PROCEEDINGS

Proceedings of the 12th Conference of the International Committee for the Conservation of Mosaics, Sardinia, October 27–31, 2014

Edited by Jeanne Marie Teutonico, Leslie Friedman, Aïcha Ben Abed, and Roberto Nardi

The Conservation and Presentation of Mosaics: At What Cost?

The Getty Conservation Institute

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À quel coût ?

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Actes de la 12e Conférence de l'ICCM
Sardinie, 27–31 octobre 2014

Edited by
Jeanne Marie Teutonico, Leslie Friedman,
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Publié sous la direction de
Jeanne Marie Teutonico, Leslie Friedman,
Aïcha Ben Abed et Roberto Nardi

THE GETTY CONSERVATION INSTITUTE
LOS ANGELES

The Getty Conservation Institute
Timothy P. Whalen, *Director*
Jeanne Marie Teutonico, *Associate Director, Programs*

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

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Foreword

The Getty Conservation Institute has long been committed to the conservation of mosaics ranging chronologically from works of antiquity to those of the Middle Ages. Over the years, the GCI has organized seminars, led training courses and workshops, and implemented field projects modeling best practices at sites in Europe, the Middle East, and North Africa. Most recently, the GCI has partnered with the Getty Foundation, the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM) in Rome, and the International Committee for the Conservation of Mosaics (ICCM) to form MOSAIKON, an ambitious regional initiative dedicated to improving the conservation, presentation, and management of mosaics in the southern and eastern Mediterranean region.

Since the ICCM's founding in 1978 as an organization of professionals dedicated to the conservation of mosaics, its triennial conferences have addressed critical topics in the field and provided a forum for debate and the exchange of information. The published proceedings of these conferences represent a significant body of literature on mosaic conservation. We are honored to contribute to this important resource with the publication of the proceedings of the 12th ICCM Conference, held in Sardinia, Italy, October 27–31, 2014. This is the second volume of ICCM proceedings published by the GCI, the first being *Lessons Learned: Reflecting on the Theory and Practice of Mosaic Conservation,* the proceedings of the 9th ICCM Conference, held in Hammamet, Tunisia, in 2005, which built on many years of collaboration with the Institut National du Patrimoine (INP) of Tunisia.

The 12th ICCM Conference took place in Sassari and Alghero, Sardinia, at the invitation of the Soprintendenza per i Beni Archeologici per le province di Sassari e Nuoro (Superintendency for the Archaeological Heritage of the provinces of Sassari and Nuoro), in partnership with the Getty Foundation, the University of Sassari, and the University of Cyprus. As government funding for culture and conservation continues to be reduced, we are faced with the challenge of finding new and innovative solutions to preserving the mosaic heritage. Over the course of five days, more than eighty papers and posters were presented by archaeologists, conservators, and art historians on the conference's theme, "Conservation and Presentation of Mosaics: At What Cost?," representing a broad range of issues and a diversity of sites in the region.

Continuing its history of support through the MOSAIKON initiative, the Getty Foundation again provided a grant to the ICCM to facilitate the attendance of seventy professionals from nineteen countries throughout southeastern Europe, Africa, and the Middle East. These are countries that have enormous mosaic collections, both in situ and in museums, but that in the past have been underrepresented at ICCM conferences. With the help of the Getty Foundation, this is no longer the case, and the international community of practice has grown and strengthened.

The success of the conference was due in no small part to the efforts of Demetrios Michaelides, who served the ICCM with incredible dedication as its president for twenty years and who deserves our special recognition. Also invaluable to the organization of the conference were Skevi Christodoulou, ICCM secretary, and Antonietta Boninu, former director of the Superintendency for the Archaeological Heritage of the provinces of Sassari and Nuoro, whose deep knowledge of Sardinia and years of government service opened many doors.

Sardinia provided a superb backdrop for the conference, enriching the sessions with its wealth of archaeological treasures and exquisite mosaics. Accompanying the regular conference sessions were a number of site visits that gave conference participants the opportunity to experience Sardinia's diverse heritage in all its dimensions. A full-day excursion took participants to the unspoiled town of Bosa and the Archaeological Museum of Cabras, which contains the extraordinary prehistoric stone sculptures known as the Giants of Monte Prama. Visits to the sites of Tharros and the Nuraghe Santu Antine provided further understanding of Sardinia's prehistory. A tour of historical Porto Torres was offered later in the week. We are grateful to our generous hosts in Sardinia for facilitating access to these exceptional sites.

In its almost four decades of history, the ICCM has produced conference proceedings that constitute a primary reference for mosaic scholars, conservation practitioners, and students. We thank the volume editors, Jeanne Marie Teutonico, Leslie Friedman, Aïcha Ben Abed, and Robert Nardi, for all their efforts in guiding this volume to publication. We hope that it will make a lasting contribution to the literature in the field.

Timothy P. Whalen
Director, The Getty Conservation Institute

Avant-propos

L'Institut Getty de Conservation (GCI) est depuis longtemps engagé dans la conservation de mosaïques datant de l'Antiquité au Moyen Âge. Au fil du temps, le GCI a organisé des séminaires, animé des sessions de formation ainsi que des ateliers, et a mis en place des projets de terrain visant à la présentation de bonnes pratiques sur des sites archéologiques en Europe, au Moyen-Orient et en Afrique du Nord. Dernièrement, le GCI s'est associé à la Getty Foundation, au Centre international d'études pour la conservation et la restauration des biens culturels (ICCROM) de Rome et au Comité international pour la conservation des mosaïques (ICCM) afin de créer MOSAIKON. Ce programme régional ambitieux a pour but d'améliorer la conservation, la présentation et la gestion des mosaïques dans le sud et l'est du Bassin méditerranéen.

Depuis la fondation de l'ICCM, en 1978, en tant qu'organisation professionnelle dédiée à la conservation des mosaïques, ses colloques triennaux ont traité de thèmes centraux dans ce domaine et fourni un forum propice au débat et à l'échange d'informations. Les actes publiés de ces colloques représentent un corpus significatif de documents sur la conservation des mosaïques. Nous avons l'honneur de contribuer à cette importante ressource *via* la publication des actes du XII^{e} Colloque de l'ICCM, qui s'est déroulé en Sardaigne du 27 au 31 octobre 2014. Ces actes sont les seconds publiés par le GCI. Le premier volume, intitulé *Leçons retenues : Les enseignements tirés des expériences passées dans le domaine de la conservation des mosaïques*, rassemblait les actes du IX^{e} colloque de l'ICCM, organisé à Hammamet, en Tunisie, en 2005, fruit d'une longue collaboration avec l'Institut national du patrimoine (INP) de Tunisie.

Le XII^{e} Colloque de l'ICCM s'est tenu à Sassari et à Alghero, en Sardaigne, à l'invitation de la Soprintendenza per i Beni Archeologici per le province di Sassari e Nuoro (Surintendance des biens archéologiques des provinces de Sassari et de Nuoro), en partenariat avec la Fondation Getty, l'université de Sassari et l'université de Chypre. Alors que les subventions publiques à destination de la culture et de la conservation ne cessent de diminuer, nous faisons face au défi de trouver des solutions inédites et innovantes pour conserver le patrimoine de mosaïques. Pendant cinq jours, archéologues, conservateurs et historiens de l'art ont présenté plus de 80 communications et posters sur le thème du colloque : « La conservation et la présentation des mosaïques : à quel coût ? » Ces interventions ont abordé un large éventail de sujets, et leurs auteurs représentaient une grande diversité de sites de la région.

La Fondation Getty renouvelle son soutien à l'ICCM au travers du programme MOSAIKON et lui a, cette fois encore, accordé un financement pour faciliter la venue de 70 professionnels originaires de 19 pays d'Europe du Sud-Est, d'Afrique et du Moyen-Orient. Ces pays possèdent d'énormes collections de mosaïques, à la fois *in situ* et dans des musées, mais étaient sous-représentés lors des précédents colloques. Grâce à l'aide de la Fondation Getty, cette situation a changé et la communauté internationale de pratiques s'en est trouvée agrandie et renforcée.

Le succès de ce colloque est dû en grande partie au travail de Demetrios Michaelides, qui a fait preuve d'un incroyable dévouement tout au long de ses vingt années à la présidence de l'ICCM. Il mérite tout particulièrement notre reconnaissance. L'organisation du colloque n'aurait pas été possible sans Skevi Christodoulou, secrétaire de l'ICCM, et Antonietta Boninu, ancienne directrice de la Surintendance des biens archéologiques des provinces de Sassari et de Nuoro. Sa solide connaissance de la Sardaigne et ses années d'expérience dans le service public nous ont ouvert de nombreuses portes.

Le superbe décor de la Sardaigne a enrichi les séances du colloque grâce à ses abondants trésors archéologiques et à ses magnifiques mosaïques. Les différentes visites de sites, organisées entre les conférences, ont permis aux participants de découvrir la diversité du patrimoine sarde dans toutes ses dimensions. Ils ont effectué une excursion d'une journée entière dans la ville de Bosa, extrêmement bien préservée, et au Musée archéologique de Cabras, qui renferme les Géants de Mont-Prama, ces extraordinaires statues préhistoriques taillées dans la pierre. Grâce aux visites du site de Tharros et du Nuraghe Santu Antine, ils ont pu mieux appréhender la préhistoire de cette région. Plus tard dans la semaine, une visite de Porto Torres, ville chargée d'histoire, a été proposée. Nous remercions nos généreux hôtes sardes de nous avoir facilité l'accès à ces sites exceptionnels.

En presque quarante ans d'existence, l'ICCM a rassemblé des actes de colloque qui constituent une référence de premier ordre pour les spécialistes des mosaïques, les professionnels de la conservation et les étudiants. Nous tenons à remercier les directeurs de ce volume, Jeanne Marie Teutonico, Leslie Friedman, Aïcha Ben Abed et Roberto Nardi, pour leur travail, qui a abouti à la publication de ce recueil. Nous espérons qu'il constituera une contribution durable à la littérature scientifique de ce domaine.

Timothy P. Whalen
Directeur
Institut Getty de Conservation

Acknowledgments

The organization of the 12th ICCM Conference and the publication of its proceedings, from conceptualization to realization, required enormous investments of time and the dedication of many people.

The Scientific Committee, consisting of Aïcha Ben Abed, Antonietta Boninu, Evelyne Chantriaux, Stefania Chlouveraki, Stefano De Caro, Sabah Ferdi, Anne-Marie Guimer-Sorbets, Attilio Mastino, Demetrios Michaelides, Roberto Nardi, John Stewart, and Jeanne Marie Teutonico, developed the theme of the conference and reviewed and selected the papers and posters from the many submissions.

Forming the Organizing Committee were ICCM President Demetrios Michaelides, ICCM Vice President Roberto Nardi, and ICCM Secretary Skevi Christodolou, joined by Antonietta Boninu, former director of archaeology for the Soprintendenza per i Beni Archeologici delle Province di Sassari e Nuoro; Attilio Mastino, rector of the University of Sassari; and Arnaldo Cecchini and Marco Marongiu, from the Department of Architecture in Alghero. Together they tirelessly organized all of the conference logistics, receptions, and visits to sites and museums. Demetrios Michaelides, Antonietta Boninu, Marco Marongiu, and Skevi Christodolou deserve special recognition for the care and attention they brought to all details of conference preparation as well as the management of day-to-day operations during the event.

In Sardinia, we are grateful to the mayors of Sassari and Alghero as well as numerous staff members of the Superintendency for the Archaeological Heritage of the provinces of Sassari and Nuoro for being such welcoming and accommodating hosts during the conference week. We also thank the University of Sassari and the Comune di Alghero for generously providing the locations for the conference sessions. Our thanks to Demetrios Michaelides, who offered eloquent opening remarks, and Simonetta Angiolillo, for an enlightening keynote presentation on the mosaics of Sardinia. The conference sessions were skillfully chaired by Evelyne Chantriaux, John Stewart, Roberto Nardi, Sabah Ferdi, Jeanne Marie Teutonico, Antoinetta Boninu, Demetrios Michaelides, Stefania Chlouveraki, Aïcha Ben Abed, and Anne-Marie Guimier-Sorbets, all of whom gave much of their time and knowledge. Thanks also to the many authors who presented their work at the conference and who contributed valuable papers and posters to this volume.

Undertaking a trilingual publication with close to seventy manuscripts is a complex undertaking. Our appreciation goes to Lucinda Schell and Cynthia Godlewski, with assistance from Eleanor Wolgast and Luann Manning, who expertly managed the proceedings for the GCI. We are also grateful to Tevvy Ball, project editor for Getty Publications; Gary Hespenheide, who designed this handsome book; and our copy editors, Sheila Berg, who skillfully handled the English manuscripts, and Marion Bello and Anna Castellari, who worked on the French and Italian language contributions, respectively.

The volume editors express sincere gratitude to all these individuals for their contributions to both the conference and this volume, which we hope will serve as a useful reference for all who care for our mosaic heritage.

Jeanne Marie Teutonico
Leslie Friedman
Aïcha Ben Abed
Roberto Nardi

Remerciements

L'organisation du XIIe Colloque de l'ICCM et la publication de ses actes, de leur conceptualisation à leur réalisation, ont demandé un énorme investissement en termes de temps ainsi que le dévouement de nombreuses personnes.

Le comité scientifique, constitué par Aïcha Ben Abed, Antonietta Boninu, Évelyne Chantriaux, Stefania Chlouveraki, Stefano De Caro, Sabah Ferdi, Anne-Marie Guimier-Sorbets, Attilio Mastino, Demetrios Michaelides, Roberto Nardi, John Stewart et Jeanne Marie Teutonico, a imaginé le thème du colloque et a étudié et sélectionné les communications et les posters parmi les nombreuses propositions reçues.

Le comité d'organisation était constitué de Demetrios Michaelides, président de l'ICCM, Roberto Nardi, vice-président de l'ICCM, et Skevi Christodolou, secrétaire de l'ICCM, auxquels se sont joints Antonietta Boninu, ancienne directrice de la Surintendance des biens archéologiques des provinces de Sassari et de Nuoro, Attilio Mastino, recteur de l'université de Sassari, Arnaldo Cecchini et Marco Marongiu, du département d'Architecture de l'université de Sassari (site d'Alghero). Ensemble, ils ont inlassablement œuvré à l'organisation de toute la logistique du colloque, des réceptions et des visites des différents sites et musées. Nous remercions tout particulièrement Demetrios Michaelides, Antonietta Boninu, Marco Marongiu et Skevi Christodolou pour le soin et l'attention qu'ils ont portés aux détails des préparatifs du colloque, ainsi que pour leur gestion des activités quotidiennes durant l'événement.

Nous remercions les maires de Sassari et d'Alghero ainsi que les nombreux membres du personnel de la Surintendance des biens archéologiques des provinces de Sassari et de Nuoro pour leur chaleureux accueil lors de cette semaine de colloque. Nous remercions également l'université de Sassari et la Comune di Alghero d'avoir généreusement mis à notre disposition des salles pour les conférences. Nos remerciements à Demetrios Michaelides, pour son éloquent discours d'ouverture, et à Simonetta Angiolillo, professeure des universités, pour son instructive présentation inaugurale sur les mosaïques sardes. Les séances ont été présidées avec talent par Évelyne Chantriaux, John Stewart, Roberto Nardi, Sabah Ferdi, Jeanne Marie Teutonico, Antonietta Boninu, Demetrios Michaelides, Stefania Chlouveraki, Aïcha Ben Abed et Anne-Marie Guimier-Sorbets, qui ont tous donné beaucoup de leur temps et nous ont fait profiter de leurs connaissances. Merci également aux nombreux auteurs qui ont présenté leurs travaux durant le colloque et qui ont contribué à cet ouvrage au travers de communications et de posters de grande valeur.

Concevoir une publication trilingue regroupant près de 70 manuscrits est une entreprise complexe. Nous sommes reconnaissants à Lucinda Schell et Cynthia Godlewski, assistées de Eleanor Wolgast et Luann Manning, d'avoir coordonné cet ouvrage pour le GCI. Merci également à Tevvy Ball, responsable d'édition au sein des services de publication du Getty, à Gary Hespenheide, pour son superbe graphisme, ainsi qu'à nos correctrices : Sheila Berg, qui s'est occupée avec talent des manuscrits en anglais, et Marion Bello et Anna Castellari, qui ont travaillé respectivement sur les contributions en français et en italien.

Les directeurs de cet ouvrage souhaitent exprimer leur sincère gratitude envers toutes ces personnes pour leur apport au colloque et à la publication de ces actes. Nous espérons qu'ils constitueront une référence utile pour tous ceux qui ont à cœur la préservation de notre héritage de mosaïques.

Jeanne Marie Teutonico
Leslie Friedman
Aïcha Ben Abed
Roberto Nardi

Introduction

Jeanne Marie Teutonico and Leslie Friedman

The 12th Conference of the International Committee for the Conservation of Mosaics, titled "Conservation and Presentation of Mosaics: At What Cost?," was held in Sardinia in October 2014. As funding for the conservation of cultural heritage becomes more and more difficult to secure and as governmental budgets for heritage continue to be cut, it is timely that the ICCM dedicated this conference to the theme of cost. The term *cost* here, however, is meant not just in financial terms, but in a wider sense. In addition to the traditional costs of materials and expertise, there are costs associated with the conservation and presentation of mosaics that are intrinsic to conservation decision making. One must constantly weigh a complex set of variables that involve real financial constraints, the views of multiple stakeholders, from national authorities to local communities, and the significance of the object itself and its state of preservation. Costs can relate to issues as varied as the potential loss of authenticity and integrity, management and staffing concerns, and the impact of archaeological excavations, urban development, and tourism.

Clearly, decisions regarding the conservation and presentation of mosaics can be heavily influenced by the financial resources available. Some degree of compromise is often required, with implications for the mosaic and the site in question. What types of approaches mitigate these compromises to arrive at ethical and sustainable solutions? How are different and competing costs balanced? The five-day conference addressed these questions by inviting presentations on financial planning and the monetary costs associated with the conservation and presentation of mosaics, as well as the social, political, and technical factors that affect decision making.

The conference was organized in seven sessions, which have been retained in this volume: Cost, Methods of Survey and Documentation, Conservation and Management, Case Studies, Education and Training, Backing Materials and Techniques, and Presentation and Display. The majority of the posters presented during the conference, almost thirty in number, are also included here, alphabetically by author.

The keynote speech, "The Mosaic Heritage of Sardinia, in Light of Recent Discoveries," by Simonetta Angiolillo of the University of Cagliari, provides a survey of the rich mosaic heritage of the host region of Sardinia, the changing local expressions of which can be traced to stylistic influences from Rome-Ostia as well as highly skilled artisans from Africa. This served as a framework for the conference and a reminder of the extraordinary breadth and complexity of the world's mosaic art and heritage—a good starting point for ensuing discussions regarding the challenges associated with its preservation for future generations.

The opening session of the conference, Cost, presented cases from Sardinia, Tunisia, Jordan, and England, exploring the real costs of conservation implementation projects and conservation planning, especially in an era when funding is often limited. Papers in this session also considered the larger "costs" associated with various conservation decisions, as the concerns and expectations of local communities and other stakeholders are balanced with the needs of the object and the right of future generations to know and experience their heritage. The current negative trend in the way conservation projects are funded and awarded (i.e., to the lowest bidder) and the overall reduction in spending for heritage and its impact were also discussed.

