχοποιία, καμάρα, παραστάδα, πεσσός, οροφή, τόξο, άλλο): Δάπεδο οικίας.

Τρόπος° δειγματοληψίας (με καλέμι, χέρι, καροτιέρα, άλλο): Εκ περισυλλογής επιφανειακά.

Ιστορική Περίοδος: Ρωμαϊκή περίοδος.

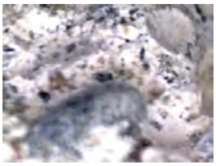
Περιγραφή περιοχής δειγματοληψίας: Στρώμα καταστροφής χωρίς την ύπαρξη κονιαμάτων δόμησης(επιφανειακό στρώμα κάλυψης περίπου 20 cm.).

Περιγραφή γειτονικής περιοχής: Καταστροφικά κατάλοιπα..

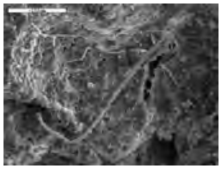
Περιγραφή δείγματος (απαιτείται 300 – 500 g. δείγματος στο οποίο να συμπεριλαμβάνεται συμπαγές δείγμα τουλάχιστον 4 X 4 X 4 cm): To δείγμα αποτελούσε μέρος σπαράγματος βοτσαλωτού έργου το οποίο αποκαλύφθηκε μετά από επιφανειακό καθαρισμό.

Επί τόπου μετρήσεις (κρουσίμετρο, σονόμετρο, βάθος από επιφάνεια): Δεν έγιναν.

Παρατηρήσεις: Τα κονιάματα του έργου βρίσκονταν αναμεμιγμένα με οργανικά κατάλοιπα σε χώμα.

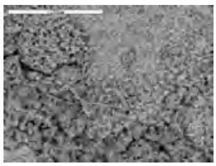


Μικροσκοπική παρατήρηση του κονιάματος.



Κονίαμα: Υποδομή (πλήρωσης λιθοδομής).

Στο δείγμα μας καταγράφεται η ύπαρξη ινών πιθανών άχυρου σε μικρό ποσοστό 1 έως 2%. Παρατηρούνται επίσης φυσικά αδρανή σκούρου χρώματος (φυσικά πυριτικά) με στρογγυλεμένα τα άκρα. Η κονία χαρακτηρίζεται ως πολύ συμπαγής και χαρακτηρίζεται ως ισχυρή η επαφή ανάμεσα στην κονία και τα αδρανή.



Elmt	*Spect. Type*	*Element %*	*Atomic %*
O K	*ED*	*37.36*	*58.74*
Na K	*ED*	*0.36**	*0.40**
Mg K	*ED*	*1.43*	*1.48*
Al K	*ED*	*0.95*	*0.88*
Si K	*ED*	*4.57*	*4.09*
S K	*ED*	*0.77*	*0.60*
K K	*ED*	*0.43**	*0.28**
Ca K	*ED*	*51.66*	*32.42*
Fe K	*ED*	*2.47*	*1.11*
Total		*100.00*	*100.00*

Elmt	*Spect. Type*	*Element %*	*Atomic %*
C K	*ED*	*70.27*	*77.76*
O K	*ED*	*24.45*	*20.31*
Na K	*ED*	*0.26**	*0.15**
Mg K	*ED*	*0.28*	*0.15*
Al K	*ED*	*0.07**	*0.04**
Si K	*ED*	*0.19*	*0.09*
S K	*ED*	*0.18**	*0.08**
K K	*ED*	*0.39*	*0.13*
Ca K	*ED*	*3.84*	*1.27*
Fe K	*ED*	*0.07**	*0.02**
Total		*100.00*	*100.00*

Fig. 5. Sample of table containing all characteristics and general information relative to mortars

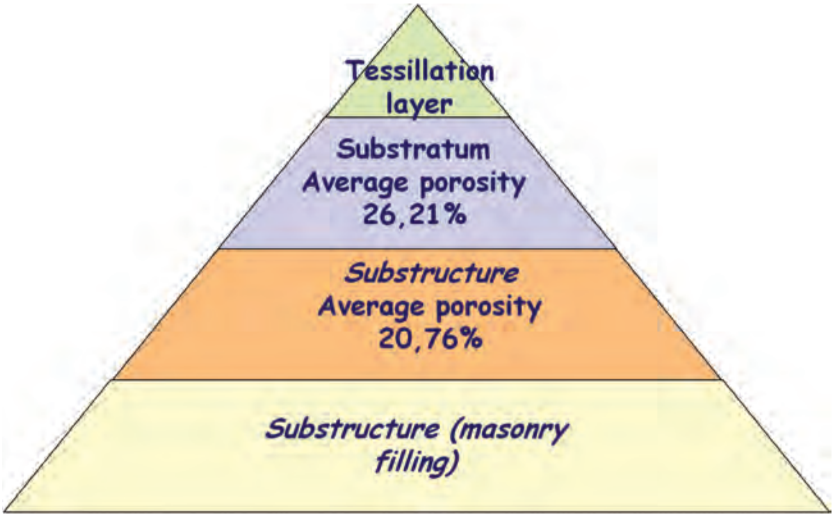


Fig. 6. Determination of the average porosity of mosaics throughout Cypriot floor mosaics

with exceptional hydraulic, mechanic and insulating properties when used as a tile) was used only as an inert material, and roof tile powder was used purely for colouring purposes. This conclusion suggests that the manufacturing technology of the mortars both in mosaic floors and also in other forms of construction had developed so much that it suited all sort of needs, and the use of some other kind of technology was out of question. A typical example is the Early Christian complex at the Akrotiri Peninsula in Limassol District, where gypsum is used for the masonry while, in the substrates of the mosaics, the tradition in the use of lime mortars continues.

Conclusions

The results of the work presented here form a foundation for research on floor mosaics in Cyprus. The creation of this database, including the results of chemical analyses on the mortars and the stones, is an important element for the research of all disciplines, focusing on this subject, such as archaeology, history of art and conservation. A conservator, aware of these facts, can develop an organized plan of maintenance and conservation, which would be based on this scientific research and would also take into account the specificities of mosaics and of the sites where these are located. The chromatic database is the key, combined with visual observation, for the identification of each tessera separately. The tables including stone properties offer all of the information needed in order for the right choice to be made regarding the maintenance and conservation of the stone. The tables including information on the mortars and the table for determining the porosity (Fig. 6) would help conservators to choose the correct type of mortar for the maintenance, based on their specific characteristics (porosity, hardness, etc.). The designated restoration of the works would help conservators to create diagrams for the conservation and of the corruptive factors and digitize them. These diagrams will help greatly the recording of the sequence of conservation of the mosaics, while allowing the monitoring of corruptive factors and of the effectiveness of the actions taken.

Acknowledgements

Thanks are due to the Department of Antiquities of the Republic of Cyprus, for giving me the authorization to take samples and for the confidence invested in me to manage such an important matter as the maintenance of the floor mosaics of the island.

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THE FISHERMAN MOSAIC IN THE HOUSE OF THE EPHEBE, NEAR THE TRIUMPHAL ARCH OF VOLUBILIS, MOROCCO

Magyda Cherradi

During a class on conservation, in 1995-1996, I learned about an interesting mosaic that 'no one' can restore. Then, in 2002, as my thesis project for a Master's degree at the Graduate School of Architecture, Planning and Preservation of Columbia University in New York City, I presented the "mosaic of the lobster" and how to treat it again. In 2007, I presented it yet again at the Institut National des Sciences de l'Archéologie et du Patrimoine in Rabat. This was a theoretical study and did not involve the actual lifting of the pavement.

In the first part of my thesis, I presented the context of the mosaic of the Fisherman (Fig. 1) in the House of the Ephebe in the zone of the triumphal arch of Volubilis, near Meknes, in Morocco (Callu *et al.* 1965, 6; Thouvenot 1945; Ichkhakh 2001). This mosaic is "une composition en quadrillage de cercles et de fuseaux tangents, l'octogone concave régulier, en tresse à deux brins" (Balmelle *et al.* 1985, pl. 150) that is nearly 17 m^2. It was restored in the 1930s according to academic norms of the time. The borders were kept but have been lost since. Later in that decade, the archaeologist leading the excavations filled the lacunae of the fisherman panel using a mortar of lime and cement. Even later and after many decades, Portland cement was poured over it because tesserae were getting detached and nobody knew a better solution. Unfortunately, there is no record of these later operations. Some excavations in the 2000s, in the vicinity of the exedra, where the Fisherman mosaic is found, showed that, apparently, there is nothing underneath the mosaic.

In my work, I presented a brief history of the city that has remains dating from prehistoric times to the Islamic period; also the House of the Ephebe that has a remarkable evolution, and described scientifically the composition of all mosaics in it dating to the 2nd century AD. The mosaic decorates the peristyle and, it seems, there is no earlier structure under it. We now know that in ancient Morocco, in Mauretania Tingitana, there were walls decorated with mosaics because in the room of the fisherman mosaic, in the exedra, there survived 21 tesserae at the base of the wall.

In this theoretical conservation project for the mosaic, I then tried to understand the pathology of the mosaic and the effect that Portland cement had on it. I studied the degradation of the mosaic from 2003 to 2009, and I presented the history of mo-

Fig. 1. General view of the Mosaic of the Fisherman (D. Michaelides)

saic restoration in Morocco. I noticed that there were zones where, over the years, a lot of dry mud had changed position over the mosaic: I thought that this was caused by the shifting of something under the pavement itself but I then realized that such accumulation of dry mud (dust, soil and water) could also be the result of human action. In fact, the mosaic of the Nereid in the atrium, treated in the same operation of the 1930s, shows a grid of cracks; and a similar grid is beginning to appear on the mosaic of the fisherman. A simple sondage in the lacuna is enough for checking in a non-invasive way, if this was the case.

The lacuna was restored together with the rest of the mosaics of the house in the 1930s; and because I studied the types of mosaic restoration in Morocco I decided that I should examine the possibility of the existence of reinforced concrete as a base. Therefore, I studied the composition of the reinforced concrete and its deterioration; and also the composition and deterioration of all the types of the tesserae and the consequences on them of the deterioration of the concrete. I also studied the biodeterioration of the mosaic and underlined the synergy of these factors towards degradation.

The next step in my work was the study of the re-treatment and the restoration of the mosaic. The problem that I was facing is the presence of the lacunae in the centre of this wonderful mosaic of eight medallions of fishes and crustaceans. As it has been demonstrated, in the restoration of painting, the lacunae become more important than the painting in the mind of the viewer, according to Gestalt

psychology. And there are also many discussions on how to restore or fill in lacunae in a painting.
Then, I demonstrated that the physical and philosophical integrity of the structure is also important in restoring lacunae. I proposed to fill them in with random grey limestone tesserae similar to those of the background of the whole mosaic. This will highlight the other eight medallions of the mosaic. I proposed this approach because we have no hint of the norms of body representations in Mauretania Tingitana; and, because we have no photographs of the missing parts. I hope this will bring an interesting discussion on restoring figures in mosaic lacunae.
In the fourth part of my work, I proposed a program for treating the mosaic once again, trying to use to the maximum possible reversible materials and I also proposed a monitoring system for protecting it. As I had no bibliography about the retreatment of lacunae on figures, I studied the geometric lacunae and, in the end, I opted (theoretically) to fill them randomly with tesserae similar to those in the background of the mosaic, so that this zone would not draw the attention of the visitors away from the beautifully coloured figurative medallions of the floor. I also tried to find a solution for the problems of humidity and water vapour transmission and suggested putting anti-UV glass over it. The proposed new treatment was intended to have a very high percentage of reversibility. This study is 244 pages long and includes a technical glossary. It was written in 2009 in French, as is the tradition of the Institut National des Sciences de l'Archéologie et du Patrimoine of Morocco.

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FLOOR MOSAICS FROM THE GRECO-ROMAN THEATRE AT NEA PAPHOS

Jennie Lindbergh

The Nea Paphos Theatre

The World Heritage site of the ancient city of Nea Paphos is within the boundaries of the modern city of Paphos/Pafos, a popular tourist destination on the southwest coast of Cyprus. Since 1995, the University of Sydney has been excavating the theatre adjacent to the ancient northwest gate. The theatre is substantial, with a final capacity to seat approximately 8,500 persons, and the site has become another of the city's many archaeological and cultural attractions. The partially reconstructed Roman theatre at Kourion, along the coast to the east of Paphos, provides a venue for theatrical events and, the Paphos Municipality has indicated an interest in using the ancient theatre of Paphos as a venue for future cultural events.

The theatre was originally constructed at the end of the 4th century BC, was reconstructed and enlarged following an earthquake in 15 BC by the Roman emperor Augustus, underwent another substantial reconstruction under the Antonines in the mid-2nd century and a Severan reconstruction a century later (see for example Barker 2007-2008, 2012; Barker and Stennett 2004; Green and Stennett 2002; Green 2003). From the late 4th or early 5th century, the theatre was abandoned and during the 6th century it was extensively quarried. During the Mediaeval period, the site was occupied by an extensive rural complex and by the 18th century there was a sparse group of farm houses. Modern 20th century services have also cut into and through the fabric of the theatre. In situ mosaics are relatively uncommon in theatres and it was not anticipated that a mosaic would be discovered.

Mosaic Floors in theatres

There are 23 examples of theatres and *odeia*, with mosaic floors identified by Sear (2006) in his architectural survey of Roman theatres. The theatres at Beneventum (Italy), Bulla Regia (Tunisia), Cyrrhus (Syria) and Delos (Greece) have mosaic floors in the *parodoi* and adjacent rooms. At Argos (Greece), Arycanda (Turkey), Byblos (Lebanon), Epidauros (Greece), Kirklareli (Turkey), Nora (Sardinia) and Simitthus (Tunisia) the orchestra floors are paved with mosaic. There are mosaics, predominantly on stage floors at Argos (Greece), Cos (Greece), Hierapolis (Turkey), Leptis Magna (Libya), Lugdunum (France), Sufetula (Tunisia), Thessalon-

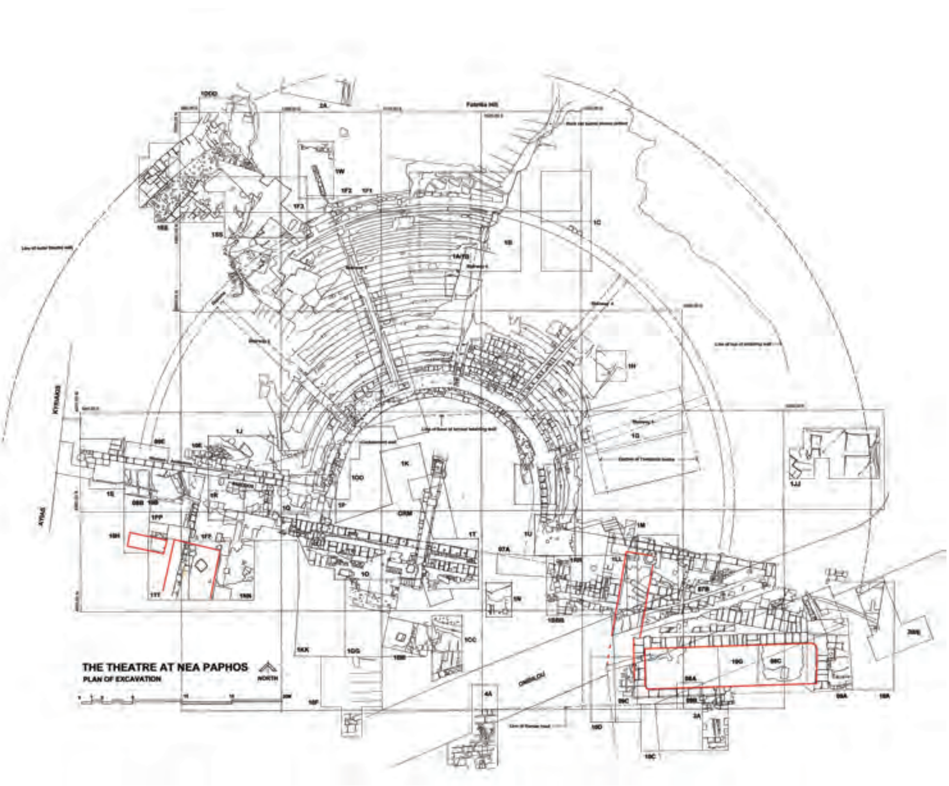

Fig. 1. Working plan of the Theatre at the end of the 2010 Season. The locations and currently known extent of each floor mosaic is outlined in red (drawing: Geoff Stennett)

iki (Greece), Thugga (Tunisia), Arausio (France) and Corinth (Greece).

The Nea Paphos Theatre Mosaic Floors

The theatre of Nea Paphos appears to be particularly well endowed with extant mosaic floors. It was not until 2004 that the first in situ mosaics were exposed in the theatre. Subsequent seasons have revealed floor mosaics in four discrete areas of the theatre; the eastern *parodos*, the southern entries to the eastern and western *parodoi*, a nymphaeum adjacent to the eastern *parodos*, and a possible room to the west of the southern entry to the western *parodos* (Fig. 1). The mosaics likely represent two phases in the life of the theatre. The floor of the eastern *parodos* and its southern entry is covered in a fragmentary black/grey and white geometric mosaic, the largest extent of which is within the *parodos* and comprises large white lozenges with infill chequerboard on a black ground (Fig. 2). The mosaic floor of the nymphaeum is in a poor condition with evidence of efflorescence, delamination and a loss of integrity in the cement setting, likely due to the use of limestone for the white tesserae relieved

Fig. 2. The fragmentary mosaic on the floor of the eastern *parodos* and its southern entry. The damage caused by later activities is clearly demonstrated (photo: Bob Miller, 10 November 2010)

Fig. 3. South-west corner of the poorly preserved nymphaeum floor mosaic. Edges are chamfered and there are patches of burning (photo: Bob Miller, 10 November 2010)

Fig. 4. The room to the south-west of the western *parodos* patterned with intersecting circles and octagons. The damage was caused by smashing columns for the lime kilns after the theatre had been abandoned and was used as a quarry (photo: Bob Miller, 10 November 2010)

by a scatter of small black semis (Fig. 3). The floor of the western *parodos* is surfaced in a hard fine white plaster, scored to imitate large pavers, possibly marble. The plastered floor extends to the threshold to the southern entry where it meets the remains of what had been an expanse of predominantly black tesserae, the only discernible pattern being one white on black crosslet. These mosaics and those in the western *parodos* and nymphaeum have been dated to the Antonine refurbishment of the theatre in the mid-second century. The simplicity of design and lack of colour in the mosaics associated with the *parodoi* was likely offset by the colourful paintings decorating the vaulted walls and ceilings, for which extensive evidence survives from the western *parodos* (Wood Conroy 2003). Dating to the late fourth or early fifth century is a polychrome geometric mosaic on the floor of what may be a small room or corridor to the west of the western *parodos* southern entry (Fig. 4). Too little of the immediate environment of this mosaic has been excavated to be certain of a room function, or its ultimate size. However, this mosaic likely dates to after the abandonment of the theatre.

Questions of interpretation and conservation

The unexpectedness of the discovery of floors paved with mosaics associated with the theatre was such that no management strategy for mosaics was in place. Preliminary advice from the Department of Antiquities to cover the mosaics with textile and to bury them with clean fill has been followed. Prior to reburial, the mosaics were planned and photographed in detail, and when re-exposed in 2010, there was no apparent deterioration of the fabric, or incursions by vegetation. The Australian team has a clear understanding of the significance of the mosaics as an important element of the fabric of the theatre site and is currently exploring avenues for the conservation of the mosaics, in consultation with the Department of Antiquities.
Reconstruction of the theatre for staging public performances will have a major impact on the local environment where encroaching hotels, bars and restaurants have changed a previously largely rural landscape. Accommodation will have to be made for the associated infrastructure such as ticket boxes, toilet facilities, parking and the inevitable influx of souvenir outlets. To ensure that the heritage values and significance of the site are recognized and preserved, the reconstruction of the theatre will need to balance the heritage requirements with those of a modern performance space in consultation with the University of Sydney. The Australian team is currently developing an interpretation strategy, in accordance with the Verona Charter, to guide the preliminary use of the theatre as a local resource for tourism. The objective of the *Verona Charter on the Use of Ancient Places of Performance* (UNESCO 1997) is to “preserve a store of scientific information, manage the monuments in the perspective of development and, where circumstances permit, infuse ancient sites once more with their full role of places of artistic creation, shared enjoyment and emotion”. The conservation and interpretation of the theatre site needs to be an integral part of any future refurbishment of the theatre. The fabric of the theatre site; the evidence of its historical phases and modifications, the post-aban-

donment activities and the Mediaeval occupation, all contribute to an understanding of the heritage values of the site. As an integral part of the fabric of the theatre, the mosaics provide an insight into a particular aspect of its historical use, and as such need to be conserved and interpreted in situ. The survival of a suite of geometric mosaic pavements within the theatre adds to our understanding of the importance of the theatre to the ancient city, and contributes to our understanding of the significance of Nea Paphos as the capital of Roman Cyprus.

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REBURIAL OF MOSAIC PAVEMENTS: AN IN SITU CONSERVATION METHOD

Vassiliki Lysandrou and Eleftherios Charalambous

Abstract

Even though mosaic pavements have survived in larger numbers by comparison to other ancient artefacts, they are exposed to a series of inevitable deterioration factors of physical, chemical and mechanical nature. Often enough, archaeologists and conservators have to deal with the seasonal protection of newly excavated mosaic pavements. The reburial of such pavements constitutes an accepted and valid in situ preservation method that falls under the preventive conservation logic. Reburial can also be successfully applied for the protection of mosaic pavements that were excavated in the past, but have remained exposed for several years. Reburial serves different needs and can be done either for a short period of time or for a longer one.

The present paper discusses some general remarks and parameters regarding the reburial of mosaic pavements. The materials normally used are examined, as well as the application of reburial techniques. Furthermore, the planning and monitoring processes necessary prior to the reburial itself are reviewed. Lastly, we give an overview of the policy followed by the Cypriot Department of Antiquities for the reburial of mosaic pavements; the methods used during the last century and those of today, giving specific examples.

Introduction

Reburial is one of the – not so many – options for the in situ preservation of mosaic pavements. It is a valid and accepted method, the main target of which is to create a stable environment for the reburied mosaic, something difficult to achieve if the mosaic remains exposed to the environment. It is a method usually applied as an immediate measure until more permanent and expensive solutions are undertaken. Reburial seems inevitable for the Cypriot reality due to the large number of floor mosaics: there are more than 248 mosaic pavements in 16 different archaeological sites that cover a total area of 18 km² including opus sectile and pebble pavements (see Hadjicosti and Charalambous 2017, where the sums given do not include pebble mosaics).

Prior to reburial

Reburying a mosaic pavement involves a series of tasks that must precede the actual reburying (Stewart 2004, 244-245). The following important parameters are considered while planning the reburial system:

- Detailed documentation of the mosaic (graphic and photographic)
- Detailed documentation of the materials used and the manufacturing technology of the mosaic (archaeometric study and documentation)
- Assessing the conservation status of the mosaic
- Decay factors the mosaic has been/is being exposed to

Fig. 1. Akrotiri, locality *Plakota*. Limassol District. Aerial photograph showing part of the excavated floor mosaics (photos: E. Charalambous for the Department of Antiquities)

- Assessment of the factors that favour this method over others
- Estimation of the duration/length of reburial
- Assessment upon the depth of fill/reburial stratigraphy based on condition and pathology surveying of the mosaic pavement and its in situ context
- Stabilization of mosaic substrata and tesserae

A Case Study – The Cypriot example

Until recently, there was no organized plan regarding excavated mosaics in Cyprus – despite the large number of pavements found on the island. Mosaics were often left exposed with no protection or were, occasionally, covered by shelters, usually of temporary nature. The detachment of floor mosaics and their transportation to museums for conservation and exhibition purposes, causing in some instances irreparable damage, was fairly common. Naturally, reburial was not totally absent, but it was incorrectly applied, using, for example, materials of questionable quality like geotextiles of high or full density, or totally inappropriate cover materials (Roby 2004, 231-234) such as sheets of plastic. Furthermore, after excavation the mosaic were usually backfilled with soil containing impurities, something that damaged rather than preserve the mosaics (Neguer 2004).

During the last decade, things changed radically and the Cypriot Department of Antiquities follows a rigorous method regard-

Fig. 2. Akrotiri, locality *Plakota*. Limassol District. The first covering layer for long-term reburial (photo: E. Charalambous for the Department of Antiquities)

Fig. 3. Akrotiri, locality *Plakota*. Limassol District. The second covering layer for long-term reburial (photo: E. Charalambous for the Department of Antiquities)

ing newly discovered mosaic pavements. A recent example is the on-going excavation at Akrotiri in the Limassol District, where the excavations revealed an Early Christian complex with a great number of floor mosaics (Fig. 1). By the end of every excavation season, the mosaics are fully documented, conserved and covered as follows:
The first layer (Fig. 2) consists of a geotextile with an 85% density, which covers all the relevant area and is intended to allow rising humidity to escape, to delineate the protected layer from the surrounding excavated area, and to reduce/prevent vegetation growth.
The second layer (Fig. 3)consists of five to ten centimetres of river sand, and is intended to protect the monument from direct contact with rain water, to provide stability to it, to help its adaptation to changing weather conditions and finally to allow its drainage. The river sand used is as pure as possible with a low salt content.
The third layer (Fig. 4) consists of ten to thirty centimetres of gravel (local limestone crashed into small pieces) and aims to enhance the protection of the monument, mainly from mechanical stresses, allowing at the same time its drainage. Its use is preferable in cases of long-term reburial.
The above-mentioned reburial method has a lifetime of about four to seven years. During this period, it is recommended to uncover the mosaics periodically, in order to avoid the formation of salt incrustations. The reburied monument should also be periodically controlled by the conservation team, in order to arrest vegetation growth.
The Cypriot Department of Antiquities applies this reburial method for three different cases. The first is that of newly excavated floor mosaics (Fig. 1), where both periodical and long-term methods are applied, accompanied by drainage and other auxiliary structures. The second case concerns floor mosaics situated in areas not accessible to visitors; and here, long-term reburial is applied (Fig. 4). Lastly, the third case concerns mosaics that are unprotected by shelters or other structures, even though they are accessible to the public. In this case, a periodical reburial is applied for the winter season only (Fig. 5-7).

Fig. 4. Akrotiri, locality *Plakota*. Limassol District. The third covering layer for long-term reburial (photo: E. Charalambous for the Department of Antiquities)

After the reburial procedure ends, another one is put into action: the monitoring of the reburied mosaic (Stewart 2004, 245; Neguer 2004, 248-252). A group of specialists, preferably those that designed and carried out the reburial, inspects periodically the area in order to guarantee the proper functioning of the reburial as well as the drainage system, and if necessary, control the reburied mosaic itself.

Conclusions

Reburial is an efficient and valid method of in situ conservation. It is an immediate solution for newly excavated mosaics, a valid method in terms of preventive conservation and, finally, an efficient method for the conservation of previously excavated mosaics. The proposed method has a low financial cost by comparison to the cost of continuously monitoring and conserving exposed mosaics or by comparison to the construction of permanent protective shelters. It is easy and fast to achieve. Furthermore, it is convenient both for seasonal, as well as for long-term reburial. It is also adaptable to specific territorial constrains, since it can cover entirely or partially the area under study. Naturally, reburial is not a panacea and does not offer absolute protection, since some common problems have been observed (Theodorakeas and Koui 2013, 1-2). Of course, every case is different and needs a special study before any

Fig. 5-7. Nea Paphos, aerial photograph of the House of Theseus and adjacent structures. Reburial of mosaics during winter (photos: A. Charalambous for the Department of Antiquities)

decision is made (Roby 2004, 231) and applying a generalized scheme for every mosaic to be reburied must be avoided.

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HERITAGE MANAGEMENT OF THE MONASTERY OF AGHIOS LOT AT DEIR 'AIN 'ABATA IN JORDAN

Konstantinos D. Politis

From the outset of the Deir 'Ain 'Abata project in 1988, I, as director, made every effort to involve the local community, emphasizing that the cultural heritage of the site belonged to them and trying to relate the archaeological discoveries to the realities of their present lives. This was particularly challenging because the Ghor es-Safi is a relatively underdeveloped region of Jordan and consequently its inhabitants are financially disadvantaged and less educated. The most immediate and obvious benefit for them was the employment offered by the project. During the project's seasons from 1988 to 2003, a core of the local labourers would return to work at Deir 'Ain 'Abata, which provided a great financial advantage to them and their extended families. Eventually, with the establishment of a Department of Antiquities office on-site and the increasing demand for ancient sites to be guarded, some of these workmen were able to secure permanent jobs. The archaeological and conservation skills which some of the workers had acquired from on-site training further enhanced their employment opportunities.

With the completion of the archaeological excavation of the Monastery of Aghios Lot, its development as a site with tourism potential created further opportunities for the local community. The Ministry of Tourism and Antiquities of Jordan made substantial funds available to consolidate all the an-

Fig. 1. View from above the Church of Aghios Lot showing conserved mosaics and security fence (photo: K.D. Politis)

Fig. 2. Blessing ceremony in the Church of Aghios Lot (photo: auto shot photo)

cient structures (Fig. 1 and 2), re-build a long protective wall above the site, and improve visitor accessibility by building a road and a stone stairway leading up to the site. The conservation of the mosaic pavements was sponsored by the European Centre for Byzantine and Post-Byzantine Monuments under the supervision of Dr Stefania Chlouveraki. The study and design for a protective shelter above them has been made by Dr Zaki Aslan and is awaiting funding.

Deir 'Ain 'Abata was proclaimed a *maqam* (holy site of Islam) by H.M. the late king Hussein in 1995. In 2004, Jordan proposed that Deir 'Ain 'Abata should be on UNESCO's World Heritage List. Although the bid was unsuccessful, it showed how valued the site had become. It is currently on the Tentative List.

Finally, in 2005, the building of a museum at Deir 'Ain 'Abata guaranteed the permanent protection of the site and ensured long-term benefits for the local community. Furthermore, the displaying of archaeological finds from the excavations demonstrated, for the first time, the presence of a long local history thereby creating a sense of heritage. This was the object of the Hellenic Society for Near Eastern Studies which designed the exhibition.

Konstantinos D. Politis, Hellenic Society for Near Eastern Studies

MOSAIC CONSERVATION PLANNING AND IMPLEMENTATION AT THE SITE OF BULLA REGIA, TUNISIA*

Thomas Roby, Livia Alberti, Cristina Caldi, Ermanno Carbonara, Moheddine Chaouali, Leslie Friedman and Hamida Rhouma

Abstract

The Bulla Regia Model Field Project, part of the MOSAIKON Initiative, grows out of ten years of mosaic conservation training activities of the Getty Conservation Institute in collaboration with the Institut National du Patrimoine of Tunisia. The project has two main components: the complete conservation treatment and presentation of an entire excavated building, and the development of a long-term conservation plan for the almost 400 mosaics throughout the archaeological site. The planning followed an inventory and rapid survey of all mosaics using a new survey form. The data collected will provide the basis for decision-making about how to conserve the site's mosaics through a combination of reburial, protective sheltering and maintenance programs involving trained conservation technicians based at the site.

Fig. 1. Recently trained INP technicians with periodic GCI supervision conserving the mosaics of the Maison de la Chasse (photo: Scott S. Warren © 2011 The J. Paul Getty Trust)

The Bulla Regia Mosaic Conservation project of the MOSAIKON initiative (Teutonico *et al.*2014; Teutonico and Friedman 2017) began in Spring 2011 and grows out of ten years of in situ mosaic maintenance technician training and mentoring activities that the Getty Conservation Institute and its partner, the Institut National du Patrimoine of Tunisia have undertaken (Roby *et al.* 2014; Roby *et al.* 2010, 207-213; Roby *et al.* 2008, 258-264; Roby *et al.* 2005, 347-355). Three of the recently trained maintenance technicians are currently employed at the archaeological site of Bulla Regia, and they form the nucleus of the project by carrying out basic stabilization operations on mosaics throughout the year (Fig. 1). One of the main goals of the project is to carry out a complete in situ mosaic conservation program, which could serve as a positive example of conserving, presenting and maintaining an entire archaeological building, the Maison de la Chasse, and its architectural decoration (Fig. 2).

The majority of the conservation work is being carried out by GCI-trained mosaic maintenance technicians, in order to complete their training by experiencing a real conservation project and to highlight the importance of their work for the successful, sustainable conservation and maintenance of mosaics at major sites (Fig. 3 and 4). The work is being planned, supervised and supported by a team of GCI staff and consultant conservators/instructors in collaboration with the INP.

Another major aim of the Bulla Regia project is to develop a conservation plan for the almost 400 excavated mosaics at the site. Many of these, after decades of being left exposed and walked on, are in very poor condition, and some are already beyond repair (Fig. 5). Given the resources of the site, both human and financial, the survival of hundreds of mosaics at Bulla Regia depends on developing and carrying out a prioritized plan of action to stabilize and protect through reburial many mosaics at the site, while conserving and presenting to the public only a selected number. The condition, significance and exposure data collected for each mosaic through the survey will provide the basis for decision-making about how best to preserve all the mosaics of the site, through a combination of reburial, protective sheltering and maintenance programs (Fig. 6). The resulting conservation plan will provide a much-needed management tool for Bulla Regia, and potentially a planning example for other sites in Tunisia and in the Mediterranean region with significant collections of in situ mosaics.

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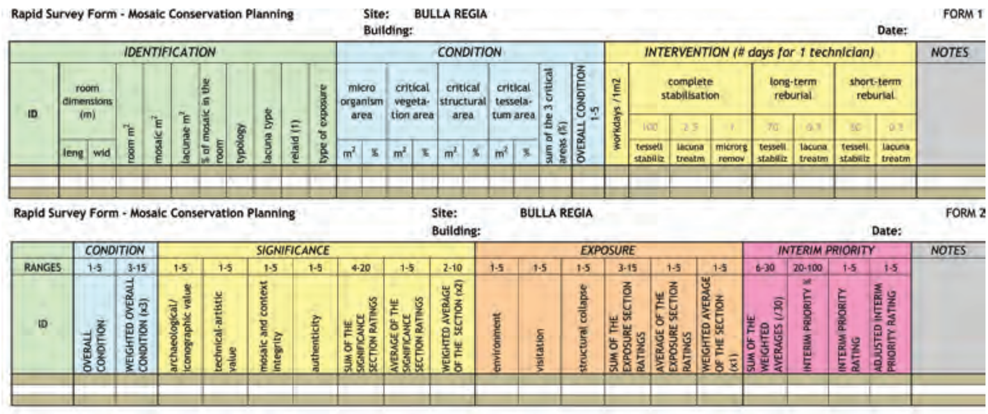
Livia Alberti, conservator, partner of Consorzio Arke, Rome
Cristina Caldi, conservator, Rome
Ermanno Carbonara, conservator, Ravenna
Moheddine Chaouali and Hamida Rhouma, Institut National du Patrimoine, Tunisia

Fig. 2. General view of the Maison de la Chasse, ground level (photo: Scott S. Warren © 2011 The J. Paul Getty Trust)

Fig. 3. A mosaic after recent maintenance treatments by INP technicians based at the site (photo: Ermanno Carbonara © 2011 The J. Paul Getty Trust)

Fig. 4. Infilling of a lacuna using lime mortar, a common maintenance operation (photo: Scott S. Warren © 2011 The J. Paul Getty Trust)

Fig. 5. One of many neglected mosaics in very poor condition throughout the site of Bulla Regia (photo: E. Carbonara © 2012 The J. Paul Getty Trust)



Rapid Survey Form - Mosaic Conservation Planning — Site: BULLA REGIA — Building: — Date: — FORM 1

IDENTIFICATION											CONDITION										INTERVENTION (# days for 1 technician)								NOTES
ID	room dimensions (m)		room m²	mosaic m²	lacunae m²	% of mosaic in the room	typology	lacuna type	relaid (1)	type of exposure	micro organism area		critical vegetation area		critical structural area		critical tesselatum area		sum of the 3 critical areas (%)	OVERALL CONDITION 1-5	workdays /1m2	complete stabilisation			long-term reburial		short-term reburial		
																						100	2.5	1	70	[illegible]	50	[illegible]	
	leng	wid									m²	%	m²	%	m²	%	m²	%				tesseli stabiliz	lacuna treatm	microrg remov	tessell stabiliz	lacuna treatm	tessell stabiliz	lacuna treatm	

Rapid Survey Form - Mosaic Conservation Planning — Site: BULLA REGIA — Building: — Date: — FORM 2

	CONDITION		SIGNIFICANCE							EXPOSURE						INTERIM PRIORITY				NOTES
RANGES	1-5	3-15	1-5	1-5	1-5	1-5	4-20	1-5	2-10	1-5	1-5	1-5	3-15	1-5	1-5	6-30	20-100	1-5	1-5	
ID	OVERALL CONDITION	WEIGHTED OVERALL CONDITION (x3)	archaeological/ iconographic value	technical-artistic value	mosaic and context integrity	authenticity	SUM OF THE SIGNIFICANCE SECTION RATINGS	AVERAGE OF THE SIGNIFICANCE SECTION RATINGS	WEIGHTED AVERAGE OF THE SECTION (x2)	environment	visitation	structural collapse	SUM OF THE EXPOSURE SECTION RATINGS	AVERAGE OF THE EXPOSURE SECTION RATINGS	WEIGHTED AVERAGE OF THE SECTION (x1)	SUM OF THE WEIGHTED AVERAGES (/30)	INTERIM PRIORITY %	INTERIM PRIORITY RATING	ADJUSTED INTERIM PRIORITY RATING	

Fig. 6. A rapid survey form has been created and is being tested in the field in preparation for surveying all mosaics at the site. The two-part form will facilitate data collection, which in turn will aid the prioritization and programming of future mosaic conservation and reburial activities throughout the site (© 2011 The J. Paul Getty Trust)

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SESSION IV:
CAPACITY BUILDING AND THE STATE OF THE PROFESSION

Jessica Lewinsky and
Jacques Neguer

Jeanne Marie Teutonico and
Leslie Friedman, on behalf of the
MOSAIKON partners

A BRIEF BIBLIOGRAPHICAL REVIEW ON MOSAIC CONSERVATION: CRITICAL AND STATISTICAL ANALYSIS OF RECENT PUBLICATIONS REGARDING EVOLUTION AND CRITERIA

Jessica Lewinsky and Jacques Nequer

Abstract

This brief bibliographical review gathered over 250 major and recent works published regarding mosaic conservation. The different bibliographical sources were then categorized and used to create a simple database in which one can correlate the different evaluation criteria. Five main categories were considered:

1. Conservation theory and principles
2. Material aspects
3. Valuation
4. Conservation practices
5. Study cases

The public addressed, the accessibility and the type of source, were also considered.

The statistics were graphically portrayed and showed interesting tendencies and facts regarding the evolution and criteria used for the intervention on mosaics throughout history, as well as the interpretation and valuation we have of these polysemic objects. The aim of this bibliographical review was to better understand the current situation of mosaic conservation. By understanding where we stand we can organize our institutions in a better way, knowing our limits and addressing part of the issues. We can help generate more studies, create a wider database, optimize the communication amongst professionals and the public, publish new research and train people. But most importantly we can convene terms regarding the language used and try to determine standards for the evaluation, policy and planning being done.

Today, we understand that mosaics work as complex systems in which the object and architecture unite to form a unified space. Through the course of the conservation process of mosaic sites, we comprehend these polysemic objects, reevaluating them and creating knowledge through our disciplinary approach.

The principles we use today are derived from the historic evolution that mosaic valuation and treatment has had. Before the establishment of the ICCM and similar bodies, conservators worked in isolation, basing their decisions on empirical knowledge. Then paradigms shifted. Mosaics were valued as part of the context and, slowly but surely, in situ preservation was sought. Throughout the following years, the protocols for recovering mosaics were changed through new methods, protection plans and even draining systems. Professionals started to focus on material technology and evolution. Instead of extreme treatment, maintenance and interdisciplinary team efforts were pursued. It was decided that planned approaches were needed for the safeguarding of the monuments. This led to minimized risk strategies that also integrate public needs and elimination of hazards, while practicing the preservation of this heritage. The focus shifted in order to create preventive conservation management plans.

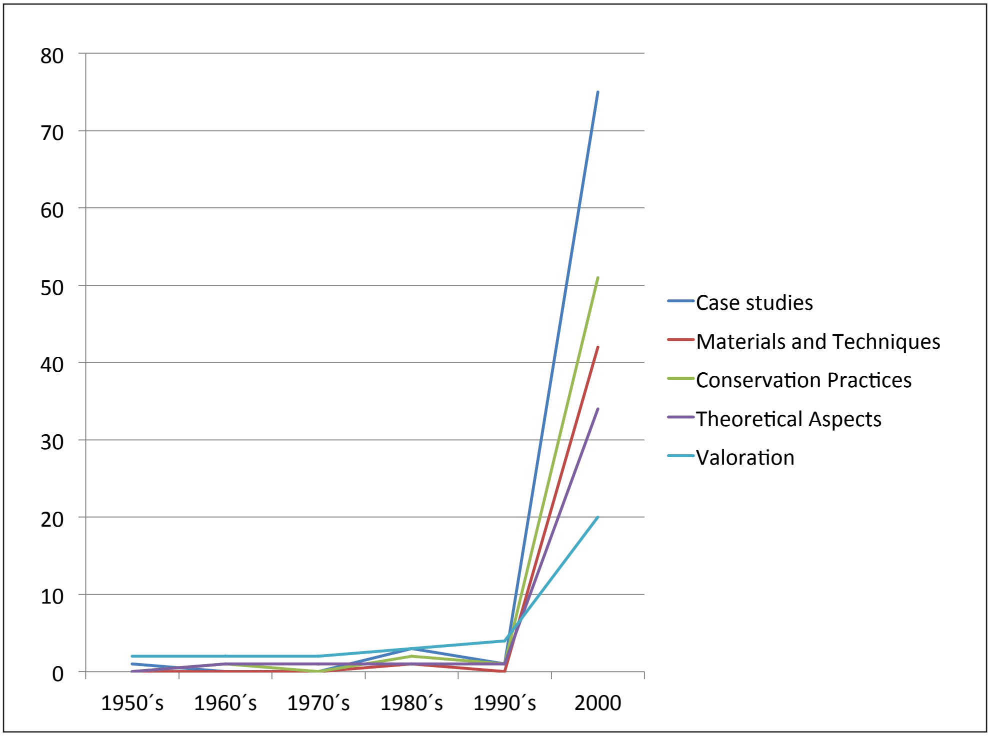

Fig. 1. The evolution of publications through the decades

The graph on Figure 1 portrays the evolution publications have had through the decades. It notes that most of the sources studied for this bibliographical review only date back to the 1950s and that the interdisciplinary paradigm began in the 1990s when professionals started sharing more of their work and conversing with their peers. The themes addressed can also be seen, noting that in more recent times study cases have been preponderantly published, but they are not necessarily contributing to the theoretic aspects of mosaic conservation or the disciplinary reach or these practices. We can also acknowledge that, as a discipline, we forget to forge bonds with the communities that live with the sites, and the importance of this heritage. It seems to be a given; yet valuation studies are the topic less developed so far. Through the review of major and recent works published, an approximation was reached about the evolution and criteria used for the intervention of mosaics throughout history. Over 250 different sources were read, evaluated and categorized. A database was created using a simple and accessible program (Excel), in which one can correlate the different evaluation criteria (see Tables 1 and 2). It helped establish and understand the status quo of mosaic conservation and research. For the study five main categories were considered:

- *Conservation theory and principles*. Ethical backgrounds and creation of methodological guidelines. This includes historic and graphical research.

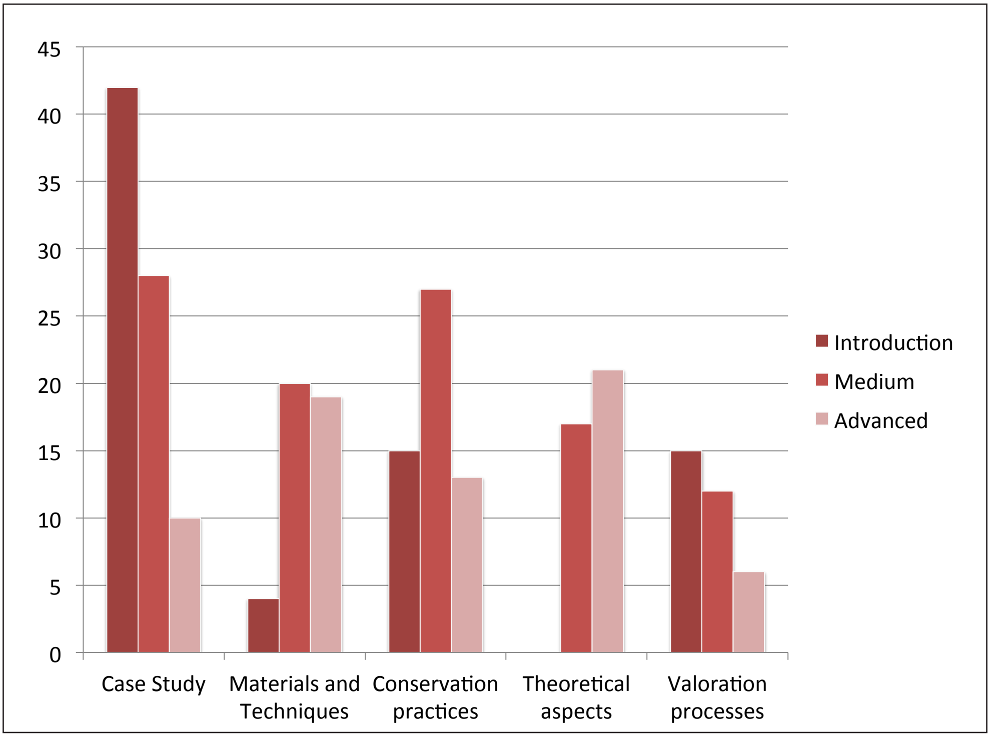

Fig. 2. Correlation of the tendency between the topic of the source and the public it is addressed to

– *Material aspects*. Scientific research of materials, mechanisms and techniques; as well as their evolution and analysis.
– *Valuation*. Interpretation and significance of mosaics. This includes the sociological importance of sites and monuments, the divulgation on their existence, iconographic descriptions, stylistic evolution and the impact on the sites by visitors and public.
– *Conservation practices*. It includes diverse treatments and process innovations.
– *Study cases*. Reports of particular cases.

The public addressed, the accessibility and the type of source, were also considered and integrated in the database. Even though some texts can be classified in more than one category, at this stage it was decided to prioritize. For future reference it would be wise to create sub-categories which would also be beneficial for research. The statistics showed interesting tendencies and facts, some of which were graphically portrayed.

The relative graph (Fig. 2) correlates the tendency between the topic of the source and the public it is addressed to. We can see that the majority of case studies are written for a general public, and very few of the cases share relevant information for the advanced researcher. That is to say that no new knowledge is being dispersed or helping consolidate the conservation discipline. It is also worth mentioning the gap between valuation processes and applied conservation theory, particularly since we now regard restoration as the reinsertion of an object in society through its values.

According to each type of publication, we could establish what the levels of communication intended in each type of source were. Hence, even though the bibliographical matrix reveals that there is a lot of material for researchers or sources with an advanced level of conservation knowledge, we must also consider the type of source. For example, not much information or analysis can be placed on a poster. Furthermore, we must reflect on the fact that the majority of sources reviewed, 158, were articles. This means that most essays tend to broach the subject and not delve into it, as a book would do. On the other hand, most online sources, and even articles, tend to be on recent research, allowing the communication between professionals to be more fluid (see Fig. 3). A major book publication on the conservation and restoration of mosaics is long overdue. Easy to come-by publications (both physically and with regard to their price) are difficult to find and compile given the small number of conservators and the vastness of the fields of study that mosaics have to offer. They range from material aspects of mosaics (i.e. chemical analysis, mortar research, materials used in situ, deterioration mechanisms) to management plans that should consider cost of maintenance, involving politics as a way to trigger responses from the visitors, communities and government, etc.

By using tools like this and fomenting a better communication between professionals, we can promote the standardization of concepts and ethical standards for our interventions on mosaics. Evaluation criteria could be, if not established, at least discussed. Amongst the many things that are still not completely approached and present a challenge to us we have the following examples: Creating new solutions regarding community integration with the monument; site management; treatment of previously relayed mosaics; depot and storage needs; reburial, relay and exhibition techniques.

Stylistic evolution and dating could be accomplished through this type of feedback. This would help define what characterizes each mosaic. We could furthermore study the implications of what a site and its mosaics need and how our actions affect the outcome and future of the said heritage. By doing qualitative and quantitative research we can follow up on the practices being implemented on and off sites. This would also help determine the retreatability and success of certain materials in general, and not only in very particular contexts. An added bonus would be our ability to evaluate the impact that our knowledge has on modern techniques. It could be a way to influence the production of new mosaics by ensuring their preservation for future generations and by helping the artist create more durable artworks. In summary, by understanding where we stand, we can organize our institutions in a better way, knowing our limits and addressing part of the issues. We can help generate more studies, create a wider database, optimize the communication amongst professionals and the public, publish new research and train more people. But most importantly, we can convene terms regarding the language used and try to determine standards for the evaluation of the work being done.

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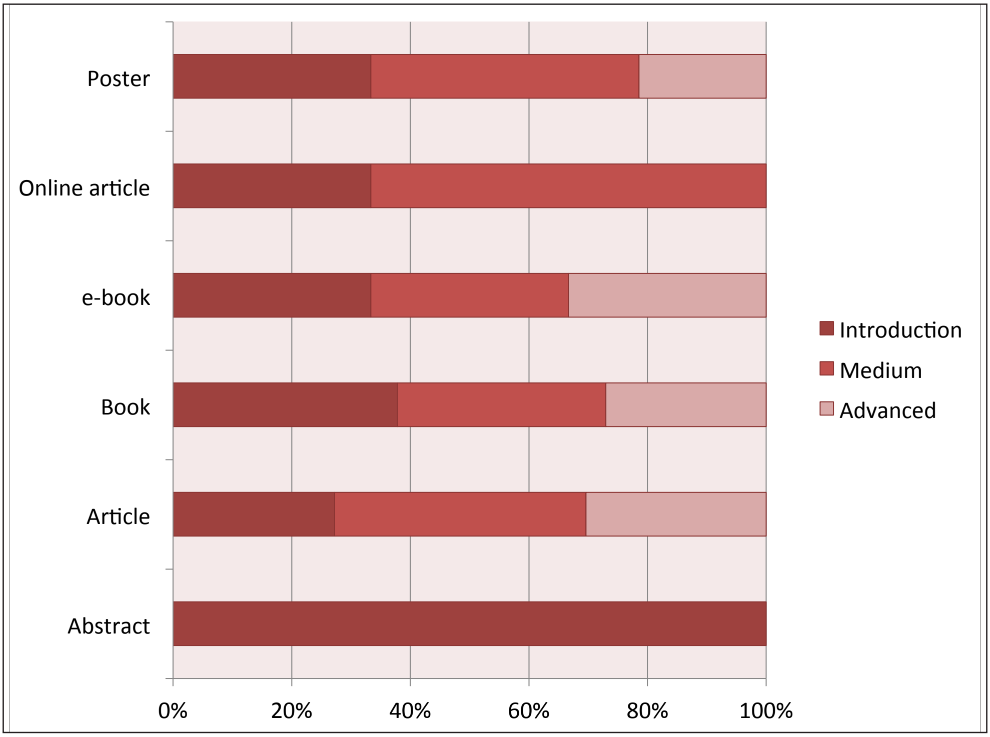

Fig. 3. Classification of sources reviewed

Author	Year	Title	Editorial	City	Classification	Type of reference	Comments	Accesability	Quality
Abdelouahab, Naïma	2003	"La mosaïque des poissons de Musée National des Antiquités d´Alger: une restauration contestée"	ICCM	Arles	cas	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	2
Abou Bakr El Khousht, Amira	2003	"Documented photographs showing the various steps for the conservation of mosaic discovered in 1993 in Alexandria District, where the New Alexandrian Library is now being erected"	ICCM	Arles	cas	poster	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	1
Abraços, Maria de Fatima	2005	"Les mosaïques romaines du Musée National d'Archéologie, Lisbone"	ICCM	Thessaloniki	t	poster	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	2
Accardo, Giorgio	2004	"il 'restauro preventivo': dalla teoria alla practica"	Dario Flaccovio Editore	Palermo	t	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	3
Aiello, Enzo	2010	Micromosaic in Smalti Filati Techinique	Online		mat	online article	http://www.aiellomosaics.com/about-mosaics/techniques-and-materials/micromosaic-in-smalti-filati-technique/	1	2
Al-Azm, Amr	2004	"Conservation and presevation of mosaics in Syria; examining the case to remove or restore in situ from a Syrian perspective"	Dario Flaccovio Editore	Palermo	prac	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	1
Alaveras, Christos	2005	"Pictorial Intervention in the presentation of the mosaics in Saint Sophia, Thessaloniki"	ICCM	Thessaloniki	cas	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002. Interdisciplinary view. Author is a painter with religious background	1	2
Alberti, Livia; Bourguignon, Elsa; Roby, Thomas	2008	Technician training for the maintenance of in situ mosaics	The J. Paul Getty Trust	Tunisia	prac	e-book	http://www.getty.edu/conservation/publications_resources/pdf_publications/pdf/technician_training_2014.pdf	1	1
Alberti, Livia; Mannunccia, Francesco; Tartaglia, Laura; Tusa, Sebastian	2004	"Conservazione e restauro musivo a Mozia, Salemi e Mazara del Vallo"	Dario Flaccovio Editore	Palermo	cas	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Desciption of work on varous sites	3	3

Alberti, Livia; Muscolino, Cetty	2005	"The conservation of the mosaics of San Vitale in Ravena, Italy, 1989-1999"	ICCM	Thessaloniki	mat	article	8th ICCM conference, Thessaloniki, 29 October-3 November 2002	1	3
Albini, Romana; Zizola, Chiara	2003	"Zippori. In situ conservation of a floor mosaic in polychrome stones and glass paste"	ICCM	Italy	cas	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	1
Alef, Yael	2002	Evaluation of shelters over mosaics in Israel	Katholieke Universiteit Leuven	Leuven	prac	thesis		3	2
Altieri, Antonella; Cacace, Carlo; Coladonato, Maurizio; Laurent, Maria Concettai; Roccardi, Ada	2004	"Aree archeologiche e conservazione; una sperimentazione di alcuni sistemi di copertura con geotessili"	Dario Flaccovio Editore	Palermo	mat	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Altieri, Antonella. Poggi, Domenico. Ricci, Sandra	2003	"Mosaic pavements from the Thermae of Caracalla (Rome): biodeterioration and methods of control"	ICCM	Italy	mat	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	3
Angelelli, Claudia; Guidobaldi, Federico; Rossi, Filli	2003	Conservation in situ des pavements de marbre du Capitolium de Brescia	ICCM	Arles	t	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999. Identifying previous interventions and criteria	1	2
Aoyagi, Masanori; Angelelli, Claudia	2004	"La villa romana di Tarquinia"	Dario Flaccovio Editore	Palermo	mat	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Ardovino, Angelo María	2004	"Manutenzione programmata e riposizionamento filologico. La stessa base di metodo e gli stessi operatori?"	Dario Flaccovio Editore	Palermo	t	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Desciption of work on varous sites	3	2
Ardovino, Angelo María	2005	"Il caso del mosaico di Alessandro di Pompei: Squardo sull´ideologia selettiva della conservazione nell´Ottocento, e riflessioni peri il restauro di mosaici già restaurati"	ICCM	Thessaloniki	cas	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	2
Ardovino, Angelo María; Gasetti, Elisabetta; Masseroli, Sara	2005	"Una scheda come strumento conoscitivo di tecnologie esecutive e di successioni di restauri nel mosaico antico"	ICCM	Thessaloniki	prac	article	Italian. 8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	1
Argyrou, Christos	2005	"Mosaics through teaching history and art in the secondary education of Cyprus"	ICCM	Thessaloniki	val	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	2

Armenteros, Josefina Blanca	2005	Gestion y coordinacion de exposiciones	UCM	España	prac	book		2	2
Artal-Isbrand, Paula; Nunberg, Sarah	2003	"New solutions for loss compensation on mosaics at the Worcester Art Museum"	ICCM	Arles	mat	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	2
Artal-Isbrand, Paula; Vignalo, Alisa	2005	"The Worcester Hunt Mosaic: a 68 year treatment history"	ICCM	Thessaloniki	t	article	8th ICCM conference, Thessaloniki, 29 Oct-0ber-3 November 2002	1	3
Aslan, Zaki	2003	"Assesing the Efficiency of Protective Structures for in Situ Conservation and Presentation of Mosaics on Archaelogical Sites. A planning and design methodology for architects and site managers"	ICCM	Arles	prac	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	3
Assimakopoulou-Atzaka, Panayota; Kourkoutidou-Nikolaïdou, Eftychia	2003	"Les mosaïques prélevées de leur contexte original: le prix de l´expérience"	ICCM	Arles	prac	article	7thI ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	2
Avi-Yonah, Michael	1978	Ancient mosaics	Keter Publishing	Israel	val	book		2	1
Aydogdu, Mustafa H.	2005	"Approach to Cultural Heritage of the GAP Region, Turkey"	ICCM	Thessaloniki	t	article	8th ICCM conference, Thessaloniki, 29 October-3 November 2002. Socio-cultural implications. The bigger context. Aslo published in Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	1	3
Bakirtzis, Charalambos; Xydas, Pandelis	2003	"Les mosaïques d´Amphipolis paléochrétiennne: conserver et/ou présenter"	ICCM	Arles	cas	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	1
Bakirtzis, Charalambos; Mastora, Pelli; Pitsalidis, Nicos	2005	"Conservation, maintenance and presentation of the wall mosaics in the Basilica of Saint Demetrios, Thessaloniki"	ICCM	Thessaloniki	cas	poster	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	1
Balmelle, Catherine	2004	"La redécouverte de mosaiques de Jebel Oust"	Dario Flaccovio Editore	Palermo	cas	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2

Balty, Janine	2004	"Les pavements de la Cathédrale d´Apamée de Syrie"	Dario Flaccovio Editore	Palermo	cas	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Banks, Joyce M.	1987	Guidelines for preventive conservation	Canadian Conservation Institute	Ottawa	t	book		2	2
Barrow, Jake	2003	"The Quapaw Dome Project"	ICCM	Italy	cas	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	2
Ben Abed, Aicha	2003	"Une nouvelle politique de conservation des mosaïques en Tunisie"	ICCM	Arles	prac	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	2
Blanc, Patrick; Courboulès, Marie-Laure	2003	"Deux nouvelles mosaïques de pavement à Alexandrie: Conservation et "restauration"	ICCM	Arles	cas	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	2
Blázquez Martínez, José María	2005	"Mosaics of Roman Spain restored in the Antiquity"	ICCM	Thessaloniki	cas	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	1
Blázquez Martínez, José María	2004	"Mosaicos de la España tardoantigua documentados sólo en dibujos"	Dario Flaccovio Editore	Palermo	val	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Stylistic evolution	3	3
Boardman, John; Griffin, Jasper; Murray, Oswyn	1986	Oxford History of the Classical World	Oxford university Press	New york	val	book	Compilation	1	1
Bonacasa, Nicola	2004	"Sabratha – Terme di Oceano, restauro dei mosaici 1999-2002"	Dario Flaccovio Editore	Palermo	cas	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Desciption of work on varous sites	3	1
Bonanno, Carmela; de Domenico, Giuseppe	2004	"L´ambiente con pavimento cementizio di Piazza S. Teodoro a San Marco, Messina"	Dario Flaccovio Editore	Palermo	cas	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Branciforti, Maria Grazia	2004	"Pavimenti in opus sectile di Catania"	Dario Flaccovio Editore	Palermo	cas	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Cacace, Carlo	2004	"Carta de Rischio: La vulnerabilità archeologica"	Dario Flaccovio Editore	Palermo	t	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	3