As techniques for documentation, recording, and survey of mosaics continue to evolve and multiply, it is more important than ever that the methods we choose are efficient, cost-effective, easy to use, and flexible enough to manage both data collected in the past and new information. The papers presented in the session Methods of Survey and Documentation explored new approaches and techniques for recording the condition of mosaic pavements, including recently developed documentation software and the use of mobile platforms that are increasingly employed as more digital data are recorded directly on-site. This session also included discussions regarding new applications of existing methods such as GIS to compile and analyze hundreds of years of data and the use of color measurement analytical software to date mosaics.

The Conservation and Management session of the conference examined another area where advances in practice continue to be made, particularly regarding holistic and long-term planning approaches to site management. Rather than consider a mosaic or a number of mosaics in isolation, it is critical to examine the larger context and to understand a site in its entirety. This requires a thorough understanding of the archaeological and excavation history of the site and its significance and condition, as well as consideration of present and future needs. Papers in this session presented a diversity of issues, from the conflicts that can result when significant archaeological remains are discovered during the construction of urban infrastructure to the unique visitation, presentation, and maintenance challenges associated with a large, underwater archaeological park. Shelters and other large-scale interventions were also discussed, especially in light of the need for careful planning and the ability to adapt to changing circumstances.

The fourth session, Case Studies, was composed of a series of seven individual cases, each of which focuses on a particular issue regarding the conservation and presentation of mosaics. These range from the necessity of multidisciplinary teamwork and the challenges inherent in balancing archaeological research and conservation to remedial conservation measures and long-term conservation maintenance planning. The problems associated with lifting and presenting mosaics in museum contexts were also explored, as well as the benefits of conservation to archaeological research when new scientific information is revealed through the conservation process.

Education and Training took up another topic that has been growing in importance over the years: the need to build capacity at the national and local levels in order to ensure the long-term conservation and maintenance of mosaics in situ and in museum environments. In recent years, increasing attention has been given to training initiatives that provide the knowledge and skills required of personnel at various levels who care for the mosaic heritage. Papers in this session discussed recent efforts to train both conservation technicians and site managers in the context of MOSAIKON, a program for the conservation of mosaics in the Mediterranean region. Another paper considered the importance of collaboration between conservators and archaeologists during excavation and presented a possible approach to providing basic conservation training to archaeologists as a way to promote better standards of practice.

The session Backing Materials and Techniques presented research and case studies related to the conservation and presentation of lifted mosaics. As the field at large becomes more concerned with the long-term sustainability of conservation techniques, it has become increasingly important to develop backing methods for lifted mosaics that make use of affordable and locally available materials. Papers in the session addressed this issue, as well as research on new materials or new uses of existing materials in order to achieve high-performing yet lightweight backing systems for both the storage and the display of mosaics. In all cases, the desired properties for these new systems include appropriate strength, low weight for easy transfer and movement, reasonable cost, and reversibility without damage to the original material.

The final session of the conference, Presentation and Display, explored a number of issues that must be considered when presenting mosaics to the public in either a museum or a site setting. Inevitably, several papers dealt with the complexities of designing, constructing, and evaluating the effectiveness and impact of shelters for the protection and display of in situ mosaics. It is clear that more work needs to be done to provide practical guidance in this area. Other presentations focused on approaches to interpretation and display that attempt to balance authenticity with legibility, especially when visitation is a primary objective. In this context, cost was explored from both a monetary and an aesthetic/historical perspective.

The 12th ICCM Conference, perhaps more than in previous years, provided an opportunity for archaeologists, art historians, educators, practicing conservators, and conservation technicians from all over the world to come together to share experiences and to build bridges between their disciplines. Specialists from more than thirty-five countries contributed papers and posters, representing what has truly become an international community of practice.

Increasingly, the presentations reflected changing approaches to practice, with greater emphasis on holistic financial and management planning and a desire to preserve mosaics in situ whenever possible. Other trends included capacity building and the involvement of local communities and stakeholders in conservation decisions, more extensive research on sustainable and affordable methods of backing lifted mosaics, and increased concern for those areas of the world where our cultural heritage is in great peril, threatened with destruction and loss.

From its beginnings more than thirty years ago, the ICCM today is a thriving organization that continues to promote improved standards of practice, a robust and inclusive network of mosaic heritage professionals, greater and more effective dissemination of information, and, ultimately, the better care and stewardship of our fragile and irreplaceable mosaic heritage now and for the future. We hope that the publication of these proceedings, and those of conferences to come, will be a contribution to that legacy.

Introduction

Jeanne Marie Teutonico and Leslie Friedman

Le XII^{e} Colloque du Comité international pour la conservation des mosaïques, qui s'est tenu en Sardaigne en octobre 2014, avait pour thème : « La conservation et la présentation des mosaïques : à quel coût ? » Alors que les financements destinés à la conservation du patrimoine culturel sont de moins en moins assurés et que les budgets gouvernementaux concernant le patrimoine continuent à diminuer, il était tout à fait approprié que l'ICCM consacre ce colloque à la question du coût. Ce terme n'est toutefois pas à prendre uniquement au sens budgétaire mais revêt une signification plus large. Au-delà des coûts habituels de matériel et d'expertise, il en existe d'autres, liés à la conservation et à la présentation des mosaïques. Ils font intrinsèquement partie de l'équation lorsqu'une décision doit être prise en matière de conservation. Il faut toujours intégrer à la réflexion un ensemble complexe de variables, parmi lesquelles figurent les contraintes financières réelles, les avis de multiples intervenants (des autorités nationales aux collectivités locales), ainsi que l'importance de l'objet en lui-même et son état de préservation. Les coûts peuvent être engendrés par des questions aussi diverses qu'une possible perte d'authenticité et d'intégrité de la mosaïque, des questions de gestion et de recrutement, ou encore l'impact que les fouilles archéologiques, le développement de l'urbanisation ou le tourisme peuvent avoir sur le site.

De toute évidence, les décisions concernant la conservation et la présentation des mosaïques peuvent être fortement influencées par les ressources budgétaires disponibles. Un certain degré de compromis est souvent nécessaire, ce qui entraîne des répercussions sur la mosaïque et le site en question. Quels types de stratégie peuvent réduire ces compromis afin d'arriver à des solutions éthiques et viables ? Comment équilibrer des coûts de différentes natures, en concurrence les uns avec les autres ? Le colloque, d'une durée de cinq jours, a abordé ces questions en proposant des présentations sur l'organisation budgétaire et les coûts financiers liés à la conservation et à la présentation de mosaïques. Les facteurs sociaux, politiques et techniques qui pèsent sur la prise de décisions ont également été étudiés.

La conférence était divisée en sept sous-thèmes, repris dans cette publication : « Coût », « Méthodes d'inventaire et de documentation », « Conservation et gestion », « Études de cas », « Enseignement et formation », « Matériels et techniques de support », « Présentation et exposition ». Une majorité des posters présentés durant le colloque – près de trente au total – sont également proposés ici et publiés par ordre alphabétique.

Le discours inaugural, « Le patrimoine de mosaïques en Sardaigne à la lumière de récentes découvertes », prononcé par Simonetta Angiolillo, de l'université de Cagliari, a dressé un inventaire du riche patrimoine de mosaïques de la région accueillant notre conférence. Les différents types de mosaïques présents sur l'île représentent les influences stylistiques de Rome-Ostie ainsi que de maîtres artisans africains. Cette allocution a parfaitement établi les grandes lignes du colloque et a rappelé l'ampleur et la complexité extraordinaires du patrimoine mondial en matière d'art et de mosaïques. Elle a constitué un bon point de départ pour les discussions suivantes, qui portaient sur les défis posés par la préservation de ce patrimoine pour les générations futures.

La session d'ouverture de ce colloque s'est intéressée au thème des coûts. Pour traiter ce sujet, des études de cas en Sardaigne, en Tunisie, en Jordanie et en Angleterre ont examiné les coûts réels de projets de conservation et de planification, particulièrement à une époque où les financements sont souvent limités. Les rapports se sont également penchés sur les « coûts » plus importants liés à différentes décisions de conservation. Ils ont aussi étudié la façon dont on peut concilier d'un côté les craintes et attentes des collectivités locales et des autres parties prenantes, et de l'autre les besoins de l'objet ainsi que le droit des générations futures à connaître et à découvrir ce patrimoine. La tendance négative actuelle en matière de financement et d'attribution des projets de conservation (c'est-à-dire au moins-disant), la réduction générale des dépenses à destination du patrimoine et ses conséquences ont également été abordées.

Alors que les techniques de documentation, de collecte de données et d'inventaire appliquées aux mosaïques ne cessent d'évoluer et de se multiplier, il est plus important que jamais de choisir des méthodes efficaces, rentables, faciles d'utilisation et assez souples pour que l'on puisse gérer à la fois des données collectées dans le passé et de nouvelles informations. Les rapports présentés dans le sous-thème « Méthodes d'inventaire et de documentation » ont exploré des approches et techniques nouvelles pour rendre compte de l'état de pavements de mosaïques. Parmi ces techniques figurent notamment un nouveau logiciel de documentation ainsi que le recours à des plateformes mobiles, dont l'usage se généralise puisque de plus en plus de données numériques sont directement enregistrées sur site. Cette session a également été l'occasion de discussions sur de nouvelles utilisations de méthodes préexistantes, comme les systèmes d'information géographique, pour compiler et analyser des centaines d'années de données, ainsi que l'utilisation de logiciels de colorimétrie pour dater les mosaïques.

La partie « Conservation et gestion » s'est penchée sur un autre domaine où les procédés sont en constante évolution, notamment en ce qui concerne les approches de planification globale et à long terme, appliquées à la gestion d'un site. Plutôt que de considérer une ou plusieurs mosaïques de manière isolée, il est crucial d'étudier leur contexte et d'appréhender le site dans son ensemble. Cela demande une solide connaissance de l'historique des fouilles et des interventions archéologiques dont la mosaïque a fait l'objet, de son importance et de son état, ainsi qu'une prise en compte de ses besoins présents et futurs. Les rapports de cette session ont présenté une série de questions. Certaines portaient sur les conflits qui peuvent apparaître lorsque des restes archéologiques importants sont mis au jour à l'occasion de travaux d'aménagement urbain. D'autres se sont intéressées aux difficultés spécifiques résultant de l'ouverture au public, de la présentation et de la gestion d'un site archéologique sous-marin très étendu. Le sujet des abris de chantier et autres interventions à grande échelle a également été traité, en prenant plus particulièrement en compte la nécessité de planifier minutieusement leur installation et de pouvoir les adapter à des circonstances changeantes.

Le quatrième sous-thème, « Études de cas », portait sur une série de sept cas individuels, ayant chacun trait à un problème particulier lié à la conservation et à la présentation de mosaïques. Certaines de ces études ont abordé le besoin de créer des équipes de travail multidisciplinaires, ainsi que les difficultés inhérentes à la conciliation entre recherches archéologiques et conservation. D'autres ont traité le sujet des mesures de conservation curative et de la planification de l'entretien à long terme. Les problèmes liés à la dépose et à la présentation de mosaïques dans les musées ont également été abordés, ainsi que les avantages de la conservation pour la recherche archéologique lorsque de nouvelles informations scientifiques sont révélées par le processus de conservation.

Le thème « Enseignement et formation » s'est intéressé à un autre sujet qui a pris de l'importance au fil des années : le nécessaire développement des compétences aux niveaux local et national afin d'assurer la conservation et l'entretien à long terme des mosaïques, *in situ* ou présentées dans des musées. Une attention croissante a été accordée ces dernières années aux programmes de formation apportant les connaissances et compétences nécessaires à toutes les personnes impliquées dans la conservation de mosaïques, sans distinction de niveau de qualification. Les rapports présentés lors de cette session ont abordé les récents efforts en matière de formation, à la fois des techniciens de conservation et des gestionnaires de site par le biais de MOSAIKON, un programme régional de conservation de mosaïques dans le Bassin méditerranéen. Un autre rapport a souligné l'importance de la collaboration entre conservateurs et archéologues pendant les fouilles, en présentant une approche possible selon laquelle les archéologues recevraient une formation basique sur la conservation afin de promouvoir de meilleures pratiques professionnelles.

Des recherches et des études de cas portant sur la conservation et la présentation de mosaïques déposées ont été exposées lors de la session « Matériels et techniques de support ». La durabilité à long terme des techniques de conservation est un sujet de préoccupation grandissante pour l'ensemble du secteur. Il est donc de plus en plus important de développer des méthodes de support pour les mosaïques accrochées qui utilisent des matériaux d'un prix raisonnable et disponibles à proximité des sites. Les rapports de cette session ont traité cette question et ont évoqué des recherches menées pour utiliser de nouveaux matériaux ou utiliser différemment des matériaux existants. Le but étant d'obtenir des systèmes de support à la fois très performants et légers pour les mosaïques, aussi bien celles qui sont dans les réserves que celles qui sont exposées. Toutes les études de cas aboutissent aux mêmes propriétés souhaitées pour ces nouveaux supports, à savoir une résistance suffisante, un faible poids pour faciliter leur transfert et leur manipulation, un coût raisonnable et la possibilité de revenir à la fonction d'origine du matériau, sans dégradation.

Le dernier sous-thème du colloque, « Présentation et exposition », a étudié une série d'aspects à considérer lorsque des mosaïques sont présentées au public, soit dans un musée, soit sur site aménagé. Inévitablement, plusieurs rapports ont évoqué les difficultés que posent les abris de chantier destinés à la protection et à l'exposition de mosaïques *in situ* quant à leur conception, leur construction et l'évaluation de leur efficacité et de leurs possibles conséquences. De toute évidence, il reste encore beaucoup de travail à faire avant de pouvoir fournir des conseils pratiques dans ce domaine. D'autres présentations se sont concentrées sur les méthodes d'interprétation et d'exposition qui tentent de concilier authenticité et lisibilité, notamment lorsque l'ouverture au public est un des objectifs principaux. Dans ce contexte, la question des coûts a été abordée d'un point de vue à la fois financier et esthétique/historique.

Peut-être encore davantage que par le passé, le XII^e^ Colloque de l'ICCM a été l'occasion pour les archéologues, historiens de l'art, médiateurs culturels, conservateurs en activité et techniciens de conservation du monde entier de se rassembler pour partager leurs expériences et jeter des ponts entre leurs disciplines. Des spécialistes de plus de 35 pays y ont contribué avec des rapports et des posters, représentant ainsi un véritable réseau d'échanges de bonnes pratiques internationalisé.

Les présentations ont reflété, de plus en plus, une évolution dans la façon d'envisager les procédés. Elles ont mis l'accent sur le financement global et la planification de la gestion. Elles ont également témoigné d'un désir de préservation des mosaïques *in situ* autant que possible. D'autres tendances sont à noter : la place de choix accordée à l'acquisition de nouvelles compétences et à l'implication des collectivités locales et des partenaires dans les décisions de conservation ; des recherches plus poussées sur les techniques d'accrochage des mosaïques durables et abordables ; une inquiétude grandissante concernant les endroits dans le monde où notre patrimoine culturel est en grave danger et menacé de destruction ou de disparition.

Créé il y a plus de trente ans, l'ICCM est aujourd'hui un organisme florissant qui continue à promouvoir les bonnes pratiques professionnelles, à construire un solide réseau de spécialistes des mosaïques ouvert à tous, et à œuvrer pour une diffusion de l'information plus large et plus efficace. Enfin, l'ICCM plaide également pour une meilleure prise en charge et une gestion plus efficiente de notre patrimoine de mosaïques, fragile et irremplaçable, pour le présent et le futur. Nous espérons que la publication de ces actes, et ceux des colloques à venir, contribuera à ce legs.

The Mosaic Heritage of Sardinia in Light of Recent Acquisitions

Simonetta Angiolillo

Abstract: *Compared to the situation described in 1981 in the book* Mosaici antichi in Italia *(Ancient Mosaics of Italy), the Roman Sardinian catalog has become considerably richer in recent years. In particular, the many excavations that have been conducted in Porto Torres now sketch an image of a city whose mosaic style, after an initial period when the urban Ostiense black-and-white style prevailed, expanded to polychromatic mosaics akin to those of Iberia and Africa and showed a predilection for figured subjects. An image of Orpheus among the animals, another of the Three Graces, and two pavements adorned with maritime scenes now enrich our understanding of this time.*

The earliest floor decorations in Sardinia were composed of pieces of pottery and opus signinum (Angiolillo 1981: plates 49, 52, 53, 58, 59, 68, 91, 92, 93, 105, 110, 111, 112, 113, 128, 129, 130, 137), sometimes with pre-Roman traditional figurative motifs, for example, the seal of Tanit. There are also a few black-and-white mosaics, found chiefly at Porto Torres, where they date to the Imperial Era. These mosaics are characterized by a markedly Urbano influence (Angiolillo 1981: plates 63, 148, 155, 157, 158, 169), a consequence of the close ties connecting the colony with the mother country.

Starting from the end of the Republic, although there were sporadic instances of opus sectile (Angiolillo 1981: plates 2, 3, 4, 21, 38), the opus tessellatum mosaic became the prevailing model, featuring the specific styles of different production centers and making it possible to distinguish among the various workshops.

Toward the end of the second century, in Nora, the city with the richest surviving heritage of mosaics, one workshop appears to have begun producing works recognizable by the exclusive use of white, ocher, and black, as well as a geometric repertory in which the patterns, most of them common in the empire, are sometimes reworked in a style that offers unusual results (Angiolillo 1981: plates 1, 5, 10, 34, 39, 40, 50, 51; 1983: 451–54). The signature motif of the workshop was an angular composition with circles and tangential curvilinear squares, with the resulting spaces occupied by circles or rectilinear squares with two superimposed shields (fig. 1). The output of this workshop, particularly apparent in large public buildings, seems to have declined around the middle of the third century.

The mosaics produced in the Casa dell'Atrio Tetrastilo in Nora during the Severan dynasty (193–235 CE) are truly innovative for their high technical level, their patterns, the use of very small tesserae, and rich polychromy (Angiolillo 1981: plates 43, 47). It is from these details that we can assume the presence of foreign craftsmen of African origin. In comparison, in one of these floors, which has a grid of cross-linked bands, ornate plant groups, and a broad palette of colors (fig. 2), it is possible to distinguish an older restoration in which the chromatic range is more limited, the motifs are simplified, and the tesserae are considerably larger. The presence of similar features in other mosaics in Nora, Carales, and Sulci (Angiolillo 1981: plates 41, 44, 66, 102; see also Ghedini 1996) suggests the possibility of a second Nora workshop trained in the school of the African artisans from whom the workshop craftsmen learned their repertoire, use of color, and the grandiosity of decorative installation but never quite attained the same level of mastery.

During the third century, a repertoire was developed throughout the region that, in terms of its patterns and choice of decorative motifs, reveals African influences. Examples are a group of funerary mosaics at Cagliari, Nora, and Porto Torres (Mureddu and Stefani 1986; Manconi 2002: 305–7;

Figure 1 Nora, Central Bath, west peristyle.
Photo: S. Angiolillo, 1981

Figure 2 Nora, Casa dell'Atrio tetrastyle, room E.
Photo: S. Angiolillo, 1981

Figure 3 Settimo San Pietro, mosaic with a foliate pattern. Photo: S. Angiolillo, 1981

Sangiorgi 2002: 353–60; Angiolillo 1981: plates 173–75) and some floors with geometric vegetation-inspired designs. In the Casa dell'Atrio Tetrastilo in Nora, the pattern of tangential octagons is created with small leaves on a delicate vine that forms the outline of the geometric figures (Angiolillo 1981: plate 44). In a bath complex in Capo Frasca, the meander with swastika and squares is created by a festoon of leaves sprouting stalks with red and ocher pomegranates and pink blossoms outlined in red (Angiolillo 1981: plate 119). On two adjoining panels at Villaspeciosa near Cagliari, acanthus leaves surround tangential and secant circles (Angiolillo 1981: plate 114; Angiolillo 1999). In these cases the particular style of the repertoire used and the attention paid to technical quality and chromatic richness once again suggest the direct or mediated presence of African craftsmen.