Calabrese, Vincenzo	2004	"Indagini non distruttive sui mosaci della Villa del Casale a Piazza Armerina"	Dario Flaccovio Editore	Palermo	mat	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	1
Campbell, Sheila D.	1988	The mosaics of Antioch	Pontifical Institute of Mediaeval Studies	Toronto	cas	book		3	2
Caple, Chris	2004	"Towards a Benign Reburial Context. The chemistry of the burial environment"	James & James	New Mexico	mat	article	Conservation and Management of Archaeological Sites	3	3
Carra Bonacasa, Rosa Maria	2004	"Il relievo come strumento per la conoscenza e documento per la conservazione"	Dario Flaccovio Editore	Palermo	prac	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Carvalho Dias, Ana; Krougly, Laurence; Monraval Sapiña, Magda	2003	"Sauvegarde et présentation 'in situ' des mosaïques de la 'villa' romaine de Torre de Palma"	ICCM	Arles	cas	poster	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	2
Cassio, Antonio; Nardi, Roberto; Schneider, Kristian	2005	"Zeugma mosaics restoration project"	ICCM	Thessaloniki	prac	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	3
Ceschi, Franco	2004	"La copertura protettiva permanente della Villa Romana di Patti Marina"	Dario Flaccovio Editore	Palermo	prac	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Chantriaux-Vicard, Evelyn; Laporte, Christophe; Hayes, Maria; Phoungas, Andréas; Simon, Maurice	2005	"Maintenance et pesentation in situ a Saint Romain en Gal"	ICCM	Thessaloniki	prac	article	French. 8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	2
Chantriaux-Vicard, Evelyne	2004	"Mosaiques conservées sur leur assise d´origine ou reposées sur un nouveau support"	Dario Flaccovio Editore	Palermo	t	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Desciption of work on varous sites	3	2
Chlouveraki, Stephania N.; Politis, Konstantinos D.	2003	"The documentation and conservation of the nave mosaic in the Basilica of Agios Lot at Deir Ain Abata, Jordan"	ICCM	Italy	cas	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	2
Chmielewski, Krysztof	2005	"Conservation of Byzantine floor mosaics from Shhim in Lebanon"	ICCM	Thessaloniki	cas	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	2

Chrysopoulous, Demetrios	2005	"First salvage and general interventions in the mosaics of the Monastery of Daphni after the earthquakes of 7th September 1999"	ICCM	Thessaloniki	prac	article	Greek. Earthquake treatments. 8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	2
Chrysopoulous, Demetrios	2003	"Aesthetic restoration and presentation of mosaics"	ICCM	Italy	prac	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	1
Cigna, Maria Concetta; Frazzio, Franco	2004	"La villa romana di Capo Boèo: Intervento di consolidamento della superficie musiva"	Dario Flaccovio Editore	Palermo	cas	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Consolidation. Methodology description	3	2
Cinquepalmi, Angela	2004	"Documentazione musiva nel Museo Nazionale di Egnazia"	Dario Flaccovio Editore	Palermo	prac	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Exhibition in museums	3	2
Clementi, Tatiana	2005	"Una banca dati computerizzata per il mosaico"	ICCM	Thessaloniki	t	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002. Collection of information	1	3
Coco, Anna Maria Daniela; Lupo, Provvidenza	2004	"Esempi di mosaici pavimentali a Solunto"	Dario Flaccovio Editore	Palermo	cas	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	1
Coco, Anna Maria Daniela; Pomilla, Rosella; Ventura Bordenca, Lucia	2004	"Villa Romana del Casale Piazza Armerina"	Dario Flaccovio Editore	Palermo	cas	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	1
Coco, Anna Maria Daniela; Ventura Bordenca, Lucia; la Placa, Angelo	2004	"Criteri e strumenti per una carta del rischio del patrimonio archeologico musivo siciliano"	Dario Flaccovio Editore	Palermo	mat	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	3
Collins, Sheldan	1986	How to photograph a work of art	American association for state and local history	Nashville	prac	book		2	1
Constanzi Cobau, Andreina; Nardi, Roberto	2003	"Conservation and protection of archaeological mosaics: the case of the building of the Nile in Zippori"	ICCM	Italy	cas	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	3
Corfield, Mike	2003	"A Framework for the documentation of in situ mosaic conservation projects"	ICCM	Italy	prac	article	6th ICCM Conference, Nicosia, 24-28 October 199. Sub category: documentation. Creation of standards and policies	1	3

Corrente, Marisa; Vona, Fabrizio	2004	"Mosaici tardoantichi di Canosa. Prospettive di recupero e analisi del rischio. Vecchi e nuovi interventi delle soprintendenze pugliesi a confronto"	Dario Flaccovio Editore	Palermo	cas	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	3
Corrente, Marisa	2004	"Il patrimonio musico della città di Canosa di Puglia"	Dario Flaccovio Editore	Palermo	cas	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	1
Cosentino, Pietro L.; Anselmo, Giacomo; Capizzi, Patrizia; Genovese, Carmelo; Martorana, Raffaele; Messina, Paolo; Miraglia, Dario; Pellerito, Santino; Romano, Loredanza; Sanfratello, Vincenzo	2004	"Indagini geofisiche in siti archeologici con mosaici: interventi sulla Villa del Casale, a Piazza Armerina"	Dario Flaccovio Editore	Palermo	mat	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Desciption of work on varous sites	3	2
Darmon, Jean-Pierre	2004	"La conservation des mosaïques de la Maison des Nymphes à Nabeul"	Dario Flaccovio Editore	Palermo	val	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Desciption of work on varous sites	3	1
Daszewski, Wiktor A.	2003	"Remarques sur l´attitude des anciens vis-à-vis de la restauration des mosaïques"	ICCM	Arles	val	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	3
Davidov, Nicky; Neguer, Jacques	2005	"Mosaic Conservation planning based on rectified photography and standard PC software"	ICCM	Thessaloniki	prac	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	2
de Felice, Giulano	2005	"The documentation during conservation of the mosaics of Zeugma, Turkey"	ICCM	Thessaloniki	prac	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002. Also in Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	1	3
de Guichen, Gäel; Nardi, Roberto	2006	"Mosaic Conservation: Fifty years of modern practice"	GCI	California	t	online article	http://www.getty.edu/conservation/publications/newsletters/21_1/feature.html	1	2

De Marinis, Giuliano; Quiri, Paolo	2004	"I nuovi mosaici della cattedrale di Pesaro"	Dario Flaccovio Editore	Palermo	cas	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	1
Dell´Aglio, Antonietta; Masiello, Laura	2004	"Recenti Rinvenimenti Musivi a Taranto"	Dario Flaccovio Editore	Palermo	cas	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	1
Demas, Martha	2003	"Ancient mosaics in situ: a project of the Getty Conservation Institute for conservation of mosaics in archeological sites"	ICCM	Arles	val	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	3
Demas, Martha	2004	"Site Unseen: the case for reburial of archaeological sites"	James & James	New Mexico	t	article	Conservation and Management of Archaeological Sites	3	3
Demus, Otto	1947	Byzantine mosaic decoration: Aspects of monumental art in Byzantium	Kegan, Trench, Trubner	London	val	book		3	1
Derram, Mouloud	2003	"Restauration de la mosaïque des Poissons au Musée National des Antiquités d´Alger"	ICCM	Arles	cas	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	1
Di Stefano, Carmela Angela	2004	"Lilibeo, Insula. Il contributo alla rilettura di un contesto archeologico"	Dario Flaccovio Editore	Palermo	val	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Desciption of work on varous sites	3	1
Di Stefano, Cosimo	2004	"Indagini chimico-fisiche sui materiali constitutivi, e studio dei fenomeni di degrado dei mosaici"	Dario Flaccovio Editore	Palermo	mat	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	3
Di Stefano, Cosimo	2004	"Aspetti chimici su materiali musivi: caratterizzazione e fattori di degrado"	Dario Flaccovio Editore	Palermo	mat	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Distefano, Giovanni	2004	"Il patrimonio musivo della provincia di Ragusa"	Dario Flaccovio Editore	Palermo	cas	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	1
Doner, Herbert	1988	Observations on the mosaic map of Madaba		Aleppo	cas	book	Reference number in the Israel Antiquities Library: X/f CON 91 (iii)	3	1
Dothan, Moshe	1983	Hammath Tiberias	Ben-Zvi Printing Enterprises Ltd.	Jericho	cas	book		2	1

Drury, Paul. McPherson, Anna	2006	Conservation principles for the sustainable management of the historic environment	English Heritage	London	t	book		2	2
Dunbabin, Katherine M.D.	2004	"Mosaics and Culture: East and West"	Dario Flaccovio Editore	Palermo	val	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	1
Edwards, Carol; Corfield, Mike; Knight, Barry; Teutonico, Jeanne Marie; Adams, John	2003	"The Investigation and Conservation of 4th Century AD mosaics at Brading Roman Villa, Isle of Wight, England"	ICCM	Italy	cas	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	1
Elsner, Jas	1998	Imperial Rome and Christian Triumph	Oxford University Press	New York	val	book		1	1
Fauquet, Fabricia; Florenzano, Michel	2003	"El Jem, la maison d´Africa. Restitution mumérique des sols pavés de mosaïques dans leur contexte architectural"	ICCM	Arles	prac	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	2
Ferlisi, Teresa	2004	"Carta del rischio del patrimonio archeologico musivo siciliano"	Dario Flaccovio Editore	Palermo	prac	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Localization map	3	2
Ferlisi, Teresa; Nicoletti, Rossana	2004	"Il patrimonio musivo dei siti archeologici Siciliani"	Dario Flaccovio Editore	Palermo	val	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Fernández, Alonso; García, Isabel	2005	Diseño de exposiciones: concepto, instalación y montaje	Alianza editorial	Madrid	prac	book		2	2
Fernandez, Charo; Arechavala, Fernando; Muñoz-Campos, Paloma; de Tapol, Benoit	2008	Exposiciones temporales: conservación preventiva. Procedimientos	Ministerio de cultura de España	Madrid	prac	book		2	2
Fernández, Miguel Ángel	2000+	Mosaicos en México. El taller de la familia Perdomo	Artes de México	México	val	book	In Spanish. Historical review. Also techniques and history of partcular factory	1	2
Ferro de la Sota, Hernán	1998	La axiología en la conservación de monumentos	Universidad de Guanajuato	México	t	book		3	3

Filloy Nadal, Laura	2000 +	Misterios de un rostro maya. La máscara funeraria de K´inich Janaab Pakal de Palenque	IN-AH-CONACULTA	México	cas	book	In Spanish	1	3
Fischbacher, Verena; Flatt, Robert; Girardet, Fred; Kaufmann, Matthias; Weidmann, Denis	2003	"Traitment in situ de mosaiques à Orbe"	ICCM	Arles	cas	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	1
Fontaine, Thomas H.M.	2003	"History as a Burden. The Mosaic Collection of the Rheinisches Landesmuseum Trier"	ICCM	Arles	prac	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999. Museum conservation	1	2
Ford, Dabney; Demas, Martha; Agnew, Neville; Blanchette, Robert; Maekawa, Shin; Taylor, Michael Romero; Dowdt, Katherine	2004	"Chaco Canyon Reburial Programme"	James & James	New Mexico	cas	article	Conservation and Management of Archaeological Sites	3	2
Foschi, Enrica	2003	"The mosaics of the baths at Sabratha, in Tripolitania: a conservation methodology for an historical 'system'"	ICCM	Arles	t	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	2
Gambogi, Pamela; Tuccino, Walter; Fontanelli, Rossano	2003	"Pavimenti musivi della mansio d´età imperiale di Collesalvetti"	ICCM	Arles	cas	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	1
Garufi, Robero	2004	"Mappa regionale del patrimonio musivo e criteri per una programmazzione dell´intervento sui processi di degrado"	Dario Flaccovio Editore	Palermo	t	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	3
Georgopoulou, Myrto	2004	"Complesso termale dell´epoca paloecristiana arachovitica di patrasso"	Dario Flaccovio Editore	Palermo	cas	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	1
Ghalia, Taher	2003	"Mise en valeur des mosaïques chrétiennes de Tafekhsite-Chatt Menzel Yahia"	ICCM	Arles	cas	poster	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999. Mosaic presentation	1	1
"Giammarusti, Antonio									

Risk Map for Saqqara Site"	2004	"Enhancement for the organisation and capabilities to preserve cultural heritage assets of Egypt: Risk Map for Saqqara site"	Dario Flaccovio Editore	Palermo	cas	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Giglio, Rossella	2004	"L´insula di Capo Boèo"	Dario Flaccovio Editore	Palermo	cas	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Giglio, Rossella	2004	"Pavimentazioni musive a Lilibeo, Marsala"	Dario Flaccovio Editore	Palermo	cas	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Gonzalez Varas, Ignacio	2003	Conservación de Bienes Culturales – Teoría, historia, principios y normas	Cátedra	Madrid	t	book		2	3
Grabar, André	1964	Greek Mosaics of the Byzantine Period	Fontana	Milano	val	book	UNESCO ART BOOK	2	1
Graham Bell, Maggie	1986	Preventive conservation: A manual	British Columbia Museums Association	Victoria	prac	book		2	1
Greco, Caterina	2004	"Problematiche di conservazione e fruizione del patrimonio musivo nella provincia di Enna"	Dario Flaccovio Editore	Palermo	cas	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Desciption of work on varous sites	3	1
Guex, François	2003	"Vallon: Tenants et aboutissants d´une réalisation en cours"	ICCM	Arles	cas	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	3
Gugliermetti, Franco; Santarpia, Luciano; Zori, Gianluca	2004	"Le simulazioni numeriche come strumento per lo studio, la progettazione e la valutazione degli impianti tecnologici destinati alla salvaguardia degli apparati musivi da agenti aggressivi"	Dario Flaccovio Editore	Palermo	mat	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Desciption of work on varous sites	3	2
Guidobaldi, Federico; Mecchi, Anna Maria	2004	"Trattamenti superficiali per il recupero del cromatismo originale dei pavimenti marmorei e musivi"	Dario Flaccovio Editore	Palermo	mat	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Desciption of work on varous sites	3	2
Guidobaldi, Federico; Angelelli, Claudia	2005	"I rivestimenti parietali in marmo"	ICCM	Thessaloniki	mat	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	2
Guidobaldi, Federico; Scoppola, Francesco	2004	"Rapporto del gruppo di lavoro: sistemi di protezione, criteri per una valorizzazione e una fruizione sostenible"	Dario Flaccovio Editore	Palermo	prac	report	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003.	3	1

Guimier-Sorbets, Anne-Marie	2004	"Les mosaïques d'Alexandrie: Nouvelles Découvertes, Recherches Récentes"	Dario Flaccovio Editore	Palermo	val	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Guzzardi, Lorenzo	2004	"Esigenze di sicurezza e problemi di tutela in un sito archeologico musealizzato"	Dario Flaccovio Editore	Palermo	prac	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Desciption of work on varous sites.	3	1
Hachlili, Rachel	2009	Ancient mosaic pavements: themes, issues and trends	Brill	Leiden	val	book		3	2
Hadjisavvas, Sophocles	2003	"Developing a World Heritage Site: the case of Paphos, Cyprus"	ICCM	Italy	cas	article	6th ICCM Conference, Nicosia, 24-28 October 1996. Could also be categorized in valoration processes.	1	2
Hadjisavvas, Sophocles	2003	"Developing a World Heritage Site: tha case of Paphos, Cyprus"	ICCM	Italy	cas	poster	6th ICCM Conference, Nicosia, 24-28 October 1996	1	1
Hamdan, Osama; Benelli, Carla; Khatib, Nidal	2007	"New discoveries in mosaics in the Territory under Palestinian Authority"		Jericho	cas	online article	Survey. Legal aspects for the protection of heritage	2	1
Hiotis, Andonis	2003	"The North Market Mosaics at Ancient Corinth, Greece"	ICCM	Arles	prac	poster	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	3
Hopkins, David W.	2004	"Relevance of soil biology and fertility research to archaeological preservation by reburial"	James & James	New Mexico	mat	article	Conservation and Management of Archaeological Sites	3	1
Justema, William	1976	Pattern. A Historical Panorama	New York Graphic Society	Boston	val	book		2	1
Kanonidis, Iannis O.; Mastora, Pelli	2003	"Preservation of the Mosaics at the Rotunda of Agios Georgios, the Basilica of Agios Demetrios and the Church of Agia Sofia -Thessaloniki 1997-1999"	ICCM	Arles	cas	poster	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	2
Kapshitz, Haim	2003	"The Integration of Mosaics – An Eternal Problem"	ICCM	Arles	prac	poster	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	2

Karatasios, Ioannis; Theoulakis, Panagiotis; Colston, Belinda; Watt, David; Lampropoulous, Vasilios; Kilikoglau, Vasilis	2005	"Analytical and microscopic techniques fot the study of mortars from the floor mosaics of Thebes, Greece"	ICCM	Thessaloniki	mat	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	3
Karivieri, Arja	2005	"Floor mosaics in the early Christian Basilica in Arethousa: Conservation, maintenance, presentation"	ICCM	Thessaloniki	prac	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	2
Kitzinger, Ernst	1965	Israeli mosaics of the Byzantine period	Mentor UNESCO art books	New York	val	book	Published by the New American Library	2	1
Kitzinger, Ernst	1980	Byzantine art in the making. Main lines of stylistic development in Mediterraean Art. 3rd-7th Century	Harvard University Press	USA	val	book		2	3
Kourkoutidou-Nikolaïdou, Eftychia	2003	"La restauration des mosaïques murales dans le monuments de Thessalonique"	ICCM	Italy	cas	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	2
La Placa, Angela; Ventura Bordenca, Lucia	2004	"La casa dei mosaici, Mozia"	Dario Flaccovio Editore	Palermo	cas	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	1
Laisné, Claude	1995	Art of Ancient Greece. Scultpure, paintings, architecture.	Terrail	Italy	val	book		2	1
Laurenti, Maria Concetta	2004	"Dall´intervento manutentivo al restauro del restauro"	Dario Flaccovio Editore	Palermo	t	report	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Laurenti, Maria Concetta	2003	"On-site protection of mosaics: covering and protecting archaeological remains"	ICCM	Italy	cas	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	1
Lavagne, Henri	2004	"Importance de la documentation graphique pour l´étude de la mosaïque"	Dario Flaccovio Editore	Palermo	t	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Lazzarini, Lorenzo	2004	"Philosophiana. I marmi policromi"	Dario Flaccovio Editore	Palermo	mat	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	1
Lazzarini, Lorenzo; Antonelli, Fabrizio; Cancelliere, Stefano; Verità, Marco	2004	"I materiali lapidei e vetrosi delle tessere musive delle Terme di Villa del Casale"	Dario Flaccovio Editore	Palermo	mat	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2

Levi, Doro	1947	Antioch mosaic pavements	Princeton University Press	New Jersey	cas	book		3	1
Levine, Lee	1981	Ancient synagogues revealed	Israel Exploration Society	Jerusalem	Val	book		2	2
Lipari, Antonino	2004	"Instituto Statale d´Arte per il Mosaico "	Dario Flaccovio Editore	Palermo	Val	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	1
Longo, Alessandra; Pomilla, Rossella	2004	"Gli opus signinum di Selinunte"	Dario Flaccovio Editore	Palermo	cas	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	1
Lopreato, Paola; Fiori, Cesare; Perpignani, Paola	2003	"Basilica di Santa Eufemia a Grado: Storia, Restauro e Indagine Scientifica"	ICCM	Arles	cas	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	3
Lugari, Alessandro	2003	"The Treatment of Lacunae in Mosaics: Research Towards a Methodology"	ICCM	Arles	t	poster	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	3
Maguire, Henry; Terry, Ann	2005	" The wall mosaics in the cathedral al Poreč"	ICCM	Thessaloniki	mat	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	2
Maines, Rachel	1990	Disaster Preparedness Plan	Rachel Maines & associates	USA	prac	book		2	2
Margalit, Ze´ev	2003	"The conservation of mosaics in situ: an alternative to shelters"	ICCM	Italy	prac	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	1
Margalit, Ze´ev	2003	"The magic touch of mosaic maitenance"	ICCM	Arles	prac	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	1
Marino, Luigi	2003	"Relevé "d´urgence" et relevé "dynamique" de dallages mosaïques"	ICCM	Italy	t	article	French. 6th ICCM Conference, Nicosia, 24-28 October 1996	1	2
Marino, Luigi; Nenci, Cinzia; Santella, Claudia	2003	"Il mosaico pavimentale della Cattedrale di Santa Reparata a Firenze: Problemi di conservazione e di musealizzazione"	ICCM	Arles	mat	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	2
Martínez del Campo Lanz, Sofía	2000+	La máscara de Malintepec	INAH-CONACULTA	México	cas	book	In Spanish	1	3

Maselli Scotti, Franca	2004	"Sullo stato di conservazione dei mosaici di Aquileia e Trieste"	Dario Flaccovio Editore	Palermo	cas	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Description of work on varous sites	3	1
Mastelloni, Maria Amalia	2004	"Frammenti di mosaici in bianco e nero"	Dario Flaccovio Editore	Palermo	val	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Mastelloni, Maria Amalia; Triscari, Maurizio; Sabatino, Giuseppe; Quartieri, Simona	2004	"Caratterizzazione dei cromofori in tessere vitree da mosaici di Taormina, Lipari e Tusa"	Dario Flaccovio Editore	Palermo	mat	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	3
Matero, Frank	2004	Editorial	James & James	New Mexico	prac	article	Conservation and Management of Archaeological Sites	3	2
Mavromichali, Katerina	2005	"Ancient interventions on mosaics"	ICCM	Thessaloniki	t	article	Greek. 8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	3
Mazzei, Marina; Patete, Salvatore	2004	"I mosaici della casa, Palazzo di Arpi"	Dario Flaccovio Editore	Palermo	mat	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Melucco Vaccaro, Alessandra	2003	"Philosophies favouring in situ conservation"	ICCM	Italy	t	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	3
Morandini, Francesca; Rossi, Filli	2005	"Una casa romana al museo. Scavo, conservazione e allestimento di un gruppo importante di mosaici da Brescia"	ICCM	Thessaloniki	mat	article	Italian. 8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	2
Menicou, Menicos; Fiori, Cesare; Macchiarola, Michele	2003	"Examples of deterioration following preservation works on mosaics in situ"	ICCM	Italy	mat	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	2
Merrony, Mark W.	2009	"Spectacular Byzantine mosaic in Israel on public display"			cas	article	MINERVA 20/3, 4	3	1
Miceli, Giovanna	2004	"Colonizzazione e processi di deterioramento causati da cianobatteri e alghe nei mosaici di Piazza Armerina, Mozia e Selinunte"	Dario Flaccovio Editore	Palermo	mat	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	3
Michaelides, Demetrios	2004	"The International Committee for the Conservation of Mosaics"	Dario Flaccovio Editore	Palermo	t	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2

Michaelides, Demetrios	2003	Mosaics make a Site	ICCM	Italy	prac	book	6th ICCM Conference, Nicosia, 24-28 October 1996: Demetrios Michaelides (ed.)	1	3
Misiani, Anna	2004	"Le attività e le funzioni della manutenzione programmata nell´ambito della gestione dei siti archeologici"	Dario Flaccovio Editore	Palermo	prac	report	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Maintenance	3	3
Monraval Sapiña, Magdalena; Krougly, Laurence	2003	"Les 80 ans d´une "mosaïque de musée". La mosaïque des Neuf Muses du Pouaig de Moncada (Valencia, España)"	ICCM	Arles	cas	poster	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	2
Muceli, Cesare Antonio	2004	"Ripari ed elementi protettivi di siti archeologici e superfici musive: soluzioni innovative"	Dario Flaccovio Editore	Palermo	prac	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. On shelters	3	2
Muñoz Viñas, Salvador	2003	Teoría contemporánea de la restauración.	Sintesis	España	t	book		2	3
Muscolino, Cetty	2004	"La scuola per il restauro del mosaico a Ravenna. Dallo studio al restauro per la conservazione del patrimonio musivo"	Dario Flaccovio Editore	Palermo	Val	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	1
Nardi, Roberto	2005	"The conservation of Zeugma"	ICCM	Thessaloniki	prac	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002. Also in Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	1	3
Nardi, Roberto	2003	"The treatment of mosaics in situ"	ICCM	Italy	t	article	6th ICCM Conference, Nicosia, 24-28 October 1996. Admintrative practices.	1	3
Nardi, Roberto	2003	"Ostia Antica, Piazzale delle Corporazioni. The maintenance of the mosaic floors"	ICCM	Arles	prac	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999. Administrative aspects	1	1
National Trust	2005	The National Trust Manual of Housekeeping	National Trust	Great Britain	mat	book		3	3
Necaskova, Milena; Piqué, Francesca; Stulik, Dusan.	2003	"Problems and Solutions: In situ conservation of the Last Judgement Mosaic in St. Vitus Catherdral in Prague"	ICCM	Italy	cas	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	3

Neguer, Jacques	2004	"Vulnerability assesment and Conservation Management Maintenance planning of in situ exposd mosaics"	Dario Flaccovio Editore	Palermo	prac	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	3
Neguer, Jacques	2005	"Integrative maintenance planning fot the archaeological sites in the territory of Caesarea Maritima, Israel"	ICCM	Thessaloniki	prac	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	3
Neguer, Jacques	2003	"The Promontory Palace at Caesarea"	ICCM	Italy	cas	poster	6th ICCM Conference, Nicosia, 24-28 October 1996	1	3
Neguer, Jacques	2004	"Reburial and protective covering of ancient mosaic pavements. The experience of the conservation department of the Israel Antiquities Authority"	James & James	New Mexico	t	article	"Conservation and Management of Archaeological Sites. Experimentation and comparison of cases"	3	3
Neguer, Jacques	2003	"Conserve… and forget. Conservation Program for the the Mosaics of Archeological Sites in Israel"	ICCM	Arles	cas	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	2
Neguer, Jacques	2003	"Conservation of mosaics in situ at Tel Itztaba, Bet She´an, israel"	ICCM	Italy	cas	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	2
Nencini Elena	2005	"Studio e progetto di restauro per I 34 lacerti musivi del triclinium del Palazzo di Teodrico a Ravenna"	ICCM	Thessaloniki	cas	article	Italian. 8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	1
Not, Rosa	2004	"Le indagini scientifiche su alcuni mosaici pavimentali Siciliani. Proposta di una metodologia di studio propedeutico all´ intervento di restauro"	Dario Flaccovio Editore	Palermo	mat	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	3
Not, Rosa	2004	"Rappresentativi esempi di indagini biologiche sui mosaici pavimentali esposti all´aperto"	Dario Flaccovio Editore	Palermo	mat	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	3
Not, Rosa	2004	"Contributi alla conoscenza dei biodeteriogeni del mosaico pavimentale dell´edificio ad est dell´agora di Solunto, Palermo"	Dario Flaccovio Editore	Palermo	mat	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	3
Orsetti, Raimondo; Frisina, Mariateresa	2004	"L´Esperienza della regione Marche: Dalla carta archeologica alla carta del rischio"	Dario Flaccovio Editore	Palermo	t	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Pagnano, Giuseppe	2004	"La copertura dei mosaici della Villa del Tellaro"	Dario Flaccovio Editore	Palermo	prac	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	1

Palla, Franco	2004	"I mosaici della Villa del Casale laboratorio di applicazione delle biotecnologie molecolari"	Dario Flaccovio Editore	Palermo	mat	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Panayiotopoulou, Anastasia; Raftopoulou, Stella	2003	"Mosaics will make a Site: remarks on the excavation and conservation of mosaic pavements in Sparta"	ICCM	Italy	cas	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	2
Panayiotopoulou, Anastassia; Raftopoulou, Stella	2003	"La présentation des mosaïques au musée de Sparte: état actuel et perspectives"	ICCM	Arles	val	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	2
Papadopoullou, Sharen T.	2003	"The values of historical research at the House of Dionysos, Cyprus"	ICCM	Arles	val	abstract	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	1
Papastamatiou, Cleopatra	2003	"Temporary restoration method for mosaic floor fragments"	ICCM	Italy	prac	poster	6th ICCM Conference, Nicosia, 24-28 October 1996	1	2
Parandowska, Ewa	2003	"Conservation of Mosaics from the early Roman villa at Kom el Dikka, Alexandria"	ICCM	Arles	cas	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	1
Paribeni, Andrea	2005	"Metodologie e pratiche di intervento nei cantieri di restauro musivo dell'Italia Centro Meridionale nella seconda metà del XIX secolo"	ICCM	Thessaloniki	t	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	2
Pasies Oviedo, Trinidad; Carrascosa Moliner, Begoña	2003	"The mosaics of Valencia: current situation of conservation and restoration. The case of pavements of Calpe (Alicante, Spain)"	ICCM	Italy	cas	poster	6th ICCM Conference, Nicosia, 24-28 October 1996	1	2
Paton, Sara	2003	"The Villa Dionysos at Knossos, Crete: Conservation and Presentation of the Mosaics"	ICCM	Arles	cas	abstract	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	1
Pellegrino, Angelo; Costabile, Tonino	2005	"Musealizzazione di una villa con mosaici a Dragoncello (Ostia)"	ICCM	Thessaloniki	val	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	1
Pellegrino, Lorella	2004	"La materia e i segni della storia"	Dario Flaccovio Editore	Palermo	val	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	3
Pellegrino, Lorella; Longo, Alessandra; Ventura Bordenca, Lucia	2004	"Intervento di riconfigurazione"	Dario Flaccovio Editore	Palermo	t	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2

Pessoa, Miguel; Gonçalves, José; Catarino, Lidia.	2004	"Method for the in situ evaluation of the state of preservation of the mosaics in the Roman villa of Rabaçal-Penela, Portugal"	Dario Flaccovio Editore	Palermo	prac	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Desciption of work on varous sites	3	3
Pflaum, Miran	2003	"Conserving, restoring, and representing very poor and fragmentary remains of mosaics"	ICCM	Arles	prac	poster	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	1
Piccirillo, Michele	2004	"L´intervento di conservazione e copertura del mosaico Omayyade di Qsar Hisham a Gerico in Palestina"	Dario Flaccovio Editore	Palermo	cas	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Desciption of work on varous sites	3	1
Piccirillo, Michele; Cimino, Claudio	2003	"Protecting and preserving the mosaics of Jordan: The Madaba Mosaic School for mosaic restoration"	ICCM	Italy	prac	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	2
Piqué, Francesca; Neguer, Jacques; Lucherini, Bettina	2003	"The Role of Maintenance in the Conservation of Mosaics In Situ: Comparative Field-Testing Methodology"	ICCM	Arles	mat	poster	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	3
Pisapia, Maria Stella	2004	"Il complesso musivo pavimentale dell´ala occidentale del Museo Archeologico Nazionale di Napoli: un mosaico di mosaico"	Dario Flaccovio Editore	Palermo	mat	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Study in a museum functioning as a storage. Results from previous interventions and materials	3	2
Prachkov, Luben; Atanassova-Putoux, Zornitsa	2003	"Structure et ètat des mosaïques antiques en Bulgarie"	ICCM	Arles	prac	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	2
Raddi delle Ruote, Giancarlo; Attardo, Francesca	2004	"Il trattamento delle lacune sui manufatti musivi: Metodi e soluzioni"	Dario Flaccovio Editore	Palermo	cas	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	1
Rizzo, Giovanni; Algozzini, Giuseppina Maria; D´Agostino, Fabio; Megna, Bartolomeo; Ercoli, Laura	2004	"Indagini chimico fisiche sui materiali constitutivi di mosaici pavimentali"	Dario Flaccovio Editore	Palermo	mat	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	3

Roby, Thomas C.	2003	"In situ stabilization during excavation of Roman floor mosaics severely damaged by root growth and their condition after temporary reburial"	ICCM	Italy	mat	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	2
Roby, Thomas C.	2004	"The reburial of mosaics: an overview of materials and practice"	James & James	New Mexico	mat	article	Conservation and Management of Archae-ological Sites	3	3
Roby, Thomas; Alberti, Livia; Ben Abed, Aicha	2005	"Training of technicians fot the main-tenance of mosaics in situ. A Tunisian experience"	ICCM	Thessaloniki	prac	article	8th ICCM Conference, Thessaloniki, 29 Octo-ber-3 November 2002	1	3
Rodríguez González, José Luis	2003	"Methodology, study and treatment of an Arabic Almofasa in Toledo"	ICCM	Arles	mat	article	7th ICCM Conference, Arles and Saint-Ro-main-en-Gal, 22-28 November 1999	1	3
Rogliano, Raymond	2003	"Un musée de site à Loupian (Hérault, France). Restaurer, présenter et étudier les mosaïques de la villa gallo-romaine des Prés-Bas"	ICCM	Arles	cas	article	7th ICCM Conference, Arles and Saint-Ro-main-en-Gal, 22-28 November 1999	1	1
Salvatore, Maria-rosaria	2004	"Le coperture delle aree archeologiche, status quaestionis e prospettive"	Dario Flaccovio Editore	Palermo	t	article	Apparati Musivi An-tichi, Piazza Armerina, 9-13 April 2003. On shelters	3	2
Santalucia, Franc-esco	2004	"La manutenzione programmata come risultato delle microanalisi"	Dario Flaccovio Editore	Palermo	prac	article	Apparati Musivi Antichi, Piazza Arme-rina, 9-13 April 2003. Desciption of work on varous sites	3	2
Sease, Catherine	2003	"Planning of conservation of an in situ mosaic, before, during and after an excavation"	ICCM	Italy	t	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	3
Silberman, Neil Asher; Small, David	1997	The Archaeology of Israel. Cosntruct-ing the past, interpreting the present	Sheffield Academic Press	USA	val	book		3	2
Sivan, Reneé	2003	"Presenting mosaics to the public: an Israeli experience"	ICCM	Italy	val	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	2
Skaf, Isabelle	2004	"Les mosaïques du Liban: Problèmes de conservation"	Dario Flaccovio Editore	Palermo	cas	article	Apparati Musivi Antichi, Piazza Arme-rina, 9-13 April 2003. Desciption of work on varous sites	3	1

Skaf, Isabelle; Roby, Thomas	2003	"The preservation of detached mosaics: Addressing storage and transportation problems resulting from the large-scale re-development of the central district of Beirut"	ICCM	Arles	cas	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	2
Solar, Giora	2003	"Protective Shelters"	ICCM	Italy	prac	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	1
Spatafora, Francesca	2004	"Osservazioni preliminari su alcuni mosaici geometrici della Palermo di etá imperiale"	Dario Flaccovio Editore	Palermo	val	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Desciption of work on varous sites	3	2
Spigo, Umberto	2004	"Pavimenti della Domus di età imperiale romana di Porta Pasquale a Taormina"	Dario Flaccovio Editore	Palermo	cas	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	1
Stanley-Price, Nicholas	1991	The conservation of the Orpheus mosaic at Paphos, Cyprus	The J. Paul Getty Trust	California	cas	e-book	Different perspectives based on one case	2	3
Stanley-Price, Nicholas	2004	Conservation and management of archaeological sites	James & James	New Mexico	t	book		3	3
Stanley-Price, Nicholas; Ponti, Gianni	2003	"Protective enclosures for mosaic floors: a review of Piazza Armerina, Sicily, after fourty years"	ICCM	Italy	t	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	2
Stewart, John	2004	"Conservation of achaeological mosaic pavements by means of reburial"	James & James	New Mexico	mat	article	Conservation and Management of Archaeological Sites. Also contains theoretical and crtieria evaluation	3	3
Stewart, John; Cosh, Steve	2005	"Protection of in situ mosaics: Lessons from England 1738-1939"	ICCM	Thessaloniki	t	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	3
Stewart, John; Staniforth, Sarah; Berry, Janet	2003	"Chedworth Roman villa: A methodology for the monitoring of In situ mosaics"	ICCM	Arles	cas	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	3
Stolow, Nathan	1979	Conservation standards for works of art in transit and on exhibition	Unesco: Museum and monuments XVII	Paris	t	book		2	3
Sturge, Theo	1987	"Polyester based supports for mosaics"	Conservation News	UK	mat	article	Newsletter. Conservation News number 2, 18	2	1
Tedeschi, Claudia; Musculino, Cetty	2005	"Il pavimento musivo di San Vitale: Nuove osservazioni reguardanti l'aula ottagonale"	ICCM	Thessaloniki	cas	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	1

Terranova, Francesca	2004	"L´insediamento dell´Antica Età del Bronzo di Mursia e Pantelleria. Studio paleobotanico e paletnobotanico"	Dario Flaccovio Editore	Palermo	mat	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Thiébault, Cécile; Tahri, Michéle	2009	Bulletin de l´Association Internatioale pour l´Etude de la Mosaïque antique	CNRS	Paris		book	Compilation of material on mosaic. Catalogues as follows: general information, coloquia, symposia, iconographic studies, epigraphic material, technical journals, museum collections and expositions. There is also a classification by country	3	1
Tusa, Delia	2004	"Contributi della pedologia alla caratterizzazione dei siti di interesse archeologico e culturale"	Dario Flaccovio Editore	Palermo	Val	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	3
UNESCO	1968	The conservation of cultural property, museums, and monuments	Unesco	paris	prac	book		2	2
UNESCO	1969	La conservación de los bienes culturales	Unesco	Paris	t	book		3	3
Ungaro, Lucrecia; Vitti, Massimo	2005	"Il restauro dei mosaici geometrici dei Mercati di Traiano a Roma"	ICCM	Thessaloniki	cas	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	1
Uprichard, Ken	2003	"The lifting, display and re-lifting of the Hinton St. Mary Mosaic"	ICCM	Arles	cas	abstract	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	1
Vaillant Callol, Milagros; Valentín Rodrigo, Nieves; Carbó, María Teresa Doménech	2003	Una mirada hacia la conservación preventiva del patrimonio cultural	UPV	España	mat	book		2	3
Villa, Benedetto	2004	"Tecniche innovative per il relievo e la rappresentazione dei siti archeologici"	Dario Flaccovio Editore	Palermo	prac	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Desciption of work on varous sites	3	2
Villa, Benedetto; Azzaro, Giuseppe; D´Amelio, Salvatore	2004	"Il modelo digitale della Villa Romana de Casale"	Dario Flaccovio Editore	Palermo	prac	poster	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	1

Villari, Gianfilippo	2004	"La musealizzazione di un sito archeologico"	Dario Flaccovio Editore	Palermo	prac	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003. Desciption of work on varous sites	3	2
Weidman, Denis; Flatt, Robert; Félix, Claude; Girardet, Fred; Glauser, André	2003	"Analyse des altérations et déformations de mosaïques à Orbe-Boscéaz"	ICCM	Italy	mat	article	French. 6th ICCM Conference, Nicosia, 24-28 October 1996	1	3
Weidman, Denis; Girardet, Fred	2005	"Contrôle climate des mosaïques in situ sous abris"	ICCM	Thessaloniki	prac	article	French. 8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	3
Weidmann, Denis	2004	"Un opus sectile de verre dans le site monastique copte des Kellia (Basse Egypte)"	Dario Flaccovio Editore	Palermo	cas	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	1
Weiss, Ze´ev; Netzer, Ehud	1998	Promise and Redemption. A synagogue mosaic from Sepphoris	The Israel Museum	Jerusalem	val	book		2	2
Winnet, Frederick Victor	1949	The mosaic tradition	University of Toronto Press	Toronto	val	book		3	2
Yiannouli, Vassiliki; Anastasatou, Nicoletta; Papastamatiou, Cleopatra	2003	"Mosaic Floors of Ancient Samos: Conservation problems"	ICCM	Italy	cas	article	6th ICCM Conference, Nicosia, 24-28 October 1996	1	1
Zizola, Chiara	2005	"Conservation and Maintenance of floor mosaics in archeological areas"	ICCM	Thessaloniki	t	article	8th ICCM Conference, Thessaloniki, 29 October-3 November 2002	1	3
Zizola, Chiara	2004	"Il restauro conservativo del mosaico di Quintus Calpurnius Eutyches-Zeugma"	Dario Flaccovio Editore	Palermo	cas	article	Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003	3	2
Zizola, Chiara	2003	"The conservation and restoration od the mosaic floor of the byzantine Church (Western) in Mamshit (Negev Desert)"	ICCM	Arles	cas	article	7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999	1	3

quality	introduction	1
	medium	2
	advanced	3
type of reference	book	
	online	
	article	
	magazine	
accessibility		1 good
		2 medium
		3 bad

Tables 1. A database of major and recent works published on mosaic conservation

Key to Table 1:
6th ICCM Conference, Nicosia, 24-28 October 1996:
Demetrios Michaelides (ed.), *Mosaics make a Site. The Conservation* in situ *of Mosaics on Archaeological Sites. Proceedings of the VI*th *International Conference of the International Committee for the Conservation of Mosaics (ICCM), Nicosia 1996*, Rome 2003.

7th ICCM Conference, Arles and Saint-Romain-en-Gal, 22-28 November 1999:
Patrick Blanc, with the collaboration of Véronique Blanc-Bijon, *Les mosaïques: Conserver pour présenter? Actes. VII*ème *Conférence du Comité International pour la Conservation des Mosaïques (ICCM), Arles – Saint-Romain-en-Gal, 22-28 Novembre 1999*, Arles 2003.

8th ICCM Conference, Thessaloniki, 29 October-3 November 2002:
Charalambos Bakirtzis (ed.), *Proceedings of the VIII*th *Conference of the International Committee for the Conservation of Mosaics (ICCM): 'Wall and Floor Mosaics: Conservation, Maintenance, and Presentation'. Thessaloniki 29 October – 3 November 2002,* Thessaloniki 2005.

Apparati Musivi Antichi, Piazza Armerina, 9-13 April 2003:
Guido Meli (ed.), *Apparati musivi antichi nell'area del Mediterraneo***.** *Conservazione programmata e recupero* ***C****ontributi analitici alla carta del rischio***.** *Atti del I Convegno internazionale di studi* ***'****La materia e i segni della storia***'***, Piazza Armerina 9-13 aprile 2003*, Palermo 2004.

Conservation and Management of Archaeological Sites, vol. 6, issue 3-4, New Mexico 2003-2004.

THE MOSAIKON INITIATIVE FOR THE CONSERVATION OF MOSAICS IN THE MEDITERRANEAN REGION: AN UPDATE ON ACTIVITIES*

Jeanne Marie Teutonico and Leslie Friedman, on behalf of the MOSAIKON partners

Abstract

MOSAIKON, a collaborative regional initiative aimed at improving the conservation, preservation and maintenance of mosaics in the Mediterranean, was formed in 2008 by the Getty Conservation Institute, the Getty Foundation, ICCROM (the International Centre for the Study of the Preservation and Restoration of Cultural Property) and the International Committee for the Conservation of Mosaics (ICCM). Through inter-related activities, MOSAIKON seeks to strengthen the ICCM and the network of professionals concerned with the preservation of mosaic heritage; improve the knowledge and skills of technicians, conservators, site managers, museum professionals, and decision makers charged with caring for mosaics in situ and in museums; develop locally available and affordable conservation practices; and promote the dissemination and exchange of information. This paper reports on activities planned and implemented during the first phase of the initiative.

Introduction

The Mediterranean region possesses an extraordinarily rich and varied archaeological heritage, including a vast number of mosaic pavements from classical antiquity. Some of these ancient mosaics remain in situ while many others have been lifted and placed in museums and storage. In recent decades, there have been increased national and international efforts to create better conditions for the conservation of these exceptional remains from the ancient world. However, in the absence of a coordinated strategic approach to the problem, many challenges still exist. Needs continue to exceed resources and important mosaics deteriorate at a rapid rate or are lost forever (Fig. 1). In an attempt to address this situation, the Getty Conservation Institute (GCI), the Getty Foundation, ICCROM (the International Centre for the Study of the Preservation and Restoration of Cultural Property) and the International Committee for the Conservation of Mosaics (ICCM) joined forces in 2008 to create MOSAIKON, a collaborative regional initiative dedicated to improving the conservation, presentation and maintenance of mosaics in the Mediterranean region (Dardes *et al.* 2010; Teutonico *et al.* 2010; Teutonico *et al.* 2014).

Partners

Each MOSAIKON partner organization has a long history of involvement with the conservation of mosaics, and each brings

Fig. 1. Near loss of mosaic at the site of Bulla Regia, Tunisia (photo: The J. Paul Getty Trust)

particular expertise and institutional capabilities to the program.

The *Getty Conservation Institute* (GCI) has been involved in mosaics conservation in the Mediterranean region since the 1980s, through research, training, and field projects. Among other activities, over the last decade the GCI has collaborated with the Institut National du Patrimoine (INP) in Tunisia to train specialist technicians skilled in the conservation and maintenance of in situ mosaics. To complement this effort, the GCI has also developed training for site managers in the principles and methods of site conservation and management, and partnered with the INP in delivering the 9th ICCM conference (2005) in Tunisia.

The *Getty Foundation* is the philanthropic arm of the J. Paul Getty Trust. For the last 25 years, the Foundation has been funding projects related to the conservation of heritage, both movable and immovable. The Foundation has chosen mosaics in the Mediterranean region as one of its current priorities. Over the past decade, the Foundation has supported several model mosaic conservation projects – for example, at the Basilica of Santa Maria Maggiore in Rome.

ICCROM, an intergovernmental organization headquartered in Rome, is dedicated to the conservation of cultural heritage worldwide and serves more than 125 member states. ICCROM has over 50 years of experience in training and institutional capacity building, as well as a long history of involvement with the conservation of mosaics dating to the creation of the ICCM in 1977.

The ICCM was created over 30 years ago, when ICCROM organized the first meeting on the conservation of mosaics in Rome in 1977. Now a large, international organization with nearly 300 members representing over 30 countries from all continents, the Committee has sponsored a number of roundtables and eleven international conferences, the proceedings of which represent the most important literature on the conservation of mosaics.

Objectives and Scope

The ultimate aim of the MOSAIKON initiative is the improved conservation, presentation and maintenance of mosaics in the Mediterranean region, both those in situ and those in museums and storage. Specifically, the program seeks to: 1) strengthen the ICCM and the network of professionals concerned with the preservation of mosaic heritage; 2) improve the knowledge and skills of technicians, conservators, site managers, museum professionals, and decision makers charged with caring for mosaics in situ and in museums; 3) develop locally available and affordable conservation practices for both in situ and museum conservation; and 4) promote the dissemination and exchange of information.

Geographically, the focus of MOSAIKON's first phase (2008-2012) is the southern and eastern Mediterranean region, where needs are perhaps the greatest. Thematically, the focus of this first phase is on archaeological mosaics, both those in situ and those that have been lifted and are presently in museums and storage. Although other aspects of the mosaic heritage are certainly at risk and require attention, it was important to limit the scope of the initiative in this initial phase in order to make best use of resources. The target groups for the initiative are purposefully broad as success will demand the engagement of many players. These include technicians responsible for the conservation and maintenance of mosaics, conservators, site managers, trainers and educators, policy makers, and local communities. Programs have been developed both to engage specific groups and to encourage improved communication across boundaries.

Activities

In order to best address the initiative's objectives and bring about significant levels of change, various activities have been initiated in each of the four identified program areas. Following is a summary of accomplishments to date, as well as planned activities, through the end of the first phase (For other MOSAIKON related activities, see Al Taweel *et al.* 2017; Antomarchi and Abend 2017; Dardes *et al.* 2017; and Stewart 2017).

Strengthening the Professional Network

One of the most important aims of MOSAIKON is to strengthen the professional network both within and outside the region. The ICCM remains the single most important organization in this regard. As one of MOSAIKON's first actions, the Getty Foundation provided a grant to the ICCM to facilitate the holding of annual board meetings, enhance the organization's website, increase the availability of online publications, and both increase and diversify representation at the triennial conference. These efforts have created a

Fig. 2. Site exercise during the course for site managers, *Conservation and Management of Mosaics at Archaeological Sites*, May 2010, Tyre, Lebanon. (photo: Leslie Friedman, GCI)

more secure and robust organization that can support the interests and needs of the community. Additionally, MOSAIKON is working to foster the development of regional networks through training courses and other means.

Capacity Building

To improve the knowledge and skills of those charged with the stewardship of mosaics, several interrelated activities are being advanced in the areas of in situ mosaics, mosaics in museums and storage, and university level education. In addition to increasing practical and theoretical knowledge, these activities will further aid in strengthening professional networks and relationships throughout the region.

In Situ Mosaics: Training for Site Managers

Based on models developed by the GCI and ICCROM, MOSAIKON has implemented the first of three sub-regional courses for site managers on the conservation and management of sites with mosaics. The working model for these courses is a three-part approach. The first component was an intensive three week workshop that took place at the World Heritage site of Tyre, Lebanon, in May 2010, spearheaded by the GCI and ICCROM (through their ATHAR pro-

Fig. 3. Conservation technician trainees during an exercise on cleaning mosaics at the site of Dougga, Tunisia (photo: GCI)

gram) in partnership with the Ministry of Culture of Lebanon (Fig. 2). Fifteen site managers from six different countries (Algeria, Egypt, Lebanon, Morocco, Tunisia and Syria) participated in the workshop. Participants represented a broad range of backgrounds including archaeology, architecture, and conservation.

The second component of the course was a mentoring period of more than a year, during which each participant or team of participants undertook a practical training project at their home site. Through regular contact with MOSAIKON team members and instructors, including periodic reporting and emails, participants were able to receive critical feedback and guidance on each project. The last component, a review workshop, took place in Rome at the headquarters of ICCROM and at the site of Herculaneum in September 2011. In addition to site visits and a site exercise that reinforced key concepts, participants presented and discussed their practical training projects. Finally, to reinforce the progress made to date, the Getty Foundation has provided grant funds to facilitate the continuation of select training projects over the next year, which will result in fully realized conservation initiatives for each participant or team of participants at their home sites. In addition to providing sustained support to a group of professionals over time, this approach has also forged links and relationships amongst the members of the group, which will be beneficial to the mosaic conservation community at

Fig. 4. The site of Bulla Regia, Tunisia (photo: Scott Warren)

large. Two future courses on the same model are planned for site managers, one to be offered in French in the Maghreb, and another offered in English to facilitate inclusion of the non-Arabic-speaking countries of the eastern Mediterranean.

In Situ Mosaics: Training for Conservation Technicians

Building on the success of the training programs carried out by the GCI in collaboration with the Institut National du Patrimoine (INP) in Tunisia (Fig. 3), MOSAIKON will develop and deliver a regional training course for mosaic conservation technicians from North Africa. The first campaign of this course is scheduled to be held at El Jem in Tunisia in spring 2012, led by the GCI in collaboration with the INP. The course is intended to bring together technicians from Algeria, Morocco, Tunisia, Egypt and Libya for a series of regional modules, between which there will be periods of supervised practical work in each of the trainees' home countries. The objective is to develop teams of conservation technicians skilled in essential conservation and maintenance of in situ mosaics, similar to those already created in Tunisia.

In Situ Mosaics: Bulla Regia Mosaic Conservation Project

In conjunction with the GCI/INP technician training program in Tunisia, a pilot project was begun in spring 2010

Fig. 5. Conservation technicians/restorers from Syria working on a lifted mosaic at CCA headquarters in Italy (photo: Centro di Conservazione Archeologica)

at the archaeological site of Bulla Regia, located in northwest Tunisia (Fig. 4). The project has two main objectives. The first is to complete a conservation plan for the approximately 300 excavated mosaics at the site, providing a reproducible conservation planning model for archaeological sites that contain large numbers of mosaics. This involves mapping and rapid condition survey, prioritization of conservation and presentation needs, and the development of treatment approaches for each mosaic pavement based on factors including significance, condition, level of risk, and maintenance capabilities.

The second goal is to develop targeted examples of complete conservation, presentation and maintenance of the more significant and visited mosaic pavements on the site, which can serve as models for best practice at Bulla Regia and elsewhere. The majority of the conservation work will be implemented over the next three years by GCI-trained mosaic conservation technicians who are employed at the site, thus highlighting their skills and the importance of their work in creating a successful, sustainable conservation and maintenance program for archaeological mosaics.

The mosaic conservation work at Bulla Regia is part of a larger project for the conservation and presentation of the site that is a partnership of the Getty Conservation Institute, the World Monuments Fund, and the Institut National du Patrimoine of Tunisia (see Roby *et al.* 2017).

Lifted Mosaics: Training for Conservation Technicians/Restorers

Parallel training activities have been developed for mosaics that have been removed from their original sites and are presently in museums and storage.
A pilot course for conservation technicians/restorers has been developed for Syria by the Centro di Conservazione Archeologica (CCA), with the collaboration of the Directorate General for Antiquities and Museums (DGAM) in Syria and support from the Getty Foundation. The first module of this two-year course took place in September and October 2011 at the CCA headquarters north of Rome (Fig. 5). Over the next 18 months, additional modules will be taught, covering different aspects of mosaic conservation, from assessment and documentation to treatment and maintenance, including issues related to the design and organization of museum storage.

Training for Museum Professionals: Lifted Mosaics

Similar to the course for site managers, MOSAIKON will deliver a regional course for museum professionals responsible for mosaic collections. Led by ICCROM, this course will focus on larger issues of preventive conservation, condition and risk assessment, and conservation management. This pilot course will take place in Jordan in June 2012 with the support of the Getty Foundation.

University Education

In order to address a more systemic need in the region for increased numbers of conservators, MOSAIKON is undertaking a survey of university-level conservation education programs in the region to determine how one or more of these programs might be developed to provide the knowledge, skills and experience required of entry-level conservators. This component of the initiative is moving forward with initial investigations and targeted visits to possible partner universities in the region. Ultimately, the aim is to create more robust conservation education programs at the university level in the region and to encourage the recognition of a professional conservator profile. In the early stages, this may entail funding for curriculum development, equipment, and the provision of visiting faculty to supplement local expertise at targeted universities.

Locally Available and Affordable Conservation Practices
Alternative Backing Research

To sustain these training efforts, it is essential to develop locally available and affordable methods for both in situ and museum conservation. Perhaps the greatest challenge in this regard is the need for approaches to backing lifted mosaics that make use of locally available and inexpensive materials as an alternative to methods based on the use of Aerolam (honeycomb aluminum) and epoxy resin supports.
In consultation with mosaics conservators, the GCI has launched a research project that will examine more cost-effective alternative methods and materials for backing lifted mosaics. This research has two main objectives: first, to investigate lime and hy-

draulic-lime mortars as backing materials; and second, to identify substitute support materials and to prepare and test mock-ups of various backing systems. The results of this initial investigation will help to define viable avenues for further research to be carried out in collaboration with other research partners in the region, potentially funded by the Getty Foundation.

Dissemination and Exchange of Information†

To launch MOSAIKON's dissemination strategy, an e-bulletin in both English and Arabic has been created for the project in an effort to reach mosaic professionals throughout the region and beyond. The first issue was circulated in spring 2011 and further issues will appear twice yearly for the duration of the project.

MOSAIKON is also disseminating information about the initiative – and about mosaic conservation in general – through the creation of an expanded website for the ICCM, which will eventually have downloadable pdfs of mosaic-related publications, as well as links to mosaic related sites and information. In addition, all project partners have information on their websites about current MOSAIKON activities as well as links to each partner site.

Conclusions and next steps

The mosaic heritage of the Mediterranean region is extremely significant but remains under threat. Through collaboration and a strategic program of activities, MOSAIKON hopes to bring about improved conservation, presentation and management of mosaics in the Mediterranean, both those in situ and those in museums and storage. The initiative aims to achieve practical and verifiable results, long-term thinking and sustainable solutions, and better coordination of national and international efforts.

The MOSAIKON partners have created a performance measurement framework for the initiative and are committed to regular evaluations against defined indicators in order to measure the project's progress and to identify the most effective strategies. A group of representatives from twelve countries in the region were brought together to help define the MOSAIKON program at the outset of the initiative, and the same will be done at the conclusion of the first phase. This will help to assess what has been achieved and where the program might be revised or adjusted to better meet regional needs and to ensure forward momentum.

By combining the expertise, organizational capabilities and resources of its partners, MOSAIKON is striving to be a catalyst for positive change. However, only sustained effort and broad-based partnerships will ensure the survival of the exceptional archaeological and mosaic heritage of the Mediterranean for future generations.

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SESSION V:
PRESENTATION AND DISPLAY

Carmelo Pappalardo

Yaşar Selçuk Şener

Posters

Mikal Kindt and
Stefania Chlouveraki

Brigitta Maria Kürtösi

Judita Lux, Manlio Titomanlio and
Sabina Kramar

Christos Pilalis

Isabelle Doumet Skaf,
Badr Jabbour-Gédéon
et Ghada Salem

Carol Snow, Jason DeBlock, Burrus
Harlow, Thomas Philips and Antho-
ny Florio

THE MEMORIAL OF MOSES ON MOUNT NEBO, JORDAN. A NEW SHELTER FOR THE MONUMENT AND THE RESTORING OF THE MOSAICS: THE ONGOING PROJECT AND NEW PERSPECTIVES

Carmelo Pappalardo

After the passing of several years since the last activities of restoration and conservation of the mosaics and structures of the Memorial of Moses, the shelter covering the ancient building exhibited serious signs of damage leading to an in-depth project of restoration. The late Michele Piccirillo wrote: «A recent instability in the metal structure that has caused a fissure in the entire length of the basilica, which also involved the mosaic floors, the southern chapels and the monolithic baptismal font, has made an intervention inevitable and urgent» («Un recente fenomeno di dissesto della struttura metallica che ha provocato una fenditura nella basilica per tutta la sua lunghezza ha reso l'intervento inevitabile e improrogabile»: Piccirillo 2004, 44). Work on the new project started at the end of 2007.

The present report describes the optimal state of the project for the new covering and restoration of the mosaics in 2011. Work was later interrupted for almost a year and then picked up again in 2012 following a much altered project, compared to the initial one. Work was completed with the reopening of the 'renewed' monument on the 15th of October 2016.

The remains of the ancient church, a pilgrimage destination since the 4th century, were unearthed in the 1930s, when the Franciscan Custody of the Holy Land – through the efforts of Girolamo Mihaic – bought the hills of Nebo: Siyagha and Mukhayyat (Fig. 1).

Between 1933 and 1938, during several excavation campaigns directed by Sylvester Saller, the relics of the Basilica with the chapels – all paved with mosaics of exquisite workmanship – and the annexes of the Monastery, were brought to light (Fig. 2).

At this stage, only small-scale restorations were carried out: the walls were consolidated and the column drums were raised and placed on their bases in order to allow a better understanding of the plan of the Basilica. The mosaics were covered with soil to protect them from decay caused by weathering and visitors.

In 1963, after the decision of Custody of the Holy Land to restore the original pavements of the Basilica in order to exhibit them. Virgilio Corbo was appointed as the person in charge of the project. A metal shelter designed in Oxford, was put in place by personnel of the workshop of St Saviour in Jerusalem under the direction of Nazareno Moretti (Piccirillo 2004, 15; Cf. Corbo 1967; 1970) (Fig. 3 and 4). The 1967 Arab-Israeli war prevented the completion of the work.

Fig. 1. The first day of excavation at the Memorial of Moses, 13th of July 1933 (© SBF, Jerusalem)

During the summer of 1973, work resumed with a salvage intervention on the mosaic of the Saints Lot and Procopios Church, which is located on the peak of Khirbet-el Mukhayyat. In 1976, during works at the Memorial of Moses at Siyagha, a beautiful mosaic – dated August 530 and made by the mosaicists Soel, Kaium and Elias – was uncovered in the Diaconicon-Baptistery.

The consolidation and renovation of the structures lasted until 1984 and consisted in the modification of the Basilica in order to enable the celebration of liturgies, and in the restoration of the mosaics, leaving them either in situ or displaying them mounted on the wall.

During these years, the need for a radical intervention on the complex began to emerge: «Over the years, consciously or not, the idea, if not the conviction, has matured to substitute the shelter in use for several decades, which had protected the sacred space, making possible, at the same time, the visit of the mosaic floors of the sanctuary» («… Durante gli anni successivi, lavoravamo in terra, all'interno e all'esterno, ma sempre con la testa rivolta verso l'alto alla ricerca di un'idea per sostituire la tettoia provvisoria»: Piccirillo 2004, 10).

In 1989 the architect Vito Sonzogni, after visiting Mount Nebo and upon the request of Michele Piccirillo, proposed a theoretical study, entitled «The Sanctuary of Mount Nebo. Preliminary guidance-notes on the cultural and functional criteria for elevating the dignity of the

Fig. 2. The Memorial of Moses at the end of the excavations directed by S. Saller, 1938 (© SBF, Jerusalem)

Sanctuary without thereby disregarding the cultural archaeological issues» («Il Santuario del Monte Nebo. Prime note orientative su criteri culturali e funzionali alla elevazione del livello di dignità del Santuario senza con ciò disattendere gli scopi culturali archeologici»: Piccirillo 2004, 29-39). Moreover, Sonzogni emphasized that «The planned interventions are intended to raise the level of dignity of the Sanctuary and must, however, be functional for both the Sanctuary and archaeological research» («Gli interventi programmati hanno lo scopo di elevare la soglia di dignità del Santuario e devono tuttavia essere funzionali sia al Santuario sia alle ricerche archeologiche»: Piccirillo 2004, 29).

During October 1999, the plan was implemented. Geological surveys and technical assessments of the structures were performed and finalized with the ultimate aim of consolidating the seriously damaged structures and the walls and pavements that had visibly cracked. Prof. Piergiorgio Malesani of the University of Florence was appointed to prepare the study. He identified the causes of the decay of the ancient walls and of the mosaic floors, suggesting the following factors:

- the nature of the soil upon which the foundations of the sanctuary were built
- the use of concrete in the reconstruction of the walls
- the use of concrete pillars and cour-

Fig. 3. The perimeter walls of the Memorial repaired to be reused for the shelter, 1964 (© SBF, Jerusalem)

Fig. 4. The Memorial and its shelter as they were until December 2007 when work for the new shelter began (© C. Pappalardo)

Fig. 5. The dismantling of the iron structure of the old shelter, April 2008 (© C. Pappalardo)

ses to which the metal structure of the shelter was fixed
– the expansion of the iron beams of the protective shelter due to the natural temperature variation

In accordance with the conclusion of the report in which Malesani suggests that "the plan of the interventions should take into account the above-mentioned factors", a schematic plan of intervention was developed based on the following steps:
- the dismantling of the shelter and of the portions of walls repaired with cement mortar
- the removal of the concrete
- the improving of the bearing capacity of the soil carrying the foundation
- the disassembling of the cement backing of the mosaic panels and their subsequent relaying on a mortar bedding
- the construction of a new structure standing on plinths placed outside the Basilica

Work began in 2007 after a long and elaborate feasibility study and several projects commissioned by the Custody of the Holy Land, and was published in 2004 under the title "Un progetto di copertura per il Memoriale di Mosè. A 70 anni dall'inizio dell'indagine archeologica sul Monte Nebo in Giordania" (Projecting a shelter for the Memorial of Moses. On the occasion of the 70 years of archaeological research on Mount Nebo in Jordan), under

Fig. 6. The scaffolding on the Memorial's perimeter for the building of the new shelter, March 2010 (© C. Pappalardo)

the scientific supervision of the Studium Biblicum Franciscanum represented by Michele Piccirillo.

Together with the construction of the new shelter for the Basilica, Piccirillo undertook the restoration of the mosaic floors which were exhibited on the wall, dismantled or embedded in concrete panels during the previous intervention.

After Christmas 2007, the basilica and the surrounding area were closed to the public in order to start work more effectively. The first phase involved the implementation of a series of 57 micro-poles, placed behind the ancient walls, in order to strengthen these structures and to support the new roof that would be built later.

Meanwhile, the demolition of the old shelter (Fig. 5), along with all the walls and concrete pillars that bore it, was carried out; then, concrete plinths and courses were erected in order to give solidity to the ancient walls and to relieve the weight of the new roof. From autumn 2008 until the end of 2009, we proceeded to finalize the design of the metal and wooden structures. Since the beginning of 2010, the implementation phase started with the erection of multi-storey scaffolding (Fig. 6). The structural components to be assembled on site were shipped from Italy. Work has continued almost uninterrupted to the present day, focusing on finding technical solutions to several problems and on designing the stone wall for the façade, and planning the internal structures on which the mosaic panels will be displayed. Efforts are underway to design

Fig. 7. The removal of the mosaics for their restoration, February 2008 (© C. Pappalardo)

Fig. 8. The mosaics being restored, October 2009 (© C. Pappalardo)

Fig. 9. The mosaics being restored, March 2010 (© C. Pappalardo)

Fig. 10. The restorers A. Vaccalluzzo and F. Sciorilli while they are repositioning the restored mosaic in its original location in the sacristy, July 2009 (© C. Pappalardo)

an on-site museum and also to preserve the church for liturgical purposes; to this end, an external mosaic-floored room to the south-east of the *cella tricora*, will be reserved as the sacristy. So, the Memorial will meet the needs of the visitors who come to admire the mosaics and the needs of the pilgrims who come to pray.

Meanwhile the restoration of the mosaic floors of the Sanctuary is in progress (Fig. 7-9). After removing them from the walls and the pavements – except for the superb mosaic of the Diaconicon-Baptistery which was found intact – the mosaics were detached from their old cement supports, cleaned and consolidated, in order to proceed, in the near future, with placing them back on the pavements on a mortar bedding or setting them on light panels which will be reassembled on ad-hoc structures and fixed on the walls of the restored building.

The timetable of the activities, which is being constantly updated and modified, currently foresees one more year to complete the work before the opening of the church to pilgrims and visitors. The sudden passing away of Michele

Piccirillo on the 25th of October 2008 did not stop the activities. We keep on working uninterruptedly thanks to the strong efforts of the Custody of Holy Land, which for the last 80 years has been taking care of the Sanctuary and its ruins which represent a universal, cultural and religious heritage.

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CONSERVATION WORK ON THE MOSAICS OF THE VILLA OF THE AMAZONS (ŞANLIURFA, TURKEY): FROM "THEME PARK" TO "ARCHAEOPARK"

Yaşar Selçuk Şener

Abstract

The villa called the Villa of the Amazons after its mosaic depicting Amazon warriors is situated in an area called Haleplibahçe to the north of the ancient citadel in the centre of Şanliurfa. At the beginning of the 2000s, the Ministry of Culture and Tourism and the Şanliurfa Municipality agreed on a project to transform Haleplibahçe into a "Theme Park". The project began in 2005. At the end of 2006, during infrastructure (sewerage) works, architectural and mosaic remains were uncovered. The project was halted and archaeological excavations were initiated by the museum. During the excavations, which were conducted between 2006 and 2008, the remains of an ancient bath-building of the Late Roman/Early Byzantine period and architectural remains of a villa were unearthed along with a large number of mosaic floors.

The Villa of the Amazons consists of the remains of a building with 14 rooms built over an area of ~1277 m^2 with most of its walls reduced to foundation level. With the partially or almost completely preserved floor mosaics in 12 of the rooms (~700 m^2) the building came into prominence. The mosaics, with tesserae of 3-4 mm laid in a scale pattern, are notable for mythological representations such as Amazon warriors fighting lions, and scenes from the life of Achilles (35 metre-long single panel). Restoration work on the villa, which was initiated in July 2008, was completed in about one year. Concentrating mainly on cleaning and reinforcement, the restoration work was carried out by one conservator, ten conservation technicians, and eight workers. Following restoration the Villa of the Amazons and its mosaics were opened to the public in 2009. This restoration has greatly contributed to the establishment of an Archaeopark, which will gain further importance with the Archaeology Museum to be built near the villa.

The villa, called the Villa of the Amazons after the mosaic with four Amazon warriors fighting lions (Karabulut *et al.* 2011, 56-67) is situated on an area called Haleplibahçe in the centre of the Province of Şanliurfa (located in the south-east of Turkey near the Syrian border), to the north of the ancient citadel.

In the early 2000s the Ministry of Culture and Tourism and the Şanliurfa Municipality agreed on a project to transform Haleplibahçe into a Theme Park. The design phase of the Theme Park Project was completed in the early 2000s and it was envisaged that the project include a mosque, a church and a synagogue, along with many other units such as cafeterias, museums, the Prophets sections, a Tower of Samarra, a Mevlevi Dervish Lodge, an amphitheatre, a conference hall, sports grounds, ponds, and a promenade and recreation Park. Infrastructure work was initiated on the site in 2005; and, by the end of 2006, architectural remains and floor mosaics were unearthed to the south of the site. Construction work was halted and archaeological excavations were initiated by the Şanlıurfa Archaeological Museum. During the excavations, which were conducted between 2006 and 2008, the remains of an ancient bath-building of the Late Roman/Early Byzantine era, and architectural remains of two villas were unearthed along with a large number of mosaic floors.

The Theme Park Project was cancelled in the spring of 2008 by a scientific and technical committee formed by the Ministry of Culture and Tourism, and decisions were made to accelerate in situ conservation work on the uncovered architectural and mosaic remains, to construct an archaeological museum there, and to transform Haleplibahçe into an Archaeopark.

The Villa of the Amazons (Karabulut *et al.* 2011; Şener 2009) consists of the remains of a building having an inverted-T plan with 14 rooms built over an area of approximately 1500 m^2 and with most of its walls reduced to foundation level. The building came into prominence because of the partially or almost completely preserved floor mosaics covering seven hundred m^2 in twelve of its rooms (Fig. 1). The mosaics are generally plain white in the pools, and in the other spaces they are composed of panels with stylized plant and geometric motifs, and also include mythological figures. The central panels of the mosaics generally depict figures, while the borders are decorated with stylized plant, geometric, and human and animal figures (Fig. 1).

The layers forming the foundation of the mosaics are as follows, from bottom to top: *statumen*, *rudus*, *nucleus*, setting bed layer, and the *tessellatum*. The tesserae used average around 4-6 mm, however in figure details they may be as small as 2 mm. The colours of the tesserae are: white, black, cream, grey, ochre yellow, mustard yellow, burgundy, red, pink, blue, light blue, green, light green, brown and light brown. The materials are sedimentary stone, marble and a small amount of glass.

Conservation problems

The state of the Villa of the Amazons after the excavations of 2006 and 2008 gave it the appearance of a building that had partially survived: its roof and walls had collapsed, the remains of its walls had mostly been dismantled, and practically only its mosaic floors survived.

At the first inspection, it emerged that, thanks to the temporary covering measures taken at the moment they were unearthed, the floor mosaics had, to a great extent, preserved the state in which they were found, both during the excavations and the interim periods since. As for the deterioration that was observed, it seems to have occurred during a period prior to the excavations. Generally speaking, it appeared that the mosaics were damaged to a great extent because the building/area in which they are situated were left unused and because of environmental conditions. Furthermore, during the time they were under the ground the mosaics suffered increasing deterioration. The marks of burning in the form of colour changes that can be seen on the mosaic surfaces show that the building had been abandoned after a fire. The lacunae occupying large areas in the mosaics and seen more often in the upper layers (such as the *tessellatum*, setting bed, and *nucleus*, which are the more fragile) show that they had been subjected to flooding and the like; and the lacunae at

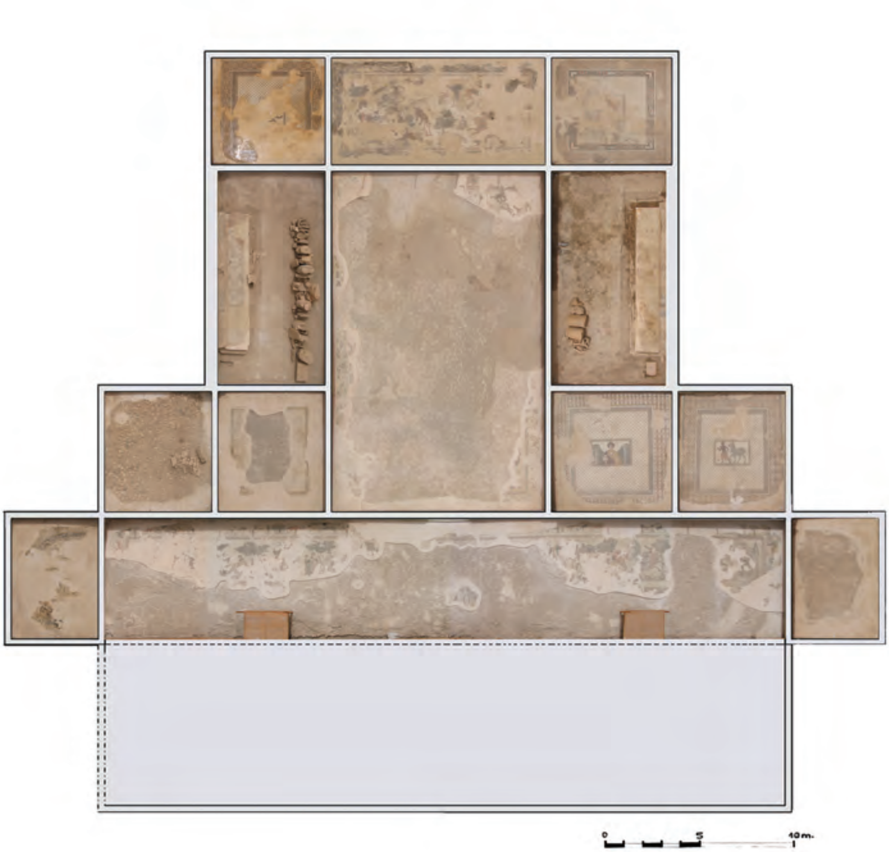

Fig.1. The mosaics at the Villa of the Amazons (photo: Y. Selçuk Şener)

the edges of the mosaics near walls and the fact that stones were missing down to the foundation level from the walls near these edges, show that, after the site was deserted and during the time it was buried, people living nearby had dismantled the walls (and damaged the mosaic edges). The scars that had damaged the walls and some of the mosaics were caused by the digging of foundations and the building of a sewerage system at the beginning of the Archaeopark project and, sad to say, show that building work continued for a while even after remains of the cultural layer had emerged.

Conservation and restoration

In the conservation and restoration of the Villa of the Amazons and its mosaics, the primary targets were the mosaics. However, this work could not be carried out ignoring the very few architectural remains, in other words the walls. If we were unable to find the walls surrounding the rooms where the mosaics were, the sole work of conserving the mosaics would not have been sufficient. Furthermore, it would have been difficult to perceive the relation between the floor mosaics, each of

Fig. 2. State of repair before the rebuilding the walls of the Amazons Villa (photo: Y. Selçuk Şener, 2008)

which is on a kind of "island", and the architecture within which they are situated. Therefore, work began with restoring the walls and continued with mosaic conservation.

Restoration and resetting of walls

Detailed excavations were carried out anew in the parts of the building where the robbed walls trenches filled with sand were situated. Taking into account all information emerging from these excavations, such as walls, traces of walls and foundations, the plan of the building was drawn (Fig. 1). During restoration work, the surviving parts of the walls that were under the level of the mosaic were raised so as to surround the mosaic flooring with at most one course of stones; parts of the missing walls were reconstructed taking into consideration measurements close to this level. Stones of a size close to those of the original walls were used for the restoration. In order to easily distinguish the newly built walls from the original ones, grout of different colour and texture was used. Thanks to the wall restoration, we both delimited the boundaries of the spaces necessary for the preservation of mosaics, and were able to better perceive the building, at least in terms of its layout (Fig. 2 and 3).

Fig. 3. Restoration and resetting of walls (photo: Y. Selçuk Şener, 2009)

Restoration and conservation of mosaics

Conservation and restoration work on the mosaics generally consisted of cleaning, consolidation and reintegration in order to preserve their general aesthetic appearance.

Cleaning

The layer of soil from the mosaic surfaces was first carefully removed with trowels, spatulas and brushes. To clean away remnants of mud adhering to the surface a "washing procedure" was carried out, which involved wet scrubbing and wiping the surface with a sponge (Fig. 4).

For cleaning away the hard and adhering deposits on the mosaic surfaces, mechanical methods were used. The dense layers of limestone were thinned down, first with diamond-pointed thin steel chisels; and the cleaning was completed using a scalpel, which gave us more control¸ and also by washing with brushes of medium firmness (Fig. 4). Surface cleaning was carried out more delicately on areas where bulging, depression and lacunae had formed. To expose the boundary between mosaic and lacunae we used a portable steam cleaner which provided low pressure hot water steam. The steam cleaner softened the soil that had filled the lacunae, thus facilitating its removal.

Fig. 4. The cleaning of mosaic surfaces (photo: Y. Selçuk Şener, 2008)

Consolidation

This involved the different procedures carried out with the aim of repairing and/or improving the poor condition of the layers constituting the mosaics.

Consolidation of edges

This is a mortar filling procedure to prevent disaggregation of the edges of the lacunae in the *tessellatum*, *nucleus* and *rudus* layers, and for stabilizing them. The mortar used in this procedure was a mixture of lime, stone powder, brick powder and water. When applying the mortar, the bases and edges of the lacunae were first cleaned and dampened with water; then the mortar was applied with spatulas, starting over a wide area at the base of the lacuna and merging on the upper side of the tesserae, so that its cross-section forms a triangle (Fig. 5). Interventions on the *tessellatum* ensure the stabilization of the mosaic edges in the initial stage; however, they constitute, in effect, a kind of concealed consolidation (because mortar fills were applied at the next stage). As for the interventions carried out on the *nucleus* and *rudus*, they are in themselves sufficient to hold/preserve the existing layer and the edges of the lacunae.

Consolidation and stabilization of the *tessellatum*, *nucleus* and *rudus* layers:

In the consolidation of the *tessellatum*, nucleus and *rudus* layers where voids and detachment occurred, we used the method of injecting fluid hydraulic lime mortar. One or two tesserae were removed in designated areas, at specific intervals, and, using long, slender chisels, channels were opened that descended into the voids beneath the *nucleus*. The voids were washed by introducing a mixture of alcohol and water into these channels, and finally a hydrous mortar was injected (Fig. 6).

Renewal of the setting beds

The renewal of the setting beds was performed on areas where detachment occurred between the *tessellatum* and the mortar layers beneath it. This procedure involved covering or binding the *tessellatum* layer with cotton cloth glued on with acrylic resin. Then, the *tessellatum* was partially lifted off the level of the bedding layer using slender wedges, and was laid on temporary

Fig. 5. The repair of the edges of the mosaics (photo: Y. Selçuk Şener, 2008)

Fig. 6. Consolidation of the mosaics (photo: Y. Selçuk Şener)

supports. After cleaning, the new setting bed was laid at the level where the lifted part had been. The partially lifted *tessellatum* was then reset, and levelled by gently hammering via small blocks of wood. After the desired evenness was achieved it was left to dry. At the final stage the remnants of cloth and resin were cleaned away.

Partial lifting of the *tessellatum* was preferred to lifting it off as a whole, with the aim of preserving its original place and position as much as possible. Indeed, this kind of consolidation was carried out only when there was no other choice and on mosaics/mosaic parts in which connection to the mortar layers had been lost to a great extent; and indeed, in cases where other methods would not be effective/sufficient (such as the application of liquid mortar) due to the mortar layers and/or the *nuclei* having lost most of their integrity.

Filling and reintegration

The filling and reintegration carried out on the floor mosaics were applied as much for mosaic conservation as for ensuring aesthetic integrity.

Reintegration of lacunae in the mortar (*rudus* and *nucleus*) layers

Reintegration in the *rudus* and *nucleus* layers was carried out by filling the lacunae at the level where the procedure would be applied. For deep lacunae, the soil surface was levelled and compressed. A new hardcore layer was formed with stone rubble. The area of the lacuna, the base of which was consolidated, was filled in compliance with its original texture, first with a coarse-grained and then with a finer-grained lime mortar (Fig. 3).

By contrast, only mortar was used for filling shallow, superficial lacunae (for example in the scars on the *rudus*). In all instances, for upper layers that were exposed and could be seen, coloured (aesthetic) mortar fills were used. Thus, through restoration practices aesthetic integrity was obtained, first within each single mosaic, and then on a wider scale throughout all the mosaics in the building. We used a "technique of indication"

Fig. 7. Reintegration of the *tessellatum* with tesserae (photo: Y. Selçuk Şener, 2008)

aiming to distinguish areas in which intervention had been carried out using original parts.

Filling of cracks in the mortar layers

In the procedure of filling cracks in the mortar layers, the earth and the like which had subsequently penetrated into the cracks, were first removed and cleaned away using brushes, spatulas, fine wire, and a vacuum cleaner. The dampened surfaces were filled in with mortar up to the level of the layer and then levelled using spatulas. In the final stage, the filling mortar was packed using brushes with soft, dense, natural bristles; in this way it was ensured that on the one hand the mortar would be compressed and, on the other, that the grainy aggregate compound constituting the mortar mix would be brought forth thus achieving a homogenous surface appearance.

Reintegration of the *tessellatum* with tesserae

Tesserae that were detached from the mortar bed and thus dislocated when the cover of soil on the surface was removed were reset with lime mortar prepared in a manner faithful to the original.

Areas with disaggregated tesserae or with small lacunae were reset using original tesserae. Prior to resetting, the tesserae were classified and separated according to colour and type, and the dirt formed by soil, mud and mortar deposits and remnants was mechanically cleaned. When resetting the tesserae, we took into consideration the motifs and designs of the extant mosaics and their position in the decoration (Fig. 7).

Filling of the *tessellatum* interstices

The procedure of filling the *tessellatum* interstices aimed at reinforcing the *tessellatum* layer which had lost its integrity due to disaggregation in the setting bed. For this procedure, the t*essellatum* interstices were first cleaned then filled with a new mortar mix prepared with hydraulic lime. The mortar mix used in reintegrating the *tessellatum* was used for filling the interstices.

Filling the *tessellatum* with mortar

This procedure involved the reintegration of lacunae using a mortar mix prepared in a way similar to the original mosaics in terms of colour, composition, and texture (aesthetic mortar).

Deep areas were first filled with pebbles in such a way as to remain 5-6 cm below surface level. Then a lime mortar prepared with coarse sand and lime (grey mortar) was spread and levelled after filling the areas so that, in general, it remained 2-3 cm below the surface (Fig. 8). The aesthetic mortars

Fig. 8. Reintegration of the *tessellatum* with aesthetic mortar (photo: Y. Selçuk Şener, 2009)

to be used on the uppermost reintegration layer were selected from among a great number of trials prepared so as to match all the mosaics and in compliance with the colour texture of the *tessellatum* layer. The mortars were prepared with a mixture of finely sifted sand, stone powder, brick powder, and hydraulic lime; and pigments were used to colour the mortars. Care was taken to leave the aesthetic mortar fills about one millimetre below the *tessellatum* layer.

Preventive conservation

In planning the conservation of the villa and its mosaics, it was decided that this should be both active and preventive, which complement one another.

Preventive conservation measures were planned so as to include a walkway to ensure controlled visits of the building and the mosaics; to build a temporary cover to protect them from environmental conditions; and to install a drainage system around the building in order to prevent moisture. The walkway was built at the final stage of active conservation work. Thanks to this walkway, made of wood and set on the walls, the area was opened to visitors (Fig. 9). Thus, thanks to the restoration work performed, we accomplished the first and second phases of the objective to "transform the area into an archaeopark" through in situ conservation,

Fig. 9. Haleplibahçe, the walkway and the building of the temporary cover (photo: Y. Selçuk Şener, 2009)

as was envisaged at the outset. The task of building the temporary cover was carried out by the museum authorities in the autumn following completion of the conservation work. Though its appearance is not so attractive, it can be said that it does fulfill its duty of protecting the site against environmental conditions until the permanent cover is built (Fig.10).

Conclusions

Conservation procedures on the mosaics were performed on location conforming to the principle of in situ conservation. For this purpose, a series of interventions was carried out in order to preserve the mosaics together with the remains of the villa to which they belong and to prepare them for display.

The first of these interventions consisted of the architectural restoration deemed necessary for the villa building and especially for the conservation of the mosaics. Architectural restoration was limited to raising the walls only so far as to surround and enclose the mosaics. In this way, not only preservation was ensured but also the building's plan, which had largely disappeared, was rendered intelligible. In the finished work we adopted the technique of indication by colour and material to distinguish between the original and the restored parts of the walls; however, restoring in a way similar to the original was usually preferred. In line with this, we remained faithful to stone size and row height; and, in order to indicate the new parts, we used differently shaped interstices (convex as opposed to concave) and colours (choosing a greyish instead of cream colour). In the conservation and restoration procedures on the mosaics the following practices were employed: cleaning of the surface, consolidation of the surface and structural layers, and filling and reintegration of lacunae. The fundamental principle observed in all procedures was to over-

Fig. 10. Haleplibahçe provisory cover, after restoration (photo: Y. Selçuk Şener, 2009)

come problems and improve the current condition. In line with this, care was taken to preserve the work's original state and to avoid unnecessary and extreme procedures. In the final stage, in order to preserve the restored villa and its mosaics and display them to the public, a walkway was built that would both enable visitors to see the building and the mosaics and prevent contact with them. Lastly and also thanks to the initiative of the museum authorities, the building was covered with a temporary roof. With these last interventions two important steps have been taken towards sustaining the effective conservation work carried out in the long term, and two additional procedures have been implemented in order to ensure the sustainability of the interventions. Our wish is that the permanent cover system or systems be designed and built, that information panels be placed to ensure better promotion of the site and the mosaics, and that, in the end, the Haleplibahçe excavation site be transformed as soon as possible into an open-air (mosaic) museum connected to an archaeological museum envisaged to be built soon.

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POSTERS

MANAGING THE LOSS: A COMPARATIVE STUDY OF THEORIES ON AESTHETIC REINTEGRATION OF LACUNAE IN MOSAIC FLOORS

Mikal Kindt and Stefania Chlouveraki

Abstract

The decision that will ultimately determine how a collection and or/a site will be managed depends on its condition and its current function and use. Mosaics are found in a variety of environments – i.e. in situ, in museum collections, in churches or mansions – and can be exhibited, kept in storage, displayed in situ or reburied. Reintegration is a treatment dealing with the stability and the prevention of further losses as well as with the aesthetics and the readability of the decorative theme. The present study analysed all the information available in the conservation literature on the issue of reintegration, including fundamental theories, practical methods, principles and international conventions. Subsequently, the perspective of various groups of specialists and of the general public on the issue of reintegration of the missing parts of mosaic floors was investigated through a questionnaire. This provided significant information that can be used in the decision-making for the presentation of mosaics in museums and sites. More specifically the questionnaire was distributed to contemporary mosaic artists, archaeologists, conservators, historians, architects and the general public. The analysis of the questionnaires points out that the perspective of specialists and the general public on the issue of reintegration of the losses differs significantly and that we need to develop solutions that can be understood and enjoyed by a wide range of viewers.

Introduction

The present research investigates the reintegration of lacunae or missing parts in floor mosaics. The information that exists today is quite general and scattered in the publications of various case studies and therefore we do not have a protocol or a collective work that can guide the professionals in their decision of how and to what extent to reintegrate the lacunae. Moreover, the general concept and values of cultural heritage have evolved significantly through the ages, especially in the late 20th century, resulting in several revisions of past concepts and practices. The increased scientific activity in the field of conservation of cultural material brought innovations into the treatment of mosaics as well as the reintegration of lacunae. However, no consensus or broad overview is present about the different aspects of the treatment and reintegration of lacunae, although many authors recognize and stress its importance. In this paper we examine the problems involved, the different reintegration techniques and the theoretical background, and discuss the materials that can be used. As M.C. Ceriotti (1993, 141) states *"the reintegration of missing sections in mosaics is certainly the most pressing and unsolved problem facing restorers."*

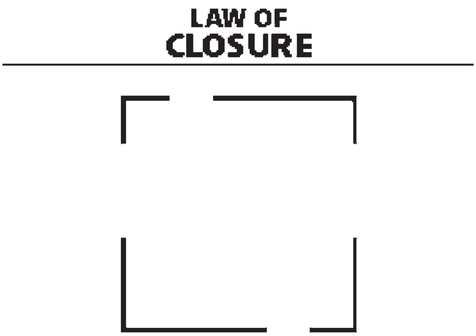


Fig. 1. *Gestalt* psychology and the law of closure in theory, adapted from Rubin 1915

Fig. 2. *Gestalt* psychology and the law of closure in practice, as applied in the Good Shepherd in the Domus dei Tappeti di Pietra, Ravenna, Italy, showing a partial continuation of the geometrical border in the white background (Photo M. Kindt 2012)

Theories and approaches on the issue of reintegration

According to Gestalt psychology humans are capable of seeing more than there is (Van Dongen 1990), which is a very important consideration on the choice of the method and extent of reintegration in mosaics as well as other forms of art.

Cesare Brandi (1963) stated that the aesthetics of a work of art are determined by the unity of form as a whole (Mittone 2011), as for example, the *law of closure* (Fig. 1 and 2); despite the fact that a curve is broken we seem to see it as a continuing curve. This theory offers less of a solution for figurative mosaics than for geometric ones.

Fig. 3. The staccato technique in progress in the Villa Romana del Casale, Piazza Armerina, Sicily (photo S. Chlouveraki, 2007)

Two-dimensional chromatic restorations (i.e. colour-drawing the missing parts of the design on the mortar) are the usual techniques applied on mosaics and originate from two-dimensional large-scale art (see Fig. 4b), such as painting and wall painting. It has always been considered that what works for wall paintings is also applicable to mosaic floors and walls. Both cases are decorative arts, which belong to an architectural context and are made of several layers. In mosaics, however, there is a clear distinction between the surface decorative layer (the tesserae) and the bedding mortar or *supra nucleus*, which is not the case with mural paintings. In wall painting, texture and colour of the preparatory layers play an important role, while in mosaic floors it is the surface of the tesserae and not that of the bedding layer that determines the texture of the decorative surface.

Based on the surface texture issue, P. Philippot (1978) introduced the idea of reintegration that creates a three-dimensional effect, by reproducing the relief of the mosaic surface, which he called *staccato*. The *staccato* is formed by outlining the shapes of tesserae on the mortar, and can be additionally coloured or not. An example of this technique can be seen today in the mosaics of Piazza Armerina, Sicily (Fig. 3), a work that is still in progress.

The reintegration approach also depends on the type and the current use of the architectural context. In archaeological sites and historical monuments, large lacunae are reintegrated with mortar or even loose

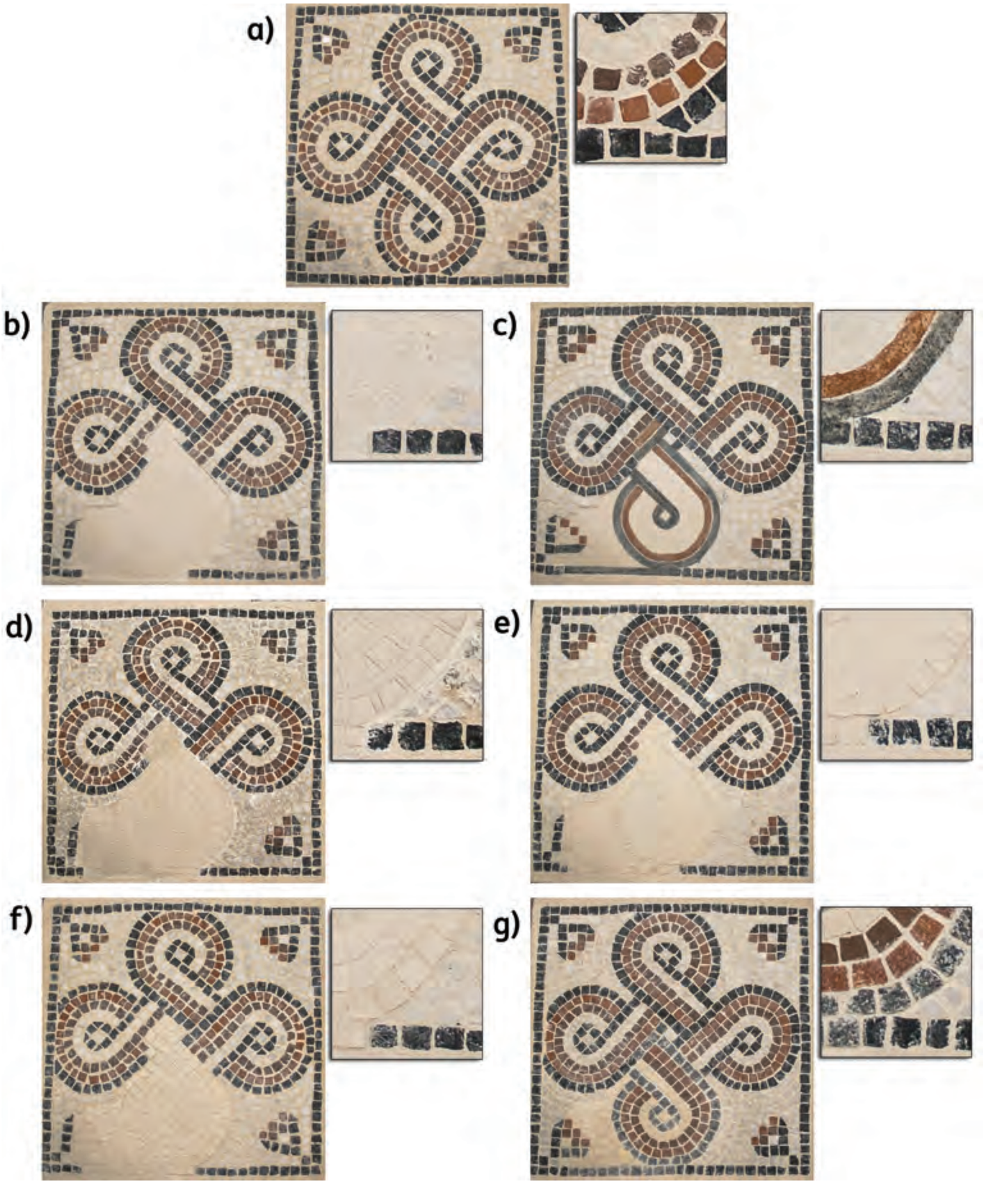


Fig. 4. a) original mosaic, b) mortar: reintegration by applying mortar in the lacuna, at same or lower level than the original surface; c) mortar + colour: reintegration by applying mortar in the lacuna and then painting the missing parts of the design; d) *staccato*: a three-dimensional effect is created by engraving the shape of tesserae in mortar without colour; e) mortar + off-white tesserae: reintegration by applying mortar in the lacuna and then adding off-white stone tesserae on the outline of the design; f) off-white tesserae: reintegration of the entire lacuna with new off-white stone tesserae; g) new tesserae: reintegration with new stone tesserae in colours close to the original ones, usually lighter in tone, Athens, Greece (photo M. Kindt, 2012)

Fig. 5. Reintegration indicated with a single line of tesserae, red line around the lacuna in the Basilica Saint Apollinaire in Classe, Ravenna, Italy (photo M. Kindt, 2012)

gravel, while in the small lacunae we can have 2D or 3D techniques. In "living monuments", the reintegration of both large and small lacunae is intended to blend in as smoothly as possible and it is often almost invisible. Examples of such reintegration can be seen at the magnificent monuments of Ravenna, such as Saint Apollinaire in Classe (Fig. 5).

A. Lugari (2003) stated the importance of approaches for *in situ* (archaeological sites) and *ex situ* (museums) reintegration. He argued that for *in situ* mosaics it should be recommended to reintegrate lacunae more extensively than for *ex situ*, in order to preserve the architectural characteristics of the site and to prevent further degradation and loss. This is a different approach that is not commonly followed. Conservators are mostly working on issues such as the compatibility, reversibility, minimal intervention and preservation of authenticity. The choice of the most suitable materials and techniques for reintegration takes into account several variables, such as size, theme (i.e. pictorial or geometric), perspective and light but also the physical properties of the mosaic (Schudel 2005) and its ability to withstand weathering.

Principal reintegration techniques

The most commonly used techniques today are (Fig. 4) mortar, mortar and colour, staccato texture, mortar and off-white tesserae, off-white tesserae and new tesserae of lighter tone colour.

For integration with mortar, arbitrary terminology is used in the restoration community, such as 'neutral colour' and 'undertone'. This complicates the interpretation of theories and recommendations, which is subject to the individual's perspective. For conservators, a neutral colour is one that attracts relatively little visual attention. But how do we define that colour? Is it determined by the common colour *next* to the lacunae, or the mean *local* colour in the mosaic floor? Like N. Murray (Murray and Vazquez 2010) states: lacunae integrated with the most common colour in that region are noticed sooner than the lacunae integrated with the mean local colour. Reintegration with tesserae is certainly appropriate when we speak about a floor that will be walked on. In this case the wear of the reintegration is the same as that of the surrounding part. This is also appropriate when original tesserae are still available and the pattern of the mosaic floor is known. An example of this is the Basilica of Saint Apollinaire in Classe (Fig. 5): on the left of the apse, integrations were applied by filling the gaps with tesserae of the same colour and size as the surrounding tesserae; between the original and the reintegration there is a single line of tesserae in complementary colour. For the general public it is not always possible to distinguish between the reintegration and the original. Is it the part inside the red tesserae which is original, or is it the part outside the red tesserae? Information panels, which point out the

Fig. 6. This reintegration technique in the Domus dei Tappeti di Pietra, Ravenna, Italy, is at a higher level than the mosaic surface. Looking at the mosaic from above it seems as if they are at the same level (photo M. Kindt M., 2012)

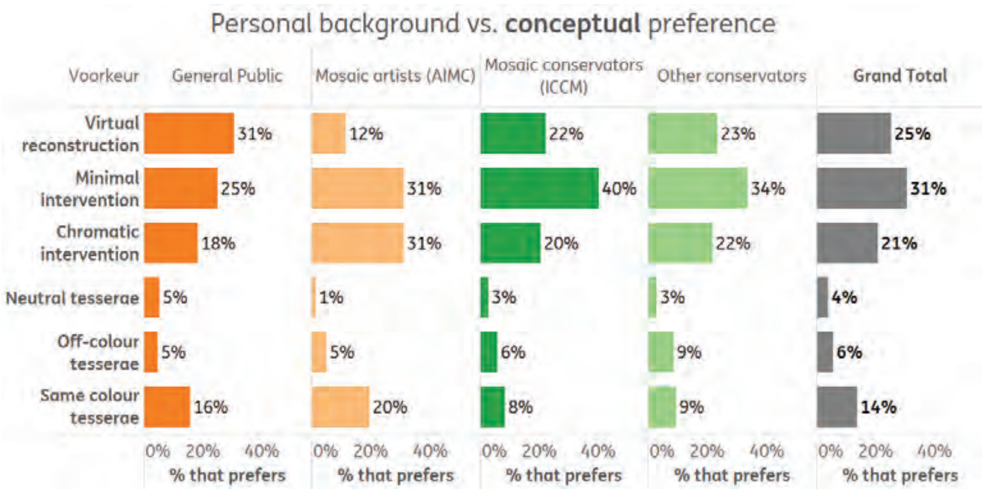
reintegration and explain the philosophy of the whole conservation treatment, can be very useful to the visitor and are highly recommended.

Examining the issue of reintegration

The issue of reintegration was examined by means of bibliographic research, macroscopic observation and evaluation, experimental applications in the laboratory and the distribution of a questionnaire for specialists and the general public. The bibliographic research focused on both the theories and the materials and techniques used in the past and present (Fig. 1 and 2) (Fiori 2004; Jokilehto 1999, 228-241). Macroscopic observation and evaluation were also undertaken on a number of mosaics in museums, archaeological and historic sites (Fig. 6). A series of mosaic samples were prepared in the lab (Fig. 4), all containing an identical lacuna which was reintegrated using the most common techniques that are reported in the bibliography and can be seen in various museums and sites today. Finally, a questionnaire was designed and presented to professionals related to the field of conservation (conservators, archaeologists, historians, artists, etc.) and to the general public to capture and compare their visions and reactions. The mosaic samples, where six different techniques were applied, were exhibited at the 12th International AIMC (Associazione Internazionale Mosaicisti Contemporanei) Congress of Contemporary Mosaic, in Athens, Greece (1-4 October, 2010), accompanied by questionnaires for the participants. A poster and prints of all the mosaic samples were exhibited together with the same questionnaire at the 11th Conference of the International Committee for the Conservation of Mosaics, in Meknes, Morocco (October 24-27, 2011).

Responses to the questionnaire

The most commonly used methods for the treatment of mosaics, in theory and practice, were judged from the perspective of specialists and the general public.
The reactions and opinions of the specialists and those of the general public are, as expected, quite different. Both groups conceptually approved the theoretically based techniques, but did not appreciate them equally when viewed in practice. Figures 7, 8 and 9 show the results of two main questions that were asked:
1) *Please select the mosaic reintegration you prefer* (visual approval). In this question, we surveyed the people's visual appreciation of the reintegration methods as demonstrated in the laboratory prepared samples that we put on display.
2) *Please mark the methods you would find the most appropriate for the integration of lacunae in geometric (not figurative) mosaics* (theoretical/conceptual approval). The following options were offered: a) virtual reconstruction (non-intervention); b) minimal intervention; c) chromatic restoration on mortar fill; d) reconstruction with neutral tesserae; e) off-colour tesserae; f) same colour tesserae. The purpose of the second question was to survey their conceptual approval (appreciation) for different reintegration techniques. In other words, we asked them how appropriate they find certain reintegration techniques from a conceptual or theoretical point of view. Ideally, their answers on both ques-



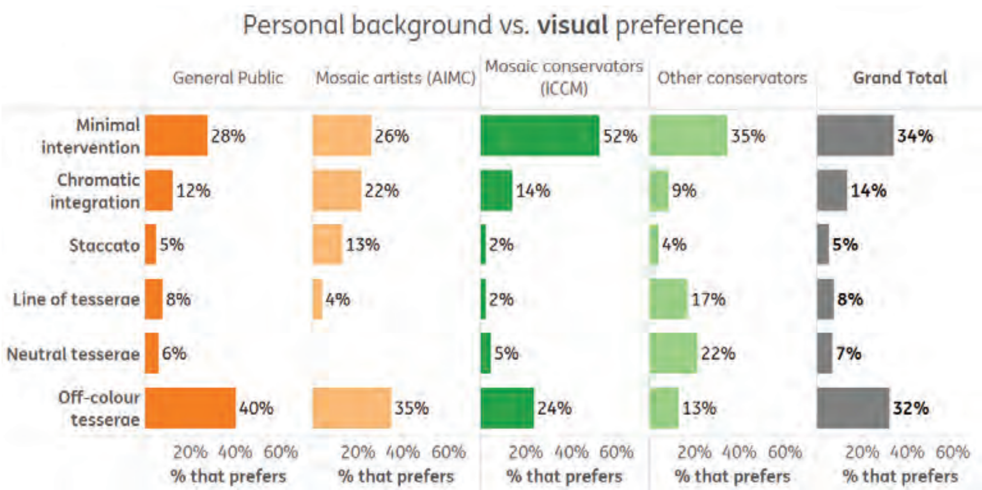


Fig. 7 and 8. The *conservators in general* are the people who do not have knowledge of mosaic restoration. The attendees of the AIMC conference are artists making new mosaics and the attendees of the ICCM conference are people with close knowledge of mosaic restoration

tions should be equal because that would mean that they do not only approve of a certain technique, but also find it aesthetically pleasing.

Conceptually, *conservators* (conservators who do not specialize in mosaics) prefer the maximum preservation (23%) and minimal intervention (34%) (Fig.7). Conceptually, reconstruction with neutral tesserae don't score (3%), while visually it is most appreciated (22%). If they have to choose between a neutral tesserae (22%) and three-dimensional (28%) restoration (i.e. techniques that imitate the original

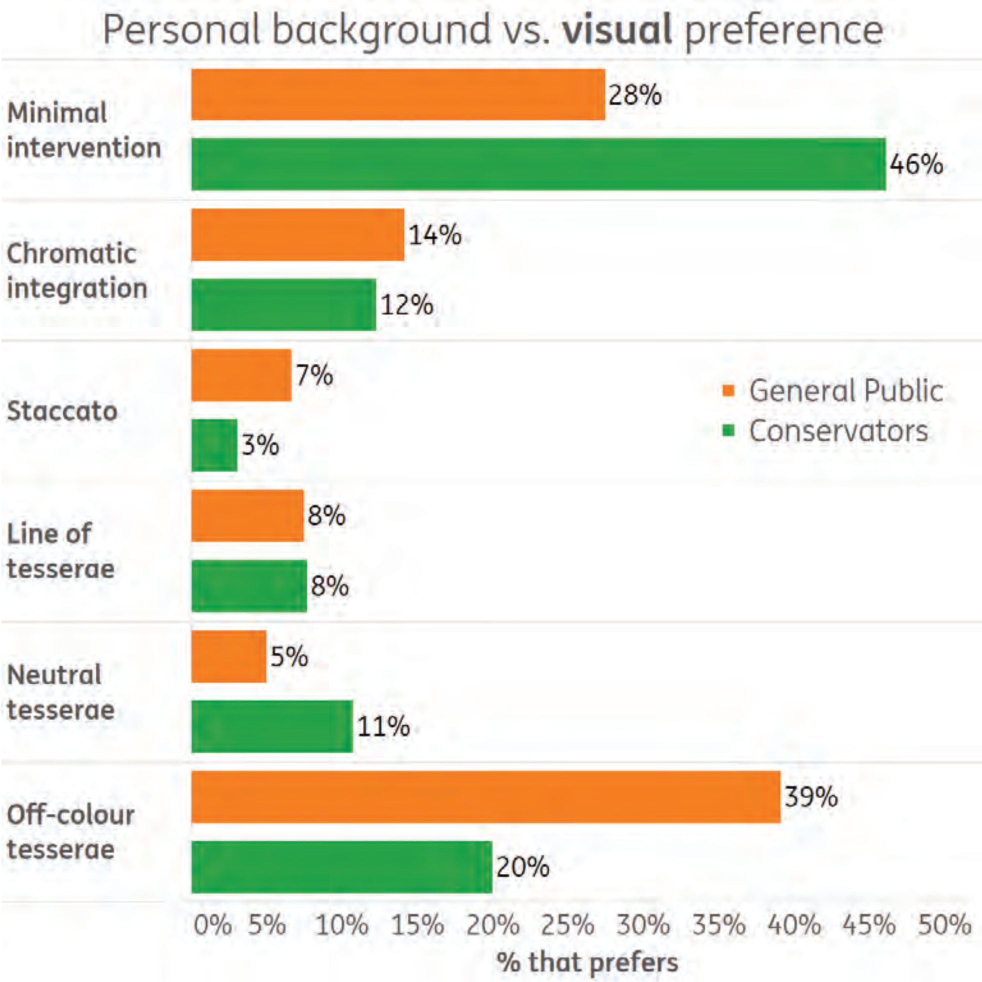


Fig. 9. The *general public* are the people visiting sites and museums. The *specialists* are conservators in general, attendees of the AIMC and ICCM conferences

surface texture) they prefer the three-dimensional.

In contrast to the conservators, *attendees of the 12th AIMC* conference, who were mostly mosaic artists (i.e. artists making new mosaics), appreciate the minimal intervention almost equally. Most of them also prefer integration with off-colour tesserae rather than integration with mortar (i.e. mortar filling at the same or lower level than the original surface).

The *attendees of the 11th ICCM conference,* who are mostly mosaic conservation specialists or archaeologists/historians specialising on mosaic art, seem to have a different point of view than those of the

AIMC conference, but they also agree on certain issues. The great majority of them prefer a minimal intervention (52%). In the other categories (two-dimensional, three-dimensional and new tesserae), they correspond reasonably well with people from the AIMC conference. It is apparent that the perspective of the general public is different from that of conservators, mosaic conservators and mosaic artists.

When comparing the specialists to the *general public* (i.e. people visiting sites and museums), it is immediately noticeable that the *specialists* (i.e. conservators in general, attendees of the 12th AIMC and 11th ICCM conferences) and the *public in general* have a contrasting opinion. The former prefer minimal intervention, while the latter prefer reintegration with off-colour tesserae. Both groups score low for two- and three-dimensional restorations.

Specialists very rarely chose a three-dimensional staccato restoration (3%). In theory, a three-dimensional integration does not seem to be an option, while in practice there is some approval (as for other conservators). Other conservators conceptually did not appreciate the off-colour tesserae (5%), even though they do appreciate it when seen in practice (40%). It is clear that *specialists* and the *general public* have opposing opinions (Fig. 7 and 8) on the integration techniques both in the concepts and the evaluation of the applied methods.

Co*nservators* are trained to preserve the original fabric and to add as few new elements as possible. This choice for authenticity is obviously the reason why they prefer the minimum intervention to new tesserae. It should be mentioned, however, that these conservators are not necessarily aware of all the different integration methods that are used for mosaics.

Notably, *the attendees of the AIMC* conference did not choose at all for neutral tesserae (0%), they prefer to see colour in the intervention techniques, whether it is a two or three-dimensional one. The most possible explanation is the importance of tangible and visual value to mosaic artists.

The *attendees of the ICCM* conference clearly prefer a minimal intervention (Fig. 9) above all other integration methods. A probable explanation for this is that it is a matter of principles, of respecting and preserving the authenticity of the original fabric, to keep the intervention very distinct. Exceptions are the living monuments that are somehow governed by a different code of ethics.

Conclusions

The research that has been undertaken up to now on the theoretical and aesthetic approaches to the reintegration of mosaics is very limited. Nevertheless, it is clear from observations on different sites that different reintegration techniques are carefully considered in regards to the architectural context of the mosaics.

Despite or perhaps due to the increased scientific activity in the field of mosaic conservation, there is no consensus about specific terminologies yet, such as neutral colour and undertone (Murray 2010, 248-252). It has been observed that the Munsell chart for soil and rock colours, which is the universal tool for describing and characterising the colour of various materials, is rarely used as a reference in mosaic conservation bibliography. As a result, the description of colour is very subjective and complicates the interpretation of theories and recommendations, which is subject to the individual's perspective. The survey showed that the current techniques have pros and cons and that no technique is perfect. However, the currently used two- and three-dimensional reintegration techniques, which respect the original stylistic and physical properties of the mosaic surface to a different degree, are not generally accepted yet. The general public's and the specialists' preference for some of the techniques differ greatly. Moreover, those techniques that are conceptually approved by both groups are not appreciated as much by either group when viewed in a real application. Further research should look into developing integration techniques that can be appreciated by both specialists and the general public, e.g. an integration technique that creates the form and shows the colours, which corresponds closely to the mosaic surface and is an economic and reversible method. This survey shows that a minimum or maximum intervention is desired by most of the public. Whatever reintegration technique is used, it is always advisable to provide adequate information to the visitor through the use of explanatory boards, distinguishing between the original part of the work and the modern additions that have often taken place in multiple phases.

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INVESTIGATION AND CONSERVATION OF A FRAGMENT OF A ROMAN MOSAIC FLOOR FROM THE GOVERNOR'S PALACE OF AQUINCUM (PANNONIA), HUNGARY

Brigitta Mária Kürtösi

Abstract

The aim of the study of the materials and the structure of this Roman mosaic is to gain thorough information about its technique. The conservation of this fragment made possible the microscopic, chemical and X-ray diffraction examinations, which gave us exact results about the structure and the special technology of the preparation of the support of the mosaic.

Fig. 1. Archive photo of 1941 showing the mosaic before removal, Óbuda, Hajógyári-sziget. It is clear that in the following years some completions were made as confirmed in János Szilágyi's 1945 publication

The mosaic fragment (Fig. 1) comes from the Governor's Palace of Aquincum, which was one of the most representative buildings (Fig. 2) of the Roman province of Pannonia Inferior. The palace is situated on an island of the Danube. Its construction began under the regency of Hadrian in AD 107-108, and the mosaic probably dates to the beginning of the 3rd century AD. According to Havas (2010, 17), it seems that the mosaic pavements of the eastern annexe could not date from an earlier period. During the excavations stamped bricks of the *cohors VII. Breucorum Antoniniana* (COH VII BR AN) and *cohors I.Ulpia Pannoniorum Antoniniana* (198-222 AD) were found under the previously undisturbed, intact mosaic floors of rooms 3 and 5 (Havas 2016, 92). The large-scale construction project took place after this period. A dockyard was later constructed on its ruins.

There were two important excavations between 1941 (Szilágyi 1945) and 1956 (Kaba 1958). During those days and political era it was impossible to establish an archaeological site in situ, and during the rescue excavations the floors were removed. Most pavements are presently in fragments as they were cut into sections and were strengthened with a thick concrete support with an

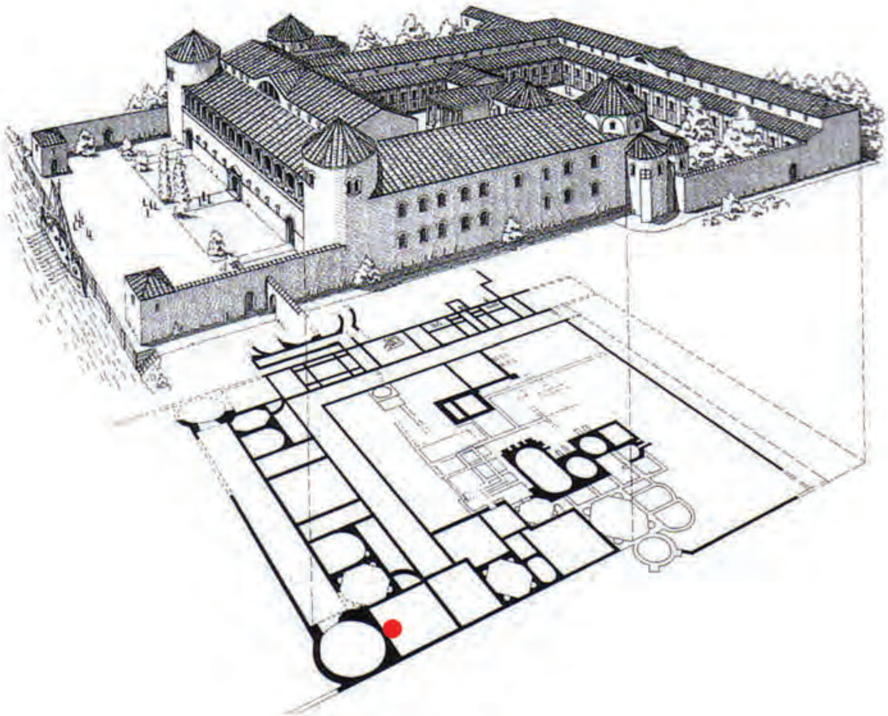
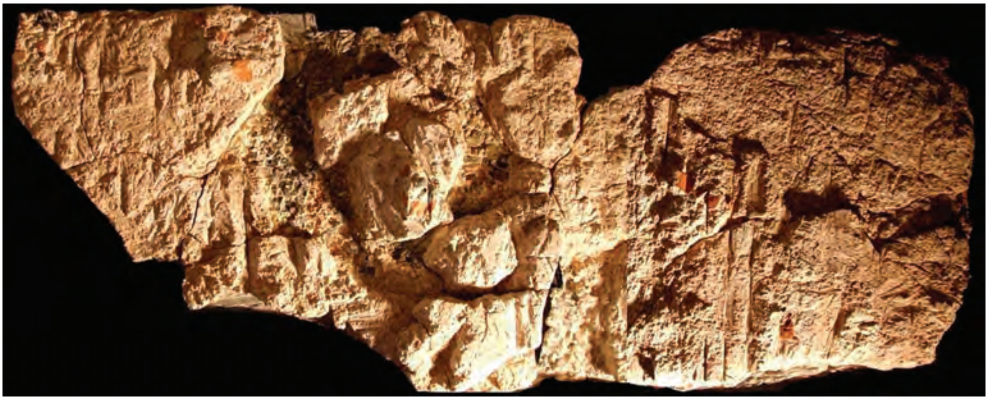


Fig.2. The findspot of the fragment in the Governor's Palace of Aquincum, chamber no. 8. (illustration by Markus Schaub)

Fig. 3. Condition of the mosaic in 2008 (photo: Brigitta Maria Kürtösi)

Fig. 5. The remnants of the original mortar layers photographed with oblique lighting (photo: Brigitta Maria Kürtösi)

Fig. 4.The removal of the concrete support (photo: Brigitta Maria Kürtösi)



iron armature. The slabs have been stored in the Museum of Aquincum. The part of the mosaic in question could be the threshold from the frame of the pavement of a large room decorated with four-coloured geometric patterns. It comes from the entrance of room 8. All of the floors in the eastern annexe possess a frame with patterns different from those of the central motifs. Our fragment is the only one remaining without the central part and other sections belonging to it. Thus, it was possible to complete the third, fragmentarily preserved motif of the mosaic. The fragment (Fig. 3) represents a complex, repeating geometric pattern; a quadruple Solomon's knot in the centre of a four-pelta swirl (Balmelle *et al.* 1985, pl. 57g: 'tangent and linked swastika-peltae with central [double Solomon] knot, alternately reversed'). The double Solomon knot is rare in the Roman world by comparison to its single form, which is a quite widespread motif, found in many cultures. The Solomon's knot is a symbol of wisdom and is currently interpreted (e.g. Sansoni 1998, 19, 21) as symbolizing eternity, immortality, because of its invisible beginning and end. The whirl is the emblem of cosmic recurrence. The investigation and conservation of the fragment was the author's diploma work in 2010 in the framework of the MA thesis at the Hungarian University of Fine Arts, "Conservation and examination of a mosaic floor fragment from Aquincum. Comparison of floor mosaics from Pannonia. Experiment for exploring technical, structural, material and aesthetic connections" (Supervisor: Bóna, István, DLA habil

Fig. 6. The stratification of the fragment (Reconstruction drawing and photo: Brigitta Maria Kürtösi)

– Painting-Conservator (Hungarian University of Fine Arts); consultants: Kriston, László – Physicist (Hungarian University of Fine Arts), Balázs, Miklós Ernő DLA habil – Mosaicist). I studied the materials and the technology of the substrate of the Roman mosaics from Pannonia, and in this case we tried to find a new, lightweight and compatible support for this fragment, while maintaining the surviving original mortar layers. This is the particularity of this restoration because in most cases, after the detachment of the layer of the mosaic tesserae, the removal of the underlying preparatory mortar layers is the general method. Naturally, the weight is the main reason for dealing with it in this way. In our case, however, the thick concrete support had saved these elements. We had to choose the treatments considering both the materials, the stones and the mortars. Therefore, the challenge was to keep them together. The fragment was severely damaged; the salt coming out of the cement and the corroded armature caused cracks not only in the support but in the original mortars too. The fixed, inflexible support was broken, and this caused loss of tesserae. After the first excavation, it was completed by using concrete on the edges, which often covered the surrounding tesserae. In the central motif, cement was applied to reintegrate losses. Here, not only the tesserae are bigger but also the spaces between the stones are larger and filled with grey cement. In these integrations the original setting aesthetics were not followed. That is why we had to remove these incorrect tesserae fillings. After the systematic removal of the concrete support and the cement fillings, we fortunately found four different fragmentary layers under the mosaic tesserae (Fig. 4 and 5). This offered a good opportunity to examine the technology of the preparation of an 1800-years-old mosaic pavement. It is fortunate that the mortar layers were not destroyed during the rescue excavations like those on the back of the fragments of the other four pavements (Fig. 6). The mortar composition of the layers in question is based on lime. The classical dry lime slaking was employed for the basic mortars. In this case, the dry raw materials are spread and water is poured on them.