Last, a refined late-era composition discovered in the countryside around Settimo San Pietro near Cagliari is of particular interest (fig. 3). Composed of tangential circles, it is bordered by a vine with leaves and tendrils (Angiolillo 2011). An almost exact equivalent is found in two mosaics, in Carthage and Majorca, however, they differ from the Sardinian example in the choice of decorative motifs. The extent of the differences is sufficient to justify a suspicion that this case represents a transmission of ideas rather than the work of African craftsmen directly.

With respect to figurative mosaics, in addition to the two emblemata in the Casa dell'Atrio Tetrastilo at Nora (Angiolillo 1981: plates 37, 42), the lone survivor of which is decorated with a marine thiasus motif, there are numerous examples in Carales, the earliest ones dating to the end of the Republic. They include a black-and-white mosaic featuring fish alternating with anchors, rudders, and labryses, or double-headed axes; eight emblemata depicting Xenia, also used in a third-century floor in the Casa degli Stucchi; and a mosaic with Venatio that is very close to the well-known specimen in Zliten, judging by the two minuscule fragments preserved (Angiolillo 1981: plates 72, 79–84, 108–9). Three figurative mosaics with a broader range of subject matter can be dated to approximately the middle of the third century. A composition in a bathhouse consists of a grid with a multistrand polychrome braid forming squares, decorated with patterned floral motifs alternating with marine thiasus scenes, in which the figures are rendered in a somewhat flat style, with definitive outlines and uniform muscle masses, though it does have a few highlights (Angiolillo 1981: plate 71). The Turin Museum houses three fragments of one mosaic, which was whole and intact at the time of its discovery. We know of its original condition from a drawing made early in the eighteenth century by the painter Domenico Colombino (Angiolillo 1981: plate 101). Orpheus with his lyre is standing in the center, accompanied only by a fox and a raven; all the other animals are spaced, sometimes separated by saplings, along the edges. The singer is seated on a rock, his lower body covered with a cloak (fig. 4). His muscle mass is defined by numerous areas of light and shadow, while the face is characterized by large eyes, a large nose joined to the eyebrow arches without any

Figure 4 Cagliari, Orpheus mosaic. Photo: S. Angiolillo, 1981

break in continuity, and a round chin. The play of light and shadow is repeated in the animals, but here the craftsmen, less influenced by sophisticated models, have worked in a more schematic and flattened form, with large, juxtaposed areas of color. Another mosaic similar in composition was discovered in the same building but now is known only from a very brief description: Hercules with his club and lion skin standing in the center, surrounded by animals and trees. The fact that these two floors stand almost alone in the otherwise abundant Sardinian patrimony, and the close stylistic relations that link the Orpheus mosaic in particular with the coeval African production, has suggested the possibility of the presence of African craftsmen.

At Porto Torres, until a few decades ago, the figurative mosaic was found only in the typology of the black-and-white marine mosaic (fig. 5), in two examples from the second and third centuries, respectively (Angiolillo 1981: plates 153, 154). While still falling within the Rome-Ostia tradition, these mosaics present technical features and iconographic rarities that warrant attribution to a local workshop. Black is used for outlines, while brown is used to render bodies. The animals are spaced evenly in parallel rows. The seal is depicted

Figure 5 Porto Torres, marine mosaic. Photo: S. Angiolillo, 1981

not as a sea calf with a terrestrial anterior half, according to the image customary in Greece and Rome, but instead as an aquatic creature with flippers and a trefoil volute tail. At the same time, in contrast to the iconographic tradition of giving preference to its terrestrial nature, the crocodile has the volute tail typical of marine monsters.

The discoveries of recent decades have, however, considerably modified our knowledge of the artistic range of Turris Libisonis (Boninu and Pandolfi 2012). While it was already evident that after an initial period of heavy dependence on the Urbano and Ostia stylistic models, there was during the third century an opening up to the geometric polychrome repertoire of Africa, new discoveries now prove a definite ascendancy of the figurative mosaic and greater richness of geometric pattern.

The mosaic complex of the Orpheus *domus*, still substantially unpublished, is located under the peristyle of the Central Baths, which were constructed toward the end of the third century or the beginning of the fourth. The central part of the space is occupied by a mosaic composed of a grid of cross-linked tangential squares diagonal to and surrounding a small polylobate pool decorated internally with a marine mosaic in gray, brown, and black. Fish of various types, sea urchins, and mollusks swim in a sea created by sections of straight or dentate black lines.

To the east of this area is a small floor full of holes. Its centerpiece, bordered on the north and south edges with a checkerboard motif, is an octagon bounded by a double-strand braid and a Greek fret. Four squares, similarly outlined with a braid and decorated with floral motifs, are superimposed on the sides of the octagon. The resulting space between the polygon and the frame of the field is occupied by a complex plant motif in which curly flowers ending in small quadripetals spring from the corolla of a polychrome flower. The center of the octagonal panel is occupied by three female figures easily recognizable as the Graces (fig. 6). Their hair is gathered up and decorated with a crown of leaves, and, to the extent that they can be seen, they are naked except for their necklaces. The girls are embracing according to the customary iconography, with each one placing her hands on the shoulders of the two others, except that the face of the girl in the center is turned toward the observer and the unnatural twist of her body allows her to place her right hand on the left shoulder of her companion.

Figure 6 Porto Torres, Orpheus *domus.* The Three Graces.
Photo: S. Angiolillo, 1981

On the west side of the Central Baths is a series of three polychrome mosaics with geometric patterns. The northernmost mosaic is slightly higher than the other two and is decorated with a grid of bands with shields facing a diagonal square, inside the rectangles, and with black tesserae half-circles outlining the intersections (fig. 7). The resulting squares are outlined with double-strand braids, a broken line forming triangles, and quadratic running waves, and they contain schematic floral and geometric motifs. This same pattern also appears in Porto Torres, in the Domus of the Mosaics.

Adjacent to this centerpiece but about 30 centimeters lower, there is a pavement divided into two centerpieces separated by a delicate structure. Inside a dark ocher connection strip there is an orthogonal composition of half-stars of diamonds and adjoining rectangles forming squares. The diamonds are filled with black, red, and ocher colors. The rectangles are outlined with a broken meander and decorated with a double-strand braid, or double thyrsus, while a cruciform floral motif occupies the center of the resulting squares. This pattern is complicated by the introduction in the centerpiece of an octagon overlaid on alternating sides with squares decorated with rushes. The octagonal panel is outlined with a wave motif and contains the figure of Orpheus playing the lyre and surrounded by animals (fig. 8). The iconography is that of the Greek Orpheus (Jesnick 1997: 69 ff.): naked except for a blue Phrygian cap and a red cloak that covers his left shoulder, his thighs, and his right leg. He is seated on a rock between two slender trees; his right hand holding the pick is resting on his right leg, and the other hand holds the lyre. To his left, viewed from the top down, are a raven, a parrot, a lion, a deer crouched at the singer's feet, and a large lizard. On the other side, again viewed from the top down, there is an owl, a long serpent wrapped around the trunk of the tree, a bull, and a leopard.

From an iconographic point of view, the Turris mosaic seems to owe a great deal to the Carales mosaic. Both cases follow the Greek model, which is not the most prevalent type. Chiefly, however, in order to resolve the problem of the distance between the right hand of the singer and the instrument, the Turris Libisonis craftsman adopted the same solution chosen at Carales, namely, depicting Orpheus in a moment of rest. Ilona J. Jesnick (1997: 68) recognizes this device as an invention of the artist active in Cagliari, who is theoretically identified with an African master.

The Turris mosaic is of a high technical level and shows a certain refinement in the choice of coloring. In contrast, however, the modeling is rather flat and schematic, as is particularly apparent in the uncovered leg and in the left foot. When we reconsider the Cagliari Orpheus, we find in it a chiaroscuro rendering of the muscle masses, a naturalistic modeling particularly apparent in the foot, and a drapery that is more clothlike and wavy than that of the Turris mosaic—in

Figure 7 Porto Torres, Orpheus *domus.* Photo: S. Angiolillo, 1981

Figure 8 Porto Torres, Orpheus *domus.* Reproduced with permission from the Superintendent of Archaeological Properties for the provinces of Sassari and Nuoro

short, a quality decidedly superior to that of Turris. However, the iconography is unquestionably the same, the only difference being the mirror arrangement of the legs, the right leg being forward and uncovered at Cagliari, the left leg at Porto Torres. Other similarities include the rendering of the face, the hairstyle, the triangular shape of the forehead, and the shape of the eyebrows, the nose, and the mouth. Extending the analysis to the animals, we find the same treatment of the musculature, depicted with alternating juxtaposed light and dark areas, visible in the lion, the deer, and the bull. Thus, with respect to the Carales work, the Turris Orpheus displays major differences in positioning and quality that, considering the iconographic similarities, inevitably suggest the possibility of a relationship between them, with the master of the Porto Torres mosaic being influenced by the Cagliari master.

A comparison of the panel of the Three Graces and the Orpheus panel reveals unquestionable similarities, particularly apparent in the structure of the face and in the flat and awkward rendering of the arms and legs, and suggests that both panels are the work of craftsmen active in the same workshop. This seems to be confirmed by the similar density of tesserae per square decimeter in the Orpheus and in the Three Graces. Based on formal analysis of these pavements, the comparison with the Cagliari mosaics with marine thiasus and with Orpheus, and the hypothetical relationship between the Turris Orpheus and the Carales Orpheus, I believe that the two Turris figurative mosaics can be considered slightly later than the middle of the third century. Possible comparisons, especially in Iberia and Africa, because of the geometric compositions of the house and the ornamental motifs, are compatible with the proposed dating (Duran Kremer 2012; Ferdi 2005: plate 5).

The same geometric pattern of the Orpheus mosaic is present, with the use of the same colors, in a floor discovered in Via delle Terme, where the one documented octagon contains a circular medallion surrounded by a festoon of leaves and contains an inscription (Boninu and Pandolfi et al. 2008: 1788–90).

Another very interesting complex is the Domus of the Mosaics, which has been only partially unearthed (Boninu and Pandolfi 2012: 454–57). This *domus* is located on the high ground that closes off the archaeological park of Porto Torres on the west and covers two floors, following the progression of the landscape and overlooking the sea and the Mannu River.

On the ground floor, a corner hallway provides access to several small rooms and two fountains. A narrow stairway leads to the upper floor, where a room has been discovered. All these areas contain mosaics.

In the hallway, a grid of bands decorated with a multistrand braid forms squares in which marine animals appear against the background of a sea represented by segments of straight lines. Notwithstanding a certain chromatic liveliness created by the use of glass tiles, the fish are depicted in a rather rigid and schematic manner. Despite the planimetric anomalies of the hallway, the regularity of the centerpiece is preserved by the introduction of generically trapezoidal panels decorated with bipartite squama embedded in a double frame.

Two small interconnected spaces that open to the hallway present an orthogonal composition of octagons. We have some admittedly incomplete knowledge of the decoration from only one source. There seems to have been a series of bands, alternating on a white-and-black background and decorated with tangential circles that enclosed wheel motifs and half-circles in contrasting and counterposed colors.

The flooring of the upper story also presents a grid of bands, with intersections created with black circles and shields facing the peaks of a square diagonal to the rectangles. The alternations in the decorative motifs of the resulting squares appear only in the first half of the floor. The pattern is the same one that we have already encountered in the Orpheus *domus*, with a few iconographic variants and in particular a lack of cohesiveness that makes it unwise to attribute both mosaics to the same workshop and the same period. As for the grid formed by the multistrand polychrome braid, three other examples are known at Porto Torres. Of these three, the only well-preserved pavement is the tepidarium of the Central Baths, which contains floral motifs inside the panels (Angiolillo 1981: plate 145). An archival photograph of the second floor, part of the Pallottine peristyle, shows a floral motif that is also present in the Central Baths (Angiolillo 1981: plate 166). All that remains of the last floor, in the Pallottine Baths, are bits of the braid, in addition to an archival photograph and the testimony of Massimo Pallottino, the archaeologist who excavated it and who says that one of its squares was decorated with a dolphin (Angiolillo 1981: plate 162). The presence of four pavements presumably organized in pairs—we are able to verify the resemblance between those of the Central Baths and the Pallottine peristyle and can hypothesize a resemblance between those of the Pallottine Baths and the Domus of the Mosaics—suggests the identity of both the workshop and the dating. Analysis of the one fully preserved mosaic, that of the Central Baths, has made it possible to date it to the end of the third century or the beginning of the fourth. Therefore, absent any excavation data, this could be extended to the other pavements examined. If we accept the same dating for the grid mosaic with black tesserae half-circles at the intersections, we can explain the differences of approach that distinguish it from the similar mosaic in the Orpheus *domus* by a chronological gap of approximately fifty years: circa 260 CE for the floors under the Central Baths; the end of the third century or the beginning of the fourth for the mosaics in the Domus of the Mosaics.

Compared to the situation described just over thirty years ago in the volume *Mosaici Antichi in Italia*, the panorama of mosaic production in the province has been enriched both in quantity and in quality. Now, since the complete uncovering of the Villaspeciosa floors and the discovery of the Settimo San Pietro floor, the heritage of mosaics with interwoven plant life is decidedly more consistent, and thanks to numerous excavation campaigns the artistic range of Porto Torres has been completely transformed. While this observation is a stimulus to continue moving forward with research, it also calls for great prudence in the complex evaluation of the artistic and cultural heritage of Roman Sardinia, with awareness of the fact that our knowledge is still extremely limited.

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Il patrimonio musivo della *provincia Sardinia* alla luce delle recenti acquisizioni

Simonetta Angiolillo

Abstract: *Rispetto al quadro rappresentato nel 1981 nel volume dei* Mosaici Antichi in Italia*, di recente il repertorio della Sardegna romana si è notevolmente arricchito. In particolare, le numerose campagne di scavo condotte a Porto Torres tratteggiano ora una città che, dopo un primo periodo in cui prevale l'adesione ai modelli urbani ostiensi in bianco e nero, si apre al mosaico policromo vicino a esemplari di area iberica e africana, e mostra una predilezione per i soggetti figurati: un'immagine di Orfeo tra gli animali, una delle Tre Grazie e due pavimenti a decorazione marina arricchiscono ora le nostre conoscenze.*

Le prime decorazioni pavimentali della Sardegna sono costituite da cocciopesti e *opera signina* (Angiolillo 1981: nn. 49, 52, 53, 58, 59, 68, 91, 92, 93, 105, 110, 111, 112, 113, 128, 129, 130, 137), talvolta con motivi figurati di tradizione preromana come il segno di *Tanit*, oltre che da pochi mosaici in bianco e nero, presenti soprattutto a Porto Torres, dove sono attestati anche in età imperiale e caratterizzati da un repertorio marcatamente urbano (Angiolillo 1981: nn. 63, 148, 155, 157, 158, 169), conseguenza dei vincoli stretti che legavano la colonia alla madre patria.

A partire dalla fine della Repubblica, accanto a sporadiche presenze di *opera sectilia* (Angiolillo 1981: nn. 2, 3, 4, 21, 38), il mosaico tessellato si afferma in modo prevalente, evidenziando le specificità dei vari centri di produzione e rendendo possibile distinguere differenti botteghe.

È sullo scorcio del II secolo che a Nora, la città che presenta fino a oggi il patrimonio più ricco di mosaici, sembra iniziare la sua attività un'officina riconoscibile per l'uso esclusivo dei colori bianco, ocra e nero e di un repertorio geometrico in cui gli schemi, per lo più comuni nell'Impero, sono talvolta rielaborati in modo da offrire soluzioni rare (Angiolillo 1981: nn. 1, 5, 10, 34, 39, 40, 50, 51; 1983: pp. 451–454). È il caso di quello che costituisce quasi il motivo firma della bottega: una composizione in obliquo di cerchi e di quadrati curvilinei tangenti, i cui spazi di risulta sono occupati da cerchi o quadrati rettilinei sui quali si impostano due pelte (fig. 1); l'attività della bottega è riconoscibile fino alla metà del III secolo, soprattutto nei grandi edifici pubblici.

Nel periodo dei Severi, nella Casa dell'Atrio tetrastilo, vengono prodotti mosaici di carattere assolutamente innovativo per l'alto livello tecnico, per gli schemi, per l'uso di tessere molto piccole, per una ricca policromia (Angiolillo 1981: nn. 43, 47). Particolarità, queste, spiegabili solo con la presenza di maestranze esterne alla città, diverse da quelle alle quali si deve il resto della produzione e che, per le loro caratteristiche, sono riconoscibili come africane. In uno di questi pavimenti, a reticolato di fasce, caratterizzato da complessi ornati vegetali e da un'ampia gamma di colori (fig. 2), è possibile distinguere un restauro antico nel quale la gamma cromatica è più povera, i motivi sono semplificati, le tessere sono sensibilmente più grandi. La presenza di questi caratteri in altri mosaici di *Nora*, a *Carales* e a *Sulci* (Angiolillo 1981: nn. 41, 44, 66, 102; cfr. anche Ghedini 1996) suggerisce l'ipotesi di un secondo atelier norense formatosi alla scuola degli artigiani africani, dai quali apprende il repertorio, l'uso del colore, la grandiosità dell'impianto decorativo, senza peraltro acquisirne la maestria.

Nel corso del III secolo si afferma in tutta la *provincia* un repertorio che, negli schemi e nella scelta dei motivi decorativi, mostra di essere influenzato dalla produzione africana: ne fanno parte un nutrito gruppo di mosaici funerari a Cagliari, Nora e Porto Torres (Mureddu e Stefani 1986; Manconi 2002: 305–7; Sangiorgi 2002: 353–60; Angiolillo 1981: nn. 173, 174, 175) e alcuni pavimenti a trama geometrica vegetalizzata. A Nora, nella Casa dell'Atrio tetrastilo, lo schema a ottagoni tangenti è reso con un sottile tralcio a foglioline, che segna il perimetro delle figure geometriche (Angiolillo 1981: n. 44); a

Figura 1 Nora, Terme centrali, peristilio ovest. Foto: S. Angiolillo, 1981

Figura 2 Nora, Casa dell'Atrio tetrastilo, vano E. Foto: S. Angiolillo

Figura 3 Settimo San Pietro, mosaico a trama vegetalizzata. Foto: S. Angiolillo

Capo Frasca, in un complesso termale, il meandro a svastica e quadrati è ottenuto da un festone di foglie, da cui partono steli con melagrane rosse e ocra e boccioli rosa profilati di rosso (Angiolillo 1981: n. 119), mentre a Villaspeciosa, presso Cagliari, su due pannelli contigui, il motivo dei cerchi tangenti e secanti vede le circonferenze delineate da foglie di acanto (Angiolillo 1981: n. 114, Angiolillo 1999). In questi casi, l'africanicità del repertorio usato e l'attenzione alla qualità tecnica e alla ricchezza cromatica suggeriscono di nuovo la presenza diretta o mediata di maestranze africane.