Fig. 7. 'Kalkspatzen'- detail of the first layer of *nucleus* (Photo: Brigitta Maria Kürtösi)

The slaking of the quicklime happens on the premises. The presence of chalk-like kernels in the lime, called 'Kalkspatzen' in German, is quite extensive. These kernels are reserves of binder and can be activated by moisture. The binder obtained from them migrates and can bind the micro-cracks all over the matrix of the preparatory mortar layers (Fig. 7). The traditional division of the preparatory layers can be found in this mosaic:

S*upra nucleus* – This is thin, white bedding mortar. Powder of limestone is present in the lime binder matrix. Based on the microscopic analyses and the X-ray diffraction examination, the sample taken from this layer does not contain any hydraulic additives.
Nucleus – There are two layers made 'wet in wet'. The 5 cm thick lower one is richer in lime than the upper 1 cm thick part, where the quantity of powdered brick is significant. That is why this stratum has a pinkish hue. The crushed brick was used as filler. The use of a quantity of brick dust in a mortar can be one of the causes leading to low density and high effective porosity. It behaves like an artificial pozzolanic additive, and here reacted with the calcium hydroxide Ca $(OH)_2$. As a hydraulic component, it increases the solidity of the mortar. The average porosity value of the samples taken from the *nucleus* of the mosaic in question is approximately 30%, and its density is about 1.5 g/cm^3. The other mortar sample comes from the Roman Villa of Serena, in the present-day municipality of Nagyharsány. The characteristic porosity is between 45-50%, and the density is about 0.6 g/cm^3.
Rudus – Only traces remained of this stratum. It is a rough layer with 4-5 cm large limestone and brick pieces embedded in lime. The materials and the colours of these parts are the same as those of the tesserae.
We do not have any information on either the dimensions or the compositions of the deeper, preparatory layers.

During conservation, we had to save the original preparatory mortar, so we were dealing with quite a heavy object. After the cleaning of the reverse side, we had to fill in and level the mortar surface. It was necessary to work out a lightweight and easily removable support, instead of the previous concrete one, and a lightweight lime-based mortar to fill in the losses. Instead of the quartz sand and crushed gravel, a mixture of ground glass foam (a Hungarian product by Geofil) and glass foam-beads (Poraver by Dennert) were used as filler (Fig. 8). The diverse grain-size dispersion ensures a properly stable mortar. The pH value of Poraver is about 9-12. The cause of this high pH value is the presence of a water soluble salt called Trona (Na_3 H $(CO_3)_2$. $2H_2O$) measured by XRD. It was necessary to re-

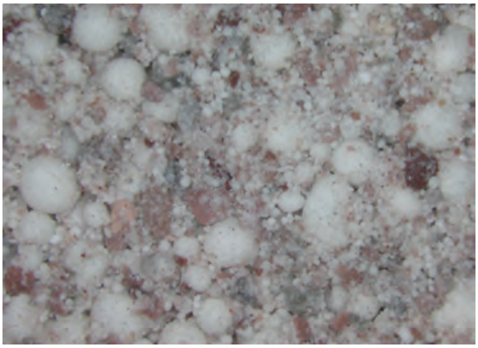


Fig. 8. The new lime-based mortar with lightweight aggregates (glass foam products) (Photo: Brigitta Maria Kürtösi)

move the salts before using the glass foam-beads as filler in the new mortar. For the backing we tried to use clear, inorganic materials. The mortar supplement had to be easily removable; and had to fit in with the original materials and their physical properties. At the same time, it is not supposed to be stronger than the ancient mortar. It is desirable that the effective porosity of the two touching layers be similar. In this case, the measured values were about 30%. The difference was between the density values as the used fillers halved the density of the new mortar (Table 1). In this case, the filling mortar has a mainly supporting role; thus, it must be lightweight and stable. Its stability increases with the process of carbonation. The new support is a composite plate made of a foam glass board (by the German Huber-Kunststoff) covered with 3P SP2 resin (by the Hungarian Polinvent Ltd.) and woven carbon fibre on both sides (Fig. 9-12). These materials were developed for industrial use. That is why it was necessary to understand their physical properties before introducing them into conservation. The artwork was fixed onto the foam glass board with acetate-free silicone rubber. As bedding mortar, a Czech grouting mortar was used (VAPO inject 01), because its composition and properties resemble those of the original. The mixture consists of white, hydraulic and volumetrically stable lime-hydrate, mixed with latently working hydraulic fired clay – alumino-silicate component. The filling in of the pattern was made with tesserae from a geologically similar limestone. The original and the completed parts show a mild difference in their hue. The extent of the completion does not exceed the provable original state of the mosaic (Fig. 13, 14 and 15). There are many types of completion methods, and the choice of materials and treatment is most often based on the personal preferences of the conservator, and on the owner's decision.

The re-restored mosaic fragment was displayed first at the Exhibition of Diploma Works, entitled *Preserved Art Treasures 2010* in the Hungarian National Muse-

Mortar samples	Effective porosity (%)	Density (g/cm3)
The mortar (from nucleus) of the examined Roman mosaic of Aquineum	30,33	1,48
The new mortar with glass foam fillers	30,00	0,69

Table 1. The measured values of the mortar samples

Fig. 9. The preparation of the new support with woven carbon fibre and 3PSP2 resin (Photo: Brigitta Maria Kürtösi)

Fig. 10. The preparation of the new support with woven carbon fibre and 3PSP2 resin (Photo: Brigitta Maria Kürtösi)

Fig. 11. The leveling of the backside of the mosaic was made by the lightweight lime-based mortar (Photo: Brigitta Maria Kürtösi)

Fig. 12. The leveling of the backside of the mosaic was made by the lightweight lime-based mortar (Photo: Brigitta Maria Kürtösi)

Fig. 13.The place of the missing parts (Photo: Brigitta Maria Kürtösi)

Fig. 14. The preparation of the new tesserae supplements (Photo: István Bóna)

Fig. 15. The material of the new tesserae supplements was a geologically similar massive limestone. The lime-based VAPO inject 01 was used as bedding mortar (Photo: Brigitta Maria Kürtösi)

um, and then at the temporary exhibition of the Museum of Aquincum entitled *There is something new under the ground, old sites – new results 2011* (Fig. 16).

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Fig. 16. The state of the threshold mosaic after conservation in 2010 (Photo: Brigitta Maria Kürtösi)

A ROMAN BLACK AND WHITE MOSAIC FROM THE *VILLA RUSTICA* NEAR MOŠNJE (SLOVENIA): THE PRESENTATION OF MOSAIC FRAGMENTS

Judita Lux, Manlio Titomanlio and Sabina Kramar

Abstract

The black and white mosaic under discussion was unearthed in 2006 and 2007 during the archaeological excavations of a Roman *villa rustica* (1st to 4th century AD) near Mošnje in the north-western region of Slovenia. Nearly 400 fragments (varying in size from 50x50 to 2x2 cm) of the mosaic were found in a rubble layer of a hypocaust in a *caldarium*. The mosaic is made of white and black tesserae, and depicts mainly geometrical ornaments such as triangles and spirals, but it is also possible to recognize at least one pair of dolphins. The starting points for the decision as to how the fragments would be presented to the public were the respect of the original materials (preservation of the various mortar layers) and the complete reversibility of the newly devised supports. These movable supports with implanted magnets also enable us to change the position of the fragments on the ground in case of eventual new findings regarding the reconstruction of the decoration of the mosaic.

Fig. 1. Air photograph of the archaeological site of the *villa rustica* near Mošnje (photo: Jože Hanc, archive IPCHS)

Introduction

The Roman mosaic was discovered during the archaeological excavations in 2006 and 2007 of a *villa rustica* near Mošnje in the northwestern region of Slovenia. The villa is dated to the 1st and 2nd centuries AD on the basis of small finds (coins, jewellery, pottery etc.). The villa consisted of five masonry structures, linked together into one whole by a supporting wall abutting the slope of the upper terrace (Fig. 1) (Lux and Sagadin 2012).

The mosaic was found in the *caldarium* of a *balneum* in complex 2 (Fig. 2 and 3). The room, with an apse on the west side, had a central heating system (*hypocaustum*) and walls covered with red and white wall paintings. The mosaic measured approximately 12.5 m². The larger mosaic fragments show that, besides triangles and frames, there are also clearly recognizable sea animals – dolphins – and a vegetal motif of ivy or acanthus. Especially interesting are some curved mosaic fragments with a motif of triangles; as well as oth-

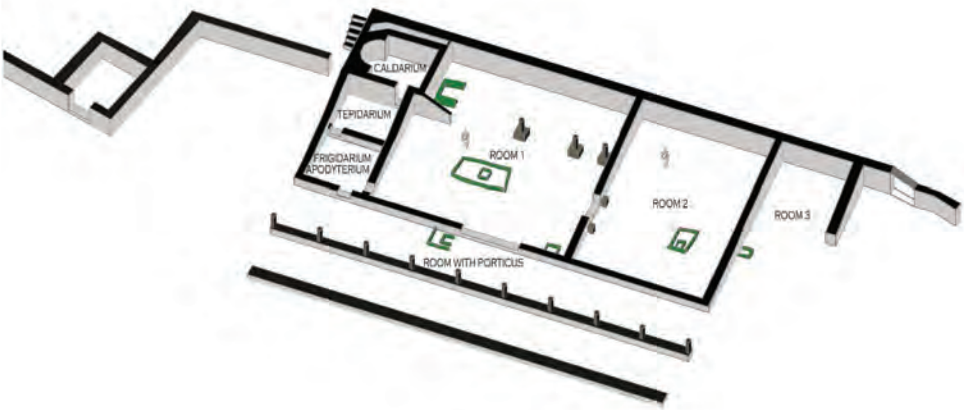

Fig. 2. The mosaic was found in the *caldarium* of the residential building (plan: J. Lux and J. Ravnik)

Fig. 3. The *caldarium* with fragments of the mosaic during excavation (photo: Maja Lavrič, archive IPCHS)

Fig. 4. The rubble layer in the room with mosaic (photo: Maja Lavrič, archive IPCHS)

er fragments that clearly show that the lower part of the wall was also decorated with mosaic. The floor mosaic consists of several layers: the *tesselatum* of black and white tesserae, a black paint layer under the black tesserae; a bedding layer 1-2 mm thick; the *nucleus* 1.5 mm thick; and the *rudus* >5 mm thick. By contrast, the lower parts of the walls were covered with *tesselatum* and one single mortar layer. The mineralogical-petrographic investigation revealed that black and white tesserae were made of limestone; the black ones of micritic and the white ones of biosparitic limestone. The aggregate of the mortar layers consisted of local fluvioglacial deposits with predominant carbonate grains and an addition of crushed brick; while the mortar layer of the lower part of the walls consists solely of crushed brick (Kramar *et al.* 2008; Kramar *et al.* 2011; Lux and Kramar 2011). The mosaic found in the rubble layer of the *caldarium* was completely destroyed, when the hypocaust collapsed (Fig. 4). Only a few pieces of mosaic are relatively large (around 0.50x0.50 m), while nearly 400 fragments are smaller (ranging in size from 2x2 to 50x50 cm). In addition, large quantities of tesserae were also found. The rubble layer covered the hypocaust floor that consisted of tuff slabs. The hypocaust columns, fragments of *tegulae* that covered the walls (part of the central heating system) and large quantities of mortar were also found. The mosaic fragments were found in the layer without any significant order. Thus, only larger fragments were documented with the use of total station combined with photography.

The restoration proposed aims to ensure an adequate preservation of some portions of the mosaic floor from the villa. Another objective is to allow a presentation of the mosaic as close as possible to its original context, respecting the original materials and putting reversibility as a priority.

Presentation of the mosaic

Conservation-restoration

The fragments of mosaic found were in an extremely poor condition. Due to the nature of the excavation (protective, during the construction of a highway) we opted for the temporary preservation of the fragments that was not expensive and reasonably fast. The bigger fragments of the mosaic were wrapped in transparent PVC foil, while the smaller ones were wrapped in protective paper and put into boxes. They were transferred to a restoration-conservation workshop of the Institute for the Protection of Cultural Heritage of Slovenia (IPCHS).

The smaller fragments that were wrapped at the excavation site tolerated well the transfer to the workshop of the IPCHS, while the bigger ones were somewhat damaged. The fragments of the mosaic were cleaned and then only partially con-

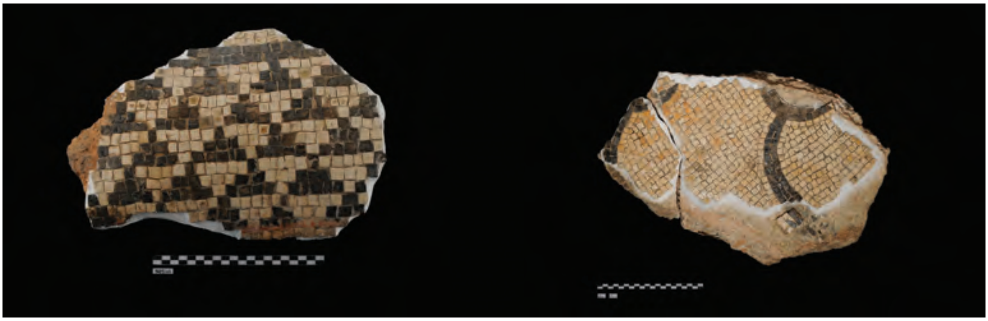

Fig. 5. Mosaic fragments after conservation (photo: Maja Lavrič, archive IPCHS)

solidated (Fig. 5), and are now prepared for further processing but they are not suitable for public presentation.

Proposal for anchoring on new a support and final presentation

The primary requirement of restoration is to preserve all ancient materials through operations targeted at inhibiting all degradations. The final presentation of the mosaics has to be compatible with the data collected during preliminary studies.

For the anchorage on the new support, the positive results of the restoration adopted for the mosaic fragments preserved in the Provincial Archaeological Museum of Western Lucania in the city of Padula (Italy) were taken into account (Titomanlio 2006; 2011).

The particular conditions in which the fragments in our possession have been preserved make the anchorage operations on new supports very complex. One of the main technical difficulties is the adjustment of the height of single mosaic fragments. Since the fragments have significant differences in the thickness of the preparatory layers, they cannot always be treated with conventional methods, such as the application of new layers of highly compatible binders that do not have a strong impact on the ancient materials, and do not affect the aesthetic value and the staticity of the artifact (Magnani 1996, 49-72).

So, it is necessary to create a system specifically suited to the situation through the creation of a support capable of giving the mosaic fragments a coplanar surface and, at the same time, ensuring their secure grip on the new support. For this purpose, we will use synthetic substrates made with a system based on the epoxy Araldit SV427 and the hardener HV 427 (Fig. 6 and 7). This product, as in the case of the mosaics of Padula, is particularly suitable for this type of intervention because its final result is perfectly stable (i.e. it has no shrinking problems), has good mechanical strength and allows easy processing even after hardening (Borgioli 2002, 21-22). The synthetic substrates can be made by shaping each piece directly on the mosaic fragments, before the epoxy hardens. During this phase, the ancient materials were protected thanks to the drafting of a thin insulating layer of cyclododecane spray that

Fig. 6. Synthetic substrate with implanted magnets (photo: Manlio Titomanlio)

Fig. 7. A fragment of mosaic on a synthetic substrate (photo: Manlio Titomanlio)

allows the separation of the hardened resin. Cyclododecane spray, an unsaturated cyclic hydrocarbon, is an excellent insulator, which sublimates in environmental conditions. It is therefore ideal for temporary protections; it is fully reversible and does not require final removal. Moreover, a spray application is particularly suitable for the irregular shape of the back of mosaic fragments (Riggiardi 2010).

So, it is possible to obtain a series of epoxy supports which follow perfectly the shape of the mortar of each fragment, and assemble them with all their top surfaces at the same level. The synthetic substrates will then be applied onto a new and more appropriate support that will take into consideration ideas regarding the exhibiting of the mosaic fragments. Adhesion between the support and the synthetic substrates will be guaranteed through a pasting of epoxy – Araldite AY 103 and hardener HY 991. To optimize adhesion between the parts, some mechanical abrasions will be applied, and the corresponding surfaces will be degreased with dimethyl ketone. Prefabricated panels (composed of a double-laminated fiberglass and epoxy, with a core of aluminium honeycomb – Areolam Ciba Geigy panels) can be used for the support of the whole floor. These panels have been extensively tested in the field of restoration. They combine great lightness with high resistance to mechanical stress, thus ensuring easy and safe shifting (Bassier *et al.* 1981, 29-59). The actual anchorage of the mosaic fragments although, as already mentioned, based on experimental data acquired for the mosaics of Padula, will always be based on preliminary tests on simulation models. These will be carried out on reproductions of individual pieces where the weight and size of the original fragments will be taken into consideration. The need to ensure high reversibility with minimum impact on the ancient materials has led us to choose magnetic attraction as a means of connecting the pieces (Matteini and Moles 1989, 197-198). More specifically, it is possible to use cylinder-shaped permanent magnets for industrial use. Each cylinder is made of a ferromagnetic zinc-coated alloy, and contains a perfectly fitted small disk of pure magnetite, which generates a force attraction of about 5 kg. Each magnet has a diameter of about 30 mm and is 10 mm

Fig. 8. Magnets implanted in the mosaic mortar (photo: Manlio Titomanlio)

thick. The body has a threaded cavity (6 mm in diameter) along the entire piece and up to the magnetite disc, which, with a thickness of about 3 mm and a diameter of 22 mm, corresponds perfectly to the body cavity.
The effectiveness of this type of connection will be enhanced by improving the surface adherence between the parts. To increase the resistance to oxidation every magnet will be coated by using an acrylic resin: Paraloid B-72 20% in nitro diluent. Once the number of fittings required for ensuring the proper adhesion of the mosaic fragments with the synthetic substrates has been calculated, the magnets will be implanted in the ancient mortar and their corresponding support (Fig. 8). The operation has to be performed in order to obtain a perfect contiguity between the magnetic poles of each pair. In some cases, a minimal quantity of mortar (7-9 cc, part of which may be used in laboratory diagnostics) will be removed from the back of some pieces in order to create a small cavity of containment, slightly larger than the magnetic cylinders. After this, each cavity will be filled with a suitable amount of epoxy in order to secure the adhesion of the magnetic cylinders to the ancient mortars. This operation requires the use of an epoxy system based on Araldite AV 121N and hardener HY 951. For this purpose a much denser adhesive is more suitable. It will be ensured that the bonding will always avoid direct contact between the metal cylinders and the ancient materials; and the aesthetic impact on the surface of the resin can be minimized by adding to the adhesive the remains of the previously removed mortar. The synthetic substrates will be treated in a similar way, implanting the corresponding magnets always using epoxy. In this case, the magnets will be attached using Araldit HV 427 and hardener SV427 since this resin provides excellent adhesion between surfaces made of the same material.
The result will be, for each mosaic fragment and regardless of its thickness, a structural system that provides full and strong cohesion between the parts. The procedure is summarized as follows

support → synthetic substrate → lower magnet (-) → ← (+) top magnet ← mosaic fragment

This method allows the separation of the magnets without posing a significant risk to the mosaic fragments, in case it is necessary to separate them from their support. In fact, at the thread crossing the body of the magnets, holes of equal diameter will be made, passing through the whole "*support → synthetic substrate*" system. In this way, by inserting screws (compatible with the threads) in the rear of the honeycomb panels, the magnetite disc in the synthetic substrate can be removed from the metal body, resulting in a significant decrease of

Fig. 9. Installation of containment edges on the honeycomb panels, with loose material as a filler between the missing parts of the mosaic (photo: Manlio Titomanlio)

the magnetic forces of attraction. Obviously the insertion of the screws (placed from bottom to top) must be made after the raising of the panels forming the support of the mosaic. In cases where a fragment has more than one magnet, the only

Fig. 10. Possible final presentation of the mosaic (reconstruction: J. Lux and J. Ravnik)

caution recommended is to put multiple screws simultaneously, in order to lift the fragment in parallel with the support.
The use of screws allows the separation of the mosaic fragments from the synthetic substrates, with an effort corresponding to the weight of the individual pieces and without a dangerous stress to the ancient mortars. Since in many cases each fragment is disjointed from the others, the question inevitably arises of how to intervene on the lacunae. The specificity of this particular case led us to consider as the most appropriate a final presentation where, using only loose material (pellets of expanded clay, as for temporary reburial on archaeological sites) as a filler between the missing parts, it is possible to see the entirely of each mosaic fragment. For this purpose, the final exhibition involves the installation of containment edges on the honeycomb panels, specially designed so as not to interfere with the detachment steps of the mosaics (Fig. 9). These small edges, high enough for the containment of the mosaic fragments on the new supports will be made in clear plexiglass. The lower part of the plexiglass will be opalescent so as to hide the honeycomb panels, while the expanded clay pellets will be visible through the transparent upper part. The assembly of panels will be made with simple joints without glue so that the entire system can be easily dismantled without causing movement and damage to the mosaics and their supports. This solution – unusual for a presentation in a museum – was chosen after a series of assessments that have allowed us to consider it as the most appropriate. In fact, despite the fact that one can guess what type of decoration the mosaic had (Fig. 10), the data presently at our disposal are insufficient for determining an exact reconstruction. Therefore, considerable uncertainties about the overall interpretation of the mosaic still exist. In this situation, the restoration gives priority to the conservation aspects, while maintaining the lowest possible impact on the ancient materials and at the same time ensuring the easy reversibility of the intervention.

Conclusions

The starting points for deciding how to present to the public the fragments of the black and white mosaic from the Roman *villa rustica* near Mošnje were the respect for the original materials (different layers of mortar) and the reversibility of all the choices to be made (Brandi 1963, 18). We have opted for the solution in which the fragments are put on supports that follow the shape of the mortar of each fragment, and are assembled with their top surface all at one and the same level. An advantage of this solution is also the possibility of moving the fragments, if a new reconstruction of the mosaic is desired.

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CONSERVING AND DISPLAYING THE MOSAICS OF THE CYCLOPS POLYPHEMUS AND THE MEDUSA

Christos Pilalis

Abstract

Greece offers a large number of remarkable mosaics, dating back to Hellenistic, Roman and Byzantine times. Two distinctive examples are the mosaic representing the Cyclops Polyphemus (size 361x574 cm) and that of the Medusa, which are currently on exhibition at the Archaeological Museum of Patras.

The main aim of the first part of the article is to list and discuss the problems and difficulties encountered during the in situ (on site) maintenance and the detachment of the Polyphemus mosaic, along with the methods chosen to address them. The complexity of such a task lay in the impossibility of detaching the mosaic from the concrete base with which it has merged, since there was a great risk of harming it. It was, therefore, transferred in segments. Detailed reference will also be made to the maintenance work conducted prior to the final placement of the mosaic at its permanent exhibition point.

The second part will give an account of one of the most representative mosaics on display in the Museum of Patras, the mosaic of Medusa, and describe the method and materials used for its exhibition.

The Polyphemus Mosaic

General information

The discovery of a large number of mosaics in several locations in the city of Patras from the 1960s up to 2006, which are part of the remains of private dwellings and public buildings of the Roman era, has resulted in the creation of a special section at the Archaeological Museum of Patras.

This section consists of two exhibition halls, one dedicated to private and the other to public life, based on the unique pictorial representations of the mosaics. The discovery of such a large number of mosaics reflects the wealth of the city, while the rich repertory of themes of both the exhibited and the stored mosaics reveals various aspects of life in Roman times (www.ampatron.gr; Pilalis 2012; 2013). The museum actually holds more than 500 m^2 of mosaics.

The mosaic was brought to light at a rescue excavation carried out in 1960 at a Roman house situated in the centre of Patras. In 1971 it was transferred and placed near the ancient Odeon of Patras, where it was accessible to the public and exposed to environmental conditions. Finally, in 2010 it was detached for the second time and moved to the Archaeological Museum of Patras as a permanent exhibit.

Historical information

The Cyclops Polyphemus mosaic (*opus tessellatum*) (Chryssopoulos 1993, 10), represents the well-known mythological creature sitting on a rock surrounded by animals (Fig. 1). The mosaic was found

Fig. 1. The Cyclops Polyphemus mosaic (photo: Chr. Pilalis)

during the rescue excavation of a Roman villa in 1969, and in 1979 it was transferred to the Roman Odeon of Patras. It was placed outdoors, in a location accessible to visitors and exposed to weather conditions. In 2010 it was transferred to the Archaeological Museum of Patras to be put on permanent display.

Iconography

The multicolored mosaic floor depicting Polyphemus is bordered by a band of crow-step and another of a lyre guilloche. Polyphemus is illustrated seated on a rock in front of his cave, reaching with his right hand to accept the cup with Maron's wine, offered to him by Odysseus. Of the latter, only the lower arm has survived. The Cyclops holds one of Odysseus' companions with his left hand, having captured him. Three of his rams are depicted seated. On the upper right, there are remnants of a largely destroyed inscription.

Pathology

Approximately half of the mosaic has survived. It is not in perfect state because of humid conditions and the fact that heavy rain has entered beneath it. Furthermore, the fluctuating temperatures of the local climate mean that the mosaic has been exposed to heat and frost. Patras is a seismic region so the mosaic has also been damaged by earthquakes. Damage included deep cracks, many dislodged tesserae (lacunae: www.getty.edu/conservation – Illustrated glossary, 7) and weeds growing over most of the surface (Watkinson and Neal 1998, 56).

Fig. 2. In situ mapping design (photo: Chr. Pilalis)

Fig. 3. Incisions were made with an electric wheel saw (photo: Chr. Pilalis)

The conservator's work

In brief, the work of the conservator was to remove the mosaic and transport it to the museum, where it was cleaned and restored (Chryssopoulos 1993, 91).

The removal of the mosaic

Before removing the mosaic, we made a full-scale survey of its surface in order to map the design (Fig. 2). We chose to follow previous incisions in order to reduce the damage as much as possible (*Mosaics No 2*, 1983, 11).
Sondages were then made at different parts of the mosaic to reveal its stratigraphy: the mosaic is made up of four layers: the *statumen*, the *rudus*, the *supra nucleus* and the tesserae.(Chryssopoulos 1993, 27). The total thickness is 25 cm.
The surface of the mosaic was cleaned with distilled water in order to remove the salt deposits. After this cleaning, the mosaic segments were covered in Vinavil and then gauze. The old fillings were then removed using hand tools, and a line of tesserae was removed from the edges of each section of the mosaic.
Next, the mosaic was cut into segments with an electric wheel saw (Fig. 3). Calico textile was then applied to all parts of the mosaic to protect it during transportation. A plan was carefully drawn on top of this textile, which would help with the reconstruction. Two lines were also drawn, crossing at the centre of the mosaic, which would ensure the correct positioning of the mosaic in the archaeological museum. This piece with the two lines was called segment A because it was from this point that positioning would begin (Fig. 4).

Fig. 4. Calico was applied to all parts of the mosaic in order to protect its surface (photo: Chr. Pilalis)

The next stage was to remove the mosaic segments from the site. There were 30 segments in total (Fig. 5).

Fig. 5. Protection and transfer of the mosaic sections (photo: Chr. Pilalis)

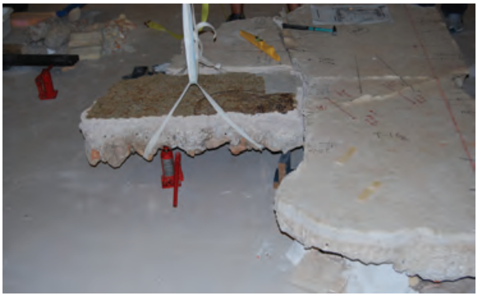

Fig. 6. Positioning of the different parts using small, high precision lifting mechanisms (photo: Chr. Pilalis)

Transporting the mosaic

The mosaic was transported by a lorry. The segments were lifted with a crane one by one and placed on a piece of wood. Foam was used between the wood and the mosaic segments for protection from vibration.

Displaying the mosaic in the Archaeological Museum of Patras

Displaying the segments using sand

First, the position for the display of the mosaic was determined, and then segment A was put in place. The mosaic surface had to be parallel to the floor and completely horizontal but its underside was uneven. Initially, in order to achieve this, the segment was placed on sand, but it was too heavy (approximately 150-200 kg) and another solution was necessary.

Displaying the segments with the use of three small lifting mechanism

A second and final solution was found using three small, high precision lifting mechanisms. Each segment was moved to the correct position with a large crane and then lowered onto the lifting mechanisms. The advantage of these mechanisms was that they could keep the mosaic level, despite its uneven lower surface (*statumen*). When with the use of a spirit level each segment was found to be completely parallel to the floor, a permanent base was made from inert materials, and the mechanisms were removed (Fig. 6).

The next stage was the edging of the lacunae of the mosaic (Fig. 7). The lost areas were then filled with inert materials (*Mosaics No 2*, 1983, 16-17) (Fig. 8). The tesserae that had been removed earlier were now put back in the same position (Fig. 9). When the tessellation was complete, the losses were supplemented. Finally, the mosaic had to be thoroughly cleaned by hand using brushes, sponges and distilled water.

For aesthetic purposes, a light grey metal frame was placed around the mosaic and the gaps were filled with dark brown sand. The mosaic was the last exhibit to be placed in the room dedicated to public life in the Archaeological Museum of Patras (Fig. 10).

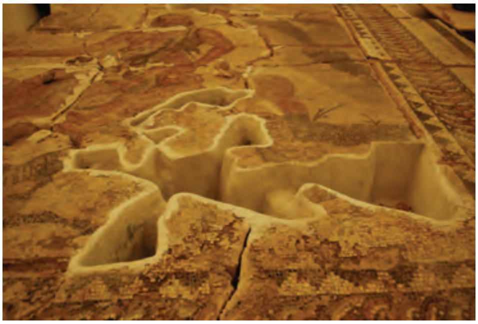

Fig. 7. Edging the lacunae of the mosaic into the gaps (photo: Chr. Pilalis)

Fig. 8. Filling the gaps with inert material (photo: Chr. Pilalis)

Fig. 9. Putting the removed tesserae back into place (photo: Chr. Pilalis)

Fig. 10. The Polyphemus mosaic exhibited after restoration (photo: Chr. Pilalis)

THE MEDUSA MOSAIC

HISTORICAL INFORMATION

The Medusa mosaic came to light in 1987 during the excavation of an ancient structure in Patras (Fig. 11), the architectural features and construction details of which identify it as a public building (*Archaiologikon Deltion* 31, 1976, *Chronika*, 88; and 42, 1987, *Chronika*, 142) of the ancient city. Significant finds include a marble male head (probably of a philosopher), fragments of statues, fragmentary inscriptions, fragments of columns of porous stone, and bronze coins. The building, part of which was decorated with marble, underwent many changes during late Roman times. Another important public building (the *Aedes Augustalium*), which was discovered in the same area has similar architectural features (*Archaiologikon Deltion* 42, 1987, *Chronika*, 142, n. 5).

ICONOGRAPHY

The head of the Medusa (Fig. 12) is depicted in a medallion in the centre of the mosaic (3.55x3.30 m). Geometric motifs surround this central figure, which was originally identified as male, possibly a god (*Archaiologikon Deltion*, as above). The Medusa is

Fig. 11. The Medusa mosaic as found (*Archaiologikon Deltion* 42, 1987)

averting her gaze from the spectator. The geometric pattern creates a shield design set in a square frame, which is surrounded by a chain of stepped squares. Ivy leaves can be seen in the inner corners of the frame. The mosaic is dated to the 2nd century AD and has been on display in the Archaeological Museum of Patras since 2009.

The mosaic's pathology – Conservation status

The mosaic floor has sustained extensive damage since antiquity, as is evident from the destruction layers that cover it. The upper left section has been destroyed as the result of more recent building activity, the mosaic substrate (plaster) has largely disintegrated and on the surface of the mosaic cracks, subsidence and losses can be seen. The main causes of deterioration, as expected, are the presence of humidity, mechanical stresses, biological and environmental factors and human activity.

Fig. 12. The head of the Medusa (photo: Chr. Pilalis)

Fig. 13. The mosaic being mounted on an upright support of pine wood (photo: Chr. Pilalis)

The conservator's work

After a study report (Pilalis and Georganis 2009) on how to exhibit the mosaics in the Museum of Patras, permission was granted by the Conservation Department of the Ministry of Culture for the installation of the mosaics on specially designed metal panels which are resistant to earthquakes.
In accordance with this study, the Medusa mosaic was placed on a special panel, which was fitted to the size of the mosaic and designed to support its weight (Fig. 13). The upright support on which the mosaic is mounted is made of 5 mm

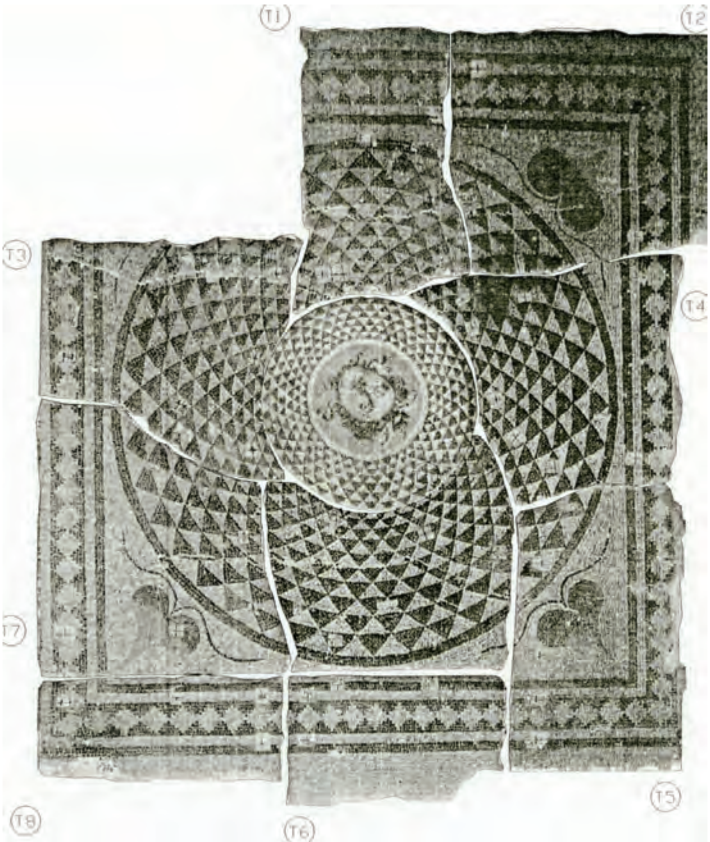

Fig. 14. The mosaic was removed in ten pieces (photo: Chr. Pilalis)

Fig. 15. Each piece of the mosaic was independently positioned and secured (photo: Chr. Pilalis)

Fig. 16. Filling the gaps between the pieces (photo: Chr. Pilalis)

thick pinewood with a positive inclination of 5%.

The Medusa mosaic was removed in ten pieces and each one was separately restored (Fig. 14). Restoration included removing the old brittle substratum, which was then replaced by new mortar and reinforced with an aluminium frame and grid. Each piece is about 3 cm thick and weighs 50-55 kg/m^2. As there were minor differences with respect to the thickness of the pieces, in order to achieve the greatest possible uniformity

Fig. 17. The Medusa mosaic exhibited after restoration (photo: Chr. Pilalis)

in the visible surface, cork sheets, 1–2 mm thick and with anti-vibration properties, were applied to the rear side.

The restored pieces were suspended in slings and lifted to the desired position by a crane. Each piece was then secured with screws, which were driven into ready-made holes (Fig. 15). Each piece of the mosaic was independently positioned and secured, with a 1-2 cm gap separating each one. When all the pieces were in place the gaps were filled with the tesserae that had been displaced during the removal of the mosaic (Fig. 16 and 17).

All stages of the procedure were documented (in particular, the exact position of the supporting screws) with photographs and drawings, in order to facilitate any future restoration work.

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CONSERVATION DES MOSAÏQUES DE LA COLLECTION DU MUSÉE NATIONAL – BEYROUTH

Isabelle Doumet Skaf, Badr Jabbour-Gédéon et Ghada Salem

Résumé

La collection de mosaïques du Musée National de Beyrouth se compose de pavements antiques provenant de divers sites archéologiques au Liban. Dans le cadre des différentes phases de réouvertures des salles du Musée, des interventions ont été effectuées pour remettre en état ces pavements dans le but de les présenter au public.

La collection de mosaïques antiques du Musée National de Beyrouth se compose principalement de mosaïques figuratives mises au jour et déposées sur dalles de ciment lors de fouilles archéologiques effectuées entre les années 1950 et 1975. Ces déposes étaient généralement exécutées sur le site même de la découverte par les ouvriers des chantiers de fouille : l'encollage était effectué avec de la colle animale et le ciment coulé directement sur le revers des tesselles fixant le *tessellatum* dans un support extrêmement lourd et rigide. Les pavements représentant des scènes figurées ou animales étaient généralement transportés au Musée National à Beyrouth pour y être exposés. Les pavements à motifs géométriques étaient laissés sur les sites ou transportés dans des réserves.

Le Musée National de Beyrouth situé sur la ligne de démarcation a fermé ses portes en 1975 au début de la guerre civile. Le bâtiment a été extrêmement endommagé et certaines des mosaïques qui n'ont pas pu être déplacées ou protégées durant le conflit ont subi des dégradations, comme la mosaïque du Bon Pasteur (Chéhab 1958-1959, 64-66, pl. XXXI), ou la stèle funéraire représentant un couple (Fig. 1).

En 1995, à la fin des hostilités et avant le début des travaux de restauration du bâtiment, des mesures de protection préventives ont été prises pour protéger les mosaïques toujours scellées au sol et au mur. Évelyne Chantriaux, Directrice de l'atelier de restauration de Saint–Romain-en-Gal s'est rendue au Liban à la demande de La Direction Générale des Antiquités pour y effectuer une mission d'évaluation et faire des recommandations relatives à la conservation des mosaïques du Musée National et de certains sites archéologiques au Liban (Chantriaux 1997 ; 1998). Par la suite, deux pavements de la collection du Musée National : l'Enlèvement d'Europe et la Naissance d'Alexandre ont été envoyés à Saint-Romain-en-Gal pour dérestauration et remontage sur nid d'abeille dans le cadre de l'exposition « Liban, l'autre Rive » qui s'est tenue à l'Institut du Monde Arabe du 27/10/1998 au 02/05/1999 (*Liban, l'Autre Rive* 1998).

Fig. 1. Stèle funéraire représentant un couple, endommagée par des tirs de balles durant les années de conflit armé

Fig. 2. Vue générale avec au premier plan la mosaïque de Bacchus; en hauteur, la mosaïque représentant Amour et Psyché

En 2011, neuf mosaïques de la collection ont été remises en état dans le cadre d'un projet visant à dédier une des salles du Musée à la mémoire de l'Emir Maurice Chéhab, Directeur des Antiquités Libanaises pendant plus de trente ans. Pour ce projet, des interventions techniques souvent minimales, car tributaires de budgets réduits ont été adoptées sans toutefois compromettre la stabilité à long terme des pavements, ni leur présentation esthétique. Six panneaux indépendants (Fig. 2) :

- Mosaïque de Bacchus de l'Odéon de Byblos (1.67x1.75 m) (Chéhab 1958-1959, 9-10, pl. I).
- Mosaïque représentant quatre aventures de Jupiter (2.00x1.75 m) (Chéhab 1958-1959, 21-27, pl. VIII).
- Mosaïque de Bacchus et du Satyre (2.07x2.20 m) (Chéhab 1958-1959, 15-16, pl. IV).
- Mosaïque d'Acmé entre Eros et Charis (2.17x1.91 m).
- Mosaïque du Silène ivre étendu sur une panthère (2.17x1.91 m)

Ces panneaux étaient initialement exposés dans salle centrale du Musée National à

Fig. 3. Armatures en fer clairement visibles suite au nettoyage des comblements de ciment

plus de 4 m de hauteur. Ils ont été descellés en 1995 au moment de la restauration du bâtiment, protégés par des coffrages en bois et transportés dans des réserves

État de préservation

Les supports des pavements étaient effectués avec du ciment mélangé à du gravier fin et renforcé par des armatures métalliques. Sur le panneau de Bacchus et Satyre, les armatures sont clairement visibles à la surface du ciment et ne sont recouvertes que par le mortier de comblement de la lacune (Fig. 3). Il y a une forte probabilité que la surface de ces panneaux ait été poncée. Certaines tesselles sont fracturées résultat probable des techniques (martèlement) utilisées lors de la dépose des pavements. L'État de préservation de ce groupe de mosaïques est inégal, certaines ayant subi des dommages notamment sur les bordures (dislocation des tesselles, effritement du ciment) lors de diverses opérations de transport. Des pertes de tesselles qui semblent plus récentes ont également été notées sur certains panneaux. Du ciment de couleur grise sans agrégat était utilisé pour combler les grandes lacunes. D'autres matériaux étaient employés pour remplir les plus petites lacunes notamment du plâtre et des mélanges de mortiers divers. Toutes les mosaïques semblent avoir été recouvertes d'un vernis aujourd'hui jauni et décoloré ou d'une couche de cire relativement épaisse qui s'est opacifiée au cours des années.

Les interventions

Les interventions que nous avons effectuées à la demande de la Direction Générale des Antiquités avaient pour but de consolider, stabiliser et améliorer l'aspect esthétique des pavements. Pour des motifs de contraintes budgétaires, il ne nous a pas été demandé d'effectuer des interventions lourdes telles que le démontage complet d'anciennes restaurations ou le remplacement des supports en ciment par des panneaux plus légers et réversibles en nid d'abeille. Les interventions se sont donc limitées à une stabilisation des supports et à un traitement de surface :
Une combinaison de nettoyage mécanique (scalpels, brosses, vapeur d'eau) et chimique (solvants organiques) a été utilisée pour nettoyer les résidus de colle et de cire accumulés sur la surface des pavements. Les tesselles désolidarisées ont été réattachées au support à l'aide d'une colle à base de nitrocellulose (HMG). Les dépôts de calcite ou de ciment ont été réduits à l'aide de scalpels, tourets mécaniques ou burins à ultrason. Les tesselles en bordure des lacunes ont été encollées avec une gaze par mesure de protection lors de la suppression des anciens comblements

Fig. 4. Mosaïque de Bacchus avant intervention.

Fig. 5. Mosaïque de Bacchus après traitement

en ciment. Les armatures métalliques apparentes durant les interventions ont été enduites d'un produit anti corrosion. Les lacunes de surface ont été reprises avec des mortiers de chaux afin d'améliorer la présentation et la lecture des mosaïques (Fig. 4 et 5). Certaines tesselles manquantes ont été remplacées par un comblement en Polyfilla (enduit de rebouchage à base de dispersion de polymère). Les bordures des panneaux ont été reconstruites en ciment afin de garantir une surface résistante et nivelée capable de supporter le poids important des pavements lors de leur accrochage.

La Mosaïque du Bon Pasteur (3.64x4.90 m)

Découverte à Jnah dans la banlieue de Beyrouth, la mosaïque est une des pièces les plus connues de la collection du Musée et date du V[e] siècle après J.-C. Elle représente le Christ (ou le Bon Pasteur) entouré d'animaux domestiques ou sauvages (Fig. 6-8) (Chéhab 1958-1959, 64-66, pl. XXXI). Suite à sa découverte à Jnah et à son transport au Musée National dans les années cinquante, la mosaïque a été scellée dans le mur est de la salle dite d'Hygea. Durant l'occupation du bâtiment par de multiples factions armées, elle a été percée par un franc tireur voulant ajuster son angle de tir. De plus, cette même façade du bâtiment a subi de l'extérieur l'impact de nombreux obus qui ont fragilisé le mur ainsi que la mosaïque elle-même en créant des cloques et pertes d'adhérence et provoquant une dislocation des tesselles.

Restauration du Musée en 1995

En 1995, lors de la réouverture du musée après la guerre civile, la mosaïque très fragilisée a dû être entoilée en urgence à l'aide d'une gaze en coton et d'une colle vinylique blanche pour prévenir une perte de tesselles. Des bandes adhésives ont été collées sur l'entoilage pour délimiter les clo-

Fig. 6. Entoilage de la Mosaïque du Bon Pasteur et bandes adhésives utilisées pour délimiter les cloques

Fig. 7. Nettoyage de la surface à la vapeur d'eau

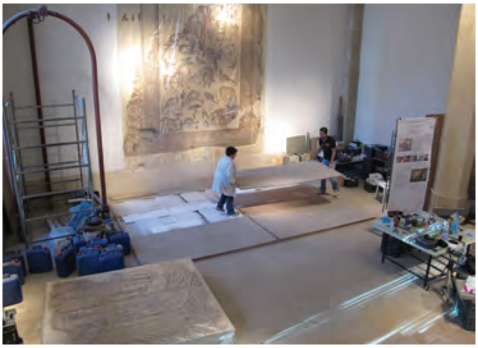

Fig. 8. Dégagement des panneaux de bois et de polystyrène sur la mosaïque aux oiseaux

ques afin de les injecter ultérieurement avec un mortier destiné à consolider le pavement en comblant les vides. La mosaïque a par la suite été protégée par un coffrage de panneaux de bois lors des travaux de réaménagement du Musée National.

Les interventions

Nous avons démonté le coffrage en bois qui consistait de planches de contreplaqué vissées sur un châssis en bois. Nous n'avons pas décelé de traces de moisissures ni d'humidité sur la surface de la mosaïque toujours entoilée (Fig. 6). Les travaux de réfection du bâtiment effectués en 1997 notamment sur la partie extérieure du mur est ont contribué à son renforcement et, par le fait même, à la stabilité du pavement créant ainsi une bonne isolation thermique et structurelle.
Les zones fissurées en bordure de la mosaïque ont été consolidées avec un

mortier de chaux dans le but de les renforcer durant l'opération de nettoyage. La colle vinylique utilisée pour l'entoilage a été ramollie et graduellement décollée à la vapeur d'eau (Fig. 7). L'examen de surface de la mosaïque a révélé la présence de résidus de colles organiques de couleur marron, reliquats probables de l'opération de dépose initiale sur le site archéologique. Il aura fallu à nouveau une combinaison de nettoyage mécanique et chimique pour venir à bout de ces dépôts très résistants. Certaines tesselles désolidarisées ont été réattachées au support en ciment à l'aide d'une colle à base de nitrate de cellulose (HMG). Les dépôts de calcite ou de ciment sur la surface ou dans les lacunes apparentes ont été réduits à l'aide de scalpels, d'un touret mécanique ou d'un burin à ultrason. Le ciment comblant les lacunes a été supprimé et les lacunes évidées ont été colmatées à nouveau à l'aide d'un mortier de chaux hydraulique mélangé à des sables de couleur. Les cloques et les pertes d'adhérence ont été comblées grâce à l'injection d'un coulis de Limepor (mélange de chaux hydraulique naturelle [NHL], de métakaolin et de poudre carbonatée très fine)... Les tesselles en pâte de verre ont été consolidées avec une solution de 10% Paraloid B72 et acétone. Certaines tesselles manquantes comblées par le passé avec du plâtre ont été maintenues en place et réintégrées avec une peinture acrylique.

Mosaïque représentant Amour et Psyché (1.77x2.20 m) (Chéhab 1958-1959, 16-17, pl. VI) fixée au mur

Ce panneau est actuellement scellé dans le mur sud de la salle d' Hygea à près de 3 m de hauteur (Fig. 2). Il était également recouvert d'un coffrage en bois installé lors des travaux de rénovation du bâtiment en 1997. Lors du démontage du coffrage, la surface de la mosaïque est apparue très irrégulière avec des fissures et de nombreuses lacunes comblées au ciment.

L'intervention a consisté en un nettoyage de la surface à l'aide de scalpels et de solvants organiques. Certaines tesselles pulvérulentes ont été ponctuellement consolidées (Paraloid B72 10%) et les grandes lacunes ont été comblées avec un mortier de chaux mélangé à différents sables de couleur en remplacement du ciment existant. La suppression de certaines de ces grandes lacunes en ciment a permis d'examiner l'état des armatures métalliques corrodées qui ont été enduites d'un produit anti corrosion. Certaines petites lacunes comblées de ciment ont été maintenues en place afin de préserver la stabilité générale du pavement. Cette mosaïque à long terme nécessiterait une dérestauration complète et un remontage sur nid d'abeille afin d'en améliorer la stabilité ainsi que la présentation esthétique.

Mosaïque aux oiseaux (4.82x3.18 m)

Découverte à Jnah, elle date du V^e^ siècle ap. J.-C. Suite au démontage des panneaux de bois et des plaques de polystyrène recouvrant la mosaïque (Fig. 8), celle-ci est apparue très irrégulière et assombrie notamment par l'accumulation de poussière et l'activité de rongeurs. Les tesselles usées à certains endroits devaient être en mauvais état déjà à la découverte du pavement. Les mêmes techniques de nettoyage mentionnées ci-dessus ont été appliquées sur ce pavement. Dans les lacunes, les comblements en ciment ont été remplacés par du mortier de chaux hydraulique mélangé à des sables de couleur.

Mosaïque funéraire représentant un couple, sur bloc de pierre d'origine (2.03x0.66x0.28 m)

Cette mosaïque est montée sur un support en pierre. Elle a été endommagée durant les années de guerre par l'impact de balles produisant une perte de tesselles et une perte d'adhérence du *tessellatum.* Comme pour les autres mosaïques traitées dans le cadre de ce projet, la surface était jaunie, résultat d'une dégradation des vernis et cires organiques appliqués lors de restaurations antérieures (Fig. 1).
La bordure en ciment a été remplacée par une bordure en mortier de chaux suite à l'application d'une gaze fine sur les tesselles avec 20% Paraloid B72 afin de la bordure durant l'intervention. Certaines tesselles désolidarisées ont été réattachées au support en ciment à l'aide d'une colle à base de nitrate de cellulose (HMG). Les dépôts de calcite ou de ciment ont été réduits à l'aide de scalpels, touret mécanique et burins. Les lacunes ont été colmatées à l'aide de mortiers de chaux. Les pertes d'adhérence ont été traitées grâce à l'injection de Primal AC 33 (émulsion acrylique) entre les tesselles et le support. Les lacunes ont été remplies d'un mortier de chaux hydraulique mélangé à des sables de couleur.

Sensibilisation du public

Le chantier de restauration a été ouvert au public pour accueillir des écoliers ainsi que pour la traditionnelle nocturne du Musée National qui se tient chaque année à l'approche des fêtes de fin d'année. Les conservateurs/restaurateurs étaient présents pour informer et répondre aux nombreuses questions des visiteurs. De nombreux articles de presse ont couvert l'événement montrant ainsi l'intérêt du public pour les mosaïques du Musée.

Isabelle Doumet Skaf, Badr Jabbour-Gédéon et Ghada Salem, CONSERVATION SARL

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THE YALE GERASA MOSAIC PROJECT: INNOVATIVE METHODS TO REPLACE REINFORCED CONCRETE BACKINGS

Carol Snow, Jason DeBlock, Burrus Harlow, Thomas Philips and Anthony Florio

Abstract

In 1929, Yale University excavated a circa 540 AD floor mosaic from the Church of Saints Peter and Paul at the Jordanian site of Gerasa. Known as a city mosaic for its isometric representations of Ale-xandria and Memphis, the limestone mosaic was backed with reinforced concrete at Yale in 1933. Over the decades the backed mosaic showed severe cracking and its condition became so unstable that concrete backing removal and replacement was necessary. Research and development led to innovative methods to adapt and program a CNC (Computer Numeric Controlled) router to use diamond bits for removal of reinforced concrete. The concrete was ground down to within a few millimetres of the ancient tesserae. Water was not used in the process and dust was extracted with high standards for health and safety. No stress was put on the deteriorated mosaic. Further research on new, lightweight composite laminates for backing mosaics provides promising options to honeycomb aluminium panels. This paper describes and illustrates problems and new solutions for dangerously unstable mosaics previously backed with reinforced concrete.

History

Ancient Gerasa, located beneath the modern city of Jerash in Jordan, is an important Roman and Byzantine site still being excavated and preserved. The first major excavations at Gerasa were carried out from 1928 to 1934 by a joint team from Yale University and the British School of Archaeology at Jerusalem (Kraeling 1938). Their excavations focused primarily on the early Byzantine churches, many of which were adorned with elaborate mosaic floors and architectural detail, as well as on associated pagan temples. The Yale Gerasa city mosaic was lifted from the nave floor of the Church of Saints Peter and Paul, which was built around 540 AD while Gerasa was under Justinian rule. Like other city mosaics discovered in Jordan, it depicts walled cities with arched gateways, towers, colonnades, tiled roofs, and domes set in a stylized landscape.

Excavation photographs show that the condition of the mosaic when first unearthed was fragmentary with overall dimensions of approximately 4x6 m (13x20 ft). The floor mosaic was divided into six sections ranging in size from less than 1 m^2 to approximately 4 m^2 as shown in a composite of 1931 photographs (Fig. 1). They are: 1) an upper panel of a wine amphora with grapevines pouring from its mouth, 2) a corner with a fruit tree bearing what appear to be pomegranates, 3) a Greek dedicatory inscription that identifies the church as being built by Bishop Anastasios and dedicated to Saints Peter and Paul, 4) the city of Ale-

Fig. 1. Yale Gerasa city mosaic (#1932.1735) panels in Jordan in 1931 (photo: Yale University Art Gallery)

xandria including an inscription referring to its famous Pharos lighthouse, 5) the city of Memphis, and 6) a lower fragment representing vegetation along the Nile River. The six panels appear to have been backed with a pigmented plaster or cement that looks dark grey in the black and white photographs. There is no known treatment record for lifting and backing the mosaic floor, and there is little evidence that any ancient mortar or substrata were preserved other than what was left behind at the site. Agreements regarding the division of finds stipulated that the city mosaic from the Church of Saints Peter and Paul be sent to the Yale University Art Gallery.

Upon the mosaic's arrival at Yale, it was prepared for vertical installation high up on a masonry wall of the Art Gallery's 1928 Swartwout Building. Again no treatment records are known to exist, but there is a reference in a July 27, 1933 letter to Yale historian Michael Rostovtzeff from Yale archaeologist Clark Hopkins, who wrote: "Eberhard is fixing the Gerash mosaics and has some new methods which are splendid" (Hopkins 1933). The mosaic was redivided and backed with reinforced concrete. As there are no treatment photographs from 1933, a digital reconstruction is shown in Figure 2. The only other known documentation for this treatment was found inscribed in the wet concrete on the reverse of one of the panels show-

Fig. 2. Yale Gerasa city mosaic panels after 1933 (digital reconstruction) (photo: Yale University Art Gallery)

ing the date 'August 1933' and initials of those involved in the project (Fig. 3). 'RGE' is most likely Yale Art School Department of Sculpture Professor Robert G. Eberhard. Close examination of the 1933 materials provided a better understanding of the methods used at that time. The six polygonal mosaic sections from Jordan were reconfigured into five rectangular panels: three side-by-side measuring approximately 2 m in width by 2.5 m in height (78x98 in), one on top measuring approximately 1 by 1 m (46x43 in), and one at the bottom measuring 0.8 by 0.6 m (32x23 in). The backing applied in Jordan was replaced by a lime plaster mortar containing varying amounts of sand that was applied to the reverse of the tesserae within the reinforcing interior steel grid and exterior steel frame. Before the plaster set, criss-cross lines were scored within each grid square to provide a better bond for the concrete. The concrete, containing stone aggregate of various sizes, was poured over the plaster and steel grid and within the steel frame. Ancient tesserae reset along the reconfigured joins during this treatment are discernible. Lacunae and voids around the fragmentary mosaic were filled on the front with more plaster, kept lower than the surface of the tesserae and painted a matte grey. The weight of each large panel was approximately 500 kg (1,100 lbs) or 100 kg/m^2 (21 lbs/f^2).

Fig. 3. Date and initials found in concrete on reverse of panel (photo: Yale University Art Gallery

The mosaic panels were attached by their interlocking steel frames to the masonry wall of the Art Gallery's Sculpture Hall. Numerous holes in the limestone blocks of the wall still provide evidence of this mounting system. The right angle frames produced a rectilinear appearance perhaps considered aesthetically appropriate at the time, but it resulted in large areas of dull grey fill material, as much as 30-40 percent per panel, and a significant amount of additional weight. The mosaic was on display for less than ten years, at which point it was removed from exhibition for reasons that remain unknown. The mosaic was crated and stored at several different storage sites over the subsequent decades.

Condition

There are numerous factors that affect the long-term stability of reinforced concrete, including concrete composition, steel composition, the bond between the concrete and steel, thermal compatibility, durability in the environment, corrosion, and stress and strain on the system. Uncracked concrete is considered isotropic, but once cracking occurs, structural failure becomes a serious risk (Suidan and Schnobrich 1973, 2109-2122).

Insubstantial packing crates and repeated moves, combined with uncontrolled storage environments, ultimately took a toll on the Yale Gerasa mosaic. Over the decades in storage the mosaic developed structural cracks running vertically, horizontally and diagonally that corresponded directly to the steel grid embedded within the concrete. Other cracks branched out from these major fault lines. Many of the cracks penetrated into the mosaic and in some areas even ran through tesserae. Crates were unfortunately stored on their long sides putting undue stress on the overlapping, joining sides of the mosaic where the steel frames did not project completely to the front to serve as protection. Considerable loss of tesserae occurred along those sides. Other edges within the frame and around lacunae also suffered some loss of tesserae. The surface of the mosaic had become dark and discoloured due to traces of animal glue, presumably from previous facings applied in the field and possibly at Yale in 1933, aged linseed oil that apparently had been used to saturate the stones, and accumulations of dirt from poor storage environments. Past efforts to secure loose tesserae included the use of masking and packing tapes that over the years became deteriorated yet strongly bonded to the tesserae. When the mosaic was examined in 2009 at its off-site storage facility, it was obvious that extreme care in handling and moving would be needed just to relocate the mosaic panels to a conservation facility. Large wood A-frames were constructed and employed to transfer the panels out of their old crates and transport them without risk of more structural damage. Upon safe arrival at the conservation facility, further examination, analysis and treatment were undertaken.

Preliminary Treatment

The mosaic was cleaned by alternating steam with acetone and 1-methyl-2-pyrrolidinone to remove grime, glue and discoloured, aged linseed oil. The cleaned surfaces were then coated with a 2-5% solution of Paraloid B-72 acrylic resin (ethyl methacrylate methyl acrylate copolymer) in 1:1 acetone:ethanol as a barrier layer prior to facing. Non-structural fills for cracks visible on the front were made from a mixture of 10-20% Paraloid B-72 in 1:1 acetone:ethanol and 25-105 micron hollow glass microspheres. Loose tesserae were secured with 20% Paraloid B-72 in 1:1 acetone:ethanol. Prior to facing the mosaics, templates relating the mosaic borders to the steel frames were made for future reference. Then, each mosaic panel was faced with cotton muslin and hide glue, a strong yet reversible aqueous adhesive that would not disrupt the materials used for coating and consolidation.

Research and Development

While the mosaic was cleaned and consolidated, research into concrete backing removal was carried out. Samples of concrete were analysed by an environmental safety division at Yale University to determine if asbestos, a common additive in the early 1900s, was present in the 1933 concrete. No asbestos was detected, but the concrete composition varied greatly from soft and sandy to very hard with large aggregate (Yale University Office of Environmental Health & Safety Asbestos Management Program, 2009). Fortunately, no metal mesh had been used to reinforce the concrete.

In considering a safe method to remove the reinforced concrete from the mosaic, experience with three-dimensional scanning and cutting devices led to adaptation of a Computer Numeric Controlled (CNC) machine, previously used for sculpting foam for packing three-dimensional works of art. The project utilized a 3-axis mill from ShopBot® Tools, Inc., custom built with a 2.75x3.05 m (9x10 foot) bed, and a 5 horsepower Colombo spindle motor RS 90. Various suites of modelling software were tried with an eye kept on simplicity and stability. A majority of the tool paths were hand rendered with PartsWorks™. The tool path could be programmed to cut the reinforced concrete down to a 5 mm layer of the plaster on the back of the mosaic. Heat dissipation was the primary technical issue. Dry milling was done to avoid wetting the mosaic or exposing it to standard cooling fluids used in industrial operations. Instead, heat mitigation was achieved through use of a Ranque-Hilsch vortex tube spot cooler and a dust extractor. The tube directed a blast of very cold air precisely at the contact point between the cutting bit and the concrete. This both cooled the cutting surface and also sent unwanted debris to the dust extractor in order to prevent regrinding the concrete dust, a significant source of excess heat generation and wear on the bits. Numerous routing bits with many different coatings and constructs were researched to select a bit that would

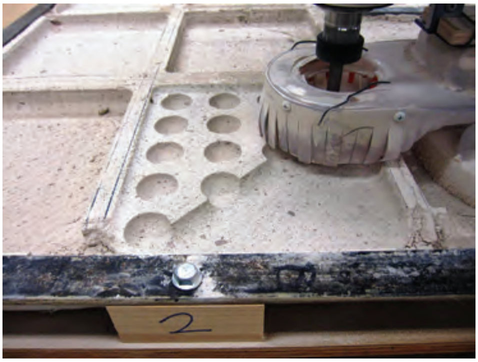

Fig. 4 Initial cutting patterns to mill concrete within steel grids (photo: Yale University Art Gallery)

Fig. 5 Mosaic panel after concrete backing removal (photo: Yale University Art Gallery)

be durable enough for the task. Solutions for manufacturing problems from many disparate industries were considered. Materials such as diamond, cubic boron nitride and aluminium titanium nitride coatings were tried with various bonding mediums and processes. At various speeds and feeds all these materials had benefits and shortcomings. A 30-grit 1" (2.54 cm) ball nosed braze-bonded diamond router proved to be the most durable. While there are established factors that influence the performance of bits cutting through specific materials, the unique quality of this project has no direct analogue; cement grinding is rarely performed outside of levelling a bumpy sidewalk or shining a shop floor, and concrete itself is a composite medium with highly variable hardness. There is scant research on accurate milling of concrete in a dry environment.

Trial and error with the various proposed solutions led us to discover that a pseudo-tricoidal pattern of the sort used in milling ultra-hard substances along with a braze-bonded diamond bit was able to withstand feeding speeds of up to 1 cm/sec at 5000 rpm with a 12% step over could remove almost 200 cm^3 of material before failure (a little less than 1 m^2 of backing material). Feed rates were adjusted as hardness varied.

Concrete Backing Removal

Each faced mosaic panel was placed face down on a torsion box purpose-built from wood and MDO (medium density overlay) plywood, with layers of 1/4 inch cross linked polyethylene foam Volara® used as inserts for lacunae and as a non-skid cushion between the uneven mosaic and the torsion box. The panel and box were placed onto the CNC cutting bed with a

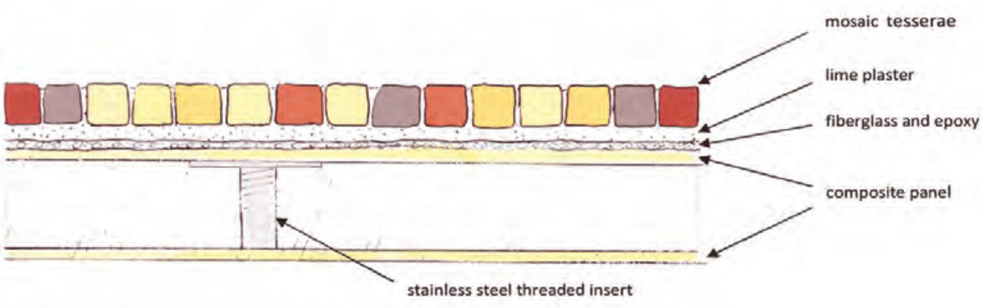

Fig. 6 Schematic of the system that was used for the Gerasa city mosaic (photo: Yale University Art Gallery)

forklift. To prepare for concrete removal, the steel grid infrastructure was mapped out in ink on the reverse of each panel and then scanned to establish a cutting pattern that would avoid hitting the steel grid.

The first round of milling was done by cutting a series of circles within the squares defined by the interior steel grids, in order to give cooling intervals during the milling process. The next round of milling cut diagonally through the circular holes, as shown in Figure 4. Any concrete remaining between the squares was chiselled off and the exposed interior steel bars and exterior frame were easily removed due to bond failure between the concrete and the steel. A finish round of milling was done using diagonal passes to achieve a surface to which new composite materials would be bonded, leaving a 5 mm layer of the 1933 plaster and exposing the score lines from that treatment. Figure 5 illustrates a mosaic panel after milling down to a consistent thickness of approximately 2 cm and prior to its removal from the cutting bed while still on its torsion box. The actual process of milling by the CNC cutter was done in approximately two weeks for each 2x2.5 m panel.

New Composite Backing

A review of published literature and unpublished reports on the subject of mosaic backing materials indicated that the majority of treatments employed aluminium honeycomb panels in various combinations with lime mortar, epoxy adhesives and different bulking agents and fillers intended to reduce weight (Blackshaw and Cheetham 1982, 70-74; Bradley *et al.* 1983, 161-170; Jobst *et al.* 1997 and 2010; Uprichard *et al.* 2000, 52-59). While generally compatible, these materials combine metal, mineral and polymer materials that differ in physical characteristics such as coefficients of thermal expansion.

A review of industrial literature prompted a re-evaluation of current materials and tests on promising new materials (Anonymous 1996; Battistella *et al.* 2008, 1851-1858; Gupta and Nagorny 2006, 1254-1261; Keller *et al.* 2008, 454-469; Langmeier and Scheuer 2010, 36-39). Laminates of epoxy resin with fiberglass, carbon fibre and Kevlar fibre were tested first. To increase stiffness, composites were made with a polyethylene foam core and facings of fiberglass, carbon fibre and Kevlar fibre. Engineers were then consulted to review the experimental laminates and composites and to choose a compatible, rigid, lightweight composite material as a mosaic backing that would provide the strength and stiffness required for safe handling, transport, vertical or horizontal exhibition, and long-term preservation. As a reversible alternative to honeycomb aluminium, a composite panel that maximizes stiffness and minimizes the coefficient of thermal expansion was chosen (Morrissey 2011). It is faced with polyester and fiberglass over a 1 inch (2.54 cm) core of AIREX® T90 closed cell structural polyester foam that is used by aerospace, architecture, marine, transit, and wind energy industries. The polyester foam is available internationally through 3A Composites Core Materials. Fiberglass and polyester foam composite panels with Rotaloc® stainless steel threaded inserts were fabricated by Composite Panel Solutions. The stainless steel inserts were imbedded into the composite panel at strategic locations as attachment points for hanging hardware. The flanged anchor was oriented toward the front of the mosaic to increase load-bearing capability. The new composite panel weighs less than 5 kg/m² (1.1 lb/f²). Figure 6 shows a schematic of the system that was used to back the Yale Gerasa mosaic. To prepare the milled surface, the plaster was vacuumed, degreased with acetone, and consolidated with 5% Paraloid B-72 acrylic resin in acetone and ethanol. Cracks were filled with a mixture of 10-20% Paraloid B-72 in 1:1 acetone:ethanol and 25-105 micron hollow glass microspheres in order to prevent seepage of epoxy from the reverse to the front of the mosaic. An initial backing of 6 ounce fiberglass was applied with West System® 105 Epoxy Resin and 206 Slow Hardener. This epoxy was chosen for its slow cure time, its compatibility with fiberglass and polyester, its bond strength, and for its durability in marine environments – far more extreme than the museum environment – with better UV resistance than previous epoxy formulations. The composite panels were adhered with the epoxy bulked with fumed silica to fill voids and increase strength. The laminating process for each panel required a team of four people and less than an hour from start to finish. The weight with the mosaic attached is estimated at 41.5 kg/m² (8.5 lbs/ft²). Each panel was considerably lighter than in 1933 due to the removal of both reinforced concrete and extraneous plaster and concrete fill materials; the large panels now weigh approximately 160 kg (350 lbs).

Final Treatment

The goal of this treatment was to present the Yale Gerasa mosaic in its fragmentary condition yet as a cohesive whole, given that it was removed from its archaeological context and will be displayed on a wall rather than on the floor (Fundel *et al.* 2008, 27-32; Podany and Matheson 1999, 21-31). Following practices of minimal intervention, the divisions made in 1933 were maintained in order to avoid recutting the mosaic and reinserting ancient tesserae. Curatorial input was vital in the decision-making processes that involved overall appearance and how far to take restorations. Structural stability was the highest priority followed by restoration of post-excavation losses using archival images as guidance for missing

Fig. 7 Installation of the Yale Gerasa mosaic at the Metropolitan Museum, New York, 2012 (photo: Metropolitan Museum of Art)

areas. Losses that were present at the time of excavation would remain visible rather than reconstructing them with reinserted surplus tesserae.

Once the mosaic panels were backed, they were flipped, facings were removed, and mosaic surfaces were cleaned to remove glue. With the mosaic face-up and all edges visible, excess plaster was trimmed further with the CNC cutter and a small diamond-edged circular saw. Excess areas of the composite panel were trimmed with a jigsaw. Losses and edges were given a skim coat, i.e., as thin a layer as possible, of Golden Hard Molding Paste, which contains marble dust, with some clean sand and acrylic paint added for texture and colour.

For the joins between the panels tubular aluminium was used as both a support and a guide for proper alignment. Losses between panels were filled with cushioning inserts of Ethafoam® polyethylene foam, which was carved and painted to replicate the missing tesserae then attached to the aluminium with hot melt adhesive. Auxiliary tubular aluminium frames were bolted to the stainless steel inserts in the composite panels to strengthen the panels and to ease stresses by minimizing handling during crating, transport, uncrating, and installation on gallery walls by art handlers and exhibition staff. The system also allows the mosaic to travel to other museums for temporary exhibitions (Fig. 7) (Brody 2012, 11-12; Brody and Snow 2015, 20-29).

Conclusions

While it is considered preferable today for excavated mosaics to remain in situ, archaeological practice at the time of the Yale Gerasa mosaic's discovery, and for decades afterward, involved lifting mosaics from their contexts. Reinforced concrete was commonly used for backing mosaics whether they were replaced in situ or in museums or storage depots. The Yale University Art Gallery shares the problems of post-excavation retreatment with archaeological museums and sites all around the world.

The Yale project redefined "reversibility" by exploring a safe and accurate method to remove reinforced concrete from a fragile limestone mosaic using a computer numeric controlled (CNC) cutting machine, which can be disassembled, transported, and reassembled for use by other museums and archaeological sites. Upgrades to the current CNC set up, such as air-powered motors with slower revolutions per minute, are worth further exploration as they become available. The Yale project also investigated new lightweight and rigid composite materials in consultation with engineers, who recommended fiberglass-faced polyester foam. Other composites deserve further research, including composites made by laminating fiberglass to polyethylene foam. For mosaics that must remain vertically mounted and/or stored, strong adhesive systems such as epoxies are being used, despite their relative irreversibility. However, given the new parameters of reversibility offered by CNC cutters, lasers and other emerging technologies, the materials used in this treatment have the potential for being removed and replaced with new materials in the future.

Acknowledgments

This project would not have been possible without the diverse team of conservators, engineers, exhibition and collections staff, who brainstormed and experimented until challenges were met and goals achieved. In addition, we also want to thank Victoria Schussler, Vicki Onofrio, Eric Litke, Thomas Reilly and Clark Crolius in applying their multifaceted talents and many hours to the project. We are as always very grateful to Chief Conservator Ian McClure, Curators Susan Matheson and Lisa Brody, and Director Jock Reynolds of the Yale University Art Gallery for their enduring commitment to support this conservation project and to share our results with conservation colleagues and the larger community responsible for mosaic preservation in museums and at sites around the world.

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www.artstor.org: for archival images of the Yale excavations at Gerasa (institutional membership required for log in)

http://artgallery.yale.edu/ and http://www.yale.edu/westcampus/: for information and video clips showing CNC cutter and mosaic backing processes

www.shopbottools.com: CNC cutter

www.pdscolombo.com: CNC motor

http://shopbottools.com/mProducts/software.htm: CNC software

http://starliteindustries.com: diamond bits

http://www.masterpak-usa.com/volara-foam.htm: Volara® and Ethafoam® polyethylene foam

www.corematerials.3ACcomposites.com: AIREX® T90 polyester foam

www.rotaloc.com: stainless steel inserts

www.compositepanelsolutions.com: fabricators of composite panels

www.westmarine.com: epoxy systems

www.goldenpaints.com: Hard Molding Paste and paints

www.3m.com: 3M™ Scotch-Weld™ Hot Melt Adhesive 3748-Q

SESSION VI: CASE STUDIES

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LES MOSAÏQUES D'EL JEM, DE HERGLA ET DE SOUSSE : DES EXEMPLES DE CONSERVATION *IN SITU*

Lotfi Belhouchet

Résumé

Une de mes missions essentielles à Sousse (2007-2008) puis à El Jem (2009), la conservation, concerne l'ensemble des pavements mosaïqués encore *in situ*. Les activités de conservation sont implantées sur plusieurs sites : la Maison antique dite aux Deux Péristyles à Hergla, la Maison aux Banquettes à Sousse et le quartier sud d'El Jem. Ils relèvent de la division de la sauvegarde des monuments et des sites au sein de l'Institut National du Patrimoine. L'équipe de travail est constituée essentiellement de techniciens de restauration de mosaïques.

Une réflexion de fond sur les travaux de conservation a été engagée pour aboutir à l'adoption par l'équipe d'un « plan de gestion » pour chaque site**.** Ce plan défini les principes fondamentaux d'un programme de conservation à long terme en établissant des lignes d'intervention prioritaires. Dans un contexte budgétaire contraint, le plan de gestion permet ainsi de concilier les travaux de fond et les impératifs quotidiens.

Introduction

D'une manière générale, trois types de risques peuvent menacer un site archéologique, nous avons :

Les risques actuels : où le problème est présent, les signes sont validés et la cause est identifiable ; les risques potentiels : où le problème à de fortes chances de survenir puisqu'il y a présence de facteurs de risque et les risques possibles où le problème peut être présent, des indices le laissent entrevoir. Une collecte de données peut le confirmer ou l'infirmer.

En outre, il existe de nombreuses manières de classer les causes éventuelles de détériorations des mosaïques. Cependant, lorsqu'on essaie de comprendre et de planifier la préservation, il est important d'avoir une liste exhaustive des causes pour ne rien oublier lors de l'investigation et de l'analyse.

Dans nos travaux nous avons utilisé un système de classification des interventions qui comprend douze étapes pour atteindre quatre objectifs majeurs (Tableau 1) : stabiliser les structures (les interventions orientées vers le problème) ; protéger les structures (les interventions orientées vers la cause) ; garantir la protection et, enfin, présenter le site et ses pavements aux visiteurs.

Cette classification permet de penser en termes de gestion des risques pour les mosaïques *in situ*.

Etudes de cas

Nous présenterons ici trois exemples avec des contextes très différents :

1. La Maison aux Deux Péristyles à Her-

Objectif	Etape	N°	Opération
A-Conserver les structures du site	Stabiliser les mosaïques	A1	Documentation puis intervention immédiate sur les mosaïques
	Stabiliser les murs	A2	Documentation puis intervention immédiate sur les murs
B- Protéger les structures du site	Protection des mosaïques	B3	Réenfouissement
	Résoudre le problème de stagnation des eaux	B4	Cartographie des zones de stagnation des eaux puis mise en place d'un système de drainage
	Protection des mosaïques à présenter (?)	B5	Système de couverture de protection
	Résoudre le problème des herbes	B6	Créer une zone sans herbes aux alentours des structures
	Protection du site	B7	Mise en place d'une clôture
C- Garantir la protection du site	Contrôler l'état du site	C8	Contrôle
	Maintenir le site dans un état satisfaisant	C9	Entretien
	Assurer la surveillance du site	C10	Gardiennage
D- Présentation du site	Mise en valeur des mosaïques et des murs à présenter	D11	Restaurer les mosaïques et les murs à présenter
	Organiser la circulation dans le site	D12	Circuit

Tableau 1. Classification des interventions dans un site archéologique (DAO. : L. Belhouchet)

gla. Les vestiges de la ville romaine de *Horrea Caelia* sont situés au sud de l'habitat actuel de Hergla où les fouilles des années 60 ont permis de mettre au jour, le long de la côte, les restes d'une luxueuse *domus* sur laquelle une église a été édifiée. D'après M. Ennaïfer et N. Ouertani (1984), la disposition classique de cette habitation s'organisai autour d'un péristyle, ainsi que l'édifice thermal la jouxtant et s'ouvrai sur un autre péristyle. D'une superficie moyenne, de l'ordre de 850 à 900 m², la demeure n'a, semble-t-il, conservé qu'un accès secondaire donnant sur le vestibule situé à l'angle sud-ouest de l'habitation. Il est, toutefois, probable qu'une entrée principale, axée sur la salle d'apparat, ait pu exister sur la façade orientale, aujourd'hui complètement disparue avec le portique correspondant, rongés par la mer. Les galeries septentrionale et méridionale sont, quant à elles, à moitié préservées, seul le portique occidental subsiste dans sa totalité. Le péristyle, en partie conservé, avait, semble-t-il, une forme rectangulaire et une superficie supérieure à 200 m². Il était séparé du *viridarium* par une murette et agrémenté tardivement d'un bassin de forme semi-ovale. Cette habitation qui date de la fin du II^e^ siècle a connu plusieurs remaniements notamment dans le secteur sud-ouest. L'aménagement le plus remarquable est, cependant, celui qui affecte l'aile occidentale, lorsque le propriétaire dota sa demeure d'un espace vaste d'environ 140 m², terminé par une grande abside. Une église à abside occidentale a été, par la suite, installée à l'intérieur des limites de l'exèdre. Cette transformation se situerait vers le milieu du IV^e^ siècle. Enfin, les tombes qui ont reçu des dalles funéraires mosaïquées sont attribuables au V^e^ siècle.

Actuellement, ce site n'est pas ouvert à la visite. Il comprend des mosaïques déposées puis remises en place et des mosaïques encore laissées *in situ*.

2. La Maison aux Banquettes à Sousse. Ce monument a été mis au jour en 1968. Il forme un complexe architectural constitué de trois ensembles. Le plus important, appelé « Maison aux Banquettes » (III^e^ – V^e^ s. ap. J.-C.), fut à l'origine une demeure privée, puis transformée, probablement à l'époque paléochrétienne, en édifice public dont on ignore la vocation. Le monument présente un plan sensiblement rectangulaire s'ordonnant autour d'une cour-salle hypostyle-pavée de mosaïques polychromes (Nabli 1975).
   Une grande partie des mosaïques du site est déposée puis remise en place. Le site est fermé à la visite.
3. Le quartier sud de Thysdrus (El Jem). Ce complexe comprend une zone d'habitation avec quatre villas situées de part et d'autre d'une grande voie dallée vaste et bordée de trottoirs. A l'ouest de la rue s'alignent du sud au nord les trois maisons les plus importantes : la *Sollertiana Domus*, la Maison du Paon, et la Maison des Dauphins. À l'est, il ne reste plus que les vestiges incomplets d'une Maison dite des Mosaïques Blanches (Alexander and Ennaifer 1996). Toutes les mosaïques du quartier sud ont été déposées puis remises en place vers la fin des années 60. Le site est ouvert à la visite.

Pour atteindre le premier objectif, à savoir la stabilisation de structures, des opérations de documentation et de stabilisation doivent être effectuées. La documentation, première étape de la conservation, consiste à transformer les données archéologiques en une série d'images graphiques (relevés) et photographiques. La photographie redressée et agrandie à l'échelle permet la production des relevés avec une très grande précision.

La documentation de l'état de conservation des mosaïques et des murs a été faite selon la méthodologie détaillée dans la publication du J. Paul Getty Trust et l'Institut National du Patrimoine de Tunisie. Ce niveau de documentation comprend :

une documentation des interventions précédentes :

- une fiche et un relevé indiquent l'emplacement et la nature des interventions précédentes sur la mosaïque.
- La documentation de l'état de conservation comprend :
- un relevé de la détérioration structurelle
- un deuxième relevé concernant la détérioration de la couche superficielle
- un troisième relevé qui documente les dommages d'origine biologique
- et un dernier relevé qui indique la détérioration des interventions précédentes.

Le deuxième objectif majeur est la protection des structures. Dans ce sens, je donne deux exemples ici :

1. Les problèmes liés à l'eau : tous les problèmes d'humidité excessive soutenue doivent être résolus rapidement. L'humidité excessive est un agent rapide et agressif qui crée de nombreux risques. Le zonage du risque que nous avons effectué a confirmé la gravité de ce problème dans plusieurs endroits. Pour établir l'ordre des priorités, nous avons commencé par évaluer les risques pour chaque secteur. Une approche quantitative (échelle de Michalski) a été utilisée pour cibler les secteurs les plus préoccupants. Le drainage permet de résoudre le problème de stagnation des eaux sur la mosaïque (Fig. 1). En revanche, la couverture est la seule solution pour éviter le contact entre les mosaïques et l'eau.
2. Les forces physiques peuvent endommager directement les objets en provoquant leur rotation ou leur déformation, ou en exerçant des contraintes ou une pression sur ceux-ci. Elles peuvent également les endommager indirectement en provoquant des collisions entre ceux-ci ou entre leurs éléments. Les dommages qu'entraînent les forces physiques varient, allant de minuscules fissures imperceptibles et de pertes négligeables aux effets de grande ampleur. Parmi les effets importants dus aux forces physiques, nous avons retenu :
   – l'impact ou le choc
   – la pression et l'abrasion
   – la déformation.

Les deux premiers effets affectent surtout les pavements exposés sans protection efficace puisqu'ils sont dus essentiellement au piétinement. Quant au troisième effet (la déformation), il affecte indifféremment les mosaïques sur support en béton visités et hors circuit de visite puisqu'il résulte de la dilatation/contraction des barres de fer dans le béton en fonction de la température. En effet, le fer se dilate environ 25 fois plus que le béton (le coefficient de dilatation du fer est de 1,2. 10^{-5} °C^{-1} et le coefficient de dilatation thermique du béton est évalué à 1/20x10^{-5}°C^{-1}). Cette dilatation différentielle des différents éléments du panneau de mosaïque crée des tensions internes qui se manifestent par des fissures et des déformations.

La solution pour résoudre les deux premiers risques est l'interdiction d'accès des visiteurs aux espaces mosaïqués en créant un circuit de visite qui permet la visite du site sans piétiner les mosaïques exposées.

Fig. 1. Travaux de consolidation des mosaïques et drainage des eaux à El Jem (Photo : L. Belhouchet)

En ce qui concerne la dilatation thermique, la seule solution est la couverture qui permet de réduire la température au niveau de la surface de la mosaïque. Or, il existe plusieurs façons de couvrir une mosaïque (réenfouissement, abri, ...) avec des avantages et des inconvénients pour chaque méthode. Dans le cas des mosaïques sur béton qui sont hors circuit de visite, si les expériences montrent qu'un quelconque type de réenfouissement réduit la température d'une façon significative (donc la dilatation du fer) cette technique, de loin la moins chère, pourrait être adoptée. Dans ce sens nous avons remarqué que les mosaïques exposées dans les salles du musée au cours des années 60 sont dans un état de conservation beaucoup plus satisfaisant que les mosaïques exposées dans le site depuis la même date. Notre objectif est donc de mettre ces dernières mosaïques dans des conditions similaires à celles du musée en attendant une solution plus efficace qui consisterait dans un changement du support.

En Tunisie, les expériences de réenfouissement de mosaïques déposées sont rares, elles ont été essentiellement opérées à Jebel Oust.

Pour cela, nous avons décidé d'expérimenter plusieurs méthodes de protection de pavements mosaïqués déposés sur béton puis remis en place. Ces différentes méthodes de protection (abri, couches de sédiments à granulométrie variable) génèrent des conditions d'humidité et de température différentes. Un contrôle continu de l'hygrométrie et de la tempéra-

Fig. 2. Réenfouissement après consolidation des mosaïques de la Maison aux Deux Péristyles à Hergla (Photo : L. Belhouchet)

ture des différents types de couvertures au cours des saisons pourrait aboutir à une méthode de réenfouissement qui permettrait de protéger les mosaïques déposées jusqu'à ce que la décision de changement de support soit prise.
Pour la mosaïque *in situ*, le réenfouissement en utilisant le sable et le gravier dans des proportions variables selon les cas reste la solution efficace la moins chère pour protéger les mosaïques dans leurs sites (Fig. 2).

Conclusion

En conclusion, nous retenons les remarques suivantes :

– Pour réussir, les opérations de conservation doivent pouvoir s'appuyer sur une équipe (techniciens de restauration et gestionnaires) bien formée et pleinement opérationnelle sur le site, de manière à intégrer efficacement les connaissances pratiques acquises par les techniciens aux connaissances théoriques (planification) acquises par le chercheur-gestionnaire.
– Les activités de cette équipe centrées sur la conservation de la mosaïque *in situ* peuvent s'avérer très efficaces, en particulier si l'on s'efforce d'identifier le problème et d'évaluer les besoins au moyen d'une démarche logique impliquant la notion « d'intervention prioritaire », au moyen d'une documentation analytique.
– Les résultats de la documentation sont extrêmement utiles pour la formulation des objectifs de l'intervention.
– Le système de classification des interventions que nous avons mis au point permet une meilleure gestion des sites et de leurs pavements. Ce système devrait être pris en considération systématiquement lors de la planification des actions à entreprendre dans un site archéologique.

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LA MOSAÏQUE AU DIEU OCÉAN DE MAUBOURGUET ET SON CONTEXTE ARCHÉOLOGIQUE

Evelyne Chantriaux, Marion Hayes, Christophe Laporte, Andréas Phoungas et Maurice Simon

Résumé

La récente ouverture à Maubourguet (Hautes-Pyrénées) d'un espace muséographique dans lequel la mosaïque au dieu Océan a été installée donne l'occasion de retracer l'histoire de ce pavement, depuis sa mise au jour en 1979 sur le site antique de Saint-Girons. L'opération réalisée par l'atelier de Saint-Romain-en-Gal s'inscrit dans un processus où l'intérêt collectif et les volontés locales ont permis d'aboutir à un projet de présentation qui restitue le contexte archéologique et l'état des vestiges à leur découverte. Bien que déplacée de son contexte initial, la mosaïque a conservé ses murs d'origine et ses particularités, ses dénivellations, ses traces d'usure et d'usage. De nouveau accessible depuis son retour à Maubourguet, la mosaïque au dieu Océan donne à voir l'originalité de son décor et l'état qu'elle présentait *in situ*, offrant la possibilité de préciser l'interprétation de certains vestiges d'aménagements.

Dans le cadre de cette conférence consacrée à la gestion des sites, notre présentation s'inscrit comme une étude de cas aux dimensions modestes : elle concerne une mosaïque et un contexte archéologique limité à ses proches abords, découverts de manière fortuite en 1979, lors de travaux agricoles effectués dans un champ situé au sud de Maubourguet (Hautes-Pyrénées). Ces vestiges d'habitat sur lequel fut implanté un lieu de culte chrétien devaient leur conservation à la présence d'un pigeonnier qui les recouvrait jusque dans les années 1930. Réenfoui après sa découverte, l'ensemble déplacé vient d'être présenté dans un espace muséographique au centre de Maubourguet.

La mosaïque

Elle présente un format rectangulaire de 4.30 m sur 4.65 m, soit 20 m^2. Le tapis est couvert par un quadrillage en lacis de tresse à deux brins délimitant des rectangles, des carrés et des triangles occupés par des animaux aquatiques : poissons, dauphins, canards, poulpes, et par des motifs géométriques. La composition, encadrée par une ligne de triangles dentelés, est centrée sur un carré occupé par un dieu Océan de facture singulière : coiffé d'une coquille, doté de moustaches en forme de dauphins, d'antennes de langoustes et d'une barbe sinueuse richement polychrome, il se distingue d'autres productions de l'antiquité tardive en Aquitaine méridionale. La datation proposée par les auteurs de la publication ayant suivi la découverte est postérieure au IV^e siècle (Balmelle 1982).

L'état *in situ* (Fig. 1 et 2)

La mosaïque était encadrée par quatre murs de 70 cm d'épaisseur constitués de galets, leur arase supérieure conservée sur une vingtaine de cm au-dessus du niveau du pavement ; leurs deux faces étaient revêtues de mortier de tuileau partiellement préservé. Le mur nord, percé par une tombe occupant sa largeur sur une longueur de 1,80 m, était doublé par un mur postérieur très massif – de 1,30 m d'épaisseur – présentant l'amorce d'une abside orientée. Des sondages effectués autour de ces structures ont livré des sépultures en pleine terre et des fragments de sarcophages en marbre indiquant l'implantation d'une église chrétienne.

Le pavement présentait une pente de 20 cm, d'un point haut dans l'angle sud-ouest vers une cuvette d'écoulement située dans l'angle nord-est, conduisant à une rigole d'évacuation percée dans le mur nord et revêtue par une plaque de marbre violet en forme de T, encastrée dans le *tessellatum* (Fig. 3). Par ailleurs, les vestiges d'une assise de maçonnerie bâtarde (briques et pierres) formant une banquette de 25 cm de largeur doublaient l'intérieur du mur ouest : ces deux aménagements, ajoutés au décor aquatique du pavement et à l'absence de seuil attesté ont conduit

Fig. 1. La mosaïque *in situ* (Cliché : HADÈS)

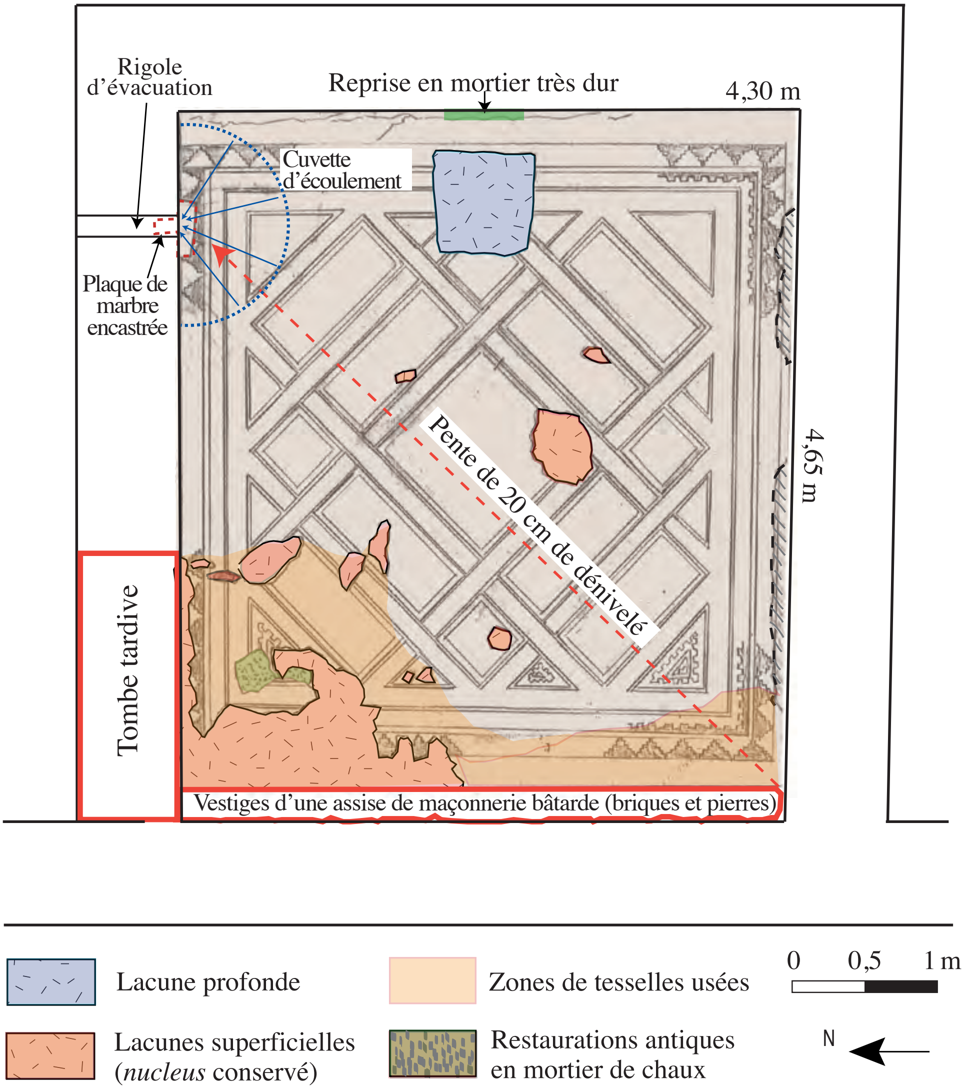

Fig. 2. Etat de la mosaïque et données archéologiques

à suggérer pour cette pièce une fonction de bassin.

La mosaïque présentait une zone brûlée en partie centrale et quelques dépôts de concrétions inégalement répartis sur sa surface. Le tapis était presque complet : quelques îlots de tesselles avaient ponctuellement disparu et l'angle du carré central était détruit en bordure du dieu Océan. Deux zones lacunaires se singularisaient : l'une occupait l'angle nord-ouest du pavement, très usé devant la tombe tardive du mur

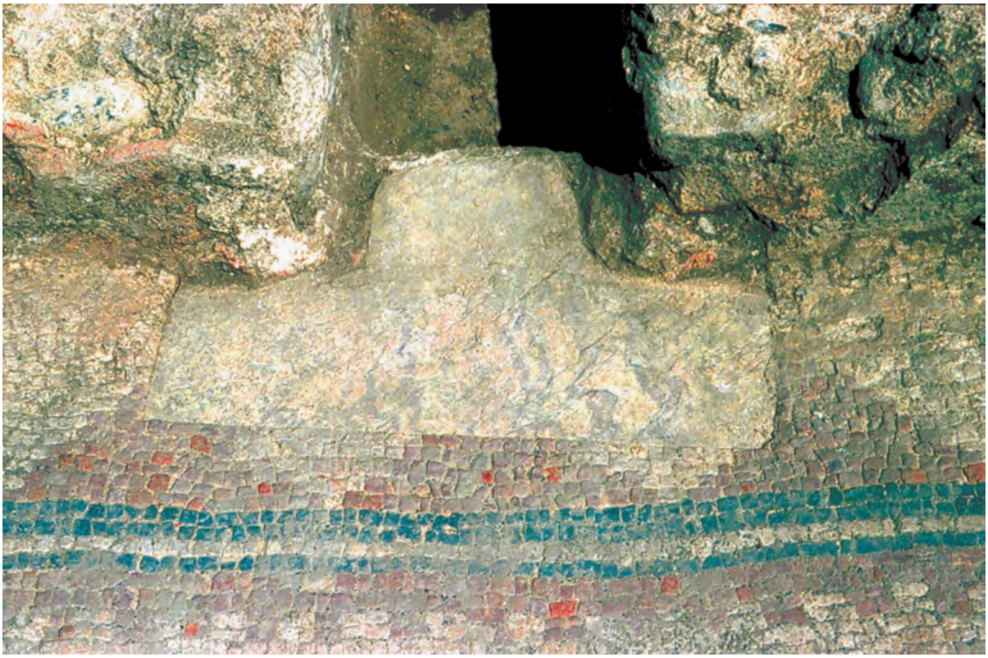

Fig. 3. Détail de la rigole d'évacuation et plaque de marbre encastrée dans le *tessellatum* (Cliché : Atelier)

nord ; ce secteur présentait des réfections antiques en mortier de chaux qui colmataient partiellement des îlots de tesselles réduites à quelques millimètres d'épaisseur (Fig. 4). La seconde lacune était centrée sur le côté est de la mosaïque (Fig. 5). De format grossièrement carré, elle se démarquait des autres lacunes par sa profondeur : alors qu'ailleurs seul le *tessellatum* avait disparu, laissant apparent le lit de pose ou le *nucleus,* la partie détruite occupait ici l'épaisseur du *nucleus* et du *rudus*, une partie descendait même sous le *statumen*. Sa première interprétation comme un creusement tardif – peut-être un sondage archéologique –, a pu être reconsidéré après l'étude de l'organisation du décor autour de ce « trou », ultérieurement précisée au cours de la restauration de la mosaïque.

La dépose (2005)

La mise en vente de la propriété, en 2004, a conduit la ville de Maubourguet à acquérir le pavement et à programmer sa dépose et sa restauration, dans la perspective de sa présentation dans le futur espace muséographique projeté au centre du bourg. L'atelier de Saint-Romain-en-Gal, attributaire du marché, a procédé à la dépose en septembre 2005, après le redégagement de la mosaïque par la Société archéologique HADÈS de Toulouse.
L'opération a été effectuée avec la contrainte de ne pas démonter les murs périphériques, en utilisant le seul accès offert par la tombe ménagée dans l'épaisseur du mur nord de la pièce. Par ailleurs, il a été décidé de prélever la mosaïque en

Fig. 4. Détail de la zone lacunaire et usée devant la tombe tardive du mur nord (Cliché : HADÈS)

Fig. 5. La lacune carrée centrée sur le côté est de la mosaïque (Cliché : HADÈS)

Fig. 6. La dépose en cours ; les plaques sont délimitées suivant la trame géométrique du décor (Cliché : Atelier)

conservant sa pente d'écoulement. L'auscultation de la surface, effectuée lors du diagnostic préalable, avait révélé une très bonne adhérence du tapis de tesselles avec son assise. Les difficultés rencontrées pour déposer la mosaïque ont ensuite confirmé son exceptionnelle solidité, liée à des caractéristiques technologiques particulières : une assise très épaisse – environ deux fois plus haute que la moyenne des fondations de pavement – et une rare compacité du mortier qui a nécessité des moyens techniques inhabituels pour le prélèvement.

Après la mise en place d'une serre de protection couvrant la surface à déposer, la mosaïque a été dégagée et nettoyée avec des brosses douces et à l'eau. L'enregistrement – graphique, photographique et descriptif – des caractéristiques technologiques de la mosaïque a été effectué. Les niveaux ont été relevés de manière à restituer la pente générale du pavement avec une intervention spécifique pour la cuvette d'écoulement : celle-ci a été moulée au moyen d'une contreforme de surface réalisée en mousse de polyuréthane expansé, coulée sur la partie dénivelée préalablement protégée par un film polyane. Après séchage et entoilage de surface, le tapis de tesselles a été fragmenté selon un plan de dépose établi en fonction de la trame géométrique. La compacité du *tessellatum* et la dureté de son scellement n'ont pas permis d'enlever les tesselles au ciseau, l'opération provoquant l'éclatement des rangées adjacentes : le tapis a donc été divisé par sciage, en 35 plaques délimitées suivant la composition du décor (Fig. 6). Le prélèvement a été effectué au moyen de broches d'acier insérées entre le *nucleus* et le *rudus*, après percement d'avant-trous au moyen d'un perforateur équipé de longues mèches. Après avoir été désolidarisées, les 35 plaques de mosaïque ont été retournées sur des panneaux de contreplaqué.

La dépose a permis de préciser la constitution de la mosaïque. Son épaisseur totale, de 32 cm, se compose comme suit :

– *tessellatum* : sa hauteur est très variable, de 10 mm jusqu'à 30 mm pour les tesselles les plus épaisses. Celles-ci, de 0,8 à 1 cm de côté en moyenne dans le tapis, sont plus fines dans les figures (0,5 à 0,8 cm), plus grossières dans les bordures (jusqu'à 1,8 cm) ; elles sont taillées dans des calcaires (blanc, gris, noir, rose, jaune), des marbres (mauve, blanc, gris) et des terres cuites rouges.
– lit de pose en chaux de 3 à 5 mm d'épaisseur.
– *nucleus* en mortier de tuileaux de 4 à 6 cm d'épaisseur, très dur, de fine granulométrie, en chaux chargée de brique pilée (1 à 3 mm de diamètre).
– *rudus* de 12 à 17 cm d'épaisseur, très dur également, en béton de chaux chargé de sable, de petits graviers, d'éclats de terre cuite de 1 à 1,5 cm de diamètre, avec des nodules de chaux grasse. Le mortier a été coulé en deux fois, la première couche liant la partie supérieure du hérisson.

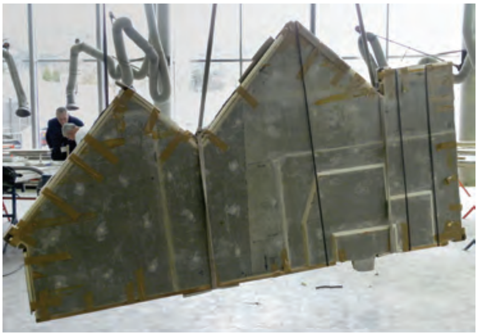

Fig. 7. Support de nid d'abeille du panneau nord avec le socle de la cuvette d'écoulement (Cliché : Paul Veysseyre)

– *statumen* constitué de galets de 7 à 12 cm d'épaisseur, posés de biais sur un sol de terre battue.

La restauration (2006-2007)

Les opérations ont consisté à réunifier la mosaïque dont les 35 éléments ont été remontés sur un support de nid d'abeille composé de 7 panneaux. La dénivellation de la cuvette d'écoulement a fait l'objet d'un aménagement spécifique, par superposition de trois épaisseurs de nid d'abeille formant le socle de cette zone creuse (Fig. 7). Les traitements de surface ont débuté par le désentoilage, effectué par dissolution à l'alcool de l'adhésif utilisé pour coller la gaze chirurgicale et la toile de jute appliquées avant la dépose. Les tesselles d'origine ont ensuite été réintégrées dans les lignes de découpe pratiquées lors de la fragmentation de la mosaïque, en utilisant l'épaisseur des tesselles sciées pour obtenir des sections compatibles avec le calibre des rangées restituées. La mosaïque a enfin été nettoyée à l'aide de brosses douces, avec une finition au scalpel sous micro-jet de vapeur d'eau déminéralisée, afin de préserver les zones fragiles et érodées : tesselles réduites à quelques millimètres d'épaisseur, et empreintes conservées dans le lit de pose des tesselles disparues. Le nettoyage a révélé des détails du décor jusqu'alors peu lisibles : l'inversion des couleurs due à l'altération des tesselles dans les parties brûlées, les cabochons blancs ponctuant chaque strie de la coquille au-dessus du dieu Océan, la pointe de sa barbe se finissant en fleurette rouge à base noire, auparavant masquée par des concrétions (Fig. 8). Il a également permis de préciser l'organisation du décor autour de la lacune carrée située sur le côté est du pavement : le motif de coquille est en effet interrompu alors qu'il se développe de manière symétrique dans les autres carrés sur la pointe de la composition (Fig. 9 et 10). Cette lacune pourrait ne pas avoir été causée par un sondage archéologique, mais correspondre à l'arrachement d'un bloc de maçonnerie qui constituait le socle d'un élément lourd : statue, ou cuve, vasque, bassin, à mettre dans ce cas en relation avec le système d'écoulement situé à proximité de cet aménagement. Cette hypothèse est confortée par la présence, révélée par le nettoyage de la bande de raccord, d'une petite reprise en mortier de chaux très dur pouvant être le vestige d'un dispositif hydraulique situé dans l'axe central de la pièce. Quelle que soit l'interprétation de cette lacune, il est certain que le décor s'organisait dès l'origine de manière différente dans cette zone de la mosaïque.

Aux interrogations suscitées par le format carré de cette lacune s'ajoutent les questions relatives à la fonction de la pièce. Celle-ci a été interprétée comme un bassin, en l'absence d'accès attesté. Mais la tombe tardive, dans l'épaisseur du mur nord, pour-

Fig. 8. Le dieu Océan après nettoyage (Cliché : Paul Veysseyre)

rait avoir été installée à l'emplacement d'un seuil préexistant. Elle était en effet posée sur une arase de maçonnerie à 15 cm au-dessous du niveau de la mosaïque. L'emplacement créé par l'enlèvement du seuil a pu être exploité pour l'installation de la sépulture, plus difficile à aménager dans un mur plein qu'il eut fallu démonter ou creuser. Et l'usure prononcée du tapis de tesselles dans l'angle nord-ouest pourrait correspondre à une zone de passage liée à cet accès. Très érodée également, toute la bordure ouest de la mosaïque invite à s'interroger sur la fonction de l'assise de maçonnerie qui doublait

Fig. 9. Carré sur la pointe situé sur le côté nord : le motif de coquille se développe de manière symétrique de part et d'autre d'un axe déterminant deux triangles égaux. C'est le cas également pour les autres carrés sur la pointe que présente la mosaïque (Cliché : Paul Veysseyre)

Fig. 10. Détail du décor autour de la lacune carrée. Les tesselles conservées indiquent un traitement différent de ce carré sur la pointe si le motif se poursuit en partie basse, l'espace restant est réduit à un triangle trop petit pour une coquille symétrique (Cliché : Paul Veysseyre)

le mur de ce côté ; les vestiges indiquent une largeur de 25 cm et une faible hauteur variant de quelques cm à 10 cm : banquette ou emmarchement lié à un accès occupant toute la largeur de la pièce ? Comme pour

Fig. 11. La mosaïque et les murs installés dans l'espace muséographique de Maubourguet (Cliché : Atelier)

Fig. 12. Détail de la mosaïque après sa mise en place (Cliché : Atelier)

chaque mosaïque traitée par l'Atelier, ces questions ont accompagné et rythmé le cours de la dépose et de la restauration.

L'installation à Maubourguet (2010)

La mosaïque a été installée dans son lieu de présentation en décembre 2010, après la construction de l'Espace muséographique de l'office du tourisme cantonal de Mau-

Fig. 13. Détail des enduits reposés en partie basse des murs (Cliché : Atelier)

Fig. 14. Détail de la pente d'écoulement et de la rigole d'évacuation (Cliché : Atelier)

bourguet (Fig. 11 et 12) (Doussau 2010). Elle y a retrouvé son cadre d'origine : ses quatre murs et l'amorce de l'abside qui doublait le mur nord, démontés en blocs et remontés dans la salle d'exposition avant la mise en place du pavement. Les opérations finales de présentation ont consisté à appliquer un enduit de chaux dans les lacunes ; l'opération a été réalisée *in situ* pour masquer les limites des sept panneaux constitutifs du pavement : le traitement de la lacune carrée, revêtue d'un enduit lisse et terreux, la différencie des autres parties lacunaires, comblées par un mortier plus grossier chargé de tuileaux. Par ailleurs, les vestiges d'enduits partiellement préservés au bas des murs ont été remis en place et un mortier de tuileaux a été appliqué en périphérie du pavement pour le raccorder aux parois et en partie basse des maçonneries, selon la configuration d'origine (Fig. 13).

La mosaïque donne ainsi à voir l'état qu'elle présentait à sa découverte : ses zones brûlées, ses lacunes, les traces d'usure parsemées de réfections antiques dans les zones de passage, la rigole d'évacuation percée dans le mur nord avec sa plaque de marbre encastrée dans le *tessellatum*, la dépression formée par la cuvette d'écoulement, et la pente générale restituée par l'inclinaison du châssis sur lequel la mosaïque a été reposée (Fig. 14).

Conclusion

L'opération présentée ne prétend pas constituer un modèle exploitable en dehors du cadre spécifique dans lequel elle a été réalisée. Il s'agit d'une réponse concrète apportée à un cas précis : celui d'un site isolé, pourvu de vestiges archéologiques très partiels, dont le devenir aléatoire, puisque privé, échappait à tout contrôle public, ce qui a conduit la collectivité à faire le choix de le déplacer, dans un lieu plus central et sécurisé. Plus de 30 ans après sa découverte, la mosaïque au dieu Océan, inconnue ou oubliée pour la plupart des habitants de Maubourguet est aujourd'hui visible, dans l'état archéologique de sa découverte. Les particularités conservées de son état initial permettent aux chercheurs de poursuivre leurs études, de préciser certaines interprétations ; et la présentation du pavement offre au public « l'image étonnamment expressive et pleine de vie » (Balmelle 1982, 156) de ce dieu Océan si singulier.

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LA MOSAÏQUE DU KHROUB (CONSTANTINE – ALGÉRIE). DÉCOUVERTE ET SAUVEGARDE

Sabah Ferdi

Résumé

En collaboration avec Kamel Laichi, chef de la mission de sauvetage du chantier d'El Khroub ; Moussa Djemel et Arab Smain, restaurateurs ; Mesdames Larbès Latifa, Faiza Boukheddar, Benallel Nacéra, Messieurs Liès Arifi et Haroun Bouzidi, archéologues du CNRA ; Nacer Boulahya, Karim Salem, Mohamed Bekkhouche et Mohamed-Lamine Boughrara, étudiants.

Circonstances de la découverte

Le site est situé sur une propriété privée appartenant aux Seraoui au nord de la commune d'el Khroub à 36°16 663'Nord et 006°41,768'Est.
L'objectif initial de notre intervention était l'identification de l'espace englobant le pavement de mosaïque exhumé lors des travaux de viabilisation, délimiter son étendue et déterminer son état de conservation ainsi que les mesures préventives à prendre. En 2011, une zone de 12x12 m a donc été délimitée à partir des abords est de la tranchée creusée lors des travaux de viabilisation du lotissement. Les premiers dégagements ont révélé un mur long de 2,40 sur 0,58 m orienté nord-sud qui délimite un espace constitué d'une grande salle de 7,35x6,18 m, décorée d'une belle mosaïque de style fleuri et bordée de murs (Fig. 1) ; au sud et au nord, les restes de murs de quatre autres pièces au sol bétonné de chaux.

Données techniques

Palette polychrome tout en nuance : grenat/ saumon/ rose/ vert/ gris/ noir/ blanc/ ocre/ jaune/ safran/ rouge brique.
Les tesselles variant entre 6 mm et 1 cm sont réalisées en grès calcaire (siliceux, quartzite, dolomitique) et en marbre. La densité variant entre 90 à 150 au dm^2.
La bande de raccord large de 19 à 24 cm est constituée de 24 à 28 rangées de tesselles noires parallèles aux murs de la pièce. Densité 140 dm^2.
La bordure : large de 22 cm présente un triple filet de tesselles blanches et une ligne de solides à bords dentelés traités alternativement en : ocre/jaune, safran/ ocre cuivré/ blanc (trois nuances) et deux tesselles noires ; en grenat/saumon/noir (deux nuances) et deux tesselles blanches ; en vert/gris/blanc (deux nuances) et deux tesselles noires. Densité : 132 dm^2.
Le tapis (Fig. 2) est une trame végétalisée insérée dans un rectangle de trois rangées de tesselles blanches et une

ig. 1. Plan du site de Khroub (cliché : K. Laichi)

double rangée de tesselles noires. C'est une composition fleurie à fond blanc faisant apparaître un double quadrillage oblique autour duquel s'organisent des motifs courbes constitués de bulbes, d'écus, de volutes en acanthes, de tiges de vigne à volutes latérales, d'octogones à quatre côtés biconcaves et d'octolobes noirs. Tous ces éléments (cercles, octogones, carrés concaves à côtés échancrés) qui rythment la composition sont traités en tiges d'acanthes colorées et dégradées avec des effets de reliefs et des rehauts de lumière les détachant sur le fond intérieur.

Fig. 2. Le tapis (cliché : S. Ferdi)

Etat de la mosaïque avant l'intervention de consolidation

La mosaïque conserve encore son support original de bonne qualité, néanmoins, nous avons recensé de multiples altérations du *tessellatum* (Fig. 3) telles :

– La désagrégation des tesselles et leur détachement
– Des fractures et des fissures
– De nombreuses concrétions calcaires
– Des pertes d'adhérence entre les tesselles et leurs assises et révélées par les sonorités dégagées en « sonnant » sur le tapis
– Présence d'un nid de fourmis
– Tesselles calcinées sur une partie du *tessellatum*
– Altérations chromatiques

Fig. 3. Multiples altérations du *tessellatum* (cliché : S. Ferdi)

Intervention de consolidation

Notre intervention a porté sur :

– Le nettoyage mécanique de la surface du *tessellatum* à l'aide de scalpels, bross-

Fig. 4. Consolidation des bords du pavement par des solins de mortier de chaux (cliché : S. Ferdi)

Fig. 5. Nettoyage général du pavement (brosses, eau, éponges) (cliché : S. Ferdi)

es et aspersion d'eau afin d'éliminer les dépôts incohérents.
– Le dégagement des bords et le nettoyage des poussières et de la terre.
– Collecte des tesselles désolidarisées.
– Consolidation des bords par la pose de solins à base de chaux hydraulique et de sable.
– Elimination mécanique des terres accumulées dans les lacunes jusqu'à l'apparition du lit de pose.

Fig. 6. Recouvrement de la mosaïque par du géotextile suivie d'une couche de sable et du gravier (cliché: S. Ferdi)

- Comblement des lacunes internes par l'application d'un mortier de renforcement à base de chaux et de sable.
- Remplissage des joints entre les tesselles par l'insertion d'un mortier hydraulique à base de chaux, sable et eau dans les interstices entre les tesselles.
- Consolidation des bords du pavement par des solins de mortier de chaux (Fig. 4)
- Nettoyage général du pavement (brosses, eau, éponges) (Fig. 5)
- Recouvrement de la mosaïque par du géotextile suivie d'une couche de sable (30 cm) et du gravier (10 cm) (Fig. 6).

En conclusion :

Le but de notre intervention est de stabiliser les parties de la mosaïque qui sont en danger de perte immédiate dans l'attente du classement du site, de poursuivre les fouilles et de programmer un chantier-école permanent du CNRA.

Sabah Ferdi, Directrice de recherches au CNRA

L'ENTRETIEN ET LA CONSERVATION DES MOSAÏQUES DE DOUGGA (TUNISIE)

Mouid Hani

Située à 100 km de Tunis, Dougga se trouve sur la route romaine reliant Carthage à Théveste. Construite sur une colline à 600 m d'altitude, *Thugga* (Fig. 1) représente aujourd'hui un site archéologique d'une ville romaine en bon état de conservation (avec ses maisons, son centre civique, ses voies dallées, etc.). L'architecture domestique de la cité antique atteignit son apogée durant la seconde moitié du II^{e} et le début du III^{e} siècle. L'auteur grec Diodore de Sicile nous rapporte qu'à la fin du IV^{e} siècle av. J.-C. *Thugga* était déjà « une ville d'une belle grandeur ». Après les fouilles de la fin de XIX^{e} siècle et du début du XX^{e} siècle, de nombreux édifices sont classés monuments historiques. En 1991, fut créé sur place un Parc Archéologique National.

Fig. 1. Dougga est construite sur une colline à 600 m d'altitude (tout en haut, les Thermes de Caracalla) (cliché : Moudi Hani)

En 1997, le site a été inscrit sur la liste du patrimoine mondial de l'UNESCO. Des projets de restauration et de mise en valeur ont été définis au bénéfice du site.
En 2008, Aicha Ben Abed qui a fait engager de grands travaux d'aménagement et de mise en valeur sur le site depuis 2005, a pris, en collaboration avec le Getty Conservation Institute, l'initiative de lancer une campagne de formation pour l'entretien de la mosaïque, au bénéfice de 12 jeunes garçons originaires de la région. Cette formation a duré deux ans et a été couronnée par un diplôme. Il y a eu, également la même année et pour la même durée, une formation de quatre gestionnaires de sites archéologiques dont un est resté sur le site. Les deux formations étaient théoriques (étapes de la documentation, remplissage de fiches techniques, relevés, études de cas, terminologie, etc.) et pratiques (interventions directes d'entretien de mosaïques et de murs, etc.).
En 2009, après l'achèvement de notre formation en conservation-restauration (Master sciences et techniques de conservation-restauration des biens culturels à la Sorbonne Paris 1), nous avons pris la relève et engagé un travail méthodique de constat d'état et de diagnostic détaillés pour tout le site (monuments, circuit de visite, terrain non fouillé, etc.).
Ce site a eu donc la chance de réunir une équipe de techniciens, un gestionnaire de site et un conservateur-restaurateur qualifiés.

- Le conservateur-restaurateur met en place des programmes d'intervention et supervise le travail sur le site
- Le gestionnaire participe à l'élaboration du plan de gestion du site et suit de près l'application du travail par les techniciens
- Les techniciens appliquent le programme (entretien des mosaïques et des murs).

La conservation-restauration des mosaïques

Les mosaïques à Dougga se trouvent dans des monuments publics et privés et présentent une facture meilleure dans les maisons. Leur constat d'état et diagnostic ont été faits d'une manière très détaillée. Le programme d'intervention était à court, à moyen et à long terme.

Les causes générales d'altération sur le site

- Changements brusques de température : eau, humidité, ensoleillement, gel-dégel, etc. (Fig. 2)
- L'eau : stagnation (Fig. 3), infiltration, évaporation et cristallisation
- Les micro-organismes à la surface et à l'intérieur des tesselles
- Cristallisation des sels dans les tesselles
- Le nombre des visiteurs (Fig. 4) avec le manque de protections adéquates.

Les conséquences sur les mosaïques

Elles sont multiples : détachement de tesselles, micro-organismes, ternissement et décoloration (Fig. 5), poussée rapide d'herbes, craquelures, affaissements, gonflements et vides entre les couches d'un pavement, et interventions précédentes inadéquates (Fig. 6).
Pour remédier d'une manière efficace à ces problèmes sur les pavements et sur

Fig. 2. Haute altitude et gel-dégel (cliché : Moudi Hani)

Fig. 3. Accumulation des eaux de pluie (cliché : Moudi Hani)

Fig. 4. Nombre important de visiteurs (cliché : Moudi Hani)

les monuments, nous avons envisagé un travail méthodique qui couvre tout le site (Fig. 7). Nous avons travaillé par secteur afin de faciliter l'organisation du travail de documentation (relevés graphiques et photographiques, remplissage de fiches de constat d'état et de diagnostic pour chaque monument et pavement) qui a

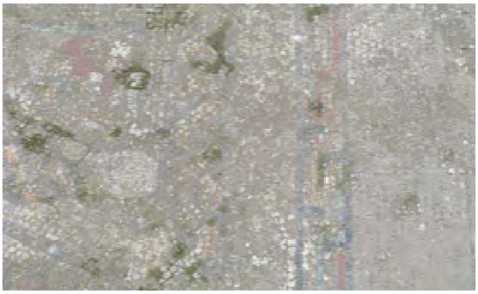

Fig. 5. Ternissement et décoloration (cliché : Moudi Hani)

Fig. 6. Interventions précédentes inadéquates (cliché : Moudi Hani)

servi de base pour la mise en place d'un programme d'intervention classé selon un ordre de priorité qui prend en considération l'état d'urgence de chaque situation. Les opérations d'intervention sont diverses, mais la documentation reste la tâche indispensable qui accompagne toute opération :

– Préparer les bases graphiques des pavements

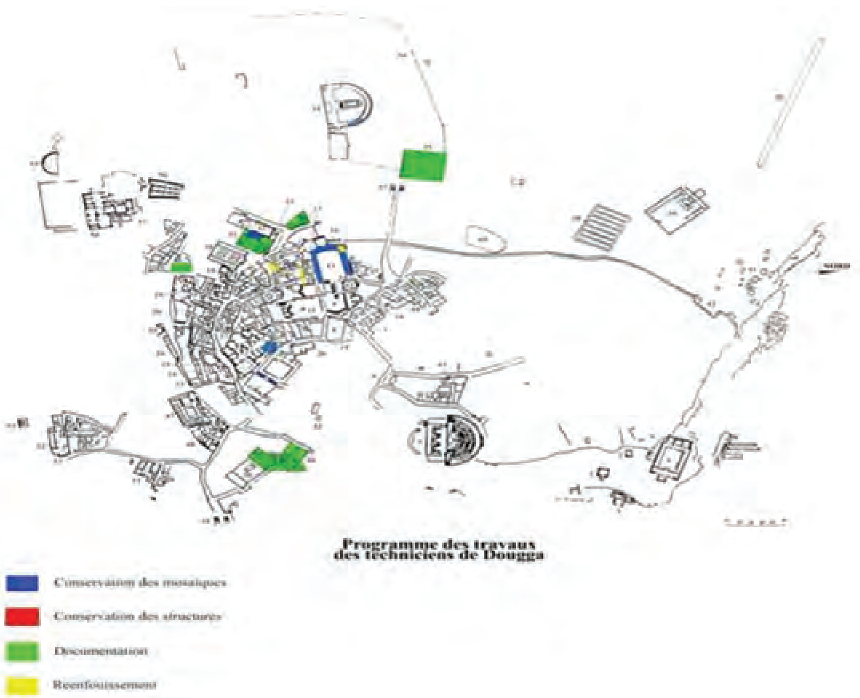

Fig. 7. Plan d'intervention des techniciens (cliché : Moudi Hani)

Fig. 8. Bouchage des lacunes (cliché : Moudi Hani)

Fig. 9. La Maison de Vénus (cliché : Moudi Hani)

Fig. 10. Le pavement de la Maison de Vénus (cliché : Moudi Hani)

- Nettoyage et désherbage
- Préparation des matériaux
- Bouchages des lacunes (Fig. 8)
- Protection de bords endommagés
- Remplissages des joints
- Traitement des panneaux déformés, des zones de soulèvement et des zones de dépression
- Traitement des problèmes liés à l'accumulation des eaux de pluie et au pié-

Fig. 11. Maison de Vénus : Tesselles détachés (cliché : Moudi Hani)

tinement des animaux (problème des sites ruraux en Tunisie) et des visiteurs
– Réenfouissement.