Particolarmente interessante è infine una raffinata composizione di età tarda, rinvenuta nelle campagne di Settimo San Pietro (fig. 3), vicino a Cagliari, con cerchi tangenti, la cui circonferenza esterna è segnata da un tralcio di vite con foglie e viticci (Angiolillo 2011). Essa trova una corrispondenza pressoché esatta in due mosaici, rispettivamente di Cartagine e di Maiorca, che però differiscono dall'esemplare sardo per la scelta dei motivi decorativi, tanto da far sospettare che non di medesime maestranze africane si possa parlare in questo caso, ma di trasmissione di modelli.

Per quel che riguarda il mosaico figurato, oltre a due *emblemata* attestati a Nora (Angiolillo 1981: nn. 37, 42), di cui se ne è conservato solo uno con motivo di tiaso marino nella Casa dell'Atrio tetrastilo, numerosi sono gli esemplari di *Carales*, a cominciare dalla fine della Repubblica: un mosaico in bianco e nero con una teoria di pesci alternati ad ancore, bipenni, timoni; otto *emblemata* raffiguranti *xenia* reimpiegati in un pavimento del III secolo, della Casa degli Stucchi; un mosaico con *venatio* molto vicino a quello noto di Zliten, a giudicare dai due minuscoli frammenti conservati (Angiolillo 1981: nn. 72, 79–84, 108–9). Circa alla metà del III secolo sono databili tre mosaici figurati di più ampio respiro. In un ambiente termale, una composizione a reticolato di fasce con treccia multipla policroma formante riquadri è decorata da schematici motivi floreali alternati a scene di tiaso marino, nelle quali le figure sono rese in modo alquanto piatto, con contorni marcati e masse muscolari uniformi, nonostante qualche lumeggiatura (Angiolillo 1981: n. 71). Al Museo di Torino si conservano solo tre frammenti di un mosaico, integro al momento del rinvenimento, di cui conosciamo lo stato originario da un disegno eseguito ai primi del XIX secolo dal pittore Domenico Colombino (Angiolillo 1981: n. 101): al centro è Orfeo con la lira, accompagnato solo da una volpe e da un corvo; lungo i bordi si susseguono, talora intervallati da alberelli, tutti gli altri animali. La figura del cantore (fig. 4), seduto sulla roccia con un mantello che gli copre la parte inferiore del corpo, è caratterizzata da masse muscolari rese evidenti da frequenti passaggi di luce e ombra, mentre il volto è segnato da grandi occhi, da un grosso naso unito alle arcate sopracciliari senza soluzione di continuità, da un mento tondeggiante. Ritroviamo anche negli animali il gioco di luci e ombre, ma qui gli artigiani, meno condizionati da modelli colti, si sono espressi in una forma più schematica e appiattita, con grosse pennellate giustapposte di colore. Nello stesso edificio, fu rinvenuto un altro mosaico simile per composizione, attestato ora solo da una descrizione molto sommaria: al centro Ercole con clava e *leonte*, tutt'intorno animali e alberi. Il fatto che questi due ultimi pavimenti siano così isolati, nel pur abbondante patrimonio sardo, e gli

Figura 4 Cagliari, mosaico di Orfeo. Foto: S. Angiolillo, 1981

stretti rapporti di stile che legano, in particolare, il mosaico di Orfeo alla produzione africana coeva, hanno suggerito l'ipotesi di una presenza di maestranze africane.

A Porto Torres, fino a qualche decennio fa, il mosaico figurato era presente solo nella tipologia del mosaico marino in bianco e nero (fig. 5) attestata in due esemplari, rispettivamente del II e del III secolo (Angiolillo 1981: nn. 153–54). Pur rimanendo nel solco della tradizione romano–ostiense, questi mosaici presentano caratteri tecnici e rarità iconografiche tali da farli attribuire a una bottega locale: al nero, usato per le profilature, si aggiunge il bruno con il quale sono resi i corpi; gli animali sono disposti in modo regolare su file parallele; la foca è raffigurata non come vitello marino, con la metà anteriore terrestre, secondo l'immagine consueta in Grecia e a Roma, ma come un essere acquatico con pinne e coda a volute e trifogliata; parallelamente il coccodrillo, al contrario della tradizione iconografica che ne privilegia la natura terricola, è dotato della tipica coda a volute dei mostri marini.

I rinvenimenti di questi ultimi decenni hanno però modificato sensibilmente le nostre conoscenze della *facies* artistica di *Turris Libisonis* (Boninu e Pandolfi 2011). Se, infatti, era comunque già evidente che dopo un primo periodo di stretta

Figura 5 Porto Torres, mosaico marino. Foto: S. Angiolillo, 1981

dipendenza dai modelli dell'area Urbana e Ostiense, nel corso del III secolo si era verificata un'apertura al repertorio policromo geometrico di matrice africana, ora le nuove scoperte dimostrano una netta affermazione del mosaico figurato e una maggior ricchezza di quello a schema geometrico.

Il complesso musivo della *domus* di Orfeo, ancora sostanzialmente inedito, si trova sotto al peristilio delle Terme Centrali costruite verso la fine del III o gli inizi del IV secolo. La parte centrale dell'area è occupata da un mosaico con una composizione reticolata di quadrati tangenti sulla diagonale, che circonda una vasca polilobata di piccole dimensioni decorata internamente da un tessellato a soggetto marino, nei colori grigio, bruno e nero; nel mare, indicato da segmenti di linea nera dritta o dentata, nuotano pesci di vario tipo, ricci e molluschi.

A est di questo vano c'è un pavimento di modeste dimensioni, pesantemente lacunoso: il tappeto, bordato sui lati nord e sud da un motivo a scacchiera, è occupato da un ottagono, delineato da una treccia a due capi e da una greca, sui cui lati si impostano quadrati ugualmente bordati da una treccia e decorati con motivi floreali. Lo spazio di risulta tra il poligono e la cornice del campo è occupato da un complesso motivo vegetale in cui girali arricciolati e desinenti in piccoli quadripetali si dipartono dalla corolla di un fiore policromo. Il centro del pannello ottagonale è occupato da due figure femminili nelle quali si possono agevolmente riconoscere le Grazie (fig. 6): hanno i capelli raccolti e ornati da corone di foglie, e, per quel che si può vedere, sono nude, tranne che per la presenza di monili. Le fanciulle si abbracciano secondo l'iconografia consueta, poggiando ciascuna le mani sulle spalle delle altre due, ma quella in posizione centrale ha il viso di tre quarti rivolto verso l'osservatore e presenta una torsione innaturale del corpo, sì da poggiare la mano destra sulla spalla sinistra della compagna.

Sul lato occidentale della casa si susseguono tre tappeti musivi policromi a schema geometrico, quello più settentrionale è sopraelevato rispetto agli altri due e decorato da un reticolato di fasce con pelte opposte a un quadrato sulla diagonale, nei rettangoli, e con segmenti di cerchio in tessere nere a segnare le intersezioni (fig. 7). I quadrati di risulta sono delineati da treccia a due capi, linea spezzata formante triangoli, onde correnti quadrate, e racchiudono schematici motivi floreali o geometrici. Questo stesso schema si ritrova a Porto Torres nella *Domus* dei Mosaici.

Figura 6 Porto Torres, *domus* di Orfeo. Le Tre Grazie. Foto: S. Angiolillo

Figura 7 Porto Torres, *domus* di Orfeo. Orfeo. Foto: S. Angiolillo

Figura 8 Porto Torres, *domus* di Orfeo. Riprodotto con il permesso della Soprintendenza per i Beni Archeologici per le province di Sassari e Nuoro

Contiguo a questo tappeto, ma a un livello inferiore di ca. 30 centimetri, si stende un pavimento articolato in due tappeti separati tra di loro dalla presenza di una sottile struttura. All'interno di una banda di raccordo ocra scuro si sviluppa una composizione ortogonale di mezze stelle di losanghe e di rettangoli adiacenti formanti quadrati. Le losanghe hanno il centro pieno nei colori nero, rosso e ocra; i rettangoli, bordati da un meandro spezzato, sono decorati da una treccia a due capi o da un tirso doppio, mentre un motivo floreale cruciforme occupa il centro dei quadrati di risulta. Tale schema viene complicato nel tappeto centrale con l'inserimento di un ottagono su cui, a lati alterni, si impostano quadrati decorati a stuoia. Il pannello ottagonale è delineato da un motivo a onde e racchiude una raffigurazione di Orfeo che suona la lira in mezzo agli animali (fig. 8). L'iconografia è quella dell'Orfeo greco (Jesnick 1997: 69 ss.): nudo, con il berretto frigio azzurro e un mantello rosso che gli copre la spalla sinistra, i fianchi e la gamba destra. Seduto su una roccia tra due alberi sottili, poggia la mano destra che impugna il plettro sulla gamba corrispondente, mentre con l'altra sostiene la lira. Alla sua sinistra ci sono, dall'alto, un corvo, un pappagallo, un leone retrospiciente, un cervo accovacciato ai piedi del cantore e una grossa lucertola; sull'altro lato, sempre dall'alto, una civetta, un lungo serpente attorcigliato attorno al tronco dell'albero, un toro e un leopardo retrospicienti.

Da un punto di vista iconografico, il mosaico di *Turris* sembra fortemente indebitato con quello cagliaritano: in entrambi i casi il tipo è quello greco, che non è il più diffuso; ma soprattutto, l'artigiano di *Turris Libisonis*, per ovviare al problema della distanza tra la mano destra del cantore e lo strumento da suonare, ha adottato la stessa soluzione scelta a *Carales*: quella di raffigurare Orfeo in un momento di riposo. Un accorgimento, questo, che Ilona J. Jesnick riconosce come un'invenzione dell'artista attivo a Cagliari (Jesnick 1997: 68), del resto ipoteticamente identificato con un maestro africano.

Il mosaico di *Turris* appare di buon livello e mostra una certa raffinatezza nella scelta della cromia; al contrario, però, il modellato si presenta piuttosto piatto e schematico, come appare evidente soprattutto nella gamba scoperta e nel piede sinistro. Riprendendo in esame l'Orfeo di Cagliari, riscontriamo in esso una resa in chiaroscuro delle masse muscolari, un modellato naturalistico, apprezzabile in particolare nel piede, un panneggio più plastico e mosso di quello del mosaico turritano; in conclusione, una qualità decisamente superiore a quella di quest'ultimo. L'iconografia è però indubbiamente la medesima, con l'unica variante della disposizione speculare delle gambe, avanzata e scoperta la destra a Cagliari e la sinistra a Porto Torres. Anche la resa del volto coincide tra le due figure, la stessa acconciatura dei capelli, la stessa forma triangolare della fronte, la stessa forma dell'arcata sopracciliare, del naso e della bocca ed estendendo l'analisi agli animali, lo stesso trattamento della muscolatura a pennellate giustapposte alternativamente chiare e scure, evidente nel leone, nel cervo e nel toro. Rispetto all'Orfeo di *Carales*, quello turritano mostra, dunque, importanti differenze, di impianto e di qualità, a fronte di tali corrispondenze di carattere iconografico, da rendere inevitabile l'ipotesi di un rapporto tra i due, non opera di stesse maestranze, ma dipendenti l'uno (il mosaico di Porto Torres) dall'altro (quello di Cagliari).

Il confronto tra il pannello delle Tre Grazie e quello di Orfeo rivela indubbie concordanze, evidenti soprattutto nella struttura del volto e nella resa piatta e maldestra di braccia e gambe, e suggerisce l'appartenenza di entrambi i pannelli a maestranze di una stessa bottega, come sembra confermare l'analoga densità di tessere per decimetro quadrato nell'Orfeo e nelle Tre Grazie. Sulla base dell'analisi formale di questi pavimenti, del confronto con i mosaici di Cagliari con tiaso marino e con Orfeo e del rapporto ipotizzato di dipendenza dell'Orfeo di *Turris* da quello di *Carales*, ritengo che i due mosaici figurati turritani possano essere considerati di poco posteriori alla metà del III secolo. I confronti possibili, soprattutto in area iberica e africana, per le composizioni geometriche della casa e per i motivi ornamentali sono compatibili con la datazione proposta (Duran Kremer 2012; Ferdi 2005: n. 5).

Il medesimo schema geometrico del mosaico di Orfeo è presente, con l'uso degli stessi colori, su un pavimento rinvenuto in via delle Terme, dove l'unico ottagono documentato circoscrive un medaglione circolare delimitato da un festone di foglie e contenente un'iscrizione beneaugurante (Boninu et al. 2008: 1788–90).

Un altro complesso di grande interesse è costituito dalla *domus* dei Mosaici, solo parzialmente messa in luce (Boninu e Pandolfi 2012: 454–57); essa è posta sull'altura che chiude, a occidente, il parco archeologico di Porto Torres e si sviluppa su due piani, seguendo l'andamento del terreno e affacciandosi sul mare e sul fiume, il riu Mannu.

Al piano terra, su un corridoio ad angolo, si aprono alcuni ambienti di ridotte dimensioni e due fontane; una stretta scala conduce al piano superiore, dove è stata messa in luce una stanza: tutti questi ambienti sono mosaicati.

Nel corridoio, un reticolato di fasce decorate da treccia multipla determina quadrati in cui, sul fondo di un mare rappresentato da segmenti di linee rette, sono raffigurati animali marini. Nonostante una certa vivacità cromatica, dovuta anche all'uso di tessere in pasta vitrea, i pesci sono resi in maniera piuttosto rigida e schematica. A dispetto delle anomalie planimetriche del corridoio, la regolarità del tappeto viene rispettata mediante l'inserzione di pannelli di forma genericamente trapezoidale decorati con embricatura di squame bipartite all'interno di una doppia cornice.

Due piccoli vani comunicanti fra loro e aperti sul corridoio presentano una composizione ortogonale di ottagoni. Di una sola fontana conosciamo la decorazione, alquanto lacunosa, in cui sembra di poter riconoscere una serie di fasce, alternativamente su fondo bianco e nero, decorate da cerchi tangenti che circoscrivono motivi a ruota o settori di cerchio in colori contrastanti, contrapposti.

Il pavimento del piano superiore ripropone un reticolato di fasce con intersezioni, evidenziate da cerchi neri, e pelte opposte ai vertici di un quadrato sulla diagonale nei rettangoli; solo nella prima metà del pavimento vengono rispettate le alternanze tra i motivi decorativi dei quadrati di risulta. Lo schema è lo stesso che abbiamo già incontrato nella *domus* di Orfeo, con alcune varianti di tipo iconografico e soprattutto, qui, con una mancanza di organicità che sconsigliano di attribuire entrambi i mosaici alla stessa bottega e allo stesso momento. Quanto al reticolato formato dalla treccia multipla policroma, a Porto Torres se ne conoscono altri tre esemplari. Di questi, l'unico ben conservato pavimenta il *tepidarium* delle Terme Centrali e presenta motivi floreali all'interno dei riquadri di risulta (Angiolillo 1981: n. 145). Del secondo, nel c.d. Peristilio Pallottino, resta una foto d'archivio che mostra ancora un motivo floreale attestato anche nelle Terme Centrali (Angiolillo 1981: n. 166). Dell'ultimo, nelle Terme Pallottino, si conservano lembi della treccia, oltre a foto d'archivio e alla testimonianza dell'archeologo che le scavò, Massimo Pallottino appunto, secondo la quale un riquadro era decorato da un delfino (Angiolillo 1981: n. 162). La presenza di quattro pavimenti presumibilmente uguali a due a due – possiamo verificare la somiglianza tra quelli delle Terme centrali e del Peristilio Pallottino, possiamo ipotizzarla per quelli delle Terme Pallottino e della *domus* dei Mosaici – suggerisce un'identità di bottega e di datazione. L'analisi del solo mosaico conservato per intero, quello delle Terme Centrali, ha permesso di suggerire per esso una datazione alla fine del III secolo o agli inizi del IV, che dunque, in assenza di dati di scavo, potrà essere estesa agli altri pavimenti esaminati. Se accogliamo questa datazione anche per il mosaico a reticolato con segmenti di cerchio in tessere nere alle intersezioni, possiamo spiegare le differenze di impostazione che lo distinguono da quello analogo della *domus* di Orfeo con lo scarto cronologico di circa un cinquantennio: 260 ca. per i pavimenti sottostanti le Terme centrali, fine III–inizi IV per quelli della *domus* dei Mosaici.

Rispetto al quadro che ero stata in grado di delineare poco più di trent'anni fa, nel volume dei *Mosaici antichi in Italia*, il panorama della produzione musiva della *provincia* si è arricchito quantitativamente e qualitativamente: ora è decisamente più consistente, con la piena messa in luce dei pavimenti di Villaspeciosa e con il rinvenimento di quello di Settimo San Pietro, il patrimonio dei mosaici a trama vegetalizzata, e, grazie alle numerose campagne di scavo effettuate, appare del tutto modificata la *facies* artistica di Porto Torres. Questa constatazione, se pure è uno stimolo ad andare sempre avanti nella ricerca, ci costringe a una grande cautela nella valutazione complessiva del patrimonio artistico e culturale della Sardegna romana, nella consapevolezza che le nostre conoscenze sono ancora estremamente limitate.

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PART ONE

Cost

Réflexions sur l'évolution de nos métiers : Alerte danger

Patrick Blanc

Résumé : *La conservation des biens culturels est confrontée aux changements en matière de législation du financement public. Les travaux de conservation et de restauration sont désormais liés au système légal d'appels d'offres. Souvent propriété de l'État, collectivités territoriales, musées publics, etc., les mosaïques sont touchées au premier chef par ces changements qui s'ajoutent à une concurrence économique entre restaurateurs. Aujourd'hui, les chantiers se remportent au moins-disant financier. Qui y gagne ? Des pavements antiques ne mériteraient-ils pas un sort plus réfléchi ? Dans une société où l'argent est roi mais manque pour bien des causes, le marché financier doit-il décider du sort des mosaïques ? Par ailleurs, peut-on comparer les prix pratiqués d'un pays à l'autre, même en Europe, où les différences peuvent être grandes… et sans parler du Moyen-Orient, du Maghreb ? Les expériences de l'atelier de conservation et de restauration du Musée départemental Arles antique, institution publique, rendent compte de telles évolutions. Quels peuvent/doivent être les choix ? Conserver, ne pas conserver ? Retour au bricolage ? Face à des enjeux nouveaux, quelle position doit/peut être celle du conservateur-restaurateur ?*

Abstract: *Those of us involved in the conservation of our cultural assets are facing challenges as a result of changes in public funding legislation, in that conservation and restoration projects are now subject to a formal tender system. As they are often owned by the state, local governments, and public museums, mosaics are particularly affected by these changes, as well as by competition on price among restorers. Nowadays, these projects go to the lowest bidder. So who wins in this situation? Shouldn't we be more considered in our treatment of our ancient mosaic pavements? In a world where money rules but is limited in supply should market forces decide the fate of mosaics? Furthermore, is it possible to compare the cost of these projects between countries, even within Europe, where there can be substantial differences from one country to another, not to mention the Middle East or the Maghreb? The mosaics conservation and restoration workshop of the Musée départemental Arles antique, a public institution, has witnessed all of these changes, and we share our views here. What are our choices and obligations? Should we conserve mosaics or not? Or simply revert to substandard restoration? Faced with these new challenges, what position can—and should—conservators and restorers adopt?*

Le bureau de notre association a souhaité poser, pour notre XII^e^ Conférence internationale, la question du coût de la conservation des mosaïques aujourd'hui.

Le coût, est-ce seulement le budget nécessaire pour une intervention ? L'évaluation financière en termes de personnel, de technique, de matériel ? Le « coût », n'est-ce pas aussi tout ce que l'on met derrière le chiffre, l'implication des partenaires, depuis les formateurs jusqu'aux gestionnaires des institutions patrimoniales, en charge de la préservation et de la sauvegarde de notre objet d'intérêt, les pavements antiques ?

Au vu de la thématique choisie pour cette conférence, je propose moins de dresser un constat global, toujours difficile à établir tant nous connaissons une diversité de situations et de statuts, de faire le point sur une situation – qu'elle soit affligeante ou pas, selon notre degré de positivité – que de poser les bases d'une discussion libre, ouverte et sans arrière-pensée, concernant l'accessibilité à notre travail, pour nous restaurateurs.

« Cours, camarade, le vieux monde est derrière toi » était un slogan des années 1968, particulièrement dans le printemps chaud que vécurent certains de nos pays en pleins mouvements – on a dit « révolutions » – de la jeunesse. Oui, le monde change ; on n'y changera rien. Aussi faut-il précéder ces révolutions malgré les difficultés rencontrées par chacun, les accompagner et trouver de nouvelles propositions.

Je ne ferai pas ici une intervention philosophique de « Café du commerce ». Je veux parler de choses concrètes, de situations bien réelles que les restaurateurs rencontrent s'ils veulent travailler sur les biens culturels publics, ce qui est en grande partie notre champ d'action à nous restaurateurs de mosaïques antiques, que celles-ci soient conservées dans les musées ou dans leurs contextes, sur les sites archéologiques.

Au préalable, signalons que toutes les réflexions qui vont suivre sont issues de discussions, de rencontres, de dossiers que nous avons eu effectivement à traiter au sein de l'atelier de conservation et de restauration du Musée départemental Arles antique.

Qu'est-ce que le « coût » de la conservation des mosaïques ?

On peut poser cette question en un sens général, global, ou dans un sens plus strictement financier. Mais notre conférence est internationale ; de combien de pays aux rythmes sociaux différents venons-nous ? Le coût des interventions de conservation est-il comparable entre pays européens du Sud et du Nord ? En France, le taux de travail horaire pour un restaurateur privé tourne autour de 40 à 50 euros, hors taxes. En est-il de même en Grèce, en Espagne, en Suisse aujourd'hui ? Certes non. Et que dire des différences du coût de la vie entre l'Europe et les nouveaux pays émergents des Balkans, entre pays du Moyen-Orient et pays du Maghreb, entre les États-Unis d'Amérique et les rives de notre vieille Méditerranée ? Lors de notre rencontre, la communication commune de restaurateurs du Maghreb et du Proche-Orient nous a montré les difficultés à globaliser le coût d'une même intervention ; du Maroc au Liban, l'accès aux matériaux n'est pas le même, et le prix d'achat s'en ressent.

De plus, le coût d'une intervention pour protéger une mosaïque peut-il être comparable entre pays où il n'y a *que* des restaurateurs publics (payés par l'État) et pays où il n'y a *plus que* des restaurateurs privés (restaurateurs indépendants ou sociétés au statut privé intervenant à la demande sur contrat ou appel d'offres des institutions publiques) ?

En France, Prosper Mérimée (1803–1870) fut celui qui posa la question de notre obligation à protéger les monuments historiques et y apporta comme réponse les prémices de l'organisation dont nous sommes encore redevables aujourd'hui : la création du service des Monuments historiques et le recensement sur tout le territoire français des ensembles architecturaux remarquables entre 1834 et 1860, sensibilisant les Français aux vestiges antiques.

À la même époque apparaissent des sociétés privées d'artisans, souvent des Italiens venus du Frioul, entrepreneurs pour lesquels le sauvetage de mosaïques antiques n'était qu'une petite partie de l'activité, leur activité principale étant liée à la réalisation de mosaïques modernes. Le premier d'entre eux, Giandomenico Facchina (1826–1903), arrive en 1847 dans le sud de la France, où de nombreuses mosaïques antiques venaient d'être découvertes ; il avait auparavant travaillé à la restauration de la basilique Saint-Marc de Venise ; mais son activité se concentre sur la réalisation de mosaïques modernes, avec en particulier le décor de l'opéra Garnier, à Paris.

L'art de la mosaïque se développe alors grâce à la multiplication des nouvelles églises du culte marial. Facchina va faire venir en France de nombreuses familles frioulanes ; lui-même sera chargé entre autres de réaliser avec son atelier le décor de Notre-Dame-du-Rosaire, à Lourdes. Le goût pour la mosaïque affiché à l'opéra ou dans ces grandes églises du XIX^{e} siècle entraîne l'adhésion et l'intérêt de la société privée, et l'on voit les sols des maisons aussi bien que les galeries commerçantes s'en orner.

Ces mêmes artisans sont également appelés à restaurer les pavements antiques nouvellement mis au jour. Entre création et conservation de mosaïques antiques, ces familles italiennes vont utiliser voire inventer de nouveaux matériaux et de nouvelles techniques, usant notamment du ciment moderne, créé vers 1840. Giandomenico Facchina dépose le 23 mars 1858 un brevet d'invention pour la dépose de mosaïques.

Parmi d'autres, la famille Tossut, également d'origine frioulane, quitte la Vénétie pour des raisons peut-être politiques, après la chute de la République vénitienne et son annexion par l'Autriche. Certains membres de cette famille s'installent à Paris, d'autres à Liège… Lors de travaux sur des mosaïques conservées dans les musées effectués en collaboration avec le ministère de la Culture algérien en 2002–3, nous avons croisé deux frères Tossut qui, installés en Algérie vers 1888, avaient restauré à Alger des mosaïques antiques de Castellum Tingitanum (Blanc 2003 : 198).

À l'occasion d'autres interventions de notre atelier, nous avons pu consulter les devis de certains de ces restaurateurs. Au musée du Louvre à l'arrivée des mosaïques d'Antioche, en 1936–37, puis pour la mosaïque de Grand, dans les Vosges, de 1955 à 1959 (Blanc 2006 : 231–51) est intervenue la société Gaudin, qui avait racheté dès 1912 l'entreprise créée par Facchina. Les devis heureusement préservés sont les seuls documents qui relatent les interventions.

À partir des années 1960 en France, la restauration des biens culturels est structurée au nom de l'État par André Malraux, premier occupant du ministère des Affaires culturelles créé en 1959. Deux ans avant la signature de la charte de Venise (1964), posant les bases du respect des œuvres dont nous recevons l'héritage, Malraux lance à son tour un grand Inventaire général des monuments et richesses artistiques de la France, service qui existe toujours. Durant son ministère, l'État français amplifie son action pour la sauvegarde et la protection des biens culturels.

À partir de la fin des années 1960 travaillent principalement trois ateliers de restauration de mosaïques, dont deux sont de statut public : l'atelier municipal de la Ville de Toulouse, dirigé par Jean-Louis Laffont, et l'atelier du musée des Beaux-arts de Besançon, que dirigeait Alfred Monterosso, qui arrivait du musée du Bardo, en Tunisie, et avait été rattaché au musée du Louvre.

Mais le principal atelier intervenant à cette époque est celui créé par Claude Bassier, décédé en début de l'année 2014. On se rappelle évidemment la figure de Claude, auquel je voudrais rendre hommage ici : il est l'un des éminents fondateurs de notre association. Précurseur, Claude, avec la Socra, la société qu'il avait fondée à Périgueux, était, chacun le sait, un restaurateur au statut privé. Il répondait à des commandes de l'État ou des collectivités par l'établissement d'un devis.

À côté de ces ateliers perdurent encore de nos jours quelques rares officines héritières des Frioulans : elles travaillent principalement à la conservation des mosaïques du XIXe siècle et continuent à produire des mosaïques modernes, comme l'atelier de Michel Patrizio, à Marseille.

Aujourd'hui, où en sommes-nous ?

Aujourd'hui sont actifs l'atelier interdépartemental de Saint-Romain-en-Gal, créé en 1981, l'atelier du Musée départemental Arles antique, créé en 1991, à côté d'entreprises et de restaurateurs indépendants.

Notre domaine de compétence portant principalement sur les mosaïques antiques, nous avons à traiter, en France, de documents qui sont la propriété du domaine public, même s'il existe quelques cas de pavements appartenant à la sphère privée, à des collectionneurs en particulier.

Dans le cadre des collections publiques, un commanditaire (musée, site…) souhaite faire réaliser une intervention de conservation ou de restauration. Il peut demander des devis ou lancer un appel d'offres. L'un et l'autre lui permettront de mettre plusieurs entreprises en concurrence. Car c'est bien de cela qu'il s'agit : nous fonctionnons dans un marché ouvert à la concurrence.

Un devis est un document écrit par lequel un restaurateur ou une entreprise de restauration va proposer un prix pour un service. Il doit comporter, outre évidemment l'identification du prestataire et du commanditaire, le mot même de « devis », la description de la prestation, la liste des prix et le total des montants. Un devis signé par les deux parties devient un document contractuel au regard du Code civil.

En France, jusqu'à 15 000 euros hors taxes, la loi impose que soient demandés trois devis. Dans notre domaine, cette somme est rapidement atteinte. Les législations européennes ne sont pas harmonisées sur ce plan, et, par exemple, en Espagne le seuil s'élève à 18 000 euros.

Au-dessus de 15 000 euros hors taxes, le Code des marchés publics français prévoit deux possibilités : d'une part la procédure de l'appel d'offres, d'autre part la procédure de l'accord-cadre.

Un appel d'offres est une procédure plus complexe que le simple devis et demande de compléter un dossier plus important. Celui-ci doit comporter toute une série de documents qui vont de l'extrait du registre du commerce aux attestations d'assurance, de formation des intervenants, des références de travaux antérieurs, avec évidemment un mémoire méthodologique et technique sur la restauration proposée à la réalisation.

Tout restaurateur peut prétendre y répondre. Il faut, bien sûr, qu'il justifie d'une formation professionnelle reconnue en France – actuellement, il y en a principalement deux qui sont de niveau universitaire (master) – ou en Europe. Il faut aussi que le restaurateur soit en règle avec les différents statuts qui lui sont proposés : travailleur indépendant, autoentrepreneur, entreprise…

En France, les marchés publics régis sur le système des appels d'offres sont devenus en quelques années une obligation. Le « marché » de la conservation et de la restauration n'y échappe pas.

Au-dessus de 207 000 euros hors taxes, la procédure d'appel d'offres doit être ouverte au marché européen. Les règles de mise en concurrence sont très variables entre pays, notamment dans l'Union européenne elle-même. Les textes législatifs, ne serait-ce qu'en France, sont mouvants, changeant régulièrement, et d'une extrême complexité.

Sans entrer dans toutes les subtilités, soulignons que les travaux de conservation et de restauration sont inscrits dans la catégorie des « prestations de services ». Par comparaison, les fouilles archéologiques sont, elles, placées dans la catégorie des « travaux », catégorie dont le seuil avant ouverture d'un appel d'offres européen est de 5 millions d'euros hors taxes.

Depuis août 2006 a été introduite dans le Code des marchés publics français une seconde possibilité : la procédure de l'accord-cadre. Elle permet une présélection des candidats pour une durée limitée à quatre ans. Les candidats retenus pourront contracter un ou plusieurs marchés lors de la survenance du besoin. L'accord-cadre offre alors la possibilité pour le commanditaire de préciser sa demande d'intervention, à laquelle les restaurateurs pressentis vont répondre.

Certaines caractéristiques, comme le taux horaire par exemple, sont fixes durant les quatre années. L'accord-cadre permet d'éviter de recourir à une succession de procédures administratives lourdes.

Le paragraphe 7 du Code des marchés publics précise comment le commanditaire peut « choisir l'offre *économiquement* la plus avantageuse ». Les conseils sur les critères de jugement des offres sont, dans l'ordre :

– l'adéquation au programme ;
– le respect de la déontologie ;
– la qualité de l'offre technique, l'installation matérielle proposée, les moyens humains proposés ;
– la méthodologie générale de l'intervention, la pertinence des choix et leur justification ;
– la clarté de la présentation ;
– le prix, en tenant compte des taux horaires et des prix de journée.

Cependant, on observe souvent que sont favorisés à 60 % le critère financier et à 40 % le cahier technique. De plus, s'il y a trop de réponses, la plus haute et la plus basse sont d'office éliminées.

Comment répondons-nous aux propositions d'intervention ?

Face à de telles procédures, quelle est notre réalité ? De nouvelles obligations sont apparues depuis quelques années, entraînant des coûts nouveaux :

– la sécurité dans le travail, la prise en compte de la santé des agents, le droit à la formation continue ;
– la sécurisation des espaces de travail (impliquant par exemple le traitement de l'air…), l'assurance des œuvres durant la période de travail ;
– l'écologie, avec l'obligation du traitement des déchets…

Cela m'entraîne à quelques remarques.

Sur les délais de livraison

Ma première remarque concerne les délais de livraison ou d'exécution. Ceux-ci sont de plus en plus souvent réduits. Sur la pression des expositions qui s'enchaînent ou des crédits à utiliser dans l'année, on vous demande fin 2014 de répondre à des appels concernant des travaux qui sont à livrer pour le printemps 2015. Il y a inadéquation dans le calendrier.

Quelles réactions possibles ? Employer des restaurateurs intérimaires sur de courtes périodes et les débaucher quand le travail est fini ?

Les autres remarques que je présenterai ici touchent au coût d'une intervention dont la part la plus importante consiste en salaires – on rappellera que ceux-ci doivent *obligatoirement* être signalés *avec* leurs charges – et aux économies qu'une entreprise peut chercher à faire afin de tirer un certain bénéfice, tout à fait normal dans le cadre d'une économie de marché.

Sur le temps de réalisation

Durant notre colloque encore, trop souvent les chiffres avancés n'ont pas inclus le coût réel d'une intervention. Pour décrocher des contrats, on en vient à la non-prise en compte du temps effectif de réalisation du travail. Sont donc avantagés les travaux qui prennent le moins de temps, l'intervention qui va au plus vite.

Quelle incidence pour les œuvres et, aussi, pour la connaissance des mosaïques ? Temps réduit, voire absent, accordé à l'observation des traces du travail antique alors qu'aujourd'hui, par rapport à nos prédécesseurs, les restaurateurs sont plus à même, de par leur formation en lien avec la recherche archéologique et scientifique, de reconnaître ces vestiges. Certes, depuis Ciro Robotti (Robotti 1973, 1982 ; Robotti et Mezzanotte 1983, 1984), on voit de plus en plus de ces vestiges du travail du mosaïste antique. Mais combien nous échappent lorsque le temps presse pour la réalisation d'une restauration ?

Pour gagner du temps, et donc de l'argent, lors d'une dérestauration d'un pavement anciennement restauré sur ciment, il peut être laissé une couche de ciment au revers du *tessellatum*. Tout le long et minutieux travail nécessaire pour retrouver le revers des tesselles n'est alors pas fait. Outre l'impossibilité d'observation technique précise sur la mise en œuvre originale du pavement ou sur la présence de restaurations antiques, les conséquences peuvent en être un risque pour la conservation à long terme de la mosaïque.

Gagner du temps, et donc de l'argent, c'est aussi, lors d'une dépose, procéder à un nettoyage insuffisant, en laissant, par exemple, une couche de calcite en surface avant l'encollage du pavement. Conséquence : des tensions dues à l'encollage de surface peuvent désolidariser cette couche de calcite du *tessellatum* ; celui-ci ne sera alors plus maintenu.

Gagner du temps, et donc de l'argent, est pratiqué aussi dans le cas de la dépose d'un *opus signinum*, montrant naturellement une plus grande rigidité. Si, pour aller au plus vite, les restaurateurs ne procèdent pas à la mise en place préalable d'un entoilage renforcé d'une structure rigide, il peut se créer des fissures dans le mortier.

Sur les matériaux mis en œuvre

Pour gagner sur le coût financier du travail, on peut aussi être tenté d'économiser sur les matériaux mis en œuvre, en quantité comme en qualité.

Nous sommes nombreux à utiliser comme nouveau support des nids d'abeille en aluminium stratifié. Ces matériaux sont maintenant produits par de nombreuses sociétés, plus ou moins sérieuses. Leur qualité de fabrication, comme par exemple le collage des tissus de verre sur les alvéoles d'aluminium, n'est pas toujours garantie. D'où le risque certain de mauvaise tenue à long terme. On a entendu, durant la conférence, des prix de vente des plaques en nid d'abeille d'aluminium très variables : il doit s'agir d'épaisseurs différentes, de matériaux différents, outre, bien sûr, le coût à l'importation variant selon les pays.

On pourrait trouver de nombreux exemples sur ce même thème, avec d'autres matériaux nécessaires : les adhésifs et résines, le petit matériel indispensable…

Et que dire en ce qui concerne la quantité des matériaux utilisés ? Utiliser le moins possible de matériaux peut apparaître à certains comme une économie immédiate.

Sur les frais de déplacement

Une autre remarque tient au chiffrage de la part la plus importante de nos coûts : les salaires, qui s'accompagnent de frais de déplacement, comptés – lorsqu'ils le sont – souvent au très juste prix.

Je l'ai dit, l'évaluation des salaires n'a que peu de chose à voir d'un pays à l'autre ; il est donc impossible de comparer ces coûts. Mais c'est aussi le cas pour les frais de déplacement : le transport, l'hébergement, le remboursement des frais de nourriture…

Aussi, comme on le voit parfois, certaines interventions qui ont été acquises sur une base de travail salarial sont-elles en fait réalisées, en grande partie, par des étudiants ou des stagiaires dont le coût salarial et le niveau de formation n'ont rien à voir avec ce qui a été initialement affiché.

Par ailleurs, il peut arriver – et c'est arrivé – qu'un chantier nécessite un temps d'intervention plus long que prévu, en raison de mauvaises situations climatiques ou de la découverte d'une difficulté technique, voire archéologique, imprévue qui nécessite alors un délai ou l'intervention de matériaux non calculés. La réponse à l'appel d'offres ayant été chiffrée *a minima*, le restaurateur n'a plus alors les ressources financières pour ce surcoût et tape dans son bénéfice, dans ses réserves, voire doit s'endetter.

Sur ces points, je voudrais dire très fortement que les économies se font aussi aujourd'hui au détriment de la vie quotidienne. Frais de déplacement, logement… réduits au minimum. C'est ce que l'on constate souvent, en particulier chez les jeunes sociétés d'archéologie et de restauration privées qui cherchent à se faire (re)connaître du marché. Le coût pèse alors sur la vie de tous les jours, notamment des plus jeunes.

Mais cela se pratique aussi chez les plus qualifiés d'entre nous. Il devient difficile de valoriser à son juste niveau l'expertise accumulée. Nous voyons partout une précarisation de notre profession. « Travailler plus pour gagner moins » a été un slogan récent de certains en France, mais aussi ailleurs. À moins d'être de ces grandes compagnies – certaines de stature internationale – pour lesquelles la restauration n'est qu'un faire-valoir et qui peuvent alors se permettre de casser les prix.