Nous présentons ici deux exemples d'intervention : Le premier est situé dans la Maison de Vénus, le deuxième est situé dans les Thermes de Caracalla.

Les degrés d'intervention sur la mosaïque de la Maison de Vénus

Dans la Maison de Vénus (Fig. 9 et 10), qui doit son nom à la fameuse mosaïque trouvée dans l'une de ses salles, nous sommes intervenus sur la mosaïque géométrico-florale polychrome de la salle rectangulaire située au fond nord de la maison. Celle-ci, souffre du détachement des tesselles sur les bords et à quelques endroits du *tessellatum* (Fig. 11) ; et ce à cause du passage des animaux. L'accumulation des eaux de pluie, dans cette salle, a provoqué des zones de gonflement.

– Les soins d'urgence : ils comprennent une protection temporaire des bords de la mosaïque et un travail localisé de stabilisation des endroits qui sont en danger de perte imminente en attendant de pouvoir intervenir dans le cadre d'un programme complet de traitement. L'intervention sur les causes a imposé le renforcement du gardiennage.
– La conservation-restauration : son objectif est de rétablir à la fois l'intégrité structurelle et l'intégrité esthétique de la mosaïque tout entière. Ceci s'est manifesté dans le traitement du décollement entre les couches de la mosaïque. Pour éviter le problème des eaux de pluie, nous avons proposé la construction d'un abri, car pour l'instant, le réenfouissement de ce pavement serait préjudiciable à la valeur d'exposition de cette maison.
– L'entretien régulier : son objectif est de préserver à long terme l'intégrité structurelle et l'aspect post traitement de la mosaïque.

Le but de ces interventions était de restituer à cette mosaïque son intégrité structurelle et esthétique en lui rendant ainsi sa lisibilité et sa visibilité.

Le problème des algues vertes

Dans quelques endroits, le nettoyage a laissé apparaître une couche d'algues vertes. Très adhérentes et même incrustées à l'intérieur des pores des tesselles, nous n'avons pas réussi à les retirer.
L'utilisation du scalpel et du bistouri n'a pas donné de meilleur résultat que l'utilisation des brosses, ces outils ne devant pas toucher au matériau constitutif de la tesselle, leur rôle n'était que très limité dans les zones affectées par ce problème.
Dans la même zone de nettoyage, se trouvait une concrétion de couleur grise

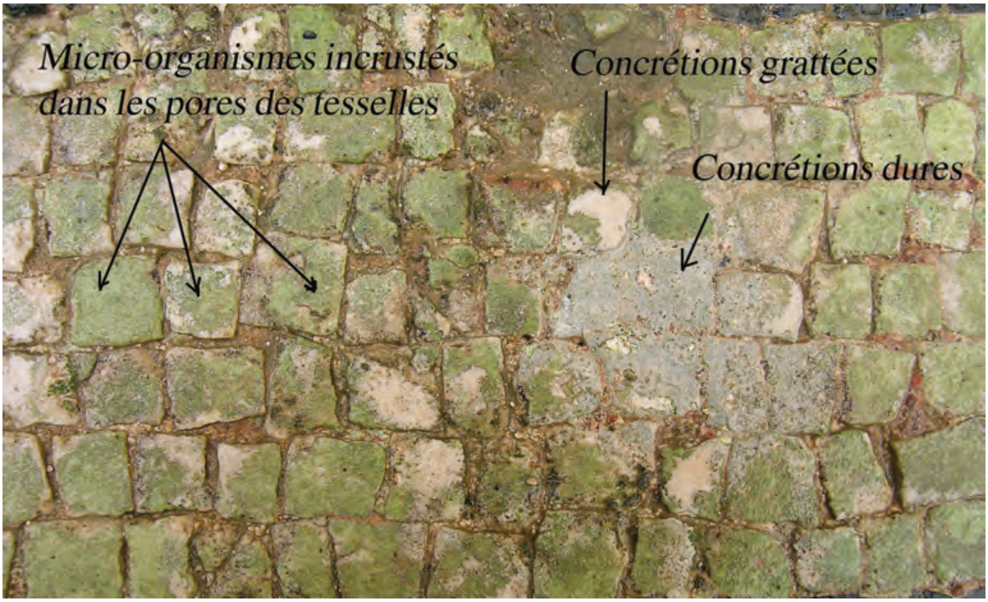

Fig. 12. Micro-organismes : Concrétions superficielles (cliché : Moudi Hani)

Fig. 13. Micro-organismes : dégâts structurels (cliché : Moudi Hani)

composée de lichens morts relativement plus épaisse que la « couche » verte de micro-organismes qui l'entourait. Le grattage de cette croûte au scalpel donna un résultat qui suscita notre réflexion. En effet, après un essai de grattage, la surface de la tesselle, apparaissait blanche, couleur qu'elle avait à l'origine (Fig. 12 et 13). Or, si la couche d'algues vertes prenait en séchant une couleur proche du gris, la blancheur authentique de cette tesselle attirait trop le regard. Donc, nous avons décidé de ne pas enlever cette concrétion grise afin que la mosaïque garde, après le traitement et séchage, un aspect général homogène.

Par ailleurs, si, au moment du nettoyage, nous remarquions qu'une tesselle était instable ou se détachait, nous effectuions immédiatement sa remise en place. Les opérations de nettoyage, de stabilisation et de réintégration étaient effectuées simultanément.

Des mortiers compatibles

Pour réintégrer les lacunes et stabiliser les décollements entre les couches supérieures de la mosaïque, tous les mortiers utilisés devant être compatibles physiquement et esthétiquement avec les matériaux constitutifs et l'aspect de la mosaïque. Ces mortiers ne doivent pas contenir de sels solubles, leur fissuration doit être limitée après leur prise, et enfin, ils doivent être stables et durables dans le temps. Ils doivent aussi avoir une bonne affinité avec les matériaux anciens et posséder en particulier une dureté et une porosité proches des leurs pour permettre un mouvement de l'eau similaire. Ces mortiers doivent aussi être réversibles.
Pour ces raisons, on utilisera donc des mortiers à base de chaux aérienne ou de chaux hydraulique naturelle.
Enfin, les mortiers utilisés pour la restauration des mosaïques doivent être adéquats d'un point de vue esthétique : la couleur et la texture superficielle du mortier sec ne doivent pas attirer l'attention afin que la surface de la mosaïque reste toujours visuellement dominante.

La remise en place des tesselles

Nous avons préparé un mortier gras à base de chaux en pâte et d'un agrégat fin avec la formule suivante :

– une part de chaux en pâte ;
– une demi-part de sable blanc de granulométrie variant entre 0 et 0.5 mm ; et
– une demi-part de gravier beige de Dougga Nouvelle de granulométrie variant également entre 0 et 0.5 mm. Soit un rapport liant/agrégat = 1/1

Fig. 14. Marquage des tesselles remises (cliché : Moudi Hani)

A la fin de l'opération, nous distinguons avec des étiquettes les tesselles remises en place afin de les marquer sur les plans des interventions réalisées (Fig. 14).

Le remplissage des joints et la consolidation des bords des lacunes

Ces opérations qui succèdent souvent à la remise en place des tesselles, utilisent toutes deux le même mortier. Lorsque les tesselles étaient de couleur sombre, le mortier des joints et de consolidation des bords, comprenait, un peu de gravier noir tout en gardant le même rapport liant/agrégat (1/2).

La stabilisation des décollements (Fig. 15 et 16)

On utilise pour cette opération un mortier liquide, appelé aussi coulis. Il s'agit d'un type particulier de mortier qui contient une proportion plus importante d'eau que les mortiers en pâte. La quantité d'eau ajoutée est juste

Fig.15. Traitement des décollements : Opérations préparatoires (cliché : Moudi Hani)

Fig. 17. Etat du pavement avant intervention (cliché : Moudi Hani)

Fig.16. Décollement: remplissage de la cavité (cliché : Moudi Hani)

Fig. 18. L'état du pavement après restauration et mise en place de la passerelle (cliché : Moudi Hani)

suffisante pour rendre le mortier fluide, mais sans excès, il est par ailleurs composé d'agrégats très fins. Le rapport liant/agrégat est de 1/1. Nous avons choisi un mortier hydraulique comme liant, car celui-ci devait pouvoir prendre sans être au contact de l'air comme nous allons le voir plus loin.

Nous posons ensuite un poids (tel qu'un sac de sable) sur la zone stabilisée pendant une durée de trois jours afin de favoriser l'adhésion du mortier aux couches traitées.

Fig. 19. La formation des techniciens (cliché : Moudi Hani)

La mosaïque de la salle d'entrée des Thermes de Caracalla (Fig. 17 et 18)

La restauration de ce pavement fut l'objet et le champ d'application de la formation des techniciens sous l'encadrement des professionnels du Getty Conservation Institute et de l'Institut National du Patrimoine (sous la direction d'Aicha Ben Abed et Thomas Roby) (Fig. 19).

La mise en place d'une passerelle

Pour préserver la mosaïque du piétinement des visiteurs, nous avons mis en place une passerelle en aluminium qui relie les deux accès. Elle est placée le long du passage des visiteurs, transformé avec le temps en des lacunes bouchées lors des interventions de conservation-restauration.

Cette solution qui dissimule les anciens dégâts, provoqués lors du passage des visiteurs entre les deux portes d'accès, protège la mosaïque de dégâts supplémentaires et permet aux visiteurs de contempler une grande partie, aujourd'hui bien conservée, de la mosaïque.

Fig. 20. Entretien des murs de la salle d'entrée des Thermes de Caracalla (cliché : Moudi Hani)

Conservation du contexte architectural du pavement (Fig. 20) et mise en valeur du site

Le contrôle, l'entretien et la stabilisation du haut des murs de la salle et des faces internes (remplissage des joints, stabilisation des pierres et de l'enduit de revêtement) ont permis de préserver la mosaïque des fientes d'oiseaux ainsi que des chutes de pierres et de morceaux d'enduit. Ces facteurs provoquent des dégâts superficiels et structurels graves sur le pavement et sur ses bordures. Cette opération a permis d'avoir un contexte architectural dans le même état de conservation que son revêtement de sol.

Pour valoriser les travaux sur les pavements de mosaïque, nous nous sommes occupés également de la mise en valeur du site : consolidations et remaniements des monuments, sécurisation du circuit, délimitation du site, balisage du circuit de visite, panneaux signalétiques adéquats, éclairage du site et des monuments, prépa-

ration de brochures, création d'un centre d'interprétation, etc.
Grâce à ces programmes et aux efforts de mise en valeur fournis depuis 1991 sur le site, Dougga présente aujourd'hui un bon état de conservation qui lui vaut sa grande renommée en Tunisie et dans le monde.

Mouid Hani, Institut National du Patrimoine

POSTERS

PRESERVATION OF THE MOSAICS AND STRUCTURES OF THE ROMAN CITY OF *TURRIS LIBISONIS COLONIA IULIA*

Antonietta Boninu, Giuseppe De Boni and Antonella Pandolfi

Abstract

The mosaics of the city of *Turris Libisonis* represent a unique heritage of Roman Sardinia. The goal of their preservation, which was carried out over a period of 30 years of conservation and research activity, has yielded a series of pavements decorated with polychrome and figured mosaics dated between the 1st and 3rd century AD. The preventative archaeological work conducted in the city of Porto Torres, focused on the areas occupied by the ancient city and led to the restoration of funerary mosaics and other mosaic pavements that belong to public and private buildings located along the coastline and in the adjacent hinterland.

The projects implemented for the preservation of the monuments of *Turris Libisonis* have respected a strategy for valorisation and use in order to ensure their

Fig. 1.Thee monumental complex of Palazzo Re Barbaro in the first phase of intervention on the peristyle. View from the north (© Soprintendenza Archeologica per le province di Sassari e Nuoro)

Fig. 2. Plan of the Palazzo Re Barbaro Baths: 1: Peristyle entrance to the Baths; 2: *Apodyteria*; 3: *Frigidarium*; 4: *Tepidarium*; 5: *Caldaria*; 6: Cryptoporticus; 7: North-south road with portico (© Soprintendenza Archeologica per le province di Sassari e Nuoro)

accessibility to the public and construct an urban archaeological-environmental park. Within the vast area of the Palazzo Re Barbaro Park, the monuments are adjacent to the railway built in two phases in the second half of the 19th century and in the early 1930s (Fig. 1). The place-name indicates a monumental complex and its surrounding areas, where, according to popular tradition, the site of the sacrifice of the protomartyrs Gavinus, Protus and Ianuarius was located. The structures, rising ten metres above street level, were formerly identified as the seat of the Emperor Diocletian, responsible for the persecution of the Christians. In reality, they are the elevations of a public bath complex (Fig. 2), which is articulated in ten rooms and, to the north, an access peristyle, built at the end of the 3rd-beginning of the 4th century AD. The ten floor mosaics partially discovered in the 1960s, not fully excavated, were removed and placed on reinforced concrete supports, five of which were then put back in situ. The major excavations carried out by the Railroad Company, removing an enormous quantity of ruins, layers and structures, weakened the containment embankment that was created for the construction of

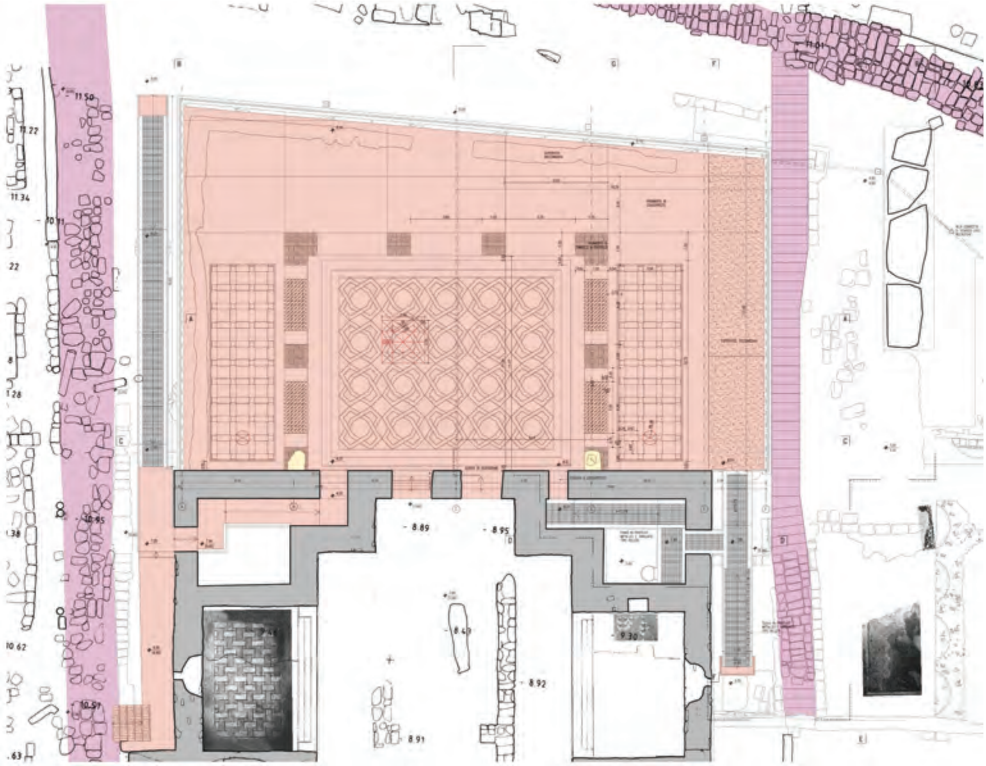

Fig. 3. Graphic reconstruction of the peristyle mosaic (© Soprintendenza Archeologica per le province di Sassari e Nuoro)

the peristyle. The consequent collapse of large sections of wall and the continual washing away of embankment layers, alternating with earth and limestone pit residue, created a real risk of collapse of the bath structure. The problem of the security of the monument was examined with a three-part goal: preservation of the structures and all major wall elevations, preservation of the mosaics and creation of a visitor route safe for both patrimony and people.

Toward these ends, a new project was undertaken in order to correct all the previous restorations made with cement carried out in the 1960s. Hence, a preliminary investigation was conducted, through the execution of archaeological excavations, in order to determine the real dimensions as well as to ensure the *anastylosis* of the present wall sections. The peristyle mosaic (Fig. 3) is articulated in three geometric motifs: one in the central carpet, another in the space between the columns and yet another in the perimeter band. Only three small fragments are preserved, which were removed from the reinforced concrete support, placed onto aerolam panels and are now displayed in the adjacent Antiquarium. The

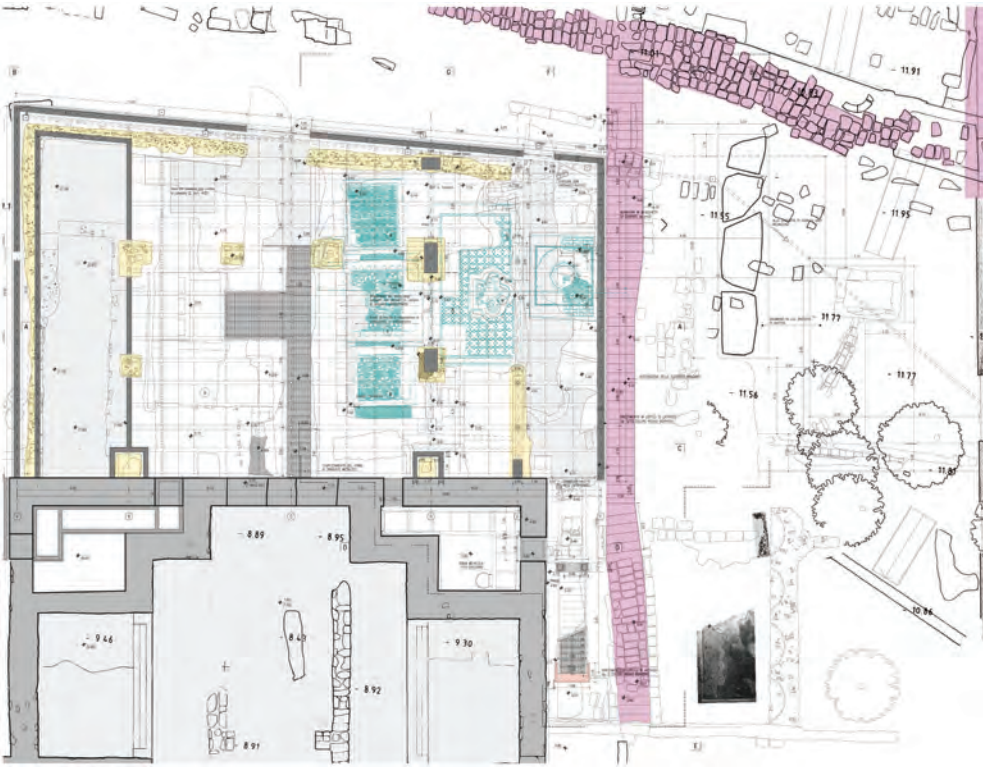

Fig. 4. The mosaics of the eastern *domus* (© Soprintendenza Archeologica per le province di Sassari e Nuoro)

decision was supported by conservation needs and by the ratio between the preserved fragments and the whole surface of the mosaic, the geometric motif of which was reproduced on the peristyle walkway. Excavations have revealed the base of the embankment, built on earlier buildings and ruins. The subjacent structures belong to two *domus* dated, by their plan, between the end of the Republic and the first Imperial period. The rich decorative programme on the walls and the pavements, consisting of painted plaster and mosaics, attests to the stable economy of the city, which was essentially based on port activities and commercial exchanges. The mosaics reveal the availability of private resources, the result of important economic and cultural ties with Rome and the Mediterranean cities and provinces, and of the intense circulation of models, motifs and perceptions, which adopt ornate elements with sophisticated solutions. Of the six polychrome floor mosaics found in the eastern *domus* (Fig. 4), three are geometric and three are figured: Orpheus playing the lyre and surrounded by eleven animals in a single composition (Fig. 5), a basin with 18 fish and a central emblem with the Three Graces (Fig. 6). At the time of discovery, the results of a robber trench along the western perime-

Fig. 5. The Orpheus mosaic (© Soprintendenza Archeologica per le province di Sassari e Nuoro)

Fig. 6. The Three Graces mosaic (© Soprintendenza Archeologica per le province di Sassari e Nuoro)

ter of the *domus*, and a foundation trench related to the containment wall of the embankment above, inside the building and parallel to the east, indicated earlier conservation interventions along the borders of the mosaics, damaged by the extraction of structural elements and the overlapping construction.

The two monumental complexes, the baths and the *domus*, intertwined in a particularly intricate composition, both vertically and horizontally, presented a high degree of vulnerability and instability, to be compensated with a planning programme founded on a strategy for the preservation of all the elements discovered. The extension of the mosaics led a series of precise safeguarding interventions, subdivided into sections and in accordance with a temporal sequence dependant on the availability of financial resources, within a single plan for the preservation of the mosaics, plasters and structures and for the targeted excavation. The articulation of seven interventions carried out over a period of 15 years, beginning in 1995, ensured the preservation of the individual mosaics with direct protection, realized with the use of a system of aggregate and alternating layers of sand and clay, enclosed by a layer of impermeable cement mortar set and fastened to a net placed at an incline so as to direct meteoric water toward the robber and foundation trenches. An analogous system was put into place for the structures with, in some cases, coverings, of geotextile and wooden frames. The site roofing, placed over the most vulnerable sections, protected the surfaces of the direct coverings over mosaics and plaster. Repeated meteoric events and wind knocked down the provisional coverings onto the cement mortar surface, which carried out its function of protecting the mosaics and plasters perfectly, as ascertained when these were uncovered. Those in charge of drafting the protection and preservation projects were invested with the responsibility proper to their roles and functions, and in proportion to the considerable importance of the monumental complexes in the context of the archaeological heritage of the city and of Sardinia as a whole. The collective search for a solution compatible with the extremely high vulnerability of the site, also in view of its archaeological and urban context, required a major commitment on the part of everyone involved. The proposal for building a shelter over the area most vulnerable and richest in mosaics, that is the peristyle of the baths and the sub-adjacent *domus*, was examined and rejected.

The considerable importance of the monument as a whole and its place in the archaeological park, the factor of landscape impact and that of environmental pollution, the effects of which are increased by significant and frequent winds, and the elevated costs of acquiring and maintaining the materials for the structure, urged a search for other solutions. The one adopted and carried out is a structure built around the peristyle and comprising the rooms of the *domus* that have mosaics, to the east up to the north-south road axis and to the west including the portion of embankment still to be explored. In the operational phase and prior to the construction of the protective structure, a modular cover of impermeable fabric was stretched over the area, anchored by aluminium posts. The installation, de-installation and re-installation of the modules followed the excavations, which aimed at the preservation

Fig. 7. The protective structure. View from the west (© Soprintendenza Archeologica per le province di Sassari e Nuoro)

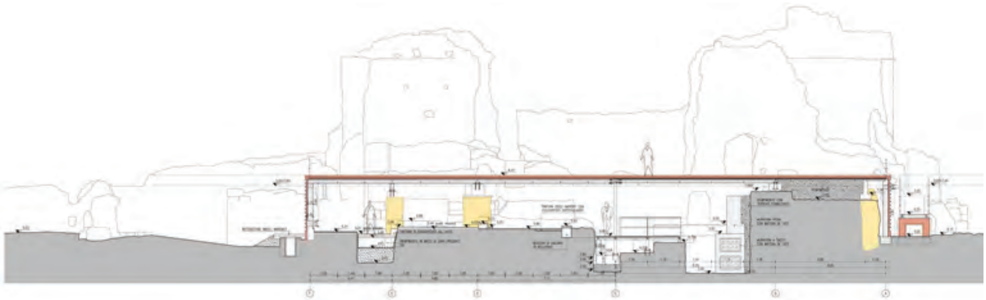

Fig. 8. Protective structure. East-west section (© Soprintendenza Archeologica per le province di Sassari e Nuoro)

of the mosaics and the preparation of the system of piers for the protective structure. Security issues and the organization of the work phases submitted the project to a verification process, always related to the progressively attained results of the excavation of micro-sections. The protective structure (Fig. 7 and 8) is supported by metal piers set in the robber and foundation trenches on a layer of compact clay that covers the natural lime-bed. The entire construction is reversible in all of its parts and employs non-deformable materials, compatible with the monumental

Fig. 9. The west entrance of the peristyle (© Soprintendenza Archeologica per le province di Sassari e Nuoro)

Fig. 10. The east entrance of the peristyle (© Soprintendenza Archeologica per le province di Sassari e Nuoro)

Fig. 11. Interior of the protective structure, west sector (© Soprintendenza Archeologica per le province di Sassari e Nuoro)

Fig. 12. Interior of the protective structure, east sector (© Soprintendenza Archeologica per le province di Sassari e Nuoro)

remains, characterized by moderate costs and low maintenance. There was no imposition or interference of any kind with anything pre-existing. Safe visiting is also ensured for the disabled. Moreover, excavation can be re-initiated in the areas which until now were not investigated due to safety and practical, economic concerns. The safeness of the restoration interventions on each mosaic is guaranteed and the surfaces are ready for the graphic completion of the decorative motifs of the mosaics. The current path around the mosaics can also be expanded with information and educational displays, to be placed on the large surfaces of the perimeter walls to the east and west. Having taken into consideration the large area of the peristyle (more than 600 m^2), the regulatory measures for safe visits and the complex issues related to restoring access to the north sector, at the base of which there is a dense network of ruins and structures relative to the oldest phase of the city, the two original entrances between the northern entry rooms and the peristyle were deemed to be suitable, and a staircase and ramp were set up at the far south and far west (Fig. 9 and 10) of the protective structure. These are entirely reversible structures constructed on unexplored archaeological strata, which were isolated with the use of aggregate. The three large entrances into the covered space, made on the north and south perimeter walls, correspond to the visitor route, which can be followed in both directions. It is closed by double-grill metal gates, to ensure the natural ventilation of the enclosed space and so that the effects of fluctuations in and exchanges with the outside temperature and humidity can be kept to a minimum. The new structure, protecting the flooring of the peristyle, offers visitors the use of both architectural dimensions that constitute the historical stratification: the usable surface relative to the entrance to the 3rd century AD bath complex, and the visitor surface reintroduced over the robber trench, which is re-proposed inside the rooms with 1st century AD mosaics (Fig. 11 and 12). Thus, the two levels of architecture discovered that were previously exposed to damage resulting from direct exposure to weather extremes, have been successfully restored and protected in their original context. The goal of reconciling the primary conservation needs of the site's singular mosaic patrimony and those of the pertinent structures, with respect to the original monumental unit, was directly connected to the aims of valorising this major architectural complex and restoring it to the public. The protective structure constitutes a tool and a vehicle for strengthening the relational balance between knowledge and preservation and between valorization and participation.

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MOSAIC FLOORS IN THE NORTH-WEST CHURCH OF SUSSITA: A CASE-STUDY ON TEN YEARS OF A JOINT CONSERVATION AND ARCHAEOLOGICAL PROJECT

Julia Burdajewicz

Abstract

The case of the North-West Church in Hippos-Sussita, Israel, represents an excellent example of practical and scholarly cooperation of archaeologists and conservators working simultaneously on an archeological site with mosaic floors. The exploration of the church began in 2000 and was completed by 2009. Mosaic floors have been revealed in the nave of the church, the aisles and accompanying rooms of the church complex. The very specific characteristics of the site, the project's and the local conditions entailed and revealed a wide range of conservation issues and problems of logistical and technical nature. Time for conservation interventions was limited to a four week season of archaeological work. Discoveries were immediately followed by conservation treatments. Since the site is not yet open to the public and was being abandoned for eleven months of the year, all discovered mosaics had to be thoroughly protected for this period of time from environmental factors as well as a large number of curious sightseers visiting the area on their own.

A significant contribution to this project was the documentation of the state of preservation of the mosaics, the techniques of execution as well as their iconographical traits. Prepared with the application of advanced digital methods, it turned out to be essential for the understanding of relative chronology of the mosaics and the history of the whole North-West Church complex. Since the exploration has now been completed, the church requires a long-term management plan and the permanent exhibition of the mosaics in their architectural context, which would allow them to speak to the public about the site's history.

Sussita (Hippos of the Decapolis) (Fig. 1) is located on the east shore of the Sea of Galilee. Founded as a Greek settlement in Hellenistic times, it developed as a city in Roman Imperial times. During the Byzantine period, Sussita reached the peak of its growth and served as a seat of a bishop. Its history, over eleven centuries long, suddenly ended in AD 749 due to an earthquake that sealed the city under layers of stone when it was still inhabited. Except for a short rescue excavation conducted by Claire Epstein in the 1950s, and research on the aqueduct by an Israeli-German team in the 1990s, the site remained unexcavated until 2000 when an international project aimed at uncovering the city was initiated. Within the framework of the Hippos Archaeological Project led by the University of Haifa, the North-West Church in Sussita was excavated in the years 2000-2009 by an archaeological team from the Polish Academy of Sciences, the National Museum in Warsaw and the University of Warsaw, under the direction of J. Młynarczyk and M. Burdajewicz. The goal of the archaeological project was to uncover an Early Christian church, analyse its architectural development and interior decoration, characterize specifics of the ceremonial practices, determine the period of use, and investigate its destiny under Umayyad rule (Fig. 2).

Fig. 1. Aerial view of Sussita Mountain. The site was inhabited between the 3rd century BC and AD 749. The North-West Church seems to be the largest of four churches uncovered so far in Sussita (photo: Zinman Institute, Haifa)

The first season of exploration, carried out without a conservator, showed that a conservator would be necessary for the continuation of the project. The following excavation seasons brought to light many finds and prompted the formation of a conservation team. The main tasks of the team were to follow up on newly discovered areas and provide necessary on-site treatments during the course of the excavations. Both the archaeological part of the undertaking as well as the conservation campaigns was carried out simultaneously, and they were to a certain degree a new experience for both the archaeologists and the conservators. Both groups had to learn how to cooperate smoothly and perform their duties while understanding and respecting each other's goals and priorities. The characteristics of the project often required improvised solutions, specific processes, immediate decisions and actions. All these challenges are presented in this paper as an account of ten years of experience in a joint archaeological and conservation project in the North-West Church in Sussita.

The mosaic pavements

Since the church was destroyed during the great earthquake of AD 749, not much of the mosaic floors were expected to have survived under the debris of basalt masonry. The exploration of the western portion

Fig. 2. Aerial view of the North-West Church and adjacent rooms (photo: Zinman Institute, Haifa)

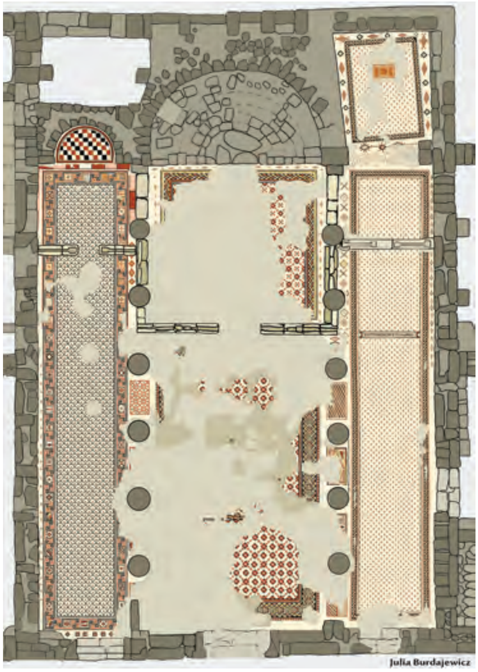

Fig. 3. The surviving mosaic floors in the North-West Church. The graphic documentation was first made as hard-copy drawings and then digitized after the end of a season. Furthermore, a software for the graphic documentation of conservation, metigoMAP, was employed to document the state of preservation and estimate the range of damages (drawing: J. Burdajewicz)

of the nave during the first excavation season did not bring very promising results. Only very scanty remains of mosaic were discovered, preserved along the foot of the walls. Tesserae, crushed into small chips, and crumbled mortar bedding were found when the fallen column drums were lifted. However, the exploration of the aisles brought to light generally well-preserved carpets of floral and geometrical patterns, along with two intact inscriptions commemorating the donors, preserved in a perfect condition in the south aisle (Fig. 3 and 5). Also two of the rooms adjacent to the basilica on the north, as well as the southern portico of the atrium turned out to have been paved with floors with simple mosaic decoration. Moreover, large fragments of plain white, large-tessera mosaic have been found face down, just above the floor level in the aisles. These were most likely mosaic pavements laid on the floors of the galleries located above the aisles. The analysis of the state of preservation of the mosaics, their decoration, and the architectural modifications of the interior of the church indicate that the carpets were laid between the middle and the end of the 6th century, while a big room in the northern annex appeared to have been paved as late as the Umayyad period (661-750).

Fig. 4. Graduate students from the Faculty of Conservation of the Academy of Fine Arts in Warsaw performing stabilization treatments to the mosaic carpet in the north aisle of the Church (photo: J. Burdajewicz)

Fig. 5. The mosaic floor in the south aisle of the Church during exploration. Stabilization treatments had to be performed immediately after discovery (photo: J. Burdajewicz)

Formation of the conservation team

The development of the conservation team over the ten-year period reflected the growing need for professional intervention, proportional to the successive expansion of the exploration areas. New discoveries had to be secured and preserved, previously discovered areas needed to be checked, and if necessary, treated again. After the first season of excavation, a conservation technician was deployed from the Israeli National Parks Authority to conduct basic protection treatments. During the following years, the Polish mission established its own conservation team which, during peak years of exploration, consisted of a senior conservator, an assistant to the senior conservator, a group of graduate conservation students and a conservation technician and mosaic maker. Graduate conservation students came from the Faculty of Conservation and Restoration of Works of Art of the Academy of Fine Arts in Warsaw, Poland. In certain cases, the archaeology students and other volunteers were allowed to assist in simple actions such as sweeping the mosaic pavements or collecting and cleaning loose tesserae that were found scattered all over the site. It should be emphasized that the conservation team was not formed exclusively for the mosaic conservation but had to share its time between the mosaic floors, the wall plasters, remains of wall paintings and excavated small objects (Fig. 4).

Limitations of the project

All conservation activities were performed in the context of this particular archaeological project. They were bound to the time frame, work hours, schedule and sequence of the exploration. Work was conducted during the four-week excavation seasons that took place every summer in July. Even though the summer is probably the toughest time of the year to perform any archaeological and, particularly, conservation activities, this time was chosen in order not to coincide with the academic year in Israel and the activities of the University of Haifa. As far as the treatment of the mosaic floors was concerned, the main goal was to secure and preserve the pavements and enable further safe exploration. This objective determined the types and range of applied treatments, and limited the time for lower-priority tasks, such as aesthetic restoration for presentation purposes. Also, due to the working conditions and limitations, most of the applied reinforcements were considered to be temporary and most likely will have to be replaced if the site opens to the public.

Major challenges

Major challenges of this archaeological-conservation project naturally arose from its characteristics. One of them was time. A four-week season practically meant 20 days of work on the site, but taking into consideration the time for the installation of the team and the tools at the beginning of each season and packing and clean-up activities on the last day, it did not leave more than 17-18 days for actual conservation activities. In order to make the most of the time given, all actions had to be carefully planned. However, the nature of working in situ during the archaeological exploration naturally imposes unexpected and unplanned actions that have to be taken immediately, every time there were new, sudden discoveries (Fig. 5).

Time limitations did not apply only to the length of the season, but also to the working hours. The site is located on the flat top of a mountain rising around 300 m above the level of the Sea of Galilee (100 m above sea level) (see Fig. 1). The team members had to be transported to the site and back with a bus and had to climb a narrow path on the ridge of the mountain. The beginning and ending times of work were strictly bound to very particular, rigid hours and, due to safety reasons and the difficult weather conditions during the day, no person was allowed to stay on the site beyond working hours. This fact imposed a very particular working mode, where all actions had to be completed before the end of the day, all tools and materials stowed and secured until the next day. Moreover, the difficult accessibility to the site often slowed down the delivery of conservation supplies. Another serious challenge were the weather conditions during the work seasons, which always took place in the month of July, except for the campaign of 2004, which was conducted in September. Temperatures in July in the area of the Sea of Galilee exceed 40° C and the air is generally dry. Such weather is not only hardly bearable for a human involved in any physical activity, but also significantly too high for a proper binding of lime-based mortar, which loses the moisture immediately and tends to crack during drying. Often, newly applied mortar bands and fills had to be covered with moistened cloth and secured under shade in order to maintain acceptable conditions for the initial stages of binding. Gusty winds, which often swept over the top of Sussita Mountain turned the cleaning of the pavements into a truly Sisyphean labour and hindered the photography and graphic documentation processes.

Condition of the mosaic pavements – initial causes of deterioration

The most serious damage to the mosaic pavement occurred when the church collapsed in the earthquake of AD 749. Large blocks of limestone and basalt collapsed on the floors, in many places breaking through them and crushing large numbers of tesserae. This resulted in numerous lacunae in the surface of the mosaics, large indentations and damaged tesserae (Fig. 6).

There is almost no mosaic pavement preserved in the nave. Several surviving patches give a total of 22.33 m², which is 22.6% of the entire area of the nave (Table 1). There are two possible explanations for the almost complete lack of the mosaic in the nave. It could have been destroyed in antiquity, perhaps for iconoclastic reasons. However, the discovered remains together with the rest of the surviving mosaic decoration suggest that the decorative motives were purely geometric and floral; hence there was no real reason for iconoclastic intervention. The other explanation is that, during the final decades of the church, the nave was excluded from ceremonial practices and was not taken care of, something that led to the gradual decay of the pavement. This explanation is partially confirmed by the archaeological investigation which shows that particular areas of the church were used during different time periods. The current state of preservation results also from the disintegration of the materials of the substrata, caused by physical, chemical and biological factors. In general, there were no symptoms of a serious detachment or separation of the layers of the mosaics' structures but already existing

Fig. 6. Serious surface deformation and large lacunae appeared throughout the mosaic carpets as a result of the earthquake of AD 749 (photo: J. Burdajewicz)

	Total area	Area of remaining mosaic	Percentage of remaining mosaic
Chancel	34.35m^2	8.71 m^2	25.35 %
Nave	68.60 m^2	13.62 m^2	19.85 %
South aisle	66.38 m^2	58.44 m^2	88.03 %
North aisle	55.82 m^2	49.71 m^2	89.05 %

Table 1. Areas and percentage of remaining mosaics in given sections of the church. The calculations were made with the use of metigoMAP graphic documentation software

lacunae were expanding easily due to the fragility and tendency to crumble of the mortar bedding. The technique and quality of execution of the pavements varies slightly in individual areas and indicates that the deterioration problems are occurring mostly in the lower mortar layers of the mosaic bedding, where a poorer quality mortar seems to have been employed. The physical and chemical erosion affected also the state of preservation of the tesserae; especially the red and yellow ones made of a soft limestone, which were very fragile, powdery, washed out or cracked.

Conservation activities

The surface of the mosaic directly after unearthing was overall moderately grimy; however, some areas were coated with a thick crust of dried hardened dirt. Also, large fragments of plaster that had fallen from the walls adhered in many places to the surface of the mosaic floors. Surface cleaning included sweeping the pavements with brushes and mechanical cleaning of incrustations with small dental tools. In some cases, low solutions of acetic acid were applied to dissolve the crust of hardened dirt mixed with crumbled fragments of wall plasters that had stuck to the surface.

Stabilization treatments of the mosaics' structure were focused on the reinforcement of edges around lacunae and securing the losses from expanding. This was achieved by the application of lime-based mortar bands and filling the lacunae. In some instances, minor losses were restored with the use of tesserae collected on the site (Fig. 7). Also, badly eroded tesserae were replaced with better preserved ones. These treatments depended on time limitations and could not be carried out in all of the lacunae. In the case of powdery tesserae, consolidation treatment with a solution of a synthetic resin was carried out. A solution of Paraloid B-72 was applied multiple times to the surface of the weakened tesserae until the desired cohesion was achieved (Fig. 8). Large indentations caused by the collapsing masonry of the church, found especially in the mosaic pavement in the southern portico of the atrium, were brought back to level. This required cutting out a certain area of tesserae, filling

Fig. 7. Some minor aesthetic restorations were carried out in small lacunae. However, due to the character of the works, most treatments were focused on immediate stabilization and preservation (photo: J. Burdajewicz)

the gap that appeared in the bedding and then placing the tesserae back with a new lime-based mortar binding. Cracked and smashed tesserae were replaced with loose ones collected on the site (Fig. 9). During the entire course of the conservation campaigns, documentation of the state of preservation and the treatments applied was being made and updated. The main means of documentation were photography and drawings, complemented with notes and reports. Again, due to the short length of the campaign and the difficult working conditions on the site, the drawn and written documentation was made with traditional methods and digitized later, after the end of the season. Also, throughout each season, previously discovered and treated areas were checked and any changes in their condition were recorded. The fact that the site is not properly guarded during eleven months of the year imposed the necessity of a very careful preparation of the mosaic floors for that period. Due to the character of the undertaking, the only available way of securing the mosaics for the rest of the year was reburial. At least two full days of work at the end of each season had to be planned for the reburial. The method was subject to changes and modification, based on experiences from previous seasons. In the early years of the project, a geotextile material had been recommended to the team and employed as a contact layer under a thick layer of sand and earth. However, heavy rainfall during the winter and spring months was causing accumulation of mud, which was hardening with time, becoming very heavy and hard to remove when dry. Polyethylene foil sheets were also tried out, but even though they kept the mosaic pavements clean, they were slowing down the evaporation of the moisture from the surface of the mosaics. After several seasons with different reburial materials and techniques, an optimal solution for the case of Sussita was devised. A thick layer of clean sand laid directly on the mosaic floor and topped with local soil for camouflage, turned out to be the best available method.

Continuing threats to the mosaic pavements

Environmental factors are still eliciting the chemical and physical deterioration of the mortar layers and some of the tesserae cut out of soft limestone. Some preventive treatments had been carried out during the years of the archaeological and conservation campaigns, but the pavements will still be exposed to these factors as long as the site is not protected with a proper roof and a rainwater drainage system.

The presence of moisture also causes biological activity, whose peak intensity falls on the rainy months of winter and early spring. Various kinds of weeds and subshrubs sprout throughout the site. Many

Fig. 9. One of the conservators preparing loose tesserae for replacement where the pavement was smashed by falling stones during the earthquake of AD 749 (photo: J. Burdajewicz)

of them have a deep-reaching system of long roots, adapted to a hot, dry climate. They penetrate the substrata of the mosaic floors, undermine their structure and often break through their surface. There were some attempts to spray the site with pesticides, but budget limitations and environmental concerns stopped this practice. Another challenge that the North-West Church complex and the conservation team have to face and prepare for is human interference. Even though the site of Sussita is not officially open to the public, there is an uncontrolled and illicit tourist circulation taking place throughout the year. Sussita has been known for decades

Fig. 8. Many of the colourful tesserae needed immediate consolidation. Particularly those made of soft red and yellow limestone, which were almost completely worn in many areas of the design (photo: J. Burdajewicz)

to the local communities, but the excavations and the spectacular new discoveries attracted masses of people wishing to witness the site being unearthed after 13 centuries. The mountain is also a popular destination among local hikers and cyclists who seek a little work-out; and among adventure-loving campers and romantics coming to simply admire beautiful views of the Sea of Galilee. Some of these visitors tend to be proactive when it comes to archaeological exploration. Often the mosaic floors reburied at the end of the season were found partially uncovered eleven months later. The problem of tourist circulation affects also the scanty remains of the wall plasters and walls of the church, many of which are made of fragile limestone or unhewn basalt stones. One more risk connected to human presence is that of theft or vandalism. Fortunately, so far none of the mosaic floors was a target of such actions. However, acts of vandalism were already noted in Sussita, the most serious of which was the smashing to pieces of a marble chancel screen with a representation of a cross, which had survived the earthquake in situ in the south aisle of the North-West Church, but could not defend itself from contemporary vandals.

Fig. 10. The North-West Church needs a project for a proper exhibition of the mosaics in their architectural context. An overall plan of opening the site to the public should include a long-term conservation plan and the upgrading of some of the solutions applied during exploration. This will allow the mosaics to speak the site's history (photo: J. Burdajewicz)

The Future

At the end of the final season of archaeological work in the North-West Church in 2009, all mosaic floors were reburied under layers of clean sand topped with local soil. Seasonal checks revealed that due to uncontrolled tourist presence on the site, the reburial should be revised regularly in order to maintain a proper protection. Proper sheltering should be designed for fulltime or seasonal exposure of the mosaics. An overall plan for opening the site to the public should include a long-term conservation project and an upgrade of some of the temporary reinforcements applied during exploration. This future project requires also a significant financial input, which could not be provided by the archaeological-conservation team and remains in the hands of the National Parks and Israel Antiquities Authority. However, the goal of the North-West Church archaeological project was achieved with the committed support and assistance of the conservation team (Fig. 10).

Acknowledgement

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SUR LES TRACES DU TEMPS – LA MOSAÏQUE DITE « D'ACHILLE À SKYROS »

Verena Fischbacher et Myriam Krieg

Résumé

La mosaïque en question a été découverte en 1993 dans la villa gallo-romaine d'Orbe-Boscéaz (canton de Vaud, Suisse), à l'occasion des fouilles conduites par l'Université de Lausanne. Il s'agit d'un important établissement situé au pied du Jura, dans la partie occidentale de l'Helvétie romaine (Fig. 1), d'un véritable palais, avec sa *pars urbana* de plus de 250 sur 90 m dotée de mosaïques prestigieuses (Fig. 2 a-b) (Flutsch *et al.* 1997 ; Luginbühl *et al.* 2001 ; Paunier et Luginbühl 2016 ; Dubois 2016). La mosaïque d'« Achille à Skyros », de 570x940 cm, ornait probablement le *tablinum* de la villa (Fig. 3).

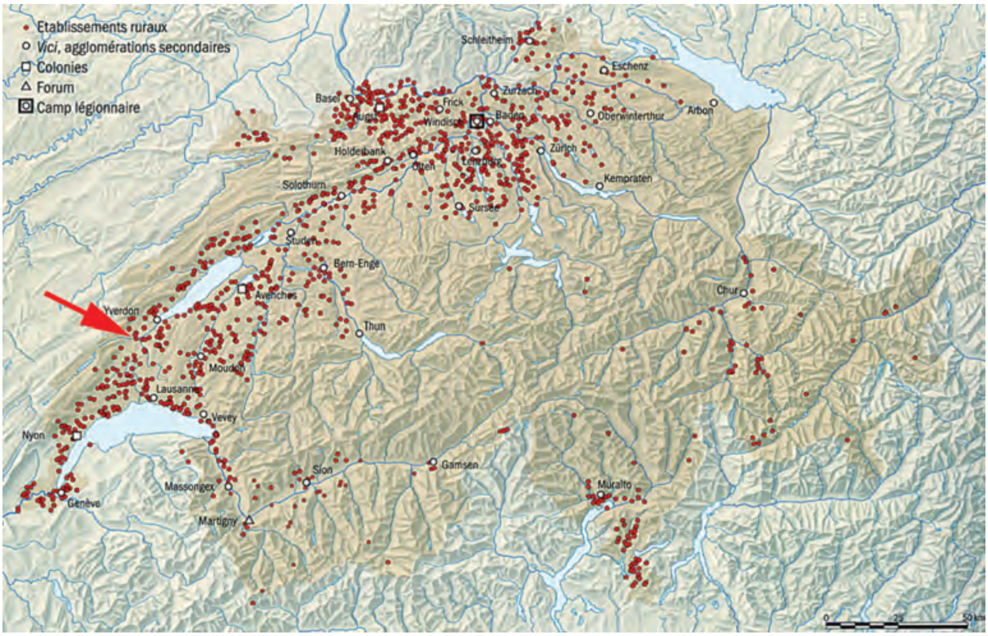
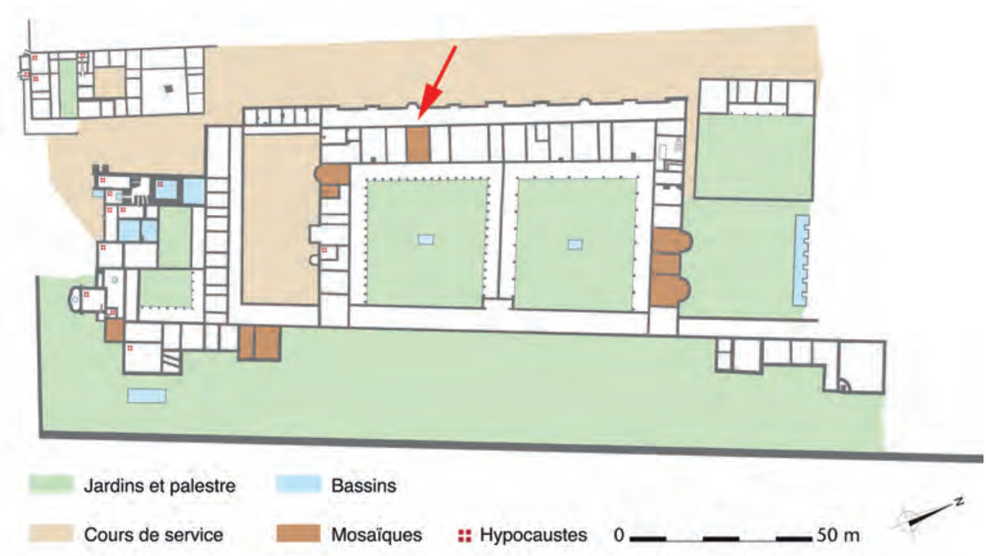


Fig. 1. Situation de la villa d'Orbe-Boscéaz dans l'Helvétie romaine, au pied du Jura, à l'ouest du Plateau suisse (S. Freudiger, Infolio)



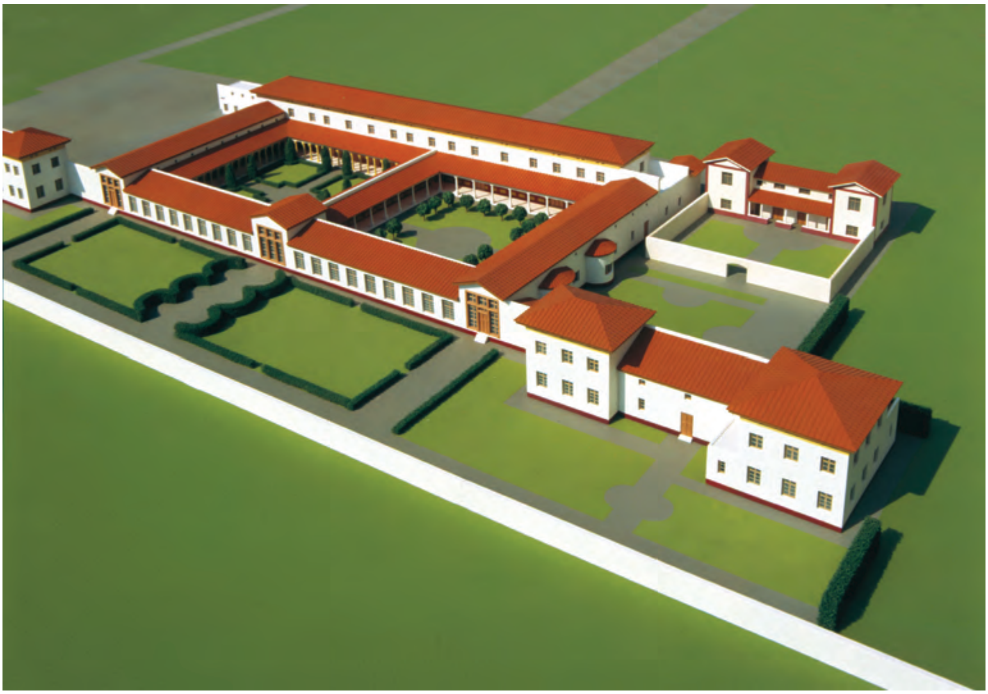
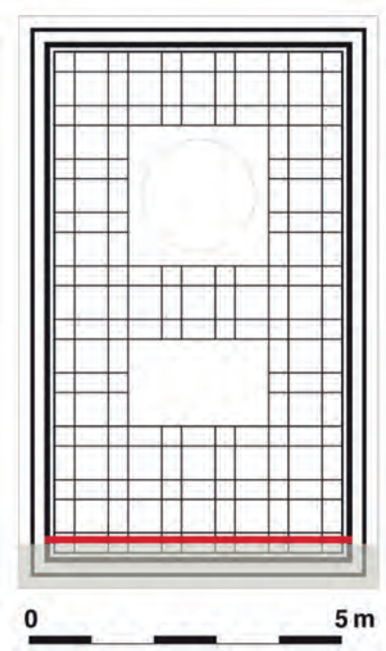


Fig. 2 a-b. Plan (a) et maquette (b) de la villa (Institut d'archéologie et des sciences de l'Antiquité (IASA) de l'Université de Lausanne)

Fig. 3. La mosaïque dite d'« Achille à Skyros » (cliché: Archéotech)



Cette neuvième mosaïque d'Orbe témoigne, au-delà de l'intérêt de son analyse iconographique, des dégradations successives qui l'ont transformée. Sa présentation au public *in situ* permettra ainsi de mettre en valeur une histoire émouvante de près de vingt siècles.

Histoire de la mosaïque et témoins archéologiques

160 ap. J.-C. Pose de la mosaïque

Au cours de la mise en œuvre déjà, un changement de plan intervient : la mosaïque

Fig. 4 a-b. La mosaïque est raccourcie en cours de pose: schéma géométrique (a) (Institut d'archéologie et des sciences de l'Antiquité (IASA) de l'Université de Lausanne), détail d'un fragment de la partie initiale et réfection de la bordure (b) (Site et Musée romains Avenches : SMRA)

Fig. 5. Détail des traces de polissage antique (cliché : SMRA)

est raccourcie pour faire place à une banquette ; sa bordure occidentale montre clairement une rupture, conséquence d'une adaptation du tapis original.

Au cours des travaux de restauration de la surface de la mosaïque, nous avons pu mettre en évidence, sous une importante couche de mortier (restes de la banquette), des fragments encore en place du décor initial (Fig. 4 a-b). Des témoins du travail des mosaïstes, des traces de polissage datant de la pose de la mosaïque, ont par ailleurs été mis au jour sous des dépôts postérieurs, concrétions calcaires et restes de mortier (Fig. 5).

250/300 ap. J.-C. Destruction et abandon du bâtiment

Un incendie est attesté par la présence de tesselles brûlées et des traces noires longilignes, qui reflètent probablement la position de poutres effondrées. L'effet de la chaleur peut même être observé sur le lit de pose (Fig. 6 a-b).

300-1980 ap. J.-C. Une longue période d'enfouissement

1700 ans dans le sol ont marqué le pavement. Un dépôt brun, très épais et dur

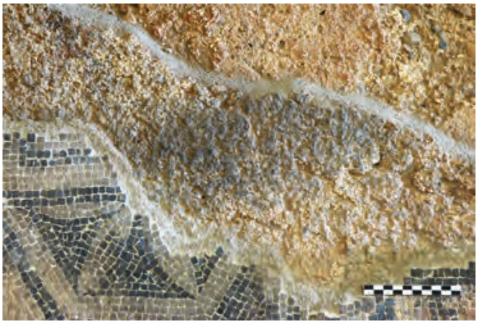


Fig. 6 a-b. Traces d'incendie sur les tesselles (a) et le lit de pose (b). (clichés: SMRA)

par endroits, obstrue une grande partie de la mosaïque : il s'agit de concrétions calcaires, probablement mélangées à des acides humiques et autres composants organiques (Fig. 7).

La disparition des joints d'origine est probablement due à l'effet érosif d'eaux de ruissellement. L'eau, les sels et des racines ont laissé des traces sur la surface des tesselles.

1980-1993 ap. J.-C. Activités agricoles modernes

Les terres sont cultivées depuis des siècles, mais l'introduction de machines agricoles plus performantes (labours en profondeur) laisse des sillons destructeurs. Ces

Fig. 7. Épaisse couche de concrétions calcaires dues à l'enfouissement de la mosaïque dans le terrain (vue au cours du dégagement mécanique) (cliché : SMRA)

« blessures » livrent toutefois des informations précieuses sur le mode de construction du pavement (Fig. 8).

2012 ap. J.-C.

La mosaïque, son environnement et les conditions requises pour sa conservation sont étudiés documentés, contrôlés (Fischbacher *et al.* 2003 ; Flatt *et al.* 1997 ; Weidmann 1987 ; Weidmann *et al.* 2003). L'état de la mosaïque est observé régulièrement par les conservateurs-restaurateurs, et des relevées périodiques par lasérométrie

Fig. 8. Les labours en profondeur ont abîmé le tapis de la mosaïque (cliché : SMRA)

Fig. 9 a-b. Une couverture multicouche protège le pavement du dessèchement et des changements de température (clichés : SMRA)

permettent d'identifier d'éventuels mouvements au sein du pavement.
En attendant sa mise en valeur pour le public, la mosaïque d'« Achille à Skyros » est protégée par un abri, sous couverture de conditionnement (Fig. 9 a-b).

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RESTITUER L'ÉTAT INITIAL D'UNE MOSAÏQUE APRÈS UN SIÈCLE D'INTERVENTIONS DIVERSES : LE CAS DE LA MOSAÏQUE NILOTIQUE DE THMOUIS (ÉGYPTE) AU MUSÉE D'ALEXANDRIE

Anne-Marie Guimier-Sorbets et Hanah Tewfik

A l'occasion du transfert pour la reconstruction du Musée gréco-romain d'Alexandrie, le Conseil Suprême des Antiquités de l'Égypte a demandé au service de restauration du Centre d'Études alexandrines (CEAlex, CNRS) de déposer le pavement de Thmouis (région du delta du Nil) de grandes dimensions (4.68x3.54 m), représentant une scène nilotique, d'époque impériale. Au centre des marais, une famille prend un repas sous une tente tout en contemplant les évolutions d'une danseuse. Tout autour, la scène présente la faune et la flore caractéristiques des paysages nilotiques et montre les activités des pygmées/nains (Fig. 1). Une étude iconographique a permis de montrer que tous les personnages du banquet sont aussi des nains et qu'il s'agit, dans un paysage nilotique caractéristique de la région où le pavement a été découvert, de la représentation parodique d'un banquet de plein air, scène exceptionnelle au III^e s. après J.-Ch. (Guimier-Sorbets 2013 ; 2015).

Ce pavement découvert par E. Breccia avait été déposé et transporté à Alexandrie pour une présentation au Musée gréco-romain (MGR). Il avait donc connu deux phases de restauration, en 1922-1924 par l'équipe du MGR, puis en 1980, par l'équipe de la Mission polonaise de Kom el-Dikka. Le pavement était fixé sur une épaisse plaque de ciment armé de barres métalliques (Fig. 2), et exposé au sol dans une salle du MGR. Le pavement est en grande partie conservé, le bas de la scène figurée manque et l'inscription est lacunaire. Des archives du MGR ont montré que, lors de la restauration des années 1980, une grande partie des tesselles avaient été déplacées à la suite d'un accident survenu au pavement.

Lorsque le service du CEAlex a entamé le travail en 2007, la première étape fut de désolidariser le pavement de la plaque de ciment : il fut découpé en dix panneaux, correspondant aux parties conservées de la bordure (perles et pirouettes, guillochis), et/ou à la scène figurée centrale.