Pour éviter ces situations et devant la lourdeur des dossiers à compléter, certains restaurateurs indépendants ne répondent plus que pour des restaurations ne passant pas par les appels d'offres, c'est-à-dire restant sous le barème des 15 000 euros.

On ne peut pas, bien sûr, rester sur un tel constat pessimiste. Il faut absolument valoriser les formations tout en assurant l'installation de nouveaux restaurateurs. En Europe, les jeunes restaurateurs sont désormais issus de formations universitaires spécialisées et de haut niveau, comme, en France, le Département des restaurateurs de l'Institut national du patrimoine ou le master en conservation des biens culturels de l'université Paris I. On est très loin des artisans mosaïstes du XIX^e siècle.

Ces formations sont longues, de quatre à cinq années *a minima*. Elles forment les étudiants tant par la pratique que par l'apport de connaissances scientifiques sur les matériaux. Elles doivent aussi informer les étudiants sur leur futur statut et les aider à passer de la formation au monde du travail.

Ici, je voudrais rappeler que, comme pour d'autres métiers, nous avons une profession où nous formons nous-mêmes notre propre concurrence, aujourd'hui, dans des ateliers hyperspécialisés. Or, nos ateliers ne peuvent plus travailler uniquement dans un domaine comme la seule préservation des mosaïques : ils doivent développer leurs champs de compétence, posséder d'autres spécialisations, comme la conservation de peintures murales, de sculptures, de céramiques… pour pouvoir vivre de tels travaux.

Quelles sont les possibilités pour les jeunes restaurateurs, et particulièrement dans notre domaine, de s'installer ? Ils ont besoin de lieux pour travailler, d'espaces sécurisés, d'espaces de stockage de matériels importants, parfois aussi de produits dangereux… besoins qui sont des impératifs pour pouvoir prétendre à répondre aux appels d'offres. Parmi les statuts qui peuvent leur être proposés, on l'a déjà signalé, il y a « travailleur indépendant », « autoentrepreneur », ou alors passer par des sociétés de portage, des regroupements de restaurateurs indépendants, voire la création d'entreprise…

Une solution serait de développer et soutenir l'ouverture d'établissements publics de coopération culturelle (EPCC) pour la connaissance, la valorisation, la conservation et la restauration des patrimoines. Il y a par exemple à Marseille le Centre interdisciplinaire de conservation et de restauration du patrimoine (CICRP), existent aussi deux structures départementales semblables à Caen et à Perpignan. Des espaces ainsi que des équipements lourds y sont mis à disposition pour des restaurateurs privés ayant répondu et obtenu des appels d'offres. Au CICRP, ils peuvent réaliser des restaurations d'œuvres de petit ou de grand format. Ce centre dispose également de laboratoires d'analyse et de spécialistes scientifiques qui sont au service des dossiers de restauration. De telles structures apportent toute sécurité pour les œuvres, mais aussi sur la qualité sanitaire des espaces de travail. Que l'on comprenne bien : ce sont d'abord de vastes espaces et des moyens lourds, publics, mis à disposition de restaurateurs privés.

Nos structures publiques muséales s'ouvrent à ce type d'accueil. Et par exemple, dans le cadre de notre laboratoire de restauration du Musée départemental Arles antique, nous recevons parfois des restaurateurs privés qui viennent restaurer des objets archéologiques ou de la statuaire.

Afin d'ouvrir le débat, j'ai évoqué des situations que je connaissais, qui sont les nôtres en France aujourd'hui. Il est impératif que ces évolutions de nos métiers soient discutées dans le cadre d'organisations internationales afin d'établir des marches à suivre qui respectent les particularités de chacun de nos pays tout en développant une déontologie commune et partagée. Un état des lieux international reste à faire. Cela pourrait être l'objet d'une très utile enquête à mener, car tel est le défi de demain pour nos métiers…

Face à la crise économique qui frappe nos pays, notre réponse doit-elle être une concurrence plus acharnée ? Ne devons-nous pas éviter de nous retrouver dans des querelles de restaurateurs et de mosaïstes comme, en 1563, le procès opposant les frères Francesco et Valerio Zuccato à la famille Bianchini, qui les accusait d'avoir utilisé du bois peint en lieu et place de tesselles pour la réfection de la voûte de l'Apocalypse à Saint-Marc de Venise (cette querelle a été romancée par George Sand dans un ouvrage paru en feuilletons dans la *Revue des deux mondes* en 1837) ?

Il est important de rappeler que notre Conférence internationale a été créée pour favoriser de vrais et réels échanges et discussions entre les professionnels que nous sommes. Nous nous devons de développer l'écoute des problèmes rencontrés par chacun, qu'il vienne des rives sud, est, ouest ou nord de la Méditerranée.

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Mosaici della Sardegna, mosaico della Sardegna, conservazione a ogni costo

Antonietta Boninu

Abstract: *Negli anni 1982–2012 il numero dei nuovi mosaici della Sardegna, almeno uno per anno, è significativo. Nella Sardegna settentrionale i 30 mosaici sono distribuiti tra la città–porto della Colonia Iulia Turris Libisonis, le ville costiere e l'interno. Il Corpus dei mosaici della Sardegna del 1981 comprende 287 mosaici per 42 località, di cui 175 riscontrati e 112 documentati in bibliografia e negli archivi. Tali dati individuano una strategia di salvaguardia del patrimonio archeologico, unita a un sistema di conservazione preventiva, nel rispetto del contesto del vano, dell'edificio, del monumento e dell'ambiente. Nel contesto monumentale della Sardegna il mosaico svolge anche un ruolo di simbolo per affermare la funzionalità della strategia della conservazione preventiva.*

Abstract: *The number of new mosaics discovered in Sardinia between 1982 and 2012—at least one per year—is significant. In northern Sardinia, 30 mosaics are scattered between the port city of Colonia Iulia Turris Libisonis, coastal villas, and inland. The 1981* Corpus of Sardinia Mosaics *comprises 287 mosaics in forty-two locations, 175 of which were reconstructed and 112 of which were documented in books and archives. These figures point to a strategy of safeguarding archaeological heritage combined with a system of preventative conservation with respect to individual rooms, buildings, monuments, and surrounding environments. Among the monuments of Sardinia, the mosaic also plays a symbolic role as a testament to the practicality of a strategy of preventative conservation.*

Rivolgo un saluto cordiale a tutti i convenuti. Grazie agli amici, al Presidente ICCM Demetrios Michaelides e al Vice Presidente Roberto Nardi, a tutti gli amici componenti il Board ICCM, sempre convinti che il compito di tutti i ricercatori e operatori dei beni culturali sia una visione del futuro. Le "tessere" dei sogni sono "andate a mosaico" nella Conferenza del Marocco del 2011 e oggi sono una realtà. La Sardegna ne può essere orgogliosa.

Per la Sardegna il *Corpus* dei Mosaici di Simonetta Angiolillo, edito nel 1981, restituisce un quadro di 287 mosaici distribuiti in quarantadue località. Di 287 mosaici, 175 sono riscontrati e 112 si registrano in bibliografia con indicazioni di carattere generico sulla località, prive di dati per l'esatta collocazione (figg. 1, 2).

La storia della conservazione, *ante* 1981 e successiva, unita ai consistenti rinvenimenti che si sono susseguiti, suggerisce un'analisi per la Sardegna centro–settentrionale. Dal 1981 al 2012 si registrano nuove scoperte che si esaminano nel processo di salvaguardia, attivato fin dagli anni Settanta. La pianificazione della salvaguardia dei siti archeologici monumentali è stata impostata in una prospettiva di acquisizione in mano pubblica delle aree interessate, con prospettive di sviluppo anche per l'istituzione di parchi, al fine di assicurarne la conservazione e la disponibilità come beni comuni e come fonte di sviluppo culturale nel rapporto dei cittadini con il territorio (figg. 3, 4).

Fra i trenta nuovi sono compresi diciotto mosaici di Porto Torres, sei di Alghero Sant'Imbenia, cinque di Sorso Santa Filitica, e uno di Bonorva Sant'Andrea Priu, in un impianto termale alla base del rilievo della necropoli neolitica a *domus de janas*. Quest'ultimo si potrebbe definire un *ex mosaico*, perché è stato rinvenuto un vano con il piano pavimentale, che conserva il negativo delle tessere, interamente asportate. Degli undici mosaici delle ville sulla costa occidentale e settentrionale, tre sono stati prelevati, collocati su supporto ed esposti nei rispettivi musei archeologici territoriali, di conseguenza gli altri ventisette sono conservati *in situ*. I diciotto mosaici di *Turris Libisonis* appartengono a quattro tipi di

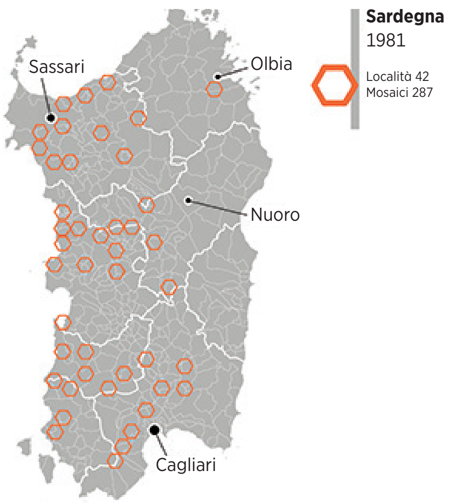

Figura 1 Mosaici della Sardegna noti fino al 1981.

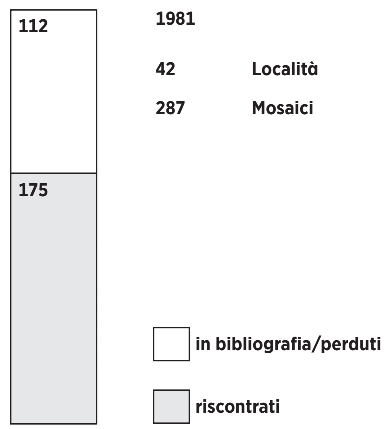

Figura 2 Rapporto tra i mosaici riscontrati e noti dalla bibliografia fino al 1981.

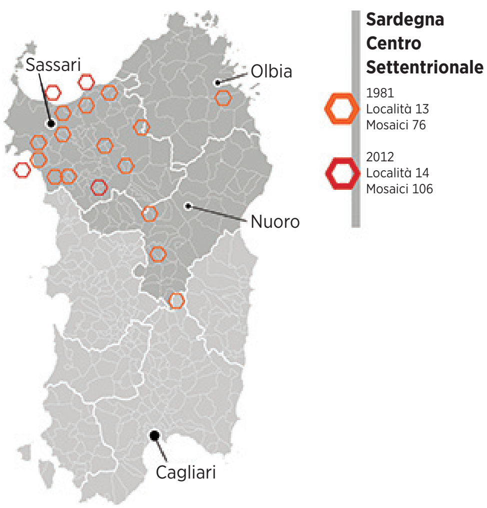

Figura 3 Mosaici della Sardegna centro Settentrionale.

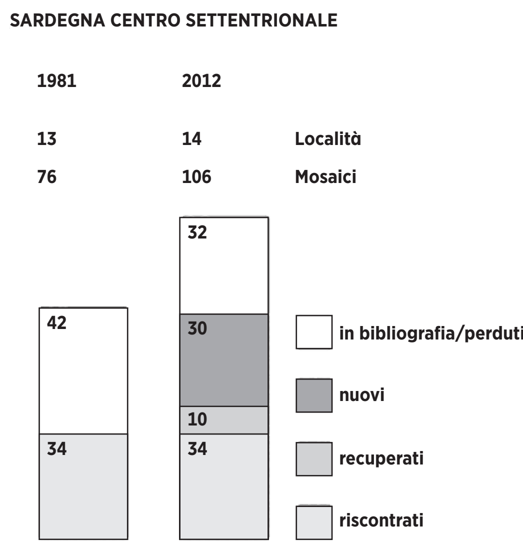

Figura 4 Sardegna Centro Settentrionale: Mosaici 1981 e 2012 a confronto.

edifici: pubblici, terme, *domus* e necropoli. La *domus* di Orfeo e la *domus* contigua ne hanno restituiti otto, l'edificio pubblico in via delle Terme uno, le Terme Pallottino, via Ponte Romano due, l'*insula* settentrionale uno, la *domus* dei mosaici quattro, la necropoli meridionale due.

La visita programmata per giovedì 30 ottobre 2014 presenta direttamente i mosaici *in situ*. Antistante l'attuale stazione marittima, sulla linea di costa, in un'organizzazione di impianti per la cattura e la riserva di acqua dolce, l'*insula* settentrionale ha conservato le strutture rasate a pochi centimetri dal pavimento. I piani degli edifici costruiti hanno subito modifiche e lacune per gli usi successivi fino alla fase di abbandono, sulla quale sono stati impostati i servizi funzionali alle attività portuali. Ciononostante un vano ha restituito un mosaico pavimentale decorato con una composizione di quadrati raccordati da rettangoli. I quattro mosaici della *domus* dei mosaici, sul rilievo prospiciente la riva destra del fiume Mannu, scoperta in un progetto di tutela, sono inseriti in vani con pareti intonacate e dipinte, sia nel settore dell'abitazione sia nel settore delle terme contigue. I motivi geometrici dei mosaici presentano riquadri con coppie di uccelli, pesci e frutta. Nella *domus* di Orfeo, delimitata su due lati, est e ovest, prevalgono i mosaici figurati, due con emblema centrale: Orfeo e le Tre Grazie, e una teoria di diciotto pesci in una vasca con fontana centrale e pareti rivestite con lastre di marmo. Un mosaico con motivo a canestro appartiene alla *domus* contigua, parzialmente sottostante il terrapieno delle Terme Centrali.

La programmazione della conservazione dei mosaici ha interessato sia quelli noti fino al 1981, sia quelli scoperti progressivamente fino al 2012. Per questi il resoconto dell'attività di conservazione, impostata già al momento della scoperta, oltre agli interventi di ripulitura, di stabilizzazione di lacune e di contenimento dei bordi, che avevano subìto asportazioni e perdite per i danneggiamenti da spoliazione, sofferma l'attenzione su progetti che hanno impegnato notevoli risorse materiali, scientifiche e tecniche.

Per le coperture si sono rispettate le raccomandazioni espresse da Cesare Brandi *in primis* e da Pietro Romanelli, ancora attuali e insuperate nella formulazione degli indirizzi. Negli anni in cui si dibattevano le problematiche per la protezione dei mosaici di Piazza Armerina, con l'obiettivo di realizzare al più presto la copertura e talvolta concentrando l'attenzione sul tipo di architettura da realizzare, Romanelli, con la doppia responsabilità di scienziato e di preposto alla tutela, formula il principio del massimo e miglior risultato con la soluzione più semplice.

Il secondo tema, promosso come tecnica risolutiva di conservazione, successivamente trattato con approccio critico, è l'asportazione dalla base originaria e la collocazione su supporto di cemento armato; a distanza di decenni è stato ancora riesaminato e rivisto nell'ottica dell'ultima *ratio*, in assenza di alternative. Di conseguenza il ricorso al restauro del restauro dovrebbe essere limitato ai casi di gravissimo degrado. I numeri che si riportano rivelano la storia della tecnica, da una diffusa e frequente applicazione alla progressiva riduzione, per evitare di cancellare i dati contenuti negli strati della malta e di separare un'unità costruttiva.

Fra i trentun mosaici del 1981, sui sedici riportati su supporto dieci sono stati oggetto di restauro del restauro, poiché il livello del degrado avrebbe condotto alla perdita del mosaico. Dei trenta mosaici del 2012, soltanto tre sono stati prelevati, riposizionati su supporto ed esposti in strutture museali. La causa è stata di forza maggiore, poiché la dinamica del mare sulle strutture archeologiche avrebbe sicuramente fagocitato i mosaici della villa di Sant'Imbenia, Alghero, e della villa di Santa Filitica, Sorso.

I sedici mosaici su supporto di cemento sono stati separati dalle strutture di pertinenza o perché distrutte al momento della scoperta, tra gli anni Venti e i Trenta, o al momento dello strappo. Soltanto per alcuni si è riusciti a identificare il vano di provenienza, su indizi iniziali e ripetute indagini. Gli interventi per i supporti, realizzati tra gli ultimi anni Cinquanta e nel decennio successivo, hanno trattato i mosaici come oggetti isolati, privi di relazioni e nessi da rispettare. Per la conservazione del mosaico il contesto di vano, inserito in quello di edificio e compreso in quello del monumento e quindi dell'ambiente, è un legame essenziale da proteggere e salvaguardare, fin dalla fase antecedente la scoperta.

La pianificazione della salvaguardia del contesto, così indicato, ha compreso anche la ricerca dei trentasette mosaici del 1981, riportati in notizie bibliografiche e i sei mosaici perduti. Dei trentasette ne sono stati recuperati sette e dei sei ne sono stati individuati tre con localizzazione puntuale, protetti in aree salvaguardate, mentre per un mosaico, strappato negli anni Sessanta e non più ritrovato, si ha il forte sospetto che sia stato utilizzato come facile fonte di approvvigionamento di tessere per gli interventi su altri mosaici.

Per i diciotto mosaici di *Turris Libisonis* lo stato di conservazione è da ritenersi buono e sono stati protetti con soluzioni differenziate elaborate per unità di edificio, definite già al momento della scoperta. La protezione realizzata per le strutture dell'*insula* settentrionale comprende il mosaico ed è funzionale anche all'accesso alla stazione dalla banchina portuale. Il complesso del sistema di accoglienza della stazione deve essere ancora completato con la sistemazione dei percorsi esterni e interni, anche per la visita archeologica.

Per il mosaico di via delle Terme, trattandosi di un'area di proprietà privata, che ha attivato una contestazione e che attende il secondo grado di giudizio dalla magistratura amministrativa, subito dopo la scoperta sono state eseguite una protezione a contatto e una copertura da cantiere per il vano di pertinenza, al fine di proteggere gli elevati residui con tracce di intonaco dipinto. Il monitoraggio della struttura, per almeno sei anni, ne ha confermato la funzionalità.

Per la necropoli di San Gavino la sistemazione della piazza dell'Atrio Metropoli con il ripristino delle quote di frequentazione costituisce una copertura definitiva del settore delle tombe con mosaico, che è visitabile con accompagnamento.

Per la *domus* dei mosaici, nel settore occidentale della città, si è progettata e realizzata una copertura, definibile provvisoria, poiché non si conosce ancora l'intera planimetria e si dispone soltanto di parte del muro perimetrale orientale, lungo una strada nord–sud. Per la costruzione sul declivio la differenza notevole di quota dei settori dell'impianto ha suggerito la messa in opera di una copertura, costituita da un telone impermeabile, ancorata con le pendenze idonee a contenitori d'acqua, semplicemente poggiati nella fascia perimetrale non scavata e quindi non interferenti con le strutture archeologiche e facilmente amovibili con costi molto ridotti.

La *domus* di Orfeo, nell'area di Palazzo Re Barbaro, ha conosciuto due fasi: al momento della scoperta la protezione a contatto e una copertura sommitale da cantiere hanno garantito il completamento dello scavo; quando sono stati disponibili i dati del contesto strutturale è stata progettata e realizzata una protezione definitiva per la conservazione dei mosaici e del fronte settentrionale dell'impianto termale, con materiali e modalità suggeriti dalle stesse strutture, caratterizzata anche da manutenzione semplice ed economica.