À partir de 2009, les différents panneaux ont été transférés sur des plaques de « nid d'abeille » assemblables les unes aux autres, afin de permettre au pavement d'être transporté vers les lieux d'exposition, temporaires comme définitive : ce pavement doit en effet faire partie de la collection qui sera exposée dans le Musée de la Mosaïque, actuellement en projet à Alexandrie.

Lors du nettoyage de cette mosaïque à la polychromie aussi riche que subtile, il fut évident que des parties avaient réagencées lors des restaurations précédentes et que la remontée des sels et certaines réfections brouillaient l'image initiale dont les

Fig. 1. Alexandrie, Musée gréco-romain : Pavement nilotique de Thmouis, scène centrale (en cours de restauration) (cliché : A. Pelle, Archives CEAlex)

qualités picturales dérivent des peintures d'époque hellénistique. Il convenait donc de nettoyer et de restituer le décor initial, dans la mesure du possible, tout en utilisant les tesselles du pavement (Fig. 3 et 4). Nous fûmes confrontés à deux problèmes majeurs : A/ le manque quasi complet de documentation relatif aux interventions précédentes : nous n'avons pu nous fonder que sur une photographie en noir et blanc, reproduite dans la publication initiale, et qu'il était difficile d'exploiter sous sa forme imprimée (Fig. 5). Dans les archives du MGR, il a été possible de retrouver le cliché sur une plaque de verre. L'équipe de la *Bibliotheca Alexandrina*, lieu de dépôt actuel des archives, en a fait une numérisation en haute définition et les agrandissements de ce cliché nous servent de guide tout au long de la restauration. Sa qualité est telle que nous pouvons faire des agrandissements de la taille de chacun des éléments de la composition. La comparaison entre l'état initial et l'état actuel du pavement en est grande-

Fig. 2. Alexandrie, Musée gréco-romain : Pavement nilotique de Thmouis, plaque de ciment armé sous-jacente (en cours de restauration) (cliché : H. Tewfik, Archives CEAlex)

Fig. 3. Alexandrie, Musée gréco-romain : Pavement nilotique de Thmouis, détail de la danseuse avant le travail (cliché : A. Pelle, Archives CEAlex)

ment facilitée. Malgré sa qualité, le cliché inoir et blanc ne peut rendre la couleur, qui joue pourtant un rôle important dans l'image, selon les principes coloristiques des peintures et mosaïques de tradition hellénistique. B/ le deuxième problème réside dans le manque de tesselles : nous n'avons à notre disposition que celles qui appartiennent à l'état actuel du pavement ; après deux interventions, il est évident que ce manque est important, d'autant que les sels remontés du ciment moderne ont endommagé les tesselles les plus fragiles.

Fig. 4. Alexandrie, Musée gréco-romain: Pavement nilotique de Thmouis, détail de la danseuse (après restauration) (cliché: A. Pelle, Archives CEAlex)

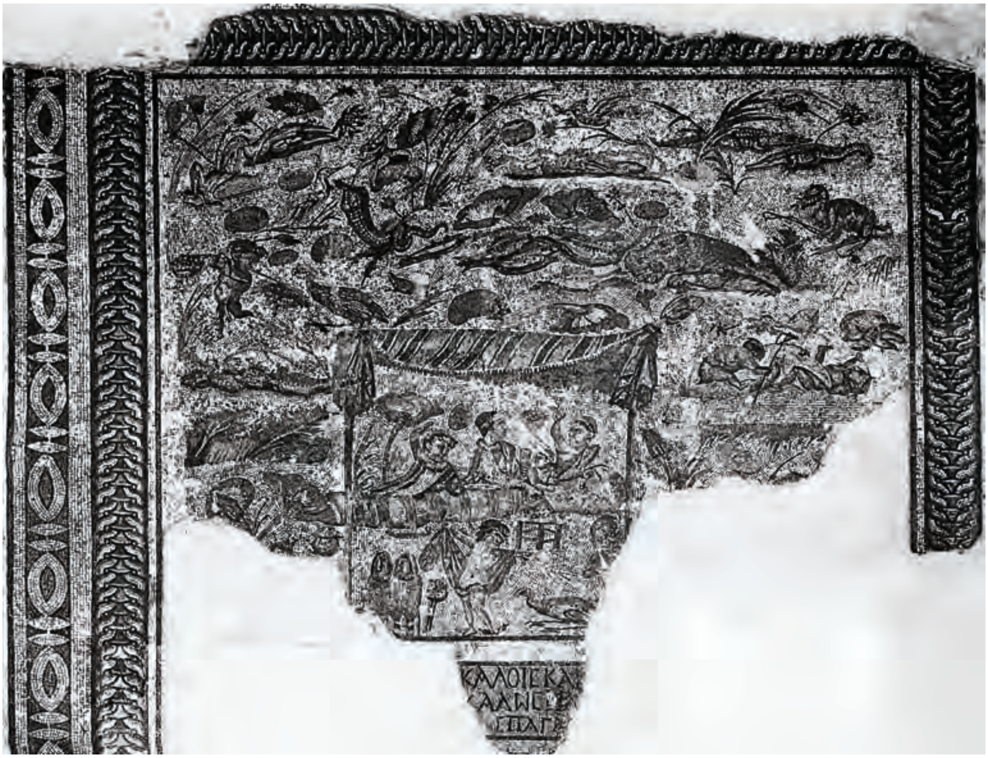

Fig. 5. Alexandrie, Musée gréco-romain : Pavement nilotique de Thmouis, prise de vue vers 1924 (Archives Musée Gréco-Romain d'Alexandrie)

Par comparaison entre le cliché originel et l'état après nettoyage de la restauration de 1980, nous avons rencontré les situations suivantes :

– Les tesselles ont été déplacées, l'image est brouillée, mais les tesselles sont en nombre suffisant et, à partir du cliché, il est possible de les réagencer pour restituer l'image initiale (exemples : la danseuse Fig. 3 et 4 ; le pêcheur, les tiges des fleurs Fig. 6).
– Les tesselles ont été déplacées, on le voit à partir du cliché initial, mais les tesselles qui subsistent sont en nombre insuffisant : on réagence les tesselles disponibles qui se sont détachées au cours de la suppression du ciment, et on laisse en lacune la partie dont les tesselles manquent (exemples : la partie supérieure de la corolle de profil du nelumbo de l'angle gauche ; dans l'angle droit, la bande de terre herbeuse sous le pêcheur ; pour d'autres plantes, on a pu restituer la file de contour, et laisser le centre en lacune, Fig. 6). A/ un élément de la composition a disparu, dans une zone qui est désormais détruite (ex : du « monstre » qui surgit de l'eau pour attraper le pêcheur, il ne reste plus qu'une portion de la tête, le reste est en lacune, Fig.

Fig. 6. Alexandrie, Musée gréco-romain : Pavement nilotique de Thmouis, angle droit du pavement (en cours de restauration) (cliché : A. Pelle, Archives CEAlex)

6) B/ un élément de la composition a disparu, dans une zone qui avait été complètement refaite sans en tenir compte : on choisit de ne pas intervenir de nouveau, surtout quand les tesselles nécessaires manquent (exemple : deux tiges dans l'angle gauche de la scène : comparer les figures 1 et 5).

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The plan for conserving the mosaic

The main problems :

– The mosaic was fixed on a cement base (15 cm thick)
– There is no documentation of the earlier restorations
– The mosaic surface was covered with dirt, and the cement salinity affected the main parts of the scene.
– Detaching the mosaic : Cleaning the surface, drawing and photography for documentation
– The surface has been protected with a layer of gauze and canvas applied with Paraloid dissolved in acetone
– Examination of the edges around the concrete base in order to calculate the suitable thickness for lifting. We found that the tesserae lay on a cement base with a thickness of 5 cm. After that we started the lifting

– The mosaic floor had been cut into ten panels and lifted with its cement base. The mosaic panels were reversed on wooden panels and cleaned mechanically from the back in order to remove the cement base
– After lifting, the panels were transported into the laboratory in order to complete the restoration

– Restoration work after the detachment of the mosaic :
– Application of separation layers (lime-based mortar)
– Application of new supports (honeycomb panels)
– Removal the protecting layers of gauze and canvas
– Removal of the cement, which was set in the interstices between the tesserae

After the above were carried out, other problems arose :

– There are significant differences between the scene in the oldest restoration (1924) and the more recent one (1980) especially in the face of the child, the dancer and the head of the dwarfs
– The glass tesserae have been eroded, became thinner and lost their colour
– The limestone tesserae, especially the yellow and brown ones,have been affected by the cement salinity.

Our task is to restore, as far as possible, the scene back to its original aspect. For this, we depend on Photoshop programs for comparing between the black and white photo of the 1924 restoration and the colour photo taken after the 1980 restoration for calibrating our intervention.

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RESTORATION OF MOSAIC OF AL-ZAHIRYA LIBRARY

Maher Jbaee

The art of mosaics, especially mural ones, considered one of the most important decorative arts, was characteristic of the Islamic era, especially during the Umayyad period. This art continued during the Mamlouk period, when in Damascus (Syria) the local mosaicists imitated the mosaics of the Umayyad Mosque in order to decorate the walls of the hall of the Al-Zahirya library. The Al-Zahirya Library is considered the oldest public library in the Levant, and is located in the vicinity of the Umayyad Mosque in Damascus (Fig. 1). There, in 1277 AD, king Al-Saeed – Al Zahir Baybars's son – bought a house in order to turn it into a school, and then built the famous dome and buried his father there (Ibn Shaddad 1983, 244).
In 2008, the Mosaic Conservation Laboratory in the General Directorate of Antiquities and Museums (DGAM) in Syria undertook the restoration of all the mosaics in this important site. This was the first time that such work was done in Syria – probably in any of the Arab countries – namely, the restoration of mural mosaics by local hands. This was done through funds provided by the Government of Kazakhstan, because Al-Zahir Baybars was actually born in Kazakhstan.

Description of the mosaic

The mosaics of the dome are considered one of the most important decorations of the type, with deep and distinct artistic and historical roots in Damascus. The subjects of the mosaics includes house and palaces with various types of roofs, inclined or conical, in addition to a variety of vegetal motifs taken from the nature of the city of Damascus, such as flowers, fruit trees, cypress and palms; as well as some geometric decorations (Fig. 2).
The mosaic area is approximately 80 m^2. It covered parts of the walls at a height of 4 m from the ground, and a width of 1.70 m, in addition to six arches and the roof of the Mihrab in the middle of the south wall. The corners of the hall are formed by columns with a zigzag profile with four faces. These were designed in this form, in order to carry the arches and the high dome (Moaz 1951, 249). They are decorated with mosaics at the same height. The tesserae are of hand-made glass produced in Damascus (al-Rihawi 1960, 42). They are of various dimensions, ranging from 7 to 13 mm, and different colours: black, red,

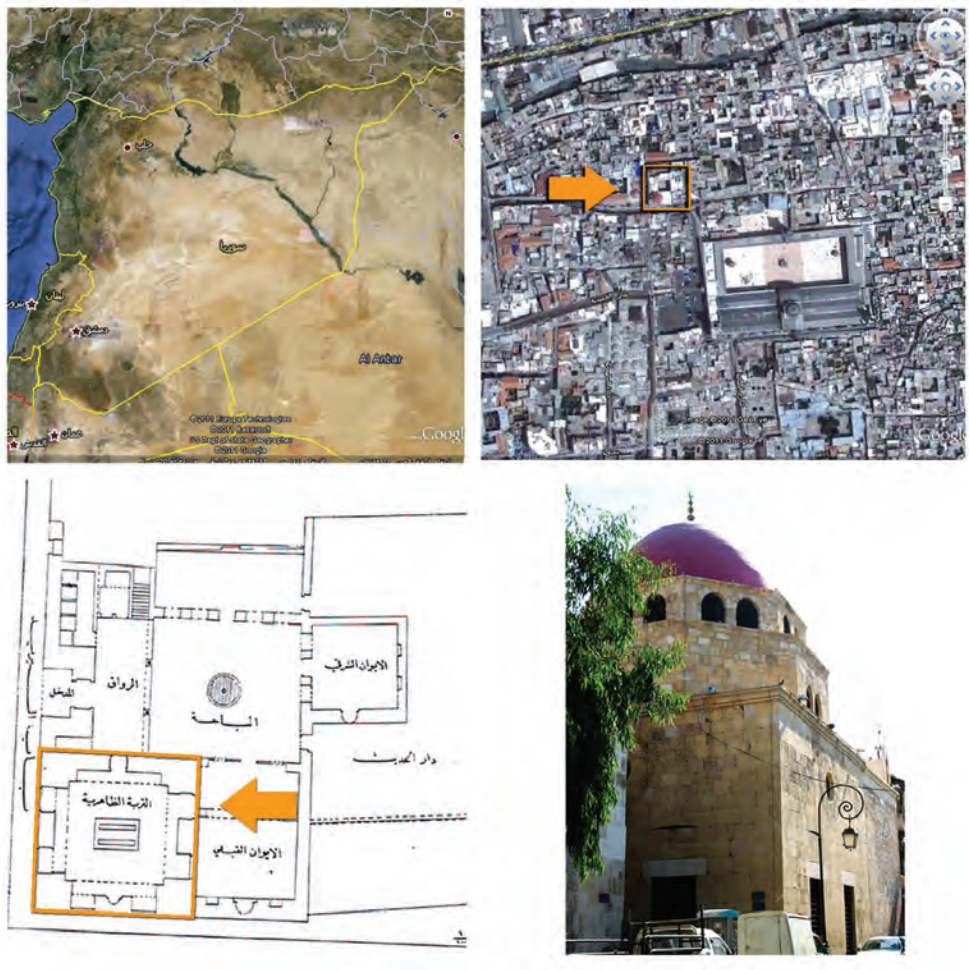

Fig. 1. Location of the Al-Zahirya Library (photo: by permission of DGAM, Syria)

light green, dark green, yellow, brown and blue. In addition, there are some stone cubes, white and pink, which were used for some leaves and twigs of trees. Silver-leaf cubes were also used, especially in the decoration of house and palace roofs; while gold-leaf cubes were used extensively as a background. The walls were prepared by putting a first layer 2-3 cm thick, composed of lime mortar mixed with powdered limestone and a large quantity of hay. The second layer, 2 cm thick, was then applied. It was composed of lime mortar mixed with powdered limestone but free of hay. This formed the ground for the artist or the mosaic worker onto which he first drew the subject with natural colours, the sinopia, and then placed the tesserae over these colours (Fig. 3).

Fig. 2. Mosaics of the Al-Zahirya Library, details (photo: M. Jbaee 2008, by permission of DGAM, Syria)

Fig. 3 Mosaic Stratigraphy (photo: M. Jbaee 2008, by permission of DGAM, Syria)

Condition assessment

During this long period, the mosaics have been exposed to many continuous damaging factors, like rain leakage, dust and substances from car exhaust fumes and factories. In addition, these mosaics were suffering from structural damage, such as detachment of layers, caused by earthquakes and vibrations resulting from large vehicles passing around the building. Furthermore, the infiltration of water and humidity led to the detachment of large parts of the mosaic (Fig. 4). There are separations either between the first layer and the wall, or between the second and the first layer, or between the tesserae and the second layer – and this latter case caused the fall of many cubes, and the appearance of lacunae. In addition there are deep cracks extending in some cases along the width of the mosaic, and some damage caused by human factors, such as the use of metal nails for fixing wooden frames on the edge of the mosaic, which penetrated the tesserae and the lower layers causing damage in several places; or the fixing of electric wires for lighting the hall with nails onto the mosaics (Fig. 5). It should be mentioned that some earlier interventions carried out by previous custodians during the last century, such as the filling of the lacunae using gypsum mortar and then painting it to appear similar to the original, have helped in stopping the damage and contributed to the consolidation of the mosaic as well.

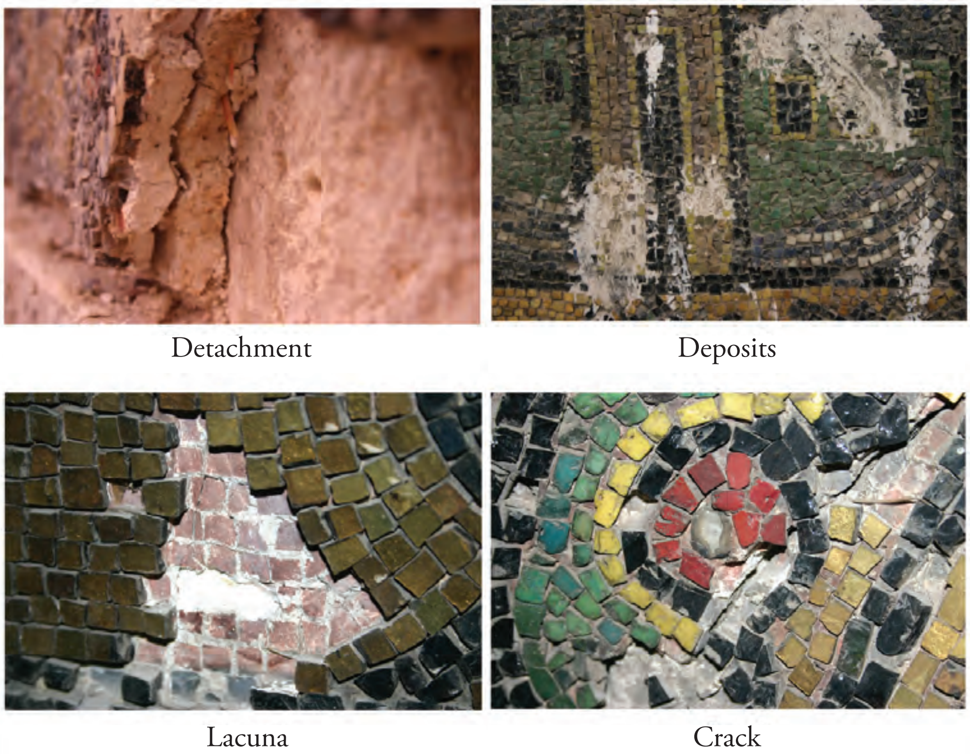

Fig. 4. Condition assessment (photo: M. Jbaee 2008, by permission of DGAM, Syria)

The interventions carried out

The restoration works lasted for eight months, from the end of 2008, to the middle of 2009, according to the following program:

- Complete documentation for all the operations carried out.
- Study and definition of all the problems by the technicians.
- Selecting best solutions, methods and materials to treat the existing problems.
- Consolidating the mosaics in places with damage and detachment, by using suitable materials to match the original mortar.

The program of work at the site divided into two phases:

Phase 1, which lasted for three months:

- Studying and defining all the problems, and best solutions and methods for re-fixing all of the damaged and detached parts to the wall.
- Studying and analysing of the stratigraphy of the mosaic, in order to establish the components; then defining the suitable materials for matching the original mortar, for use in the process of consolidation.
- Taking samples from tesserae, the original mortar and previous interventions for analysis.

Fig. 5. Damage by humans (photo: M. Jbaee 2008, by permission of DGAM, Syria)

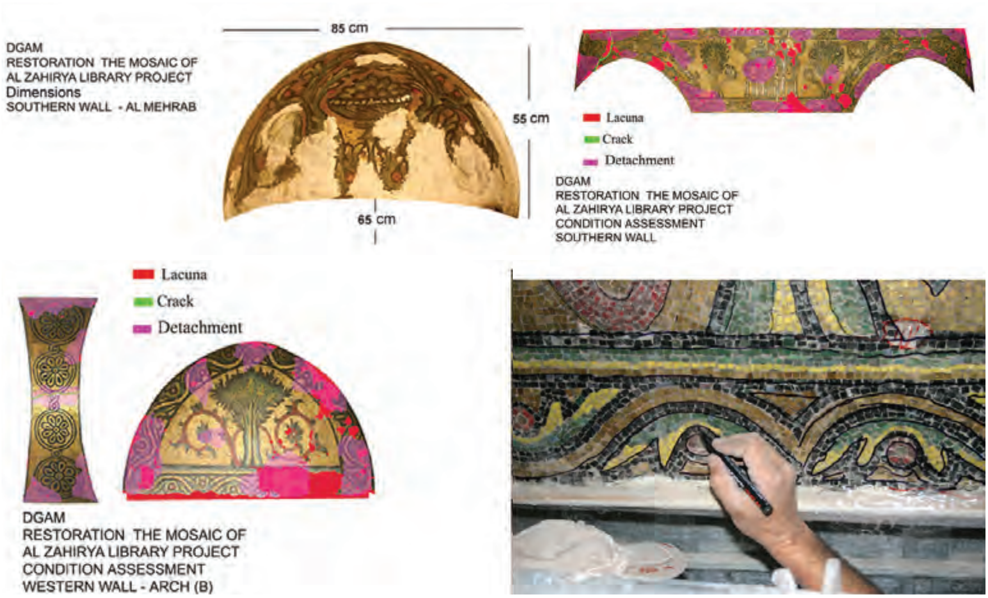

Fig. 6. Documentation (photos and drawings: M. Jbaee 2008, by permission of DGAM, Syria)

– Documenting the condition assessment (Fig. 6) as follows:
  - Photography of the entire mosaic, problems and particular details
  - Defining problems on the plans and on the photographs taken previously
  - Drawing the entire mosaic on nylon at a scale of 1:1.

Phase 2, which lasted for five months:

– Simple cleaning of the surface of the mosaic, in order to remove dust and dirt, then consolidating all the detached parts by injecting mortar and acrylic resin between the tesserae, and the deeper layers (Fig. 7). In places with a high risk of collapse, we used wedges

Fig. 7. Interventions-consolidation (photo: M. Jbaee 2008, by permission of DGAM, Syria)

of stainless steel to re-fix the layers of the mosaic to the wall, and these operations were accompanied with wooden support pieces pressed onto the detached parts of the mosaic in order to prevent bulging.

But during this phase, we faced a big problem because the first layer which covered the wall was very porous, fragile and damaged, due to the large quantity of hay in the mortar.

– Removing of all of the wrong previous human interventions, like nails and electric wires, then cleaning all of the lacunae and earlier mortar.
– Cleaning the entire surface of the mosaic from dirt and sediments of factory and car exhaust fumes, and the lime and paint, which existed on the surface of the mosaic, which were applied during the successive works in the hall, during the last century. The cleaning was carried out with the use of water and solvents, and the suitable compresses for each case (Fig. 8).
– Refilling the lacunae by using the previously fallen cubes, or by using mortar, as a replacement of the missing cubes, in order to create new cubes from mortar to be placed in the lacunae, and then coloured in suitable and harmonious colours, in the final phase (Fig. 9).

Important note: The first plan for the treatment of the lacunae, especially in the Mihrab, was to refill them with new mortar harmonious with the environment, or by cleaning the lacunae in order to show the original mortar layer. After starting the

Fig. 8. Interventions-cleaning (photo: M. Jbaee 2008, by permission of DGAM, Syria)

Fig. 9. Interventions-refilling of the lacunae and colouring (photo: M. Jbaee 2008, by permission of DGAM, Syria)

Fig. 10. Interventions-refilling of the lacunae (photo: M. Jbaee 2008, by permission of DGAM, Syria)

Fig. 11. Comparison-before and after (photo: M. Jbaee 2008, by permission of DGAM, Syria)

cleaning process, however, the colouring layer (sinopia), which had been applied by the artist or the mosaic worker, appeared. This layer defined the main lines of the drawing and the colour of the cubes that were to be placed on top of it. For this reason we changed our plan for a new one, which included creating new cubes from mortar and placing them in the lacunae, then colouring them with suitable colours similar to the original, especially in the Mihrab (Fig. 10), because of the wonderful decorations used there, and its close proximity to the visitor. We then adopted this method for refilling the lacunae of the entire mosaic decoration.

– Colouring the new cubes of mortar, in suitable stable colours, very close to the original ones.

– Cleaning the entire surface of the mosaic from the solvents and chemicals used, and cleaning the remnants of the old dirt and smoke in order to recover the splendour and value of mosaic.
– Documenting all new interventions with photographs and drawings (Fig. 11).
– Documenting all the accomplished works, in scientific reports, for publishing in the future, and for using in later experiments. Also, explaining to the tourists and visitors the value of the accomplished work, and the aesthetic, historical, artistic and archaeological value of this great artistic work, and the site as a whole.

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THE OLDEST FORM OF PEBBLE MOSAIC FLOOR DISCOVERED IN SYRIA. SITE OF TEL AL AHMAR: DETACHMENT AND RESTORATION

Mouhamad Kaied and Borhaan AlZraa

Location

The site of Tell al Ahmar is located 20 km south the city Jarablus, at the meeting of the Sajour River with the Euphrates, to the south of the Syrian-Turkish border. The archaeological hill rises above the most prominent archaeological sites in Syria, because it embraces the Aramean kingdom of Bit Adini and its capital Til Barsib (Bunnens 1995).

The investigation of the hill began in 1929 by a French mission headed by F. François Thureau-Dangin. The more recent rescue excavations by the Australian mission started in 1988 under the direction of G. Bunnens of the University of Melbourne. The investigation included eight sectors in different parts of the site, identified by Latin letters, from A to H. The most prominent was sector C where a yard belonging to an Assyrian palace was found, its floor paved

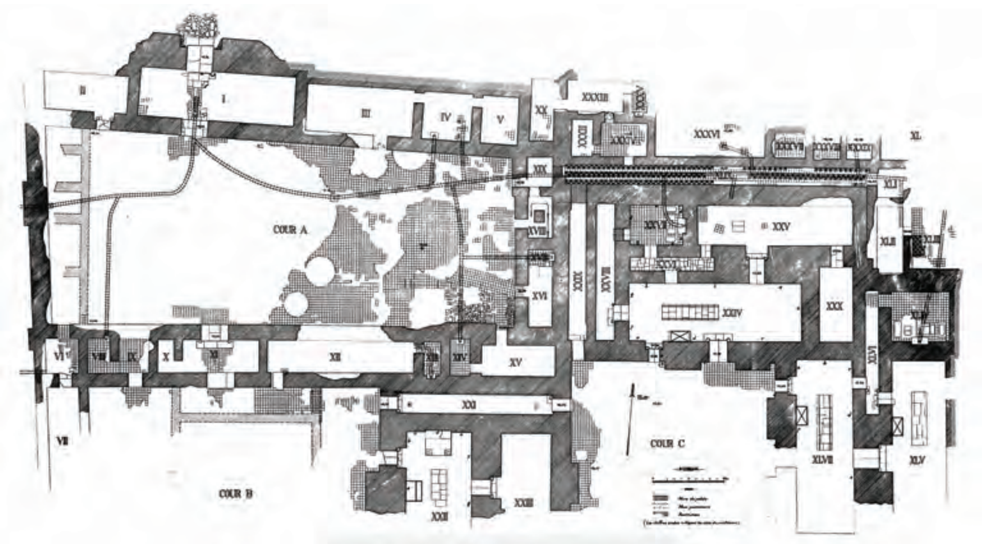

Fig. 1. Plan of the site of Tell Ahmar (from Bunnens 1997)

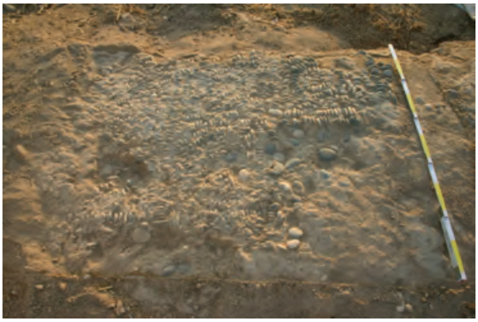

Fig. 2. The mosaic as excavated

Fig. 3. Making the plaster mould

with a black and white pebble mosaic with a chequerboard pattern. The floor covered an area of 190 m^2, and is so far the world's oldest pebble mosaic (Fig. 1). In 2000, a shared Belgian-Syrian mission excavated within the sector XLIII in the north-eastern side of the palace another mosaic.

History

This mosaic, dated to the 9th-8th century BC is very interesting because it is composed of black and white pebbles (Fig. 2). These are of oval form and 8-13cm long. They are fixed with a natural mud mixture to create different geometric shapes (concentric circles within the squares of a chequerboard).The surviving section that was detached measures approximately 1 m^2.
This kind of mosaic, because of the size and weight of the pebbles and gravel-bearing nature of the soil, requires a different method of detachment from the traditional one. A wooden box, 30 cm high, was designed, around the panel in order to make a mould of plaster (Fig. 3 and 4). Then the traditional way of detaching mosaics was applied: the edges and bottom of the panel were liberated, the surface was cleaned (Fig. 5 and 6) and the panel was turned up-side down.

Fig. 4. The mosaic in the mould

Restoration work

This involved the decision on the type of finish and the presentation of the work in the museum.

– A layer of soil was removed from the back, bearing layer, to a depth of 6 cm (Fig. 7) and replaced by new mortar (hydraulic lime, Primal, sand free of salt, crushed brick and water) (Fig. 8).
– The restoration work required a support plate, and for this reason we have been working on a support – under experi-

Fig. 5. Cleaning the surface of the mosaic

Fig. 6. The mosaic after cleaning

Fig. 7. Cleaning the soil from the back

Fig. 8. New backing with hydraulic mortar

Fig. 9. Roughing the surface of the support

Fig. 10. Putting the mortar on the board and panel

mentation – using local materials with characteristically high qualities in terms of resistance, weight and insulation.

– The support that carries the mosaic consists of sheets of aluminium and foam

Fig. 11. Cleaning the gypsum from the surface

Fig. 12. Completing some missing parts

Fig. 13. Completion of restoration

material (Fig. 9). After treatment, the panel was fixed on the board (Fig. 10) with a layer of fiberglass, resin and soft

Fig. 14. The restored mosaic ready for exhibition in Aleppo Museum

gravel. At this stage, the plaster mould on the surface of the mosaic was cut into squares and then removed mechanically.

– The dry plaster was cleaned (Fig. 11) with plastic brushes and an air compressor in order to remove the remnants of soil, and a layer of mortar and gravel was added. Some missing parts were remade (Fig. 12 and 13). Finally a protective layer of beeswax was added. After the addition of a metal frame, the mosaic was placed in the Ancient Near East Department of Aleppo Museum (Fig. 14).

Conclusions

It is important to find a suitable way to detach the mosaic, according to the nature of the area and the mosaic itself. However, we managed to:

- use a new support and local materials.
- have accurate work and documentation before, during and after the completion of the restoration
- determine the style of finish of the work and the museum presentation.

Work Team

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All photographs by Mouhamad Kaied, Borhaan AlZraa and Rania al Ali

Mouhamad Kaied and Borhaan Alzraa, Restorer, Conservation Laboratory, DGAM, Damascus, Syria

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LEARNING FROM THE CONSEQUENCES OF INAPPROPRIATE LIFTING METHODS: CASE STUDIES AT THE MOSAIC CONSERVATION LABORATORY IN HAMA, SYRIA

Anna Tsoupra, Ali Al Ahmad, Nader Lada, Georgios Misemikes and Stefania Chlouveraki

Abstract

A study and documentation of the damages and losses that are attributed to inappropriate methods and materials which were used in the past for lifting mosaics, was carried out at the Mosaics Conservation Laboratory of the Archaeological Museum of Hama and the broader region of central Syria. The systematic use of rubber glue as an adhesive for facing mosaics and the hammering of the faced surface of the *tessellatum* in order to detach it from the bedding, are the main causes of the severe weathering features that have been identified in a number of mosaics which, at the time of writing, were stored or exhibited in the museums of Syria. The recovery of these mosaics and the training of Syrian conservators in the conservation and maintenance of detached mosaics has been the main objective of the training program of the European Centre for Byzantine and Post Byzantine Monuments since 2004. A series of laboratory tests and conservation treatments, demonstrate the difficulties involved in the recovery of the mosaics and the importance of training technicians and conservators in the use of materials and methods which comply with the contemporary principles and ethics of mosaic conservation. Key issues such as the compatibility and reversibility of conservation materials are addressed and better understood through daily on-the-job training and set the foundation for the abandonment of the disastrous conservation practices of the past.

Introduction

Conservation and management of the mosaics of Syria has been acknowledged as one of the most important priorities in the field of cultural heritage. Thousands of square metres of mosaics, representing a long span of time from the Hellenistic to the Byzantine era, have been discovered throughout the country, most of which have been lifted and transferred to the local museums. Until 2011, only a few of these mosaics were on display while the majority of them were kept in storage awaiting conservation (Chlouveraki 2010; Al Azem 2004; 2008). Due to the lack of qualified mosaic conservators and of a university program on archaeological conservation in the country, the Directorate General of Antiquities and Museums of Syria (DGAM) had initiated a series of international cooperation programs aiming at the training of Syrian conservators and the establishment of state of the art conservation laboratories to serve the ever-increasing needs of the rich mosaic collections of the Syrian museums. The European Center for Byzantine and Post Byzantine Monuments, Greece (*EKBMM*) was invited in 2004

Fig. 1. Mosaic conservation trainees at the laboratory of the archaeological museum of Hama

to contribute towards the documentation and the preservation of this especially rich mosaic heritage of Syria in the form of a cooperation program with the Directorate General of Antiquities and Museums of Syria (DGAM). As a result a Mosaic Conservation Laboratory was set up in the museum of Hama in 2007 in the framework of a cooperation program between the two establishments (Fig 1). A series of training courses that were undertaken in 2009-2011 as part of this program, enabled a closer examination of surface losses and weathering features on mounted mosaics as well as the examination and study of the back of non-mounted mosaics held together only by the facing. It is acknowledged that the lifting of mosaics and their transfer in museums or storages is a practice, which inevitably causes destruction to the archaeological context and loss of evidence even when carried out with special care (Guidobaldi 1992). When lifting is practiced by unqualified personnel the losses are much greater and severe. A large number of detached mosaics that are stored or exhibited in the museums of Syria, as in many other countries in the Eastern Mediterranean, have been subjected to serious damages and losses of the *tessellatum*, caused by inappropriate lifting methods undertaken in the past. The insufficiency of training and the absence of the conservation discipline from the academic programs of the universities of Syria have resulted in the lack of specialized personnel and consequently in poor understanding of the mosaics and the architectural context in general. Thus, there are usually no records of the condition of mosaics prior to lifting or the methods and the materials that were used for the detachment of the *tessellatum* in the past. However, oral information by workmen and technicians, combined with macroscopic observation of the mosaics allows us to understand and reconstruct the methods used in the past and to assess the damage that has been caused by these practices.

Past lifting methods

Mosaics were commonly lifted in the past in large sections, which were rolled, or smaller ones that were transferred and stored upside-down on a flat bed. They were usually faced with cotton cloth and occasionally with other coarser cloths that were available on the spot. The adhesives that were usually applied for the facing were various types of rubber glue, which are available in the local market.

Once the facing had dried, the surface of the mosaic was pounded with hammers in order to detach it from its bedding. The mosaics were transferred to a storage where they were stored in rolls or placed on wooden boards and piled on the floor,

Fig. 2. Lifted mosaics piled in storage without any protective padding

often without any separation padding between the boards (Fig. 2). The most usual padding used between mosaic panels for transfer or storage was cushioning polyester foam, which often deteriorates and stains the mosaic surface.

Documentation of the losses

Several mosaics were macroscopically examined at the archaeological museums of Hama, Afamia, Maraat and at the gardens or the national archaeological museum in Damascus in order to identify the losses that can be attributed to inappropriate lifting methods of the past. Furthermore, the conservation and mounting of a large mosaic inscription from the early Christian church of Abu Rubeiss that was undertaken at the conservation laboratory of the archaeological museum of Hama, in the framework of the *EKBMM* training program in 2009 and 2010, permitted the close examination and documentation of the losses that have been caused during lifting and transferring the mosaic to the museum storage.

Losses and weathering features

The major types of damage that occurred in these mosaics as a result of past lifting practices and materials are the following:

a. Mechanical damage from pounding has caused severe cracking of the tesserae, loss of their edges, or their total loss. In several areas the tesserae are cracked or completely broken and in many cases only a thin flake or small fragments from the surface remain attached to the facing cloth. The main body of the tesserae is either sitting loose above these fragments or has been completely lost (Fig. 3).

Fig. 3. Remains of tesserae, which have been broken and lost due to the pounding of the *tessellatum*

b. A large number of loose tesserae are found on the back surface of the mosaics as a result of inappropriate packing and transfer of the lifted mosaics. The condition is usually worse in mosaics that have been stored in rolls, as additional stresses are imposed which cause the loosening and disorder of the *tessellatum* (Fig. 4).

Fig. 4. Several tesserae lying loose and displaced on the rear of the mosaic

c. Deteriorated rubber glue remains have caused discoloration of the mosaic surface, which is affecting the legibility of the mosaic and creates aesthetic problems (Fig. 5 and 6).
d. The strong adherence of the glue and the difficulty in the removal of the facing cloth has often caused loss of tesserae edges and corners, loss of flakes or scales from the surface and loss of the original mortar between the tesserae (Fig. 7). The result is a mosaic surface with rounded and cracked tesserae (Fig. 8).

Fig. 5. Remains of rubber glue covering most of mosaic surface

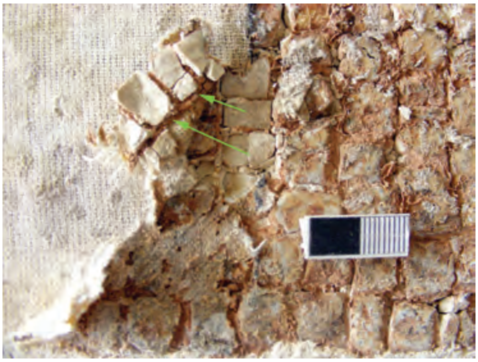

Fig. 7. Surface flakes detaching from the tesserae while removing the facing fabric

Fig. 6. Deteriorated remains of rubber glue

Fig. 8. Rounded and cracked tesserae after the loss of edges and corners

e. Rubber glue has deteriorated and has lost its adhesive properties. As a result, the tesserae have become loose and in most cases they have been lost. Their imprints and flakes of the stone surface still remain on the facing cloth.
f. Tesserae loss, due to the use of inappropriate coarse facing cloths has been identified in several cases (Fig. 9).

Fig. 9. Inappropriate facing fabrics, i.e. burlap, do not adhere well to the *tessellatum*

g. Extensive losses seem to have occurred during lifting due to insufficient cleaning of the mosaic surface before the application of the facing materials. This is clearly indicated by loose depositions (soil and loose encrustations) with tesserae imprints, which remain on the facing cloths.
h. Extensive loss of tesserae form the edges of the mosaic sections have made their reassembling problematic and often impossible.
i. Finally, the oversized sections of detached mosaics and especially those that have been lifted in one piece and rolled, present difficulties in handling, transferring and storage and continue to be a major unresolved problem, which causes continuous losses.

Case study: The mosaic inscription of Abu Rubeiss

Some of the aforementioned damages were recorded and mapped on the mosaic inscription of Abu Rubeiss. Although the mosaic seemed to be well preserved when viewed from a distance, a closer examination of the back surface of the *tessellatum* revealed quite extended damage caused by the usual aggressive lifting technique that was used for several years in Syria. Several tesserae were cracked and/or are completely broken due to the pounding of the mosaic surface. In some areas the tesserae fragments still adhered well on the facing cloth while in others the main body of the tesserae was detached and only a few flakes of the surface were still preserved (Fig. 3). The major damages were mapped and treated before the mosaic was mounted. The most extended type of damage regards the broken or cracked tesserae, which still adhere to the facing fabric (indicated in blue in Fig. 10). There are also several areas where only a few fragments or flakes of the tesserae still remain on the facing fabric while the rest of them have been inevitably lost (marked in orange in Fig. 10).

Most of the damaged tesserae, especially those belonging to the letters, had to be treated individually before the mosaic section was mounted in order to rescue as many of surface flakes and small fragments of 'lost' tesserae as possible. Larger fragments of tesserae were mended with Paraloid 72 and then filled with Paraloid B72 mixed with glass micro-balloons, while small ones were filled directly with the same filler. The removal of the facing cloth after the mounting of the mosaic on honeycomb panels (Hexlite 620) proved

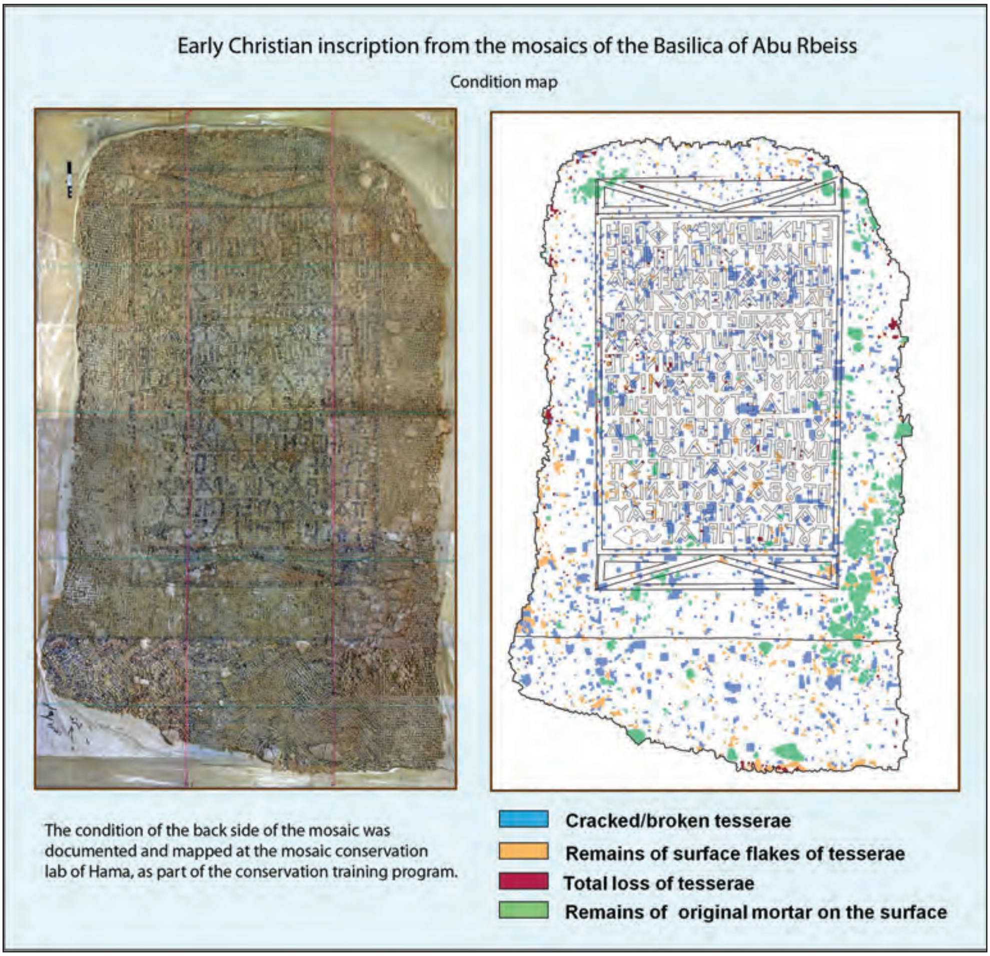

Fig. 10. The main damages that were cause by lifting, mapped on the back of an Early Christian inscription from the Basilica of Abu Rubeiss

to be an extremely difficult and time-consuming operation. Small chips and flakes of the tesserae were detached while the facing was being pulled off the surface of the mosaics. When possible, there were attached back to the surface with Paraloid B72 (Fig. 7). All these small-scale but necessary treatments on individual tesserae complicated and delayed the conservation work. However, every tessera that belongs to an inscription, thus part of an invaluable historical document, is important enough to justify this lengthy treatment.

Conclusion

The identification and detailed recording of the weathering features that have been caused by inappropriate lifting methods and materials has demonstrated the extent of the damage that has been caused up to now, which is often severe. Unlike the physical or chemical processes of deterioration that have taken place after abandoning the building in the open air or a burial environment, which are unavoidable, the damage caused by inappropriate lifting methods can be prevented if understood and acknowledged. Inappropriate conservation treatments of the past, such as the mounting of mosaics in concrete slabs reinforced with iron bars has already been banned after several years of training and dissemination.

The main argument for the use of these techniques, as we have witnessed in field cases in Syria, is the easiness, the convenience and effectiveness of the method while the side effects, which are demonstrated through this study, are rarely accounted for and considered. Indeed the rubber glue dries very fast and it adheres very well when the mosaic surface is clean; however, it is very difficult to remove afterwards. Similarly, the pounding of the *tesellatum* is indeed very effective in detaching the mosaic from its bedding but at the same time it destroys a considerable amount of tesserae and even though the mosaic may seem fairly complete, its recovery may be impossible or, if possible, a difficult and time-consuming operation. Therefore, the convenience of the technique cannot compensate for the losses. This study aims to alarm the conservation professionals of this region and lead them to abandon these practices and to adopt the methods and the materials which have been tested in the field for a long time and have been approved by professional conservators. Modern methods of mosaic lifting are included in various volumes of the ICCM proceedings (Bassier 1980, Barov 1985, Chantriaux *et al.* 1994), as well as in other relevant publications (Sease 1994, 71-74, Fiori *et al.* 2008).

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SESSION VII: EDUCATION AND TRAINING

Maja Frankovic
and Branislava Lazarevic

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Amr al-Azm
and Charalambos Bakirtzis

Will Wootton

Poster

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RESULTS OF THE REGIONAL SURVEY *MOSAIC CONSERVATION AND TRAINING OF CONSERVATORS IN SOUTHEAST EUROPE*

Maja Frankovic and Branislava Lazarevic

Introduction

The regional survey *Mosaic Conservation and Training of Conservators in Southeast Europe* was initiated in 2007 with the aim of defining the needs for conservation of ancient mosaic pavements in the region and developing educational programs in the field of mosaic conservation at a regional level. It was initiated by a group of young professionals from the region, all being participants in the ICCROM Programme of Archaeological Conservation in Southeast Europe. The idea behind this initiative was to try to raise awareness at regional level, both amongst professionals and national authorities, about the need for more organized and active protection of the ancient mosaic heritage in the region. After the preliminary survey was done in 2008 and the first results presented at various meetings of conservation professionals in the region and internationally, the survey received the attention and support of the conservation community, which took into consideration the obvious benefit that could be gained from a systematic review on the situation in the region, and the fact that surveys of this type were rare. The survey was presented at the 10th ICCM Conference, "Conservation: An Act of Discovery", 20-26 October 2008, Palermo, Italy; the IIC 2010 Congress "Conservation and the Eastern Mediterranean", 20-24 September 2010, Istanbul, Turkey; the ICOM Twenty-second General Conference, "Museums for Social Harmony", 7-12 November 2010, Shanghai, China; and the 11. Strokovno srečanje konservatorjev-restavratorjev, Slovenski etnografski muzej, 17 May 2011, Ljubljana, Slovenia.
The survey was then developed into the project by the Central Institute for Conservation in Belgrade. From 2011, the project was supported by the UNESCO Office in Venice, the Regional Alliance ICOM SEE and the National Academy of Art, Sofia, and was led by the Central Institute for Conservation in Belgrade.
The project mission was to determine the capacities of the region regarding ancient mosaic heritage and its state of conservation, as well as conservation resources, in order to allow for efficient planning and implementation of conservation and educational projects in the future. The survey referred to ancient mosaic pavements in the region of Southeast Europe. The region is rich in mosaic heritage, but a large number of sites are closed to the public, and documentation is mostly unavailable. To make the survey feasible, it was direct-

ed only at ancient mosaic pavements on archaeological sites that are open to the public and at mosaics in museum collections. It covered eight countries in the region: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Montenegro, the Former Yugoslav Republic of Macedonia, Serbia and Slovenia. The survey was conducted through questionnaires. Three questionnaires were conceived to fulfil the following objectives:

1. To present a quantitative picture of the existence of ancient mosaic pavements on archaeological sites open to the public and in museums in the region of Southeast Europe.
2. To present the quantitative and qualitative picture of the state of conservation of ancient mosaic pavements on archaeological sites open to the public and in museums in the region of Southeast Europe.
3. To determine the number of people working in mosaic conservation, their professional qualifications, as well as the existence of academic study programs and professional training programs in the region.

The questionnaires for mosaics on sites and in museums were conceived in a way so as to provide answers needed to achieve the first two objectives. They contained questions concerning general information on the archaeological site/museum, surfaces of mosaics in relation to conservation methods, preventive conservation and maintenance, availability of mosaics for public visit, assessed state of conservation and urgency of conservation treatment, current and planned conservation projects (funding systems, institutions involved in the execution of such projects), as well as availability of information (existence and accessibility of archaeological, conservation and monitoring documentation, mosaic corpuses, published papers).

The questionnaire treating mosaic conservation practice served to achieve the third project objective. It gathered information on educational systems (existence of academic studies, specializations and/or training courses in the field of mosaic conservation), number of people working in the field of mosaic conservation, their level of education, affiliation and membership in international and local professional organizations, institutions responsible for mosaics conservation, institutional and professional collaboration at local, regional and international level.

The survey team was composed of colleagues from the region who undertook to coordinate the survey in their countries. The list of institutions responsible for mosaics was established. An invitation to take part in the survey was sent to 59 institutions around the region, out of which 43 accepted to participate and filled in questionnaires for mosaics under their responsibility. Two institutions refused to participate in the survey, four were responsible for mosaics on sites that are not open to the public and therefore could not be included in the survey, and ten institutions did not reply to the invitation. A complete survey, that included all museums and sites with mosaics open to the public, was carried out in Bosnia and Herzegovina, Montenegro, the Former Yugoslav Republic of Macedonia, Slovenia and Serbia. As some institutions in Albania, Bulgaria and Croatia did not take part in the survey, not all museums and sites open to the public from those counties have been included in the survey. In

ALBANIA	
MUSEUMS	SITES
Butrint Museum, Saranda	Apolonia, Fier
National Historical Museum Tirana	Butrint, Butrint National Park, Saranda
	Bylis, Hekal
	Roman Villa and Paleochristian Church, Tirana
	Shen Mehillit Arapaj Basilica, Durres
BULGARIA	
MUSEUMS	SITES
Archaeological Museum Sandanski	Basilica 7, Kyustendil
NAIM-BAS Sofia	Largo, Kyustendil
RHM «Acad. Yordan Ivanov» Kyustendil	Stationary Shop, Kyustendil
RHM Stara Zagora	32, Neofit Rilski Str., Kyustendil
	Bishop's Basilica Sandanski
	House in G. Stoletov Str, Stara Zagora
	Peristyle building near the Post Palace, Stara Zagora
BOSNIA AND HERZEGOVINA	
MUSEUMS	SITES
City Museum of Zenica	
Museum of Herzegovina, Trebinje	
National Museum, Sarajevo	
CROATIA	
MUSEUMS	SITES
Archaeological Museum of Istria, Pula	Baska, Island Krk, Baska
Archaeological Museum Narona, Vid	
	Verige villa rustica, Verige bay Brijuni
Archaeological Collection Osor	Complex of Early Christian Churches St Ivan/St Maria, Hvar
Cres Museum	Early Christian Basilica, Liznjan
Lošinj Museum	Osor
Museum of Stari Grad, Hvar	Cathedral of the Assumption of the Blessed Virgin Mary, Pula
	St Franjo Monastery, Pula
Museum of Trilj County	Villa urbana – Punishment of Dirce mosaic, Pula
NI National Park Brijuni	St Thomas the Apostle Church, Porec
Poreč Heritage Museum	Uzarska 23, Rijeka

	Diocletian's palace, Arhidjakonova Street, Split
	Diocletian's palace, Sector I, Buliceva Street, Split
	Gradina, Roman Thermae, Vis
Former Yugoslav Republic of Macedonia	
museums	sites
Church of the Holy Mother of God Perybleptos, Ohrid	Heraclea Lyncestis, Bitola
Deboj/NI IPCMM-Ohrid	House of Manchevi, Ohrid
House of Miladinovi brothers – Struga	Plaoshnik, Ohrid
NI Institute and Museum – Bitola	Stobi
Montenegro	
museums	sites
PI «Museums, Gallery and Library» Budva – Museum	Ancient Roman Villa with Mosaics, Risan
Slovenia	
museums	sites
Museum and galleries of Ljubljana	Archaeological Park Early Christan Centre (Baptisterium and porticus), Ljubljana
National Museum of Slovenia	Archaeological park Emonian House, Ljubljana
Regional Museum Celje	Church of St Spiritus, Crnomelj
Regional Museum Koper	Simons' Bay, Izola
Regional Museum Maribor	
Regional Museum Ptuj Ormoz	
Serbia	
museums	sites
Belgrade City Museum	Caričin Grad (Ivstiniana Prima), Lebane
Museum of Srem	Felix Romuliana, Zajecar
National Museum in Belgrade	Mediana, Nis
National Museum Zajecar	Sirmium, Sremska Mitrovica

Table 1. List of museums and archaeological sites open to the public that participated in the survey

the period from April 2011 to April 2012, questionnaires were filled for 38 sites and 33 museums (Table 1).

Survey Results

Data processing of 71 questionnaires received from the whole region give a total of 12,452.95 m^2 of mosaic pavements. From that

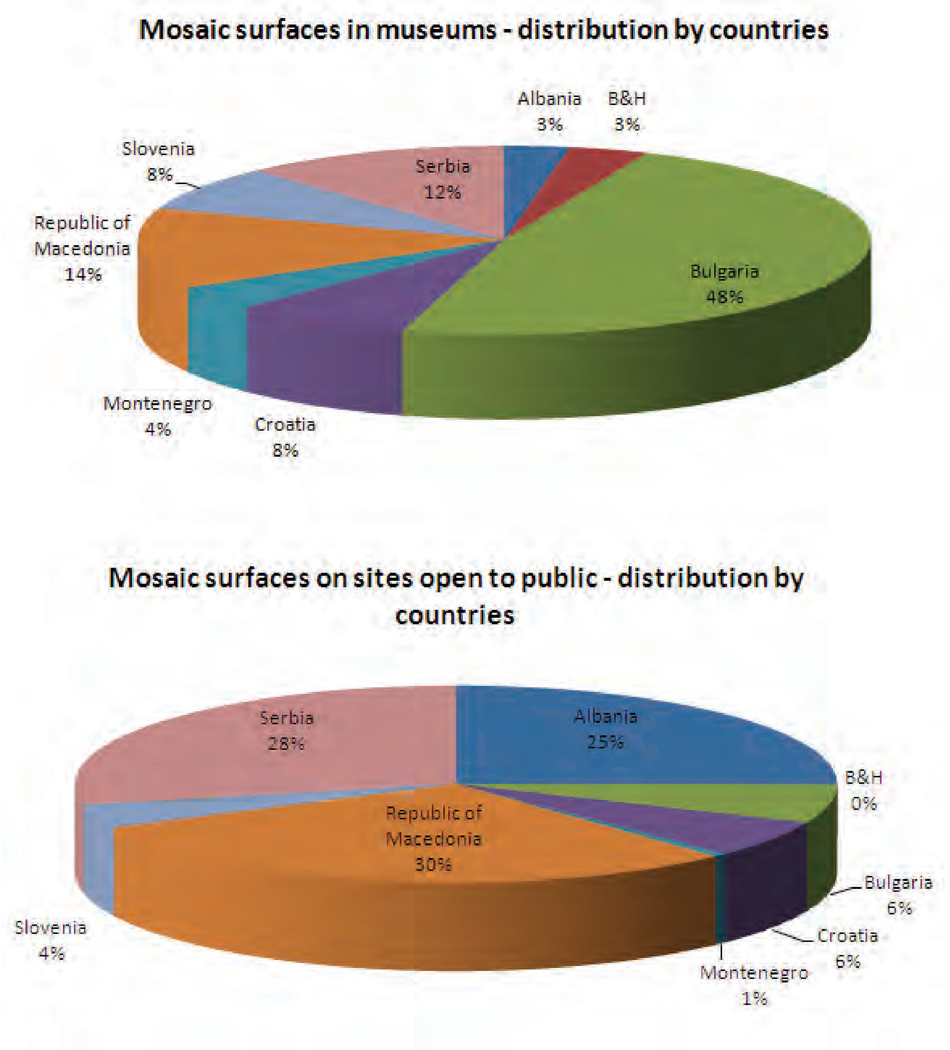
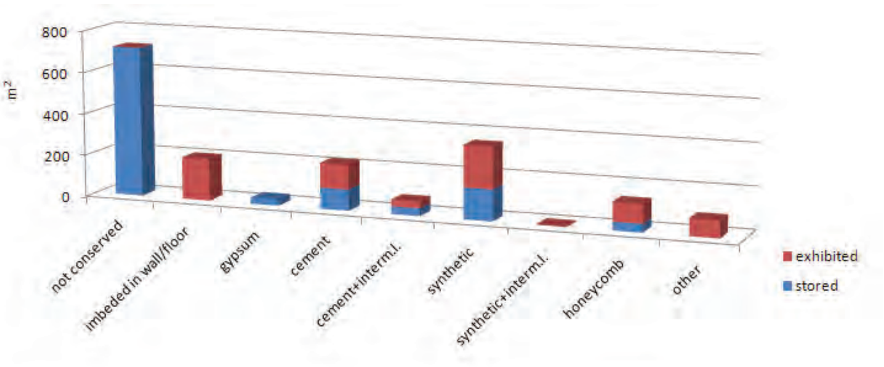


Fig. 1. Surfaces of mosaic pavements in museums and on archaeological sites open to the public, distribution by country

number, 1,807.45 m^2 (15%) are in museums and 10,645.50 m^2 (85%) are on archaeological sites open to the public. The contribution of each country in the total sum is calculated from mosaic surfaces, not the number of museums and sites included in the survey (Fig. 1).

Mosaic pavements in museums

In museums, 728.65 m^2 (40%) of mosaic surfaces are exhibited and 1,078.90 m^2 (60%) are in storage (Fig. 2). From the total surface of mosaics in museums, both exposed and in storage, 40% is not con-



	not conserved	imbeded in wall/floor	gypsum	cement	cement+interm.l.	synthetic	synthetic+interm.l.	honeycomb	other
exhibited	0.1	201.55		118.19	31.88	200	2.8	92.13	82
stored	718.31		30.07	101.13	37	150	0.98	41	0.41

Fig. 2. Stored and exhibited mosaic surfaces according to the type of support

served, i.e. they are mostly left as they were when lifted from the sites (Fig. 3). This number represents a very high percentage that indicates a significant risk of loss over time if nothing is done to restore them on a stable support. The largest surfaces of not conserved mosaics in museums are in Bulgaria and the Former Yugoslav Republic of Macedonia, followed by Serbia and Montenegro (Table 2).