Per la visita dei mosaici, i percorsi hanno utilizzato le fosse di spoliazione parallele all'identificato perimetro nord–sud della *domus*. Il sistema di protezione è stato presentato nell'undicesima Conferenza ICCM del Marocco nel 2011.

L'analisi dei numeri, delle proporzioni e delle percentuali nel tempo indicato restituisce un bilancio positivo. La media di un mosaico all'anno, che diventerebbero due per tutta la Regione, con ritmo regolare almeno per i prossimi dieci anni, costituisce un parametro sicuramente alto di potenziamento del patrimonio musivo. I numeri sono dati significativi, ma è importante condurre un esame per rilevare le modalità e per valutare l'attività che ha restituito i trenta mosaici e che ha permesso la conservazione dei precedenti.

Ogni scoperta archeologica, perché ne sia assicurata la trasmissione, deve nascere insieme all'attività di conservazione; eventuali separazioni e dilazioni nel tempo provocano sicure perdite. Scoperta e conservazione non sono scientificamente e metodologicamente scindibili, né separabili nel tempo. La ricerca archeologica attiva la conservazione; la ricerca della conservazione potenzia la scoperta archeologica. Si conduce l'indagine di valutazione, per giungere a conoscere le motivazioni, le cause e a esaminarne i costi (fig. 5).

Il tema dei costi, non riducibile a cifre di spesa, è tema di economia che concerne i mosaici e i beni culturali, dovrebbe muovere l'analisi dal valore, dal ruolo e dalla loro funzione nella società. Se si affronta l'esame separando i costi e i beni per riportare numeri e confronti, mutuati da altri settori, si rischia di giungere a risultati, valutazioni e decisioni a sicuro danno dei beni.

Una cerchia di economisti, per fortuna ristretta, riesaminando il carico economico sostenuto dal pubblico, solleva il problema del "costo opportunità". Tale teoria, ovviamente, non trova concordi gli "addetti ai lavori" della ricerca e della conservazione, che ritengono la spesa pubblica insufficiente, necessaria e irrinunciabile. La riduzione sempre più drastica delle risorse finanziarie, non potendo assicurare la conservazione, avvia alla perdita sicura dei beni.

Tale rischio è reale, ma dovrebbe essere arginato con apporti documentati per il rapporto tra esistenza e distruzione del bene. Con quali conseguenze? Con quale diritto?

Per fortuna, tra gli esperti di economia aumenta il numero di coloro che affrontano l'analisi economica evidenziando i molteplici ruoli dei beni culturali e che li ritengono un settore strategico per lo sviluppo economico. Alcuni economisti, in

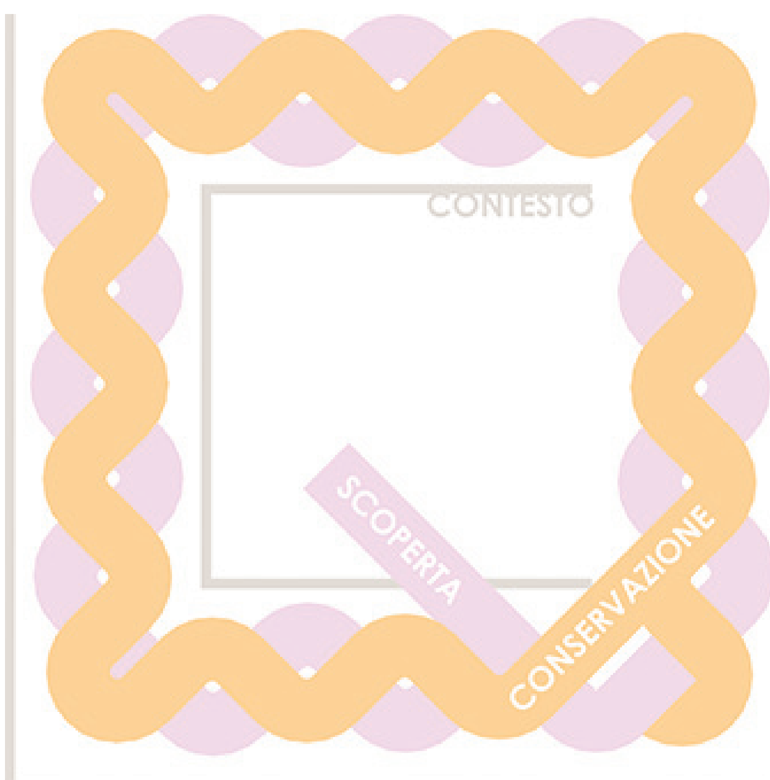

Figura 5 La scoperta e la conservazione contestuale assicurano i mosaici

anni recentissimi, evidenziano il passaggio da una valorizzazione economica della cultura a una valorizzazione culturale dell'economia. In questa direzione la conservazione del mosaico è conservazione del contesto e occorre indirizzare le forze degli esperti di conservazione, insieme all'ICCM e ai contributi di queste giornate, anche in questa funzione, per affermare la cultura della Conservazione, dei mosaici, del patrimonio archeologico e dell'eredità culturale, per saldare il rapporto con il contesto monumentale di appartenenza e rafforzarne il ruolo nel sistema economico.

I parametri dei costi, isolati dal contesto dell'economia, rischiano facili equazioni: a parità di operazioni i costi non possono essere troppo differenti, per inseguire un risparmio inconsistente che si riversa negativamente sulla qualità; in parallelo, il costo più alto non equivale a un alto livello dell'intervento. Insomma, il fulcro della conservazione è l'intervento, la qualità e non il costo. La conservazione è alimentata dalla ricerca che si applica, per ristabilire e curare un equilibrio tra le parti del mosaico e tra le unità identificate del contesto. Il progetto di conservazione si avvia con la consapevolezza che si tratta di un progetto della complessità e gestione di processi in un campo in continua mutazione ed evoluzione.

L'impegno per la salvaguardia del patrimonio archeologico comporta un processo che si origina nella pianificazione articolata in espliciti obiettivi e nell'individuazione delle risorse scientifiche, tecniche e finanziarie, segue la programmazione delle attività e la progettazione degli interventi. Tale sistema è saldamente ancorato a una realtà complessa, che muta in continuazione, che presenta esigenze, che richiede e attende soluzioni. L'intero processo, caratterizzato da una dinamica pluridirezionale, da una conoscenza degli strumenti e delle risorse, dalla strategia di competenza, ricerca le soluzioni in percorsi flessibili e coordinati.

L'albero concettuale che esemplifica il processo riassume le funzioni e le interrelazioni delle attività e i risultati (fig. 6).

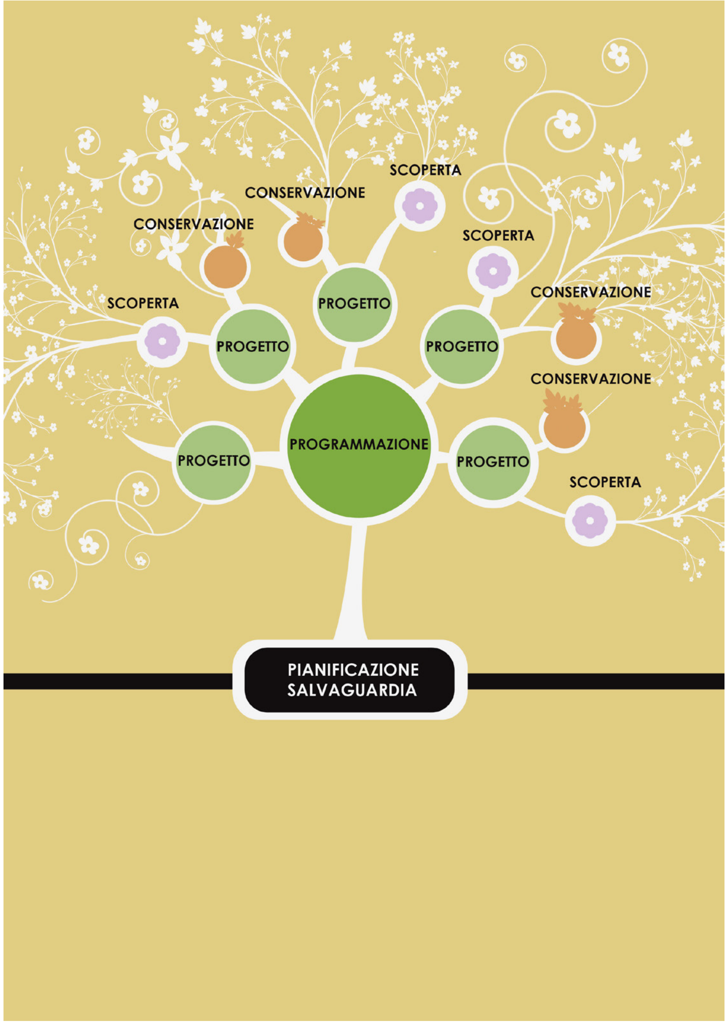

Figura 6 Mosaici: La conservazione ha origine nell'attività di salvaguardia.

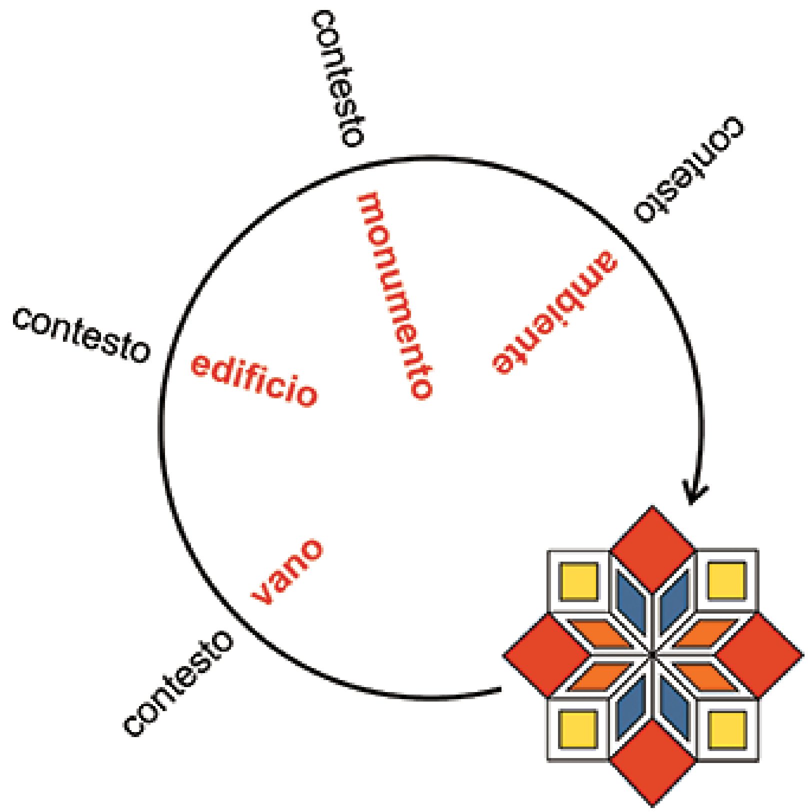

Figura 7 Mosaici: La motivazione e lo sviluppo della ricerca sono da ritrovare nel contesto.

Se si accoglie l'importanza del rapporto tra mosaico e contesto, micro contesto per il vano decorato e macro contesto per il monumento, il principio va esteso all'ambiente circostante e al territorio, ove gli apporti per ridurre le cause del degrado investono le scelte che si effettuano in ambito di urbanistica, di pianificazione territoriale e di programmazione economica, che comportino investimenti e modificazioni inevitabili. Per giungere alla conciliazione delle soluzioni richieste dalle esigenze molteplici, derivanti dall'uso del territorio, il ruolo e la funzione del patrimonio archeologico si affermano nelle operazioni riscontrabili (fig. 7).

Se nell'ambito di tale patrimonio si attribuisce al mosaico una funzione di guida, per quanto finora noto e per quanto da scoprire ancora, il richiamo alla pianificazione della salvaguardia e alla conservazione preventiva diventa un imperativo per operare.

Il mosaico è monumento, il monumento è patrimonio del territorio e quindi patrimonio comune, insieme costituiscono un sistema da conservare, a prescindere dalle tipologie decorative, monumentali e cronologiche.

Con quali costi?

I costi non sono i costi del singolo intervento sul mosaico, ma i costi della conservazione del contesto. Ma se il contesto del mosaico è l'oggetto delle cure della pianificazione di salvaguardia, la valutazione parte dall'analisi del processo con parametri rilevabili e criteri predefiniti in termini di efficienza, efficacia ed economicità.

L'efficienza si declina in competenza, tempestività e capacità di raggiungere gli obiettivi, ossia salvaguardia del contesto, capacità di azione, progettazione e realizzazione, e di esiti con il minimo di risorse strumentali e finanziarie.

Per efficacia si intende l'incisività delle azioni e la validità dei risultati, che in materia di protezione e conservazione comprendono anche l'abbattimento dei costi per la manutenzione e la durabilità degli interventi.

L'economicità si articola nel rapporto tra obiettivi conseguiti e risorse utilizzate, anche metodologiche: un esempio può essere dato dalla validità della documentazione, dalla forma e dalla conservazione della stessa, dalle modalità di registrazione e di gestione del monitoraggio.

La valutazione dei dati e le soluzioni possibili di intervento guidano nell'individuazione delle operazioni, da calibrare tra un'ipotesi di protezione totale del monumento, di difficile realizzazione e di costi elevati, e la ricerca per attenuare l'azione di fattori di degrado naturali, per esempio le forze eoliche, con provvedimenti indiretti di protezione nel contesto monumentale e ambientale; si pensi al recupero e/o all'impianto di specie arboree e arbustive.

La conoscenza del patrimonio musivo perfeziona la competenza per creare le basi della conservazione: tutte le opere, se interrogate, parlano, e quanto più numerosi sono gli interrogativi, tanto più eloquente è la risposta. La soluzione della protezione è contenuta nel bene, mosaico e contesto.

Per mutuare il concetto di mosaico, il pavimento musivo è tessera del mosaico–monumento e il monumento è tessera del tessuto urbano, dell'insediamento nel territorio. Così come l'analisi dello stato di conservazione del mosaico non può essere circoscritta a una tessera o a un insieme di tessere, l'indagine per la conservazione del mosaico non può essere condotta esclusivamente sul rivestimento pavimentale, ma deve essere estesa al vano e alle strutture dell'edificio, inteso anche come contesto monumentale del mosaico. Soltanto la ricerca per la conservazione dell'edificio potrà avere effetti positivi per la conservazione del mosaico.

È auspicio condiviso che gli investimenti per la conservazione e per la ricerca sulla salvaguardia debbano essere potenziati e garantiti.

Per sostenere che i costi per la conservazione dei mosaici e del patrimonio archeologico sono necessari e rilevanti, sempre più importanti, ma purtroppo sempre più insufficienti, occorre dimostrare che il ruolo dei mosaici e dei monumenti è dentro l'economia e nella società.

In una fase di riduzione progressiva delle risorse economiche disponibili è evidente che, per il governo dei beni comuni, i mosaici e i beni archeologici non sono ritenuti sempre strategici per lo sviluppo. Rivendicarne il ruolo in tal senso dovrebbe essere impegno individuale e collettivo in un processo delle conoscenze e delle competenze indirizzate a rimarcare funzioni e disponibilità dei beni, per provocare rispetto e decisioni. È cruciale elaborare sistemi innovativi per comunicare il tema della conservazione consolidando l'identità disciplinare.

Si deve ben comprendere la differenza tra un progetto frutto di ricerca, calibrato alle reali esigenze del mosaico e del monumento, e un altro che applica ricette non riscontrate, non dimostrabili e in tutti i casi con elevati costi. Occorre innovare. Per sistemi innovativi si intende anche una formula di dialogo per elaborare strumenti di comunicazione.

L'analisi e la rielaborazione del flusso che intercorre tra costi delle attività di conservazione, trasmissione e generazione di valori ed effetti sul sistema economico, fondata sull'individuazione e sull'esplicitazione del contesto, assume dimensioni e proporzioni innegabili e di conseguenza da non eliminare, trascurare o sottovalutare. Il processo ha un andamento circolare, ove il contesto risulta la prima protezione del mosaico.

Qualora l'esigenza di conservazione del mosaico possa essere ignorata, trascurata, risulta più difficile trascurare e ignorare il contesto più ampio, che comprende il bene–mosaico indagato. Soltanto il flusso di valori non interrotto può garantire interesse per la costruzione di politiche decisionali. La declinazione dei valori e i percorsi di partecipazione nei processi di conservazione devono ricercare formule in un contesto ampio.

La conservazione dei mosaici non si risolve in un progetto che opera in tempi definiti e contenuti, ma si struttura in un processo che si sviluppa nel tempo, che si potenzia con aggiornamenti e suggerimenti, provenienti anche dall'uso culturale e dai sistemi di gestione. Dimostrare che il mosaico è monumento e che il monumento è patrimonio imposta una direttrice, che estende informazione concettuale per giungere alle decisioni.

Occorre con forza affermare che i costi costituiscono un fatto ineluttabile e che l'analisi deve essere estesa al metodo, ai criteri, agli strumenti, ai tempi. Al rapporto tra l'investimento materiale e immateriale, l'efficienza delle soluzioni che si adottano, la durabilità, l'economicità. I principi sono contenuti nelle direttive europee, che indicano i criteri da rispettare perché siano articolati in un piano di coerenza, continuità d'azione, e che siano riscontrabili.

Nella prevalente e indubbia consistenza insediativa della Sardegna, preistorica e protostorica, l'estensione concettuale del mosaico–simbolo–monumento e insieme simbolo di patrimonio archeologico diffuso può contribuire a visualizzare l'immagine della pianificazione della salvaguardia.

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Bulla Regia : La conservation des mosaïques à quel coût ?

Hamida Rhouma-Ghmari et Mohedinne Chaouali

Résumé : *La conservation des mosaïques en Tunisie nécessite des ressources humaines et financières importantes ; l'Institut National du Patrimoine (INP) doit allouer chaque année un budget conséquent pour l'entretien et la valorisation de ce patrimoine culturel. À travers le projet de partenariat international entre l'INP, le Getty Conservation Institute (GCI) et le World Monuments Fund (WMF) pour la conservation du site de Bulla Regia, il est désormais possible d'estimer le coût de la restauration des pavements de mosaïque. Nous essaierons, à travers l'étude de cas du projet de conservation des mosaïques de la maison de la Chasse, d'estimer le coût des matériaux et matériels nécessaires pour l'élaboration de différentes interventions sur les mosaïques (documentation, nettoyage, stabilisation, réenfouissement) et d'évaluer les honoraires des intervenants des ressources humaines mises à disposition pour mettre en œuvre les multiples actions de conservation.*

Abstract: *The conservation of mosaics in Tunisia requires significant financial and human resources. Each year, the National Heritage Institute (INP) is obliged to allocate a substantial budget for the maintenance and enhancement of this cultural asset. Thanks to the international collaboration of the INP, the Getty Conservation Institute (GCI), and the World Monuments Fund (WMF) on the conservation of the site of Bulla Regia, it is now possible to estimate the cost of the conservation of the mosaic pavements. Using the House of the Hunt mosaic conservation project as a case study, we will attempt to assess the cost of the materials and equipment used for the different interventions carried out on these mosaics (e.g., record keeping, cleaning, stabilization, reburial) and to evaluate the fees charged by the professionals who are in the position to carry out the various conservation tasks.*

Présentation du site de Bulla Regia

La cité de Bulla Regia est située au nord-ouest de la Tunisie. La ville antique a été fondée à une date non encore précisée mais probablement antérieure au IV^{e} siècle av. J.-C. À l'époque romaine, elle accéda aux différents statuts municipaux. Tous les éléments essentiels d'une cité romano-africaine y sont représentés : forum, basilique civile, arcs de triomphe, thermes publics (les thermes memmiens, les thermes sud, les bains des Venantii…), théâtre, latrines, nymphée, aqueducs, citernes, fontaines, bassins, bibliothèque, marché, amphithéâtre, nécropoles, mausolées, capitole, temples (d'Apollon, d'Isis, géminés, temples anonymes…).