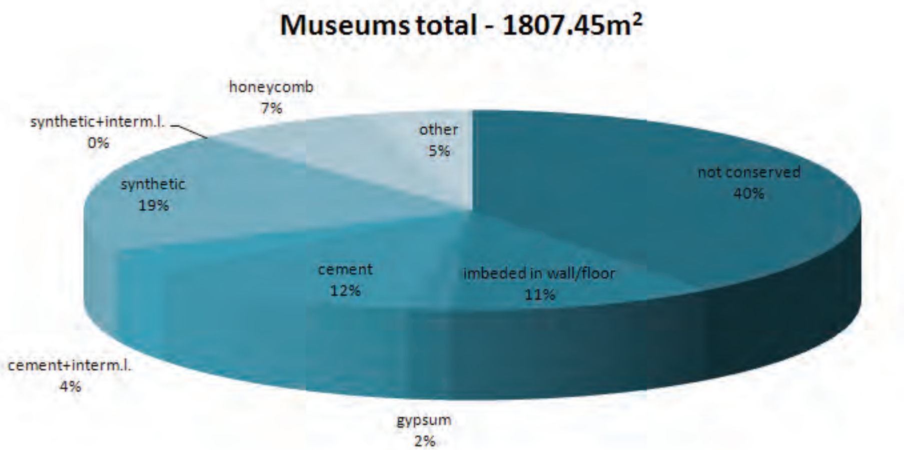


Fig. 3. Methods of conservation of mosaic surfaces exhibited in museums

Mosaic surfaces exhibited in museums (m^2)										
country	not conserved	embedded in wall/floor	gypsum	cement	Cement + interm. layer	synthetic	Synthetic + interm. layer	honeycomb	other	total
Albania	0	1	0	0	21	0	0	0	0	22
B&H	0.1	0	0	18.8	0	0	0	0	0	18.9
Bulgaria	0	0	0	50.5	0	200	0	20	6	276.5
Croatia	0	111	0	0	3.88	0	0	8.33	0	123.21
F.Y.R. of Macedonia	0	3	0	0	7	0	0	50	0	60
Montenegro	0	0	0	0	0	0	0	0	0	0
Serbia	0	83.2	0	0	0	0	2.8	13.8	0	99.8
Slovenia	0	3.35	0	48.89	0	0	0	0	76	128.24
total	**0.1**	**201.55**		**118.19**	**31.88**	**200**	**2.8**	**92.13**	82	728.65

Mosaic surfaces stored in museums (m^2)										
country	not conserved	embedded in wall/floor	gypsum	cement	cement + interm. layer	synthetic	Synthetic + interm. layer	honeycomb	other	total
Albania	0	0	0	0	30	0	0	0	0	30
B&H	17.81	0	0	26.62	0	0	0	0	0	44.43
Bulgaria	366.52	0	1.87	73.39	0	150	0.98	0	0	592.76
Croatia	5.62	0	0	0.96	0	0	0	13.2	0	19.78
F.Y.R. of Macedonia	190	0	0	0	0	0	0	0	0	190
Montenegro	75	0	0	0	0	0	0	0	0	75
Serbia	52.7	0	27.9	0	7	0	0	27.8	0.1	115.5
Slovenia	10.66	0	0.3	0.16	0	0	0	0	0.31	11.43
total	**718.31**		**30.07**	**101.13**	37	150	0.98	41	0.41	1078.9

Table 2. Mosaic surfaces according to the type of support, exhibited and stored in museums – distribution by country

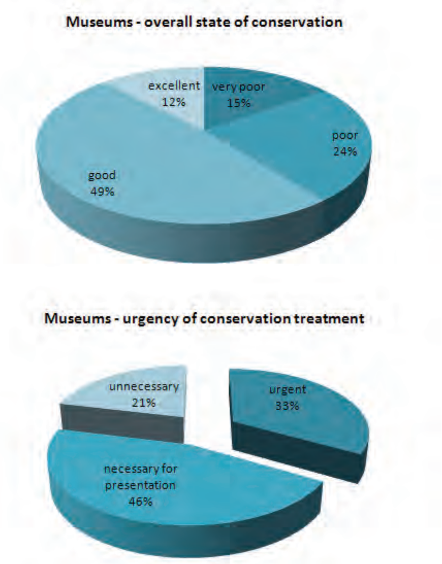


Fig. 4.Assessed state of conservation and urgency of conservation treatment of mosaics in museums

Conserved mosaics are placed on different types of supports, following the development of conservation methods over time. Supports differ from gypsum and cement, to honeycomb panels (Fig. 3). It is interesting to compare to what extent various kinds of mosaic supports were adopted in different countries in the region (Table 2). Since the type of support can roughly be tied to the period when mosaics were restored, it can also suggest when most of conservation work had been done. Even if statistically there is a significant surface of mosaics under the category *embedded in wall or floor*, this refers mostly to mosaics on sites in urban areas, where museums are built over the sites and mosaics are conserved in situ or lifted and relayed on the new support.

The questionnaires also included questions that required respondents to provide an assessment on the mosaics condition and need for conservation. Although subjective, these ratings showed the overall trend related to the need of mosaic conservation in the region (Fig. 4). The processed data showed that 33% of museums rated their mosaics as in urgent need of conservation and 46% stated that mosaics conservation is necessary for the presentation of the mosaics. Ten museums (30%) have plans regarding the conservation of the mosaics in their collections, but only five (15%) have active conservation projects.

MOSAIC PAVEMENTS ON ARCHAEOLOGICAL SITES OPEN TO THE PUBLIC

Unlike mosaics in museums, mosaics on archaeological sites open to the public are, for the most part, conserved. With respect to the method of conservation, almost equal parts of mosaics on sites are conserved in situ (43%) and lifted and relayed on cement with an intermediate layer (37%). Adding to these small portions of mosaics lifted and relayed on a lime support (2%), mosaics lifted and relayed directly on cement (3%) and mosaics lifted and restored on a movable support (2%), 87% of mosaic surfaces in the region have undergone conservation treatment in one way or another (Fig. 5).

Removing mosaics from sites is an approach that is rarely practiced. Only 178.7 m^2 are lifted and restored on a movable support and 366.3 m^2 are lifted and not restored, which makes 5% of mosaic surfaces in the whole region that have been removed from sites open to the public. Lifting and relaying mosaics on the new support seems to be the predominant practice in Serbia, while conservation in situ is more often practiced in Albania, Croatia and Bulgaria. In the

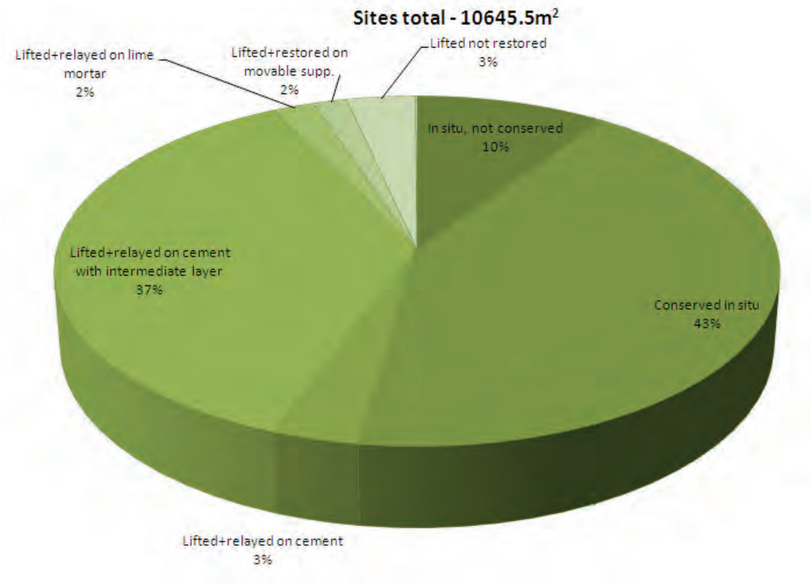


Fig. 5. Methods of conservation of mosaic surfaces exhibited on archaeological sites open to the public

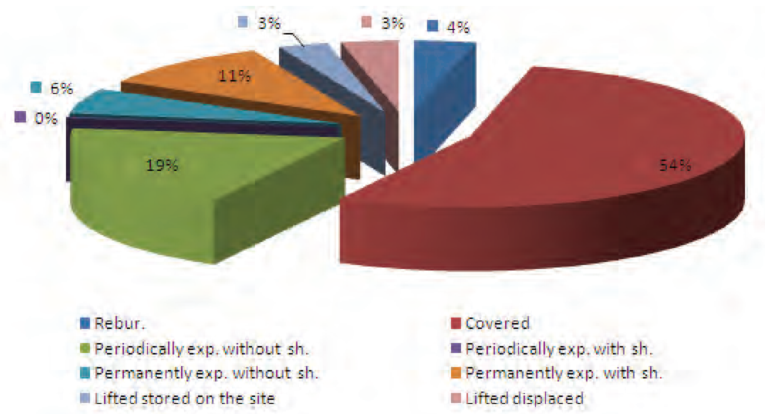
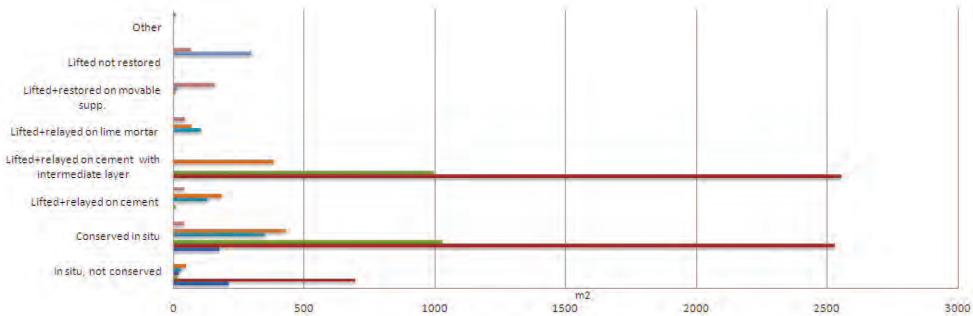


Fig. 6. Appearance of mosaic surfaces on archaeological sites open to the public

Former Yugoslav Republic of Macedonia, both methods are almost equally represented (Table 3). This can be related to the period when most of conservation had been carried out, but since the question about the period of conservation treatment had not been included in the questionnaire, it cannot be taken for a fact. In Bosnia and Herzegovina, no sites with mosaics are currently open to public. Even if the majority of mosaics are conserved, quite a small portion is accessible to the public – 17% are permanently exposed and 19% are periodically exposed during the season. Covering is the predominant measure of preventive conservation taken to protect mosaics on sites – 73% are covered (54% throughout the year and 19% only periodically) (Fig. 6). Sheltering is quite rare: of the 17% that are permanently exposed, only 11% of mosaic surfaces are protected with shelters. Figure 7 shows different methods of conservation in relation to the appearance of mosaics on sites open to the public (i.e. reburied, covered, periodically or permanently exposed with or without shelters, lifted and stored on the site or lifted and moved elsewhere).

According to the respondents' assessments, the overall state of conservation of mosaics on sites is not satisfactory – 47% of mosaics are rated as in poor and very poor condition. Conservation treatment is rated urgent on 32% of the sites and necessary for the presentation of the mosaics on 55% (Fig. 8). These ratings are due to the fact that maintenance of mosaics on sites is not planned and organized. Fifteen out of 38 sites have developed a maintenance plan or a strategy, but only three have a separate budget for maintenance activities. On another eight sites maintenance activities do take place, even though there is no main-



	In situ, not conserved	Conserved in situ	Lifted+relayed on cement	Lifted+relayed on cement with intermediate layer	Lifted+relayed on lime mortar	Lifted+restored on movable supp.	Lifted not restored	Other
Lifted displaced		41	41,2		45	159,6	67,4	8
Lifted stored on the site						14,6	298,9	1
Permanently exp. with sh.	47,05	428,803	186	384	70,5	4,5		
Permanently exp. without sh.	30	348,5	130	4	105			
Periodically exp. with sh.	21,65							
Periodically exp. without sh.	16,35	1026,1	10	995				
Covered	693,5	2526,78		2554,05				
Rebur.	211	176						

Fig. 7. Methods of conservation of mosaics in relation to their appearance on archaeological sites open to the public

	ALBANIA	BULGARIA	B&H	CROATIA	F.Y.R. OF MACEDONIA	MONTENEGRO	SLOVENIA	SERBIA
in situ, not conserved	196	303	0	42.3	13	0	38	427.25
conserved in situ	2470.1	211.5	0	337.3	1292.2	0	263.58	24
Lifted + relayed on cement	27	30	0	139.7	114.5	43	116	0
Lifted + relayed on cement with intermediate layer	0	0	0	0	1369	8	0	2560
Lifted + relayed on lime mortar	0	70.5	0	145	124.5	0	0	0
Lifted + restored on movable support	30	48	0	0	2	0	7.5	91.2
lifted not restored	16	30	0	0	312.8	7.5	0	0
other	1	0	0	7	1	0	0	0

	ALBANIA	BULGARIA	B&H	CROATIA	F.Y.R. OF MACEDONIA	MONTENEGRO	SLOVENIA	SERBIA
reburied	150	200	0	0	37	0	0	0
covered	1776.1	103	0	12	752.1	0	263.58	2970.55
periodically exposed without shelter	734	0	0	0	1416.6	0	16.35	0
periodically exposed with shelter	0	0	0	0	51.5	0	21.65	0
permanently exposed without shelter	0	0	0	379.5	234	0	0	4

permanently exposed with shelter	33	282	0	221.6	378	51	118.5	36.75
lifted stored on the site	0	0	0	0	1	7.5	0	12
lifted moved elsewhere	47	108	0	58.2	67.4	0	5	76.6

Table 3. Methods of conservation and appearance of mosaic surfaces on archaeological sites open to public (m^2) – distribution by country

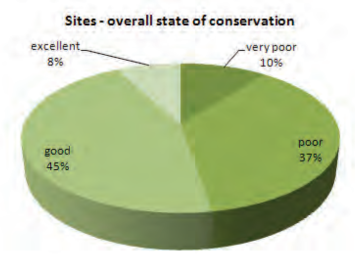
tenance plan, but these vary in frequency and quality. As for conservation projects, 12 sites (32%) have active conservation projects, and 23 sites (60%) have projects planned for the future.

Mosaic conservators

The results of the survey regarding conservation professionals working in the field of mosaic conservation indicate that there is an imbalance between the quantity of mosaics (Fig. 1) and the number of conservators involved with their conservation, especially those who have had specialized training in mosaic conservation (Table 4). Conservation treatment on sites is carried out by conservators from institutions specialized in conservation. It is interesting that mosaic maintenance on 49% of the sites is entrusted to conservators-restorers from those institutions as well. Only seven museums (21%) have conservators in their staff that can carry out treatment on mosaics. Private companies, freelancers and NGOs are involved in mosaic conservation in 4% of cases.

Database

The data obtained through the questionnaires have been incorporated into a database in order to be systemized, statistically analysed and to enable presentation of the survey results. The database can be searched through a number of parameters: conservation methods, accessibility of the mosaics to the public, preventive conservation, assessed state of conservation, urgency of conservation treatment, maintenance, active and planned conservation projects, collaboration, existence of academic studies and training programs,



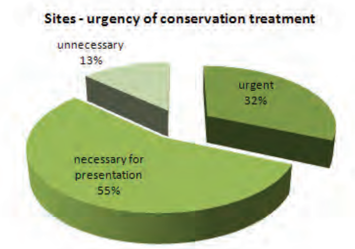


Fig. 8. Assessed state of conservation and urgency of conservation treatment of mosaics on archaeological sites open to the public

institutions involved in mosaic conservation, availability of documentation, existence of publications, etc. The database is available online on the website www.seemosaics.org.

As well as a tool for presenting the survey results, the website is also conceived as a way of presenting all the sites, museums and other institutions that took part in the survey. As such, it could be further developed to serve for the promotion of the mosaic heritage of Southeast Europe. It could also serve as an information source for activities related to mosaic conservation in the region and, through a forum, as a meeting point for people involved in mosaic research and conservation. These possibilities for expanding the contents are directions in which the website will be developed in the future.

Conclusion

The overview of the situation regarding mosaic conservation in the region obtained through the survey, points out several critical issues. In museums, the most serious problem is presented by the quantity of mosaics that have been lifted but never transferred to a new support. By leaving them untreated, the risk of loss increases progressively. On sites, the majority of mosaics are inaccessible to the public, mostly due to the fact that shelters are rare. Since most of the mosaics on sites are conserved, poor assessments of their state of conservation are linked to their unorganized maintenance, especially to the lack of a separate budget for these activities, but also to the lack of personnel. An insufficient number of conservators are in charge of conservation and maintenance of mosaics on sites and in museums.

When we take into the account the quantity of mosaic pavements in the region, the professional capacities, the estimated needs for mosaic conservation and the accessibility of mosaics to the public, the general conclusion is that mosaic conservation in Southeast Europe needs to be improved. Improving mosaic conservation and presentation in the region was discussed at the meeting of the survey team that was held in September 2011 in Ohrid. Representatives from all the countries involved in the survey were present. The meeting was organized in order to have an overview of the survey results and plan the completion of the project, but also in order to discuss possibilities for the project's development in the future. From the conclusions of this meeting, the possibilities for further development and continuation of the project could be summarized as follows:

The best way to improve the situation at the regional level would be to connect in-

Country	Academic studies in conservation	Specialization in mosaic conservation on academic level	Approx. no. of graduates with mosaic conservation	Approx. no. of graduates working in the field	Courses and other kinds of training	Approx. no. of people working on mosaic conservation	Level of education of people practicing mosaic conservation
Albania	no	no	/	/	yes	10	MA and PhD in archeology
B&H	no	no	/	/	no	2	MA in arts and archaeology
Bulgaria	yes	yes (MA)	5 (MA)	3	no	12	mostly MA in conservation
Croatia	yes	yes	30	10	no	20	BA in conservation
F.Y.R. of Macedonia	no	no	/	/	yes	6	BA in arts
Montenegro	no	no	/	/	no	3	BA in conservation
Serbia	yes	yes (MA)	3 (MA)	1	yes	7	BA/MA in conservation, conservation technicians
Slovenia	yes	yes (MA)	2 (MA)	2	no	10	BA/MA in arts or conservation

Table 4. Profession of mosaic conservators in Southeast Europe

stitutions by providing training programs in mosaic conservation with the objective of developing and putting into practice conservation projects through the training of participants. The double objective of such programs could have greater impact on ameliorating the state of mosaic heritage in the region – dissemination of knowledge regarding modern approaches to mosaic conservation, while at the same time improving the state of conservation of mosaics on sites/museums, where the program is implemented. Organized in that way, training programs would advance communication and exchange of experience amongst conservators in the region and allow joint work on either regional or international projects. Annual meetings of mosaic conservators from the region could also contribute to creating contacts and exchange between professionals and institutions involved in the conservation of mosaic heritage. The website, made through this project, could be developed to serve as a source of information for activities related to mosaic conservation in the region and as a meeting point for people involved in mosaic research and conservation. On the other hand, it could also help towards the wider promotion of the mosaic heritage of Southeast Europe.

The joint work of the survey team on this project, created a nucleus of professionals interested in fostering the mosaic heritage in the region, and a platform for developing a network of specialists involved in mosaic conservation – namely, SEE mosaics. Continuing work on regional networking will surely contribute towards improving all aspects of caring for the mosaic heritage and its promotion.

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THE SYRIAN MOSAIC PAVEMENT DOCUMENTATION TRAINING PROGRAMME

Konstantinos D. Politis, Amr al-Azm and Charalambos Bakirtzis

Syria's unique geographic location on the crossroads of the great civilizations of the East and West enabled it to amass an extraordinary amount of cultural heritage spanning thousands of years. This wealth was mainly the product of the role played by Syria as a crucible in the development of numerous civilizations, which in turn were further enriched by the interactions between them and other neighbouring cultures. Part of this immense cultural heritage is the rich corpus of mosaic pavements of the Graeco-Roman and Byzantine periods, which decorated the floors of public buildings, churches and private houses. The vast majority of these mosaics are in storage with only a relative few on display in museums across Syria (Dunbabin 1999, 10-186).

A 'rapid assessment survey' of the mosaics in the museum stores during 2000 and 2001 revealed that due to very poor storage practices, many of these mosaics were in poor condition. Furthermore, an alarming number of these mosaics had little or no known documentation associated with them. These problems were initially highlighted at the conference on mosaics held in 2003 at Piazza Armerina in Sicily (Al-Azm 2004).

The issue of lack of documentation became even more critical following the catastrophic looting of Iraqi museums and sites following the US-led invasion of 2003 raising fears that if a similar event were to occur in Syria, then the lack of documentation would render it almost impossible to recover any stolen items. (In light of the on-going tragic events in Syria, this work has taken on even more importance).

As a result, it was decided to establish a collaborative training programme with the aim of fully documenting all the ancient Syrian mosaics on display or in museum storage. The programme ran from 2004-2008 and participating institutions included the Centre for Archaeological Research of the Department of Archaeology at the University of Damascus and the European Centre for Byzantine and Post-Byzantine Monuments (*EKBMM*), with the full co-operation of the Syrian Directorate of Antiquities and Museums (DGAM) and the collaboration of the Hellenic Society for Near Eastern Studies (HSNES). The programme was funded by *EKBMM* with additional support coming from the above-mentioned institutions.

The principle goals of the programme (Politis *et al.* 2011) were to establish a new working database in order to fully document as many Syrian mosaics (primarily, though not exclusively, pave-

Fig. 1. The Syrian Mosaic Pavement Documentation team at Mara'at Nama'an (photo: auto shot photo)

ments) as possible, using modern methods, and to conduct a training course for Syrians who would actually carry-out this process. It was intended that the end result would comprise a published corpus of all mosaics in Syria in a digital format, openly available to anyone interested for future study. A hard-copy publication highlighting some of the Syrian mosaics was deemed as an additional and very valuable product. The main sources of information were mosaic pavements on display or in storage.

During the first years of work a database was formulated to allow data to be recorded, retrieved, searched, compared and cross-referenced quickly and accurately. At the same time training courses were held at Damascus University and practical field exercises at Damascus and Mara'at Nama'an museums for eight Syrian students. The trainees included Khaled Hiatlih, Rasha Haqi, Nivin Saad al Deen, Basel Zeno, Ola Abu Rached, Manal Ganem, Smr Ramadan and Lorna Asaad. Their programme included formal lectures and practical sessions in archaeology, art history, conservation, recording and management. Once the initial phase of their training was completed, the students were then required to begin gathering and documenting information about the mosaics. Several hundred mosaic pavements were photographed, recorded and registered in the new database.

Fig. 2. The mosaic pavements being measured, photographed and recorded on datasheets (photo: K.D. Politis)

They included floor mosaics from museums and sites at Damascus, Mara'at Nama'an, Afamia/Apameia, Hama/Epiphania, Bosra/Bostra, Shahba/Philippopolis, Latakia/Laodikeia, Idlib, Sweida/Dionysias, Tadmur/Palmyra as well as the wall mosaics from the Baibars Mausoleum and the Umayyad mosque in Damascus.

The instructors of the training programme were Dr Konstantinos Politis (HSNES) on mosaic art history and recording techniques, Dr Amr Al-Azm (Damascus University) on computer applications in archaeology, and Mr Vicken Abajian (DGAM) on database management. In addition, special lectures were given by Prof. Dr Demetrios Karadimas (HSNES) on the Greek language, Dr Stefania Chlouveraki (HSNES) on mosaic conservation, and Prof. Dr Ma'amoun Abdelkarim (Damascus University) on Classical and Byzantine archaeology. Prof. Dr Charalambos Bakirtzis (*EKBMM*) was the general co-ordinator.

A Memo of Understanding for the collaborative programme was signed by the presidents of Damascus University and *EKBMM* in September 2005 which stipulated that the first phase of the programme be concluded by September 2006. In May 2008, a committee of the *EKBMM* including Isidoros Kakouris, Charalambos Bakirtzis and Eleni Peristeropoulou visited Syria to assess the results of the programme and present the eight Syrian trainees with certificates of participation.

The apparent success of the programme and a request to continue the documentation in order to complete the catalogue, led to its extension in July 2008. This phase was conducted by three of the trainees (Khaled Hiatlih, Rasha Haqi and Basel Zeno) under the supervision of Prof. Dr Ma'amoun Abdelkarim with the assistance of Dr Jamal Tamoum (Damascus University) in collaboration with Dr Konstantinos Politis. This included important mosaics from Dera'a, Tartous, Arwad, Raqqa and particularly Aleppo/Beroea. An additional necessary objective was to modify the database to correspond with international standards (used by *EKBMM*) and make it more 'user-friendly'. This was facilitated by Prof. Dr Georgios A. Papaioannou (HSNES).

In March 2009 upon completion of this extension, the director of *EKBMM*, Dr Anastasia Tourta attended a ceremony at Damascus University hosted by its Pre-

Fig. 3. Information from record sheets being entered into the database (photo: K.D. Politis)

sident, Prof. Dr Wael Mualla officially recognising the efforts of the trainees and thanking the sponsoring institutions. In attendance was also Dr Bassam Jamous, Director General of Antiquities and Museums of Syria.

The Results

The recording process aimed at gathering all available information on both conserved and un-conserved mosaics found in Syria. The main sources of this information were mosaic pavements on display or in storage. In addition, records kept by the DGAM were used. These records included original plans and photographs of the mosaics in situ prior to their removal. In order to present the information in a meaningful way, it was necessary to formulate a standardized systematic method to describe and record the mosaic pavements. However, this documentation procedure was not intended to include comprehensive analyses, but rather act as an aide for that purpose.

For optimal data storage and management, a relational database was created. The database was designed to allow data to be recorded, retrieved, searched, compared and cross-referenced quickly and accurately. The information can then be made widely available by permitting access to the database through the internet.

By the end of 2008, a total of 365 mosaic pavements located in 14 museums across Syria were documented as part of the *Syrian Mosaic Documentation Training Programme*. Full copies of these archives are held by the Syrian DGAM, *EKBMM* and HSNES offices. It is hoped that one of the by-products of this project will be the creation of a risk map of existing mosaics, both in storage and in situ, that can be used as a basis for supporting a future restoration and preservation program at the DGAM to eliminate the massive backlog of stored mosaics both restored and un-restored, as well as promoting new management policies aimed at encouraging and supporting in situ conservation.

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CONSERVING AND MANAGING MOSAICS IN LIBYA (*CaMMiL*): A NEW COLLABORATIVE PROJECT

Will Wootton

Abstract

This paper reports on a collaborative project designed to enhance Libya's decision-makers' and technicians' understanding of the principles of mosaic conservation as applied within a broader strategy for the management of archaeological sites. At the time of the conference and the submission of the paper, the project had been delayed due to the political context in Libya. As circumstances changed, we adjusted the project's timetable and were able to undertake an evaluation trip in early 2012. This publication reviews the genesis of the project and its aims and methods. It looks at the historic situation of Libyan mosaics in terms of their conservation and management as well as the impact of the current socio-political situation. It also discusses the evaluation trip and its relationship to the subsequent workshops. A complete overview has now been published, see Will Wootton, Alaa El-Habashi, John Stewart and Hafed Walda in *Libyan Studies* 46 (2015), 103-113.

When I wrote the abstract for this ICCM conference, I intended to reflect on a short project entitled *Conserving and Managing Mosaics in Libya* (*CaMMiL*), which was due to take place during 2011. *CaMMiL*'s primary objective was to raise awareness amongst site-controllers, archaeologists and technicians of contemporary approaches to mosaic conservation and site management. It would achieve this during three visits to Libya, a reconnaissance trip in April followed by two workshops between May and September 2011. Circumstances were to radically alter these plans. This paper reports on the project in its early stages and the evaluation trip which took place in April 2012. The project has now been successfully completed and the results published (Wootton *et al.* 2015). *CaMMiL* was developed in collaboration with the Libyan Department of Antiquities, Hafed Walda of King's College London and John Stewart of English Heritage, with the input of colleagues from various international institutions including Jeanne Marie Teutonico of the Getty Conservation Institute. It was funded by the Getty Foundation and intended as a "practical solution" to the "real problems" that the Department has been facing, in particular a lack of trained personnel to effectively protect and manage their heritage in general, and their mosaics more specifically.

Libya now: the recent past and present

In February 2011 the uprising against Gaddafi's regime began and his death on 20th October marked the transition from dictatorship to democracy; in early 2012 power was in the hands of the National Transitional Council who were responsible for holding democratic elections in July 2012. These elections were intended to result in the formation of a national assembly who would draft a new constitution upon which there would be a referendum (for a review of the current crisis, see Toaldo 2016). The Libyan Department of Antiquities remained the single custodian of the country's heritage which includes some of the most significant archaeological remains in the world.

In late 2011 there were two missions to assess the state of Libya's antiquities, both collaborations between the Blue Shield and the International Military Cultural Resources Work Group (*IMCRWG*). The first, in September, was concerned with Tripolitania (mission report online at http://www.blueshield.at/libya_2011/09-2011/mission_report_libya_09-2011.pdf – accessed April 2012). It was followed by a visit to Cyrenaica in November (mission report online at http://www.blueshield.at/libya_2011/11-2011/mission_report_libya_11-2011.pdf – accessed April 2012). These reports, co-authored by one of the *CaMMiL* project team, highlighted important initiatives undertaken by the Department's staff during the uprising often with the support of local people. They include individual and collective acts of courage and offer examples of good practice whether the creation of inventories, the movement of objects into store, the sealing of museum entrances or the setting up of watching briefs (a useful handbook has just been published by UNESCO and ICCROM on the safeguarding of threatened heritage collections, see http//:www.iccrom.org/free-publication-on-emergency-evacuation-of-collections/ (accessed 2017).

In general it seems that damage to sites in western Libya was limited. Signs of small-arms and anti-aircraft fire were visible on some monuments; offices were occasionally looted and perimeter fences destroyed. Antiquities in the east suffered more. There were illegal excavations and looting, including thefts from museums. There were two notable incidents related to mosaics. At Ptolemais, the house of the Polish Archaeological Mission was occupied by armed squatters. As a result, the Blue Shield and *IMCRWG* team were unable to access the property, where some of the finds were stored including mosaic fragments from the upper storey of the House of Leukaktios (Mikocki 2005; 2006; 2010, 188-190, fig. 8 and 9; Chmielewski 2014, 484, fig. 7 and 8). At Cyrene the Seasons mosaic in the House of Jason Magnus was vandalized by the removal of Spring and Winter from the spandrels (Fig. 1 and 2) (Mingazzini 1966, 80-81, pl. XXX.1, XXXII.1-2; Bonacasa and Ensoli 2000, 96-99, colour image of Winter on p. 98). This action was reported as having taken place during the revolution but may have happened a couple of days preceding it. Such a destructive theft remains particularly deplorable.

Although free from dictatorship, Libya faces systemic problems that need addressing. In an article written before the uprising, Paul Bennett and Graeme Barker (2011, 20) summed up the situation: "The incredible pace of change, the potential impact of development on heritage assets and the weakness of the state heritage infrastructure have all the makings of a "perfect storm" regarding the threats to Libya's archaeological heritage. There is a desperate need to bring forward a new

Fig. 1. Overview of the Seasons mosaic within its cover building, House of Jason Magnus, Cyrene (photo: W.T. Wootton)

Fig. 2. Details of the removed spandrels, Spring to the left and Winter to the right, the Seasons mosaic, House of Jason Magnus, Cyrene (photo: W.T. Wootton)

Fig. 3. Overview of the ancient site of Berenice, Sidi Khrebish, Benghazi (photo: W.T. Wootton)

generation of Libyan curators and archaeologists to strengthen the capacity of the Department of Antiquities to protect and manage the country's cultural heritage resources effectively in the face of threats that are on an unparalleled scale". These issues risk being further exacerbated as the country enters a volatile post-conflict period, a time of increased danger due to the availability of weapons, the presence of armed militias, and continued political instability.

Conserving and managing Libya's mosaics: some background and context

Concerns about the state of Libya's mosaics have previously been voiced (see for example Witts 1993, 27; Foschi 2003; Bennett and Barker 2011, 16-17). Enrica Foschi, for example, has drawn attention to the continued use of out-dated conservation techniques and inappropriate materials at Sabratha, which have resulted in the degradation of the mosaics. A situation made worse by large visitor numbers and open access. She calls for new evaluations, conservation methodologies, treatments and maintenance. A more devastating combination of now-defunct conservation techniques, a desire to display the mosaics outside and no system of monitoring can be seen in Benghazi (Fig. 3). During the 1970s rescue and more systematic excavations took place at the Turkish cemetery of Sidi Khrebish when part of the ancient site of Berenice was exposed after a decision to develop the area (Lloyd 1985, 11-14). Thirty-four tessella-

Fig. 4. Mosaic 16, below in 2005 and above in 2012, Sidi Khrebish, Benghazi (photo: W.T. Wootton)

Fig. 5. Pavement 25, below in 2005 and above in 2012, Sidi Khrebish, Benghazi (photo: W.T. Wootton)

Fig. 6. View of the covered mosaics at the Villa of the Nereids at Tajourah (photo: W.T. Wootton)

ted pavements, one *emblema* and one *opus sectile* floor were uncovered (Michaelides 1988), some of which were then lifted by the Libyan authorities, re-laid onto concrete reinforced with iron, and moved together to form a new suite of pavements. Two mosaics found at the entrance to the Turkish cemetery in 1965 had already been lifted by the Department of Antiquities prior to these excavations (Lloyd 1985, 11). Comparison to the published excavation photographs shows the rate of deterioration, while photographs taken in 2005 and 2012 indicate its acceleration in some cases. Compare for example Fig. 4 and 5 to Michaelides 1998, no. 16, fig. 39-45, col. pl. II-III, and no. 25, fig. 62, 75-87, 89, col. pl. IX-XV.

The severity of the situation at many Libyan sites – the Villa of the Nereids at Tajourah is particularly critical (Fig. 6) – demands swift and decisive action (Di Vita 1966; Mattingly 1995, 141 ('Taggiura'); Kenrick 2009, 142). Any remedial work, however, should be part of a wider programme of condition assessment so that the Department can make informed decisions about the allocation of funds at local, regional and national levels based on an understanding of the scale of the problem. This will not only require time and specialist knowledge but also innovative solutions; John Stewart's proposal to train site managers and archaeologists to undertake rapid surveys, for example, could be usefully tested (see Stewart 2017). During this process appropriate long-term preventive measures should also be identified.

An initial survey of lifted mosaics in Libya was completed in association with Mosaikon before the conference was held (Antomachi and Abend 2017, report on the project although without the Libyan data). Its purpose was to record their "quantity, location, support type, and conservation condition", in order to understand the extent of the problem and to provide tangible solutions, whether the identification of specialized training needs or the development of new backings from affordable and locally-available materials (see Teutonico and Friedman 2017).

The original conference poster of Catherine Antomachi *et al.* showed that Libya has a reasonable amount of lifted mosaic including 1,753 m^2 in museums, of which 480 m^2 has been re-laid on concrete-based supports, 1,564 m^2 is exhibited in galleries and 135 m^2 outdoors. These numbers, however, are significantly smaller than those in countries such as Algeria, Syria, Tunisia or Turkey, especially in terms of re-laid mosaics – Tunisia, for example, has 6,377 m^2 of re-laid mosaic. Importantly, their project plans to develop an online database "to facilitate the collection, sharing and analysis of the survey data". As there is no catalogue of Libyan mosaics, this review should represent an important step forward in the Department's ability to manage the lifted mosaics and monitor their condition.

The mosaics of Tripolitania and Cyrenaica have attracted significant academic interest throughout the 20th century (see, for example, the entries in the volumes of the *Bulletin d'information de l'Association Internationale pour l'Etude de la Mosaique Antique*, published since 1968). As a result, extensive documentation already exists in publications as well as in unpublished archives belonging to the Department. For example, Ward-Perkins and Toynbee (1949) speak of important documentation in the Department's archives detailing the excavation, consolidation and restoration of the Hunting Baths at

Fig. 7. Rubbish on the Lower City, Euesperides (Benghazi) (photo: W.T. Wootton)

Lepcis Magna in the early 1930s, while Foschi (2003) mentions records surviving from the restoration work at Sabratha between 1927 and 1959.

All such documentation, including any new condition assessments, need to be consolidated, integrated and centralized while remaining available to, and able to be updated by those involved in their management and conservation. Such a resource – a 21st century corpus? – should be undertaken in conjunction with a national sites and monuments record so that Libya's heritage can be properly assessed, monitored and safeguarded against the growing pressures of development in both urban and rural contexts (Bennett and Barker 2011, 14-20).

Construction has already happened near and on sites of archaeological importance, such as Apollonia (see Marzano 2006, 93), and development continues to be a significant problem since the uprising. Although legislation exists it has been rarely used and could be better prosecuted with a sites and monuments record in the hands of a strong Department. A sense of responsibility among the general public could be simultaneously engendered via a programme of education across the country aimed at building awareness of, and pride in Libya's heritage. There are instances of public engagement being undertaken by foreign missions, for example by the international team excavating Benghazi's other classical site, Euesperides (Marzano 2006, 91).

The preservation of Euesperides has been threatened by the development of electricity substations, an illegal bus station and a shopping centre, the latter blocked by legal means (Bennett *et al.* 2001, 221;

Wilson *et al.* 2004, 186-187). However, despite boasting some important pebble and tessera mosaics, which contribute to our knowledge of the development of tessellation in the early 3rd century BC (Wilson *et al.* 2004, 155-158), the Lower City has been used as a rubbish dump (Marzano 2006, fig. 1; Wilson *et al.* 2004, fig. 17) (Fig. 7). This has not only affected the archaeology but also the rare *sebkha* vegetation which is an important but endangered natural habitat.

Plans exist to turn the area into an archaeological park, thus demarcating the site, and to create a museum, both of which include significant educational elements (Marzano 2006). Such a vision of the future is crucial to the survival of this urban site and is echoed in an even more ambitious plan – the "Benghazi Urban Charter" – proposed by Medurb to create the "Venice of North Africa". There are other exciting and positive initiatives that have been developed over the last ten years. These include the "Tripoli City Code" for the Medina Kedima, the Green Mountain Project for a sustainable future, and the five-year plan, sponsored by the World Bank, for the Department of Antiquities. Considerable thought and effort has gone into their production – collaborative initiatives between the Libyans and the international community – and they provide an important foundation for the future.

Capacity building is a crucial part of these plans and must be used to overturn the "chronic lack of state investment" since 1969 (Bennett and Barker 2011, 16 – although they note the training done by Richard Goodchild in the 1960s). The importance of training has been recognized since the first meeting of the ICCM in 1977, becoming a regular feature of the conferences (de Guichen and Nardi 2008, 10-12). As a result, there is a growing body of published material on the aims and methods of training efforts with useful evaluations of their outcomes including reflections on making such projects more effective. For example, the proceedings of the 9th ICCM conference includes a chapter on the "Training of Conservation Practitioners" with four papers on training projects in the Middle East and North Africa (Ben Abed, Demas and Roby 2008, 245-272). In one case, the associated training manual has been made available online in three different languages, including Arabic (available on the Getty website: http://www.getty.edu/conservation/publications_resources/pdf_publications/tech_training.html – accessed April 2012).

There is, however, still no major synthetic work bringing together the dramatic changes in conservation practice over the last 35 years, much of this knowledge remaining diffuse and inaccessible to many (de Guichen and Nardi 2008, 13). Attempts are being made to collate bibliographic data but the efficacy of this depends on managers, conservators and technicians acquiring the appropriate publications, understanding the languages in which they are written and being able to apply the knowledge with appropriate adjustment to their own particular context (Piqué *et al.* 2008; see also Bakirtzis and Mastora 2008; and Lewinsky and Neguer 2017).

Future work in Libya has much to learn from initiatives in Jordan, Palestine, Syria, Tunisia and Turkey. Their situations bear an uncanny resemblance, whether the low value of cultural heritage, the lack of educational programmes and public awareness, inadequate legislation and funding, or the pressures of rapidly deteriorating and numerous mosaics all with their own special set of circumstances (Hamdan, Shaaban and Benelli 2008). The challenges facing Libya are, in fact, international ones. In Turkey, for example, the absence of money, time and trained personnel results in unsatisfactory documentation and condition assessments as well as the continued lifting of mosaics without an appropriate infrastructure for storage and maintenance (Kökten 2017). Professionals from Turkey and elsewhere continue to call for an international set of standards, whether guides to preventive conservation aimed at non-specialist conservators or codes for site management tied to legislation, and, above all, for specialist programmes for the long-term training of maintenance technicians and conservators.

Such training programmes have not existed in Libya and there has been no system for the monitoring and maintenance of archaeological sites. The critical situations found at Benghazi and elsewhere are unfortunate witnesses to this. As the problems become increasingly serious so the appropriate response becomes harder to formulate and requires more time, effort and money. Training is needed at all levels, from site-controllers to technicians, and should be used to build consensus of approach to ensure that out-dated methods are removed from the decision-making process. There is a lot to learn from work in Tunisia, whether the matching of participants' profiles to the nature of the course or the tailoring of the teaching to the needs and backgrounds of the learners (Roby, Alberti, Bourguignon and Ben Abed 2008).

In Libya, as Bennett and Barker (2011, 20-22) point out, it is desirable to identify and train the next generation of site-controllers, archaeologists, conservators and technicians. In 2012 there were some indicators that this process was beginning to happen. Libyans, for example, were due to join the next Mosaikon training courses for technicians and for curators, both run by the Getty Conservation Institute. In addition, as Lesley Fitton, Keeper of the Department of Greece and Rome at the British Museum had announced at the "Libya Matters" conference at King's College London on 18th February 2012, the Department would select two Libyan curatorial staff to take part in their International Training Programme. There were also important initiatives underway by Luisa Musso of Roma Tre University at Lepcis Magna and the Villa Silin in Tripolitania, and by Susan Kane of Oberlin College (Ohio) at Shahat (Cyrene) in Cyrenaica. This latter initiative was supported by grants from the Ambassador Fund for Cultural Preservation from the U.S. State Department and included a training course for current staff – taught by an Arabic-speaking cultural heritage professional – focused on modern international standards for site survey, monitoring practices, and cultural heritage management (my thanks to Susan Kane for providing this information via email – 29th March 2012).

CaMMiL was part of that momentum, belonging to a group of distinct and complimentary efforts designed to help the Department during this challenging post-conflict period and beyond.

Piece by piece: reporting on CaMMiL as it was originally conceived

CaMMiL was developed in 2010, at a time when Gaddafi was in power and, it was assumed, would remain so for the foreseeable future. The project's aim was simple: to start bridging the gap in knowledge of up-to-date conservation practices and management skills created during Libya's long absence from the international stage. This would be achieved via two five-day workshops forming an affordable, initial effort to build capacity by providing foundation-level skills, new professional networks and a context for the assessment of need. The knowledge gained could then be expanded by joining training schemes offered by Mosaikon, the Getty Conservation Institute or ICCROM.

We were to visit Libya on three separate occasions. A reconnaissance trip would evaluate the Department's current situation and identify participants and assess their knowledge levels. Our focus was on the decision-makers at sites and in museums, often archaeologists by training, but we also felt it important to create consensus by engaging those working at a technician level. At the same time we wanted to target Libyans at the early- or mid-stages of their career, who would be involved with the Department over the longer term and be responsible for its future management.

Once this assessment was complete, planning for the workshops would begin. The structure of both would start out being identical in content and coverage; repeating the programme ensured the same knowledge was disseminated across the country (Fig. 8). Some adaptation, however, was expected in order to respond to issues specific to the area or participants. The programme was structured in three parts. On the first morning was scheduled a half-day round-table discussion with the top-level decision makers, the Chairman and his team. This was followed by a three-day workshop with the site-controllers and other archaeologists or scientists connected to the Department, the site or a university in the area. In addition, one-and-a half days were to be devoted to the technicians. The sessions were broadly conceived to address different themes associated with mosaic conservation and site management via lectures, seminars and practical on-site classes. There were those specific to mosaics, such as 'Materials, techniques and context', 'Documentation and recording', 'Condition assessment (on sites and in museums)', and 'Appropriate interventions, maintenance and monitoring'. And those that dealt with issues related to mosaics and archaeological sites: 'Mosaic conservation and management strategies', 'Making decisions for mosaics: sites and museums' and 'Risk assessment, site management and tourism'. They were to be delivered in English with Arabic translation, each session having a corresponding Arabic "hand-out" for reference both during and after the sessions.

The project team in 2011, at that time, numbered seven, including three native Arabic speakers, who, in addition to their own particular expertise, could support the Libyan participants by acting as role models and future contacts. It consisted of (in alphabetical order): Lotfi Belhouchet (Chargé de Recherches, INP, Tunisia), Martha Demas (Getty Conservation Institute, USA), Niki Savvides (PhD student in Archaeological Site Management, UCL, UK), Isabelle Skaf (Freelance conservator and founding partner of Conservation SARL, Lebanon), John Stewart (Senior Architectural Conservator, English Heritage, UK), Hafed Walda (Senior Analyst, Research Fellow and Lecturer, KCL, UK) and Will Wootton (Lecturer in Roman Art, KCL, UK).

Workshop programme

	Day 1	Day 2 (Group 1)	Day 3 (Group 1)	Day 4 (Group 1)	Day 5 (Group 2)
Session 1 (0930-1100)	Planning meeting: conserving & managing mosaics in Lybia	Ancient mosaics & their study: materials, techniques & context	Condition assessment of mosaics: site & museums	Documentation & condition assessment exercise	Materials & their deterioration processes
Session 2 (1130-1300)	Planning meeting: conserving & managing mosaics in Lybia	Documentation & recording for ancient mosaics	Materials & their deterioration processes	Management strategies exercise	Appropriate interventions, maintenance & monitoring
Lunch	Day 1 (Group 1)			Day 4 (Group 2)	
Session 3 (1430-1600)	Introduction: aims & overview	Making decisions for mosaics: sites & museums	Appropriate interventions maintenance & monitoring	Principles & ethics of conservation	Condition maintenance& monitoring exercise
Session 4 (1630-1800)	Principles & ethics of conservation & site management	Risk assessment, site management & tourism	Future conservbation & management strategies	Ancient mosaics: documentation & assessment	

Participants: Group 1: Site and museum controllers, academics and archaelogists, Group 2: Museum & site technicians.

Fig. 8. *CaMMiL* workshop programme for Tripolitania and Cyrenaica, designed in 2011 but never carried out

At the end of each visit, team members were expected to report on their experience, information that would have been collated and presented to the Department. This document's purpose was to offer a review of the current situation along with recommendations for the future. In the end, however, the project never took place in this form.

Conclusions: a different *CaMMiL*?

When this paper was originally submitted for publication in the spring of 2012, three of the project team – Hafed Walda, John Stewart and Will Wootton – had just returned from Libya. This trip, which took place in April 2012, evaluated the present situation there and raised awareness of the project among the Department's staff and other interested members of the general public. It was funded by the Getty Foundation and made possible by the Department of Antiquities of Libya through the help given us by the Chairman, Dr Saleh Agab, and his staff, especially Mustafa Turjman. We remain very grateful to both organizations and their employees.

Over ten days we visited sites with mosaics along the Libyan coastline and delivered five presentations. The locations were chosen beforehand on the basis of their size, the presence of mosaics and the facilities available. In each case we met with the site-controller and their management team before the presentations to introduce them to the project, discuss the content of the presentations and any particular issues associated with the conservation and management of mosaics on their site or in the region.

The presentations usually followed the next day and were advertised in advance. We had prepared a single presentation, given at each site and delivered in Arabic, which defined what a mosaic is, examined some of the problems associated with their conservation and management, and proposed some easy and effective solutions. The slides were translated into Arabic and hard copies were given to all those attending.

In total 121 people attended, coming from many different spheres: current and previous employees of the Department, staff and students of universities, and those with an interest in the local archaeology, including journalists. After questions and discussion, a form was circulated on which those attending could register their interest in participating in the subsequent workshops. This was done by a large percentage of those attending.

During and after the presentations there was considerable engagement. The opportunity for discussion elicited enthusiastic responses in the form of questions and comments. The issues raised were then used to guide the format of the future workshops, although some of these problems were outside of our scope. In addition, site visits took place usually with members of the Department with whom we discussed recommendations for the conservation of problematical pavements. This also offered an opportunity to survey the exposed mosaics to gauge the problems being experienced as well as the didactic potential of the site to the workshops.

It became evident during our visit that planning and construction activity is having a significant impact on Libya's archaeological heritage, including its mosaics. In particular, rescue excavation has become a core part of the Department's work and therefore documentation and inventory were identified as necessary inclusions in the workshops. Two main conservation techniques were raised with regularity: reburial and treatment of mosaics with iron-reinforced cement backing. There was also an express need for advice on storage as well as the maintenance and renovation of existing cover buildings.

Following the completion of the evaluation trip, the project team began planning for the delivery of the two workshops, one in Tripolitania and one in Cyrenaica, which took place during the following twelve months (Wootton *et al.* 2015). The evaluation trip highlighted a number of areas that were crucial to their subsequent success. The importance of the venue, selected on the basis of the quantity and availability of mosaics, their didactic value as well as logistical issues such as accommodation and lecture facilities. The format and programme of the workshops was updated to respond to the needs of the region and aimed at the different groups of participants, which was still divided between site-controllers and their management teams, and the technicians.

Selection of the participants was done in collaboration with the Department using the data we had collected and specially-prepared questionnaires translated into Arabic. Numbers were limited, between five to seven for the round-table discussions with the site-controllers and about 15 for the technicians attending the lectures and practical activities. It was also deemed critical to identify appropriate project personnel. The choice was made on the basis of the final curriculum of the workshops and the need for Arabic speakers. To this end, Alaa El-Habashi – an experienced conservation architect and academic from Egypt – joined the project team for the two workshops.

Libya is not alone in facing "real problems" in the conservation and management of its heritage. *CaMMiL* was designed to help the Libyans with "practical solutions". It hoped to achieve this by serving as a foundation to more formal training courses run by major international organizations and empowering Libyans in the conservation and management of their own heritage by giving them the confidence to make simple and sound decisions. The subsequent workshops helped to establish and develop professional networks between Libyans and international experts, but there is still significant work required to create a robust plan for the future conservation and management of Libya's mosaics. Although the situation in Libya remains in crisis, the country could benefit enormously from the positive changes which have taken place in conservation techniques and training over the past quarter of a century. The application and integration of these new approaches by the current and next generations in Libya could result in a well-managed heritage that would have important economic and social benefits by healing wounds, bridging divides and restoring a sense of national pride and common identity.

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POSTER

TRAINING OF ARCHAEOLOGICAL SITE MANAGERS: MOSAIKON'S APPROACH TO THE CONSERVATION AND MANAGEMENT OF MOSAICS AT ARCHAEOLOGICAL SITES IN THE MEDITERRANEAN REGION*

Kathleen Dardes, Leslie Friedman, Thomas Roby and Zaki Aslan

The first major activity of the MOSAIKON strategic initiative (Dardes *et al.* 2010; Teutonico *et al.* 2014; and Teutonico and Friedman 2017), a partnership of the Getty Conservation Institute, the Getty Foundation, ICCROM (the International Centre for the Study of the Preservation and Restoration of Cultural Property), and the International Committee for the Conservation of Mosaics (ICCM), began in May, 2010 with a regional course, the *Conservation and Management of Mosaics at Archaeological Sites* (for other MOSAIKON projects, see Roby *et al.* 2010. Also Antomarchi and Abend 2017; and Roby *at al.* 2017). Fifteen site managers from throughout the region took part in a three-week workshop held at the World Heritage

Fig. 1. Course participants during on-site group exercises, Tyre, Lebanon (Photo: Leslie Friedman)

site of Tyre, Lebanon (Fig.1). The workshop, the first of the three components, addressed concepts such as archaeological site management, documentation and recording of mosaics, material deterioration, condition assessment, and preventive and remedial interventions (Fig. 2 and 3).

The second component of the course was a year-long mentoring phase during which the participants pursued independent training projects and prepared reports at their home sites or institutions, guided by instructors who followed their progress and provided constructive advice and direction. Projects ranged from developing a mosaic

Fig. 2. Presentation of group conservation planning exercise, Tyre, Lebanon (Photo: Gaël de Guichen)

Fig. 3. Course participant learning about remedial interventions such as grouting with lime mortars (Photo: Leslie Friedman)

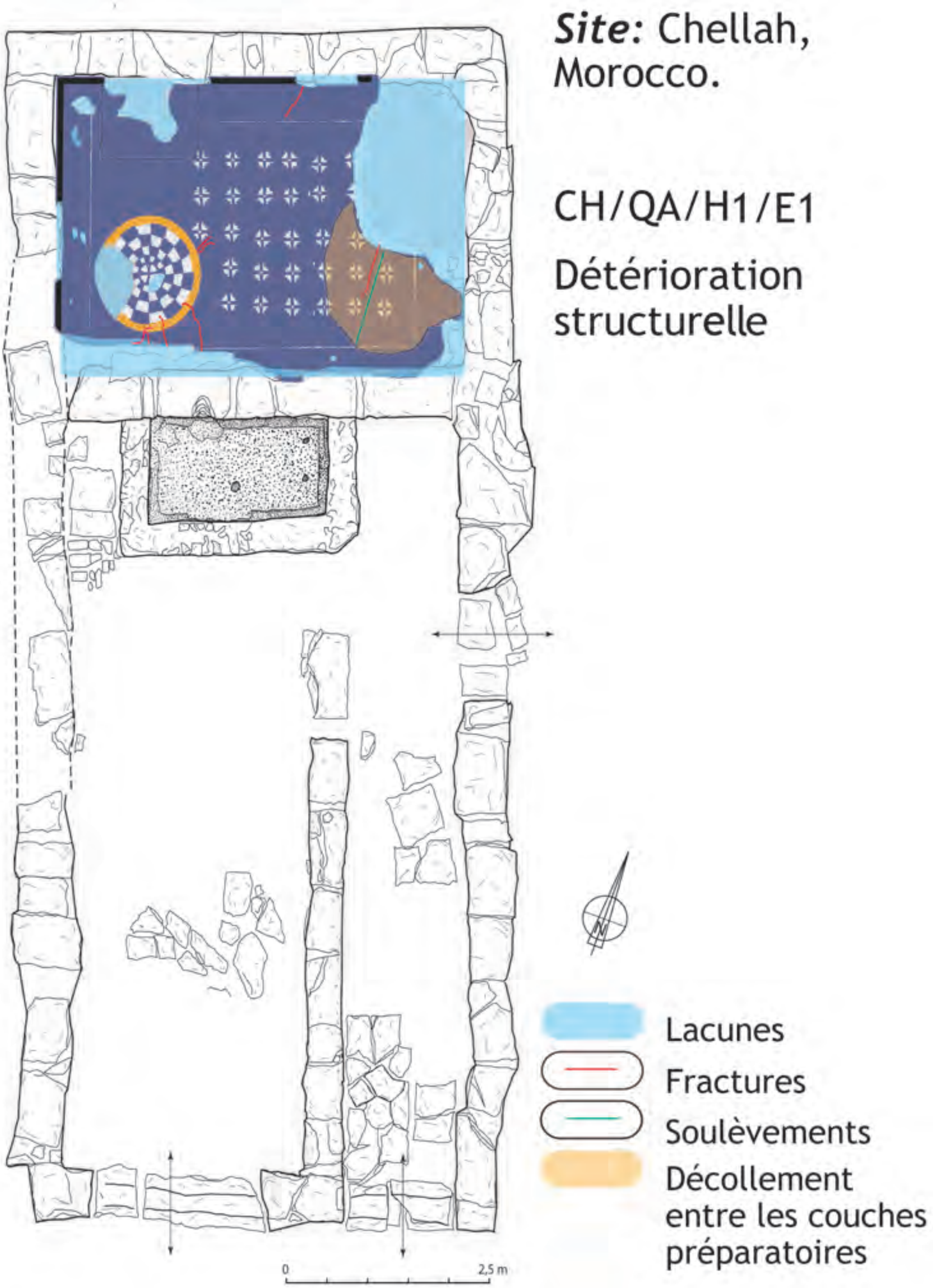

Fig. 4. Example of condition recording produced by one of the students during the mentoring phase of the course (Courtesy of Hicham Rguig)

Fig. 5. Course participants from Algeria, Egypt, Lebanon, Morocco, Syria and Tunisia, and instructors at the follow-up workshop at ICCROM, Rome, Italy (Photo: Sabina Giuriati)

conservation program for a particular site (Fig. 4), to planning a research project comparing protection methods for mosaics re-laid in situ on reinforced concrete.

The last component was a review meeting held at ICCROM, in Rome, which brought together the participants and core instructors (Fig. 5). Participants presented their work for further discussion, while key ideas and concepts that were introduced in the first workshop were revisited and emphasized. Site visits in Rome and Herculaneum, hosted by the Soprintendenza Archeologica di Roma and the Herculaneum Conservation Project, allowed the participants to observe recent and ongoing mosaic conservation and main-

Fig. 6. Student presenting an action plan developed by the group during the follow-up workshop, Herculaneum, Italy. (Photo: Leslie Friedman)

tenance planning and implementation. Group exercises developing mosaic conservation action plans further utilized the didactic opportunities offered by site of Herculaneum (Fig. 6). Bringing together participants from throughout the region with both local and international expertise provides a more wide-ranging view of the problems facing archaeological mosaics and allows a more varied consideration of the possible solutions.

Additionally, the expansion of the training course to include an extended mentoring period, practical training projects, and active communication amongst the participants, instructors and the MOSAIKON team, provided a more substantial and effective learning environment. Two more such courses are planned for site managers from the Maghreb and the non-Arabic speaking parts of the Mediterranean region.

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Zaki Aslan, ICCROM

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Closing Remarks

.. Soon the 11th Conference of the International Committee for the Conservation of Mosaics will draw to a close.
What is one could take-home from such an event? Certainly, one cannot forget the exceptional hospitality of the Moroccan authorities, the excellent organisation and the overall friendly atmosphere. This conference was a great opportunity to meet with colleagues, encounter old friends and make new ones, get the chance to discuss with a new generation of emerging professionals and learn about current developments and important achievements in the field.
It is indeed great pleasure to see the ICCM growing year by year as an organization, and its network of professionals getting stronger and more diverse over time. In consequence to this, increasingly mosaic pavements are expected to be better conserved, appropriately stored, as well as accessed and enjoyed by the visitors of archaeological sites and museums.
Faithful to the strategic-orientation given in 1977 in Rome, ICCM continues to operate successfully as the reference organisation for the professional community of mosaics conservation - a function that is strengthened considerably through its thematic conferences, which in turn provide an occasion for knowledge exchange on issues of current concern.
Being a scientist by training (no one is perfect!), I listened to all 20 presentations and looked – during the conference breaks – at all 40 posters with a scientific approach.
Allow me to express two comments.
Since my very early days in this field, I have had the privilege to meet, work with, and learn from some of the

scientists who have made conservation a well-recognised and respected discipline. If their names remain, if their publications are still influential, that is because their research focused on providing feasible solutions (both technically and financially) to real-life conservation problems. Of course, everyone would agree that research is necessary but, first of all, one should ask him-/herself: "What is the problem?"

Then, once the problem is clearly identified, one should reflect on the three following questions:

- Would the potential answer be relevant to Conservation?
- Can I reach a desirable conclusion in a simple way?
- Does my study require the use of sophisticated instruments, (ESM, PED-XRF, XRD, SEM-EDS and others) or the latest technology to get an answer?

By reading some of the posters and listening to some of the presentations, I wonder if the authors have asked themselves these questions.

The use of such equipment and technology has probably contributed more to the professional development of those using them, than to the conservation of individual artefacts. We must not forget that the word "Conservation" is written in the acronym of ICCM.

As for my second comment, that should come as no surprise to those who have attended previous ICCM conferences: Surely we work with enthusiasm and dedication; but often we fail to respond to the breadth of our professional responsibilities. Mosaics in need of conservation represent several hundreds of square meters of pavements, yet sometimes we find ourselves content to look at the treatment of just a few rows of tesserae.

In fact, we do not know well what we are dealing with. It seems that professionals dealing with mosaic conservation are scared to confront numbers. They rarely give an answer to questions beginning with "How much…?" or "How many…?".

It is important every so often to challenge ourselves, and as a reality check try to seek answers and reflect on some very basic questions:

– How many officially registered mosaics exist in our countries? And, how many hundreds of square meters do they represent?

– How many of those are in a good condition? How many of those are preserved outdoors with no protection (shelter)?
– How much could the maintenance of one square meter of this treasure cost? How much time would it require?
– How long does it take to train a conservation professional?
– How much does a well-maintained site contribute to the citizens' quality of life? How much does accessibility to heritage sites improve a given community's resilience and well-being? Etc.…etc.

As professionals we should be able to present to decision-makers a cost/benefit analysis through which one could pick the optimal solution out of a series of options, when a pavement is discovered?
As long as we are not able to provide those answers we will never been able really move ahead.
Not long ago, I was attending a Forum for Culture. A delegate representing the World Bank highlighted in her presentation how difficult it was for their organisation to finance cultural projects because they are not supported with data. She concluded her speech with three slides.
– At the centre of the first slide, there appeared a single: "Measure".
– On the second slide, the same single word "Measure" was written in much bigger letters.
– And on the last one, the word "Measure" was covering the whole screen.
I transmit you her conclusion.
Following this approach, we will ensure more effective and better-quality technical work, but, more importantly, we will enable visitors to discover, better understand and enjoy how our distant ancestors were living. All in all, we always have to keep in mind that we are skilled technicians, but above all social workers in the service of heritage and society.

Gaël de Guichen
27 October 2011

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