Le paysage urbain de Bulla Regia se caractérise par l'existence de prestigieuses demeures, dont certaines comportent un étage souterrain, comme les maisons de la Chasse, de la Nouvelle Chasse et d'Amphitrite (fig. 1).

Projet de conservation du site de Bulla Regia

Le site de Bulla Regia est privilégié car faisant l'objet d'un projet de partenariat tripartite entre l'Institut National du Patrimoine (INP), le Getty Conservation Institute (GCI) et le World Monuments Fund (WMF) depuis 2009. Ce projet consiste en la mise en place d'un plan de conservation, de mise en valeur et de gestion du site basé notamment sur les maisons à étages souterrains. La conservation et l'entretien des mosaïques forment la partie essentielle du projet, car le site de Bulla Regia compte quelque 360 pavements en mosaïque *in situ*.

L'état de conservation des mosaïques *in situ* de Bulla Regia est variable. Beaucoup d'entre elles sont en très mauvais état. Compte tenu des ressources du site, à la fois humaines et

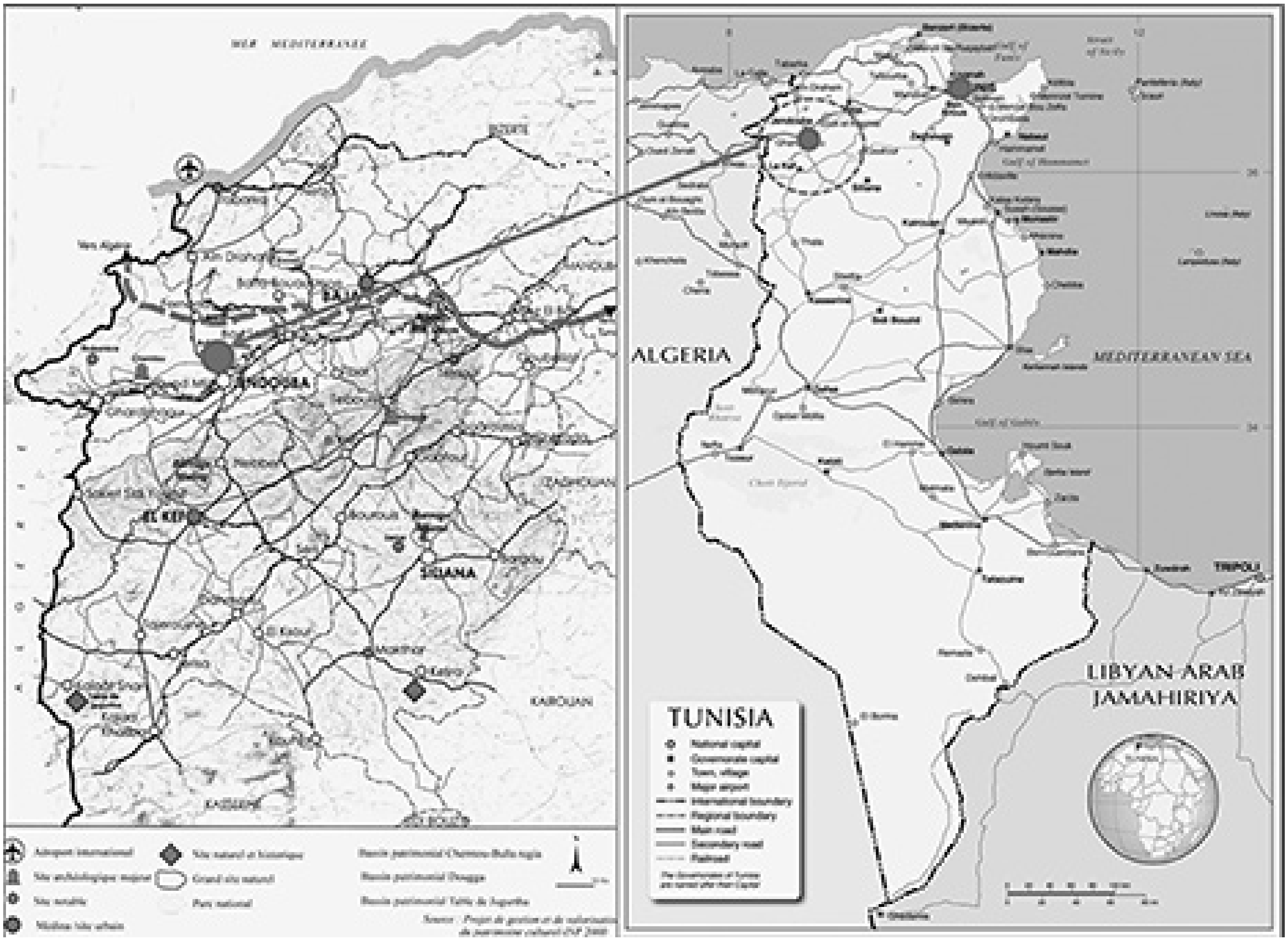

Figure 1 Situation géographique de Bulla Regia. Source : Projet de gestion et de valorisation du patrimoine culturel. © INP 2000

financières, la survie de centaines de mosaïques de Bulla Regia dépend du développement et de la réalisation d'un plan d'action prioritaire pour stabiliser et protéger par réenfouissement de nombreuses mosaïques sur le site, tout en conservant et présentant au public quelques tableaux significatifs.

Vers les années 1990, l'INP et le GCI ont mis au point un programme de formation destiné à des techniciens choisis parmi le personnel ouvrier pour la stabilisation et l'entretien de la mosaïque *in situ*, mais nous n'avons toujours pas le profil des conservateurs-restaurateurs dûment formés. Il est important de noter qu'en Tunisie les archéologues ont cessé de procéder à la dépose des mosaïques, sauf dans des cas de force majeure.

À partir de 2011, les travaux de conservation des mosaïques de la maison de la Chasse sont organisés dans le cadre du projet MOSAIKON. La programmation est basée sur le travail de trois techniciens formés par le GCI. Le calcul des jours de travail se base sur les compétences des techniciens (fig. 2).

Présentation de l'*insula* de la Chasse

L'*insula* de la Chasse se compose de deux parties distinctes : la maison de la Chasse, découverte au début du XX^e^ siècle, située au sud et occupant une large partie de l'*insula*, et la maison de la Nouvelle Chasse, découverte dans les années 1970, qui se situe au nord. Elles sont toutes les deux pourvues d'étages souterrains (fig. 3).

La maison de la Chasse

L'habitation doit son nom à l'existence d'une scène cynégétique qui ornait un de ses pavements situé sous le portique

Figure 2 Restauration des mosaïques.

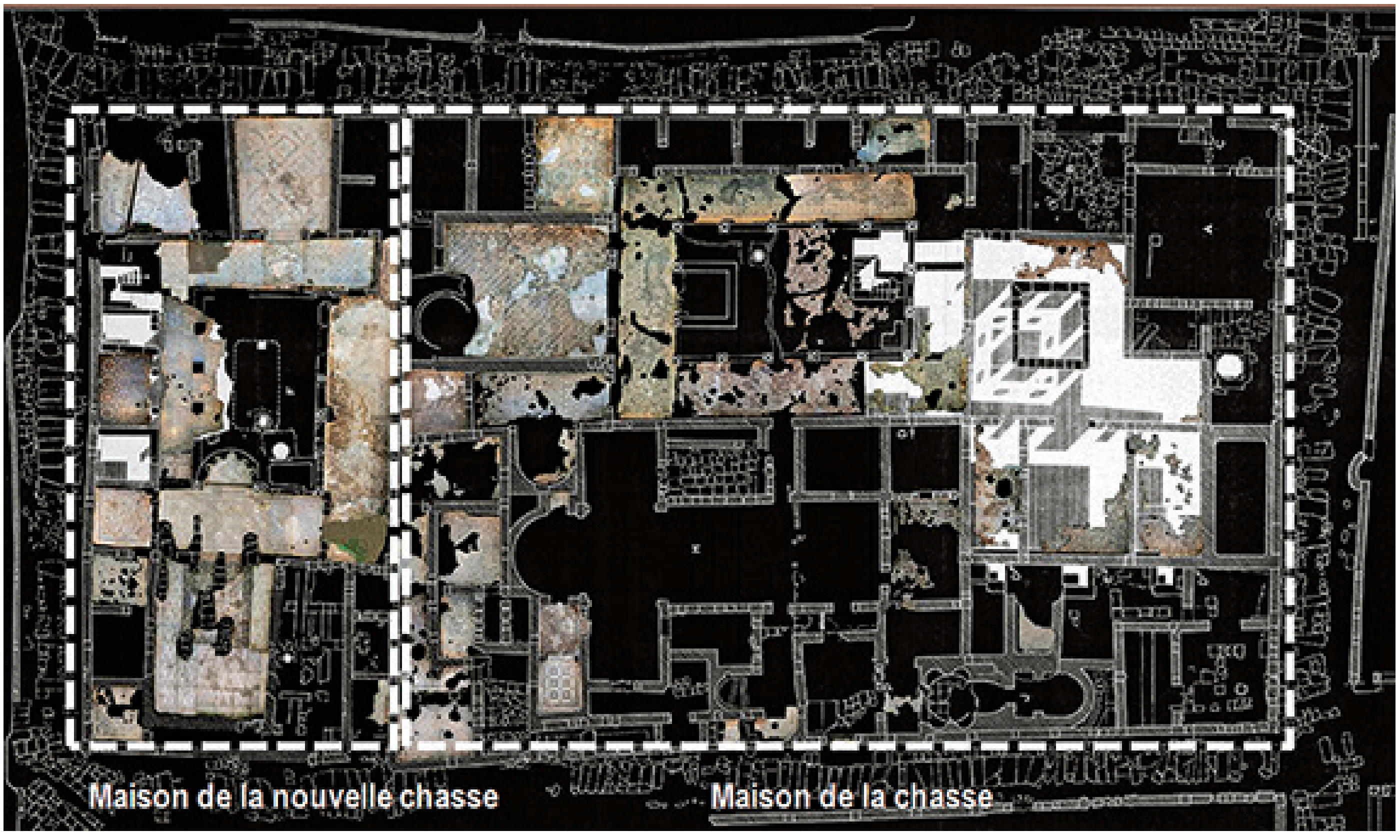

Figure 3 *Insula* de la Chasse.

ouest du péristyle de l'étage souterrain, juste en face de la baie centrale du *triclinium*.

La vaste cour largement ouverte en son centre joue le rôle de prise d'air et de lumière pour l'étage souterrain. Les pièces à l'ouest de la cour reposent sur des pièces semblables à l'étage souterrain. L'étage souterrain s'organise autour du péristyle, dans lequel débouche l'escalier de descente. La salle à manger (6,6 m sur 5,2 m) est décorée d'une mosaïque monochrome blanche à l'emplacement des lits et d'un tapis central polychrome. Au milieu de la composition géométrique de ce dernier pavement apparaît le symbole de la sodalité des Pentasii. Le même symbole est repris devant la salle à manger sur une mosaïque figurée qui s'insérait dans le décor géométrique du portique. Sur ce même tableau étaient représentés les amours *venatores* aux prises avec des fauves. Hélas, cette mosaïque qui est à l'origine de l'appellation de la maison a subi beaucoup de dégradations, et les traces de ce qui en reste sont aujourd'hui effacées ; ne subsiste que la panthère sanglante (figs. 4, 5).

Figure 4 Étage souterrain de la maison de la Chasse.

Figure 5 Rez-de-chaussée de la maison de la Chasse.

Tableau 1 Coût du matériel de dessin pour un pavement de mosaïque d'une superficie de 10 m^2

Désignation	Unité	Quantité	Prix unitaire en TND[1]	Prix total en TND
Papier millimétré format A3	u	1	1	1
Papier-calque A3	u	1	0.5	0.5
Planche de dessin	u	1	5	5
Crayons	u	2	3	6
Règle	u	1	1	1
Mètre	u	1	5	5
Boussole	u	1	3	3
			Total	21.5

Le coût du matériel pour documenter 1 m^2 est de 21.5 TND.

[1] TND : dinar tunisien

Le coût de la conservation des mosaïques de la maison de la Chasse

Le coût de la restauration des mosaïques conditionne en partie le choix du programme d'intervention. Nous allons essayer de quantifier le coût des travaux engagés dans la maison de la Chasse afin de mettre en exergue l'importance des ressources financières et humaines dans la conservation des trésors mosaïstiques de la Tunisie.

Le coût de la documentation graphique et photographique

La documentation graphique

Une documentation exhaustive d'une mosaïque se fait en remplissant des fiches (fiches de l'état de conservation, fiche d'intervention…) et en dessinant les plans et en prenant des photos. La documentation graphique d'une mosaïque se fait avant et après l'intervention (tab. 1).

Le coût du matériel pour documenter 1 m^2 est de 21.5 TND.

La documentation photographique

Ce matériel était utilisé pour toute la maison de la Chasse, soit une superficie de pavement en mosaïque de 550 m^2, ce qui ramène le coût pour 1 m^2 à 3.2 TND. (tab. 2.)

En plus du coût du matériel, un technicien de mosaïque met trois jours pour réaliser une documentation complète de 1 m^2 de pavement de mosaïque ; le salaire du technicien s'élève à 20 TND par jour, d'où le coût global de documentation graphique et photographique de 1 m^2 de mosaïque, qui s'élève à 63.2 TND (fig. 6).

Le coût de la stabilisation de bouchage et de la consolidation des bords

Cette opération consiste à faire des travaux de nettoyage, de bouchage et de consolidation des bords.

Opération de nettoyage

Superficie de 10 m^2. (tab. 3.)

Tableau 2 Coût du matériel pour la documentation photographique

Désignation	Unité	Quantité	Prix unitaire en TND	Prix total en TND
Appareil photo numérique	u	1	400	400
Flèche nord	u	1	5	5
Ordinateur	u	1	1,000	1,000
Imprimante	u	1	295	295
Matériels bureautiques (boîtes d'archives, rames de papier, encre…)	Forfait	1	50	50
			Total	1,750

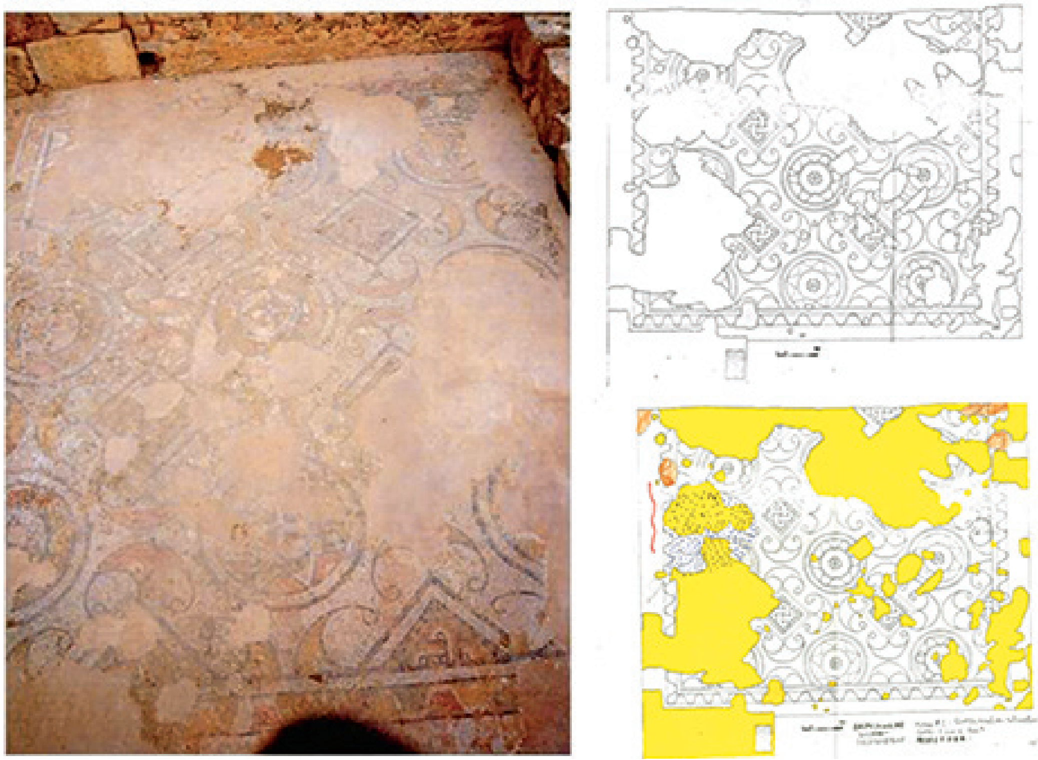

Figure 6 Un des pavements de mosaïque de la maison de la Chasse. Documentation graphique et relevé des dégradations (lacunes).

Tableau 3 Coût du matériel pour une opération de nettoyage de 10 m^2 de mosaïque

Désignation	Unité	Quantité	Prix unitaire en TND	Prix total en TND
Seau	u	2	6	12
Brosse en plastique	u	3	3	9
Lame de dentiste	u	4	1	4
Pelle de poussière	u	3	1	3
Burin	u	3	2.5	7.5
Marteau	u	3	3	9
			Total	44.5

Un technicien peut exécuter le nettoyage de 1 m^2 de mosaïque en 1 jour, soit 1 × 20 = 20 TND. Le coût du matériel à 4.5 TND. Le coût global est de 24.5 TND.

Opération de stabilisation

Le coût du matériel pour stabiliser 1 m^2 est de 11.8 TND (tab. 4).

Le coût de matériaux pour stabiliser 1 m^2 est de 13.2 TND (tab. 5).

D'après un document de suivi du GCI, les trois techniciens ont pu stabiliser 550 m^2 de mosaïque en vingt mois. Nous pouvons en déduire qu'ils peuvent stabiliser 1,4 m^2 par jour. Le salaire du technicien est de 20 TND par jour, donc on peut déduire que le coût du salaire des techniciens pour stabiliser 1 m^2 de mosaïque est de 84 TND, soit 3 × 20 × 1.4.

Ce qui porte le coût global de la stabilisation de 1 m^2 de mosaïque à 109 TND, soit 84 + 13.2 + 11.8.

Opération de réenfouissement

Réenfouir 10 m^2 de mosaïque avec 20 cm de sable, une membrane de séparation (géotextile) et 10 cm de gravier nécessite le travail pendant un jour de quatre ouvriers (4 × 12 = 48 TND) et d'un technicien : 1 × 20 = 20 TND. (tab. 6).

Le coût pour le réenfouissement de 1 m² est de 19 + 4.8 + 2 = 25.8 TND. (figs. 7, 8).

Coût global de la conservation des mosaïques de la maison de la Chasse

Le rez-de-chaussée de la maison de la Chasse est couvert par des pavements en mosaïque de l'ordre de 350 m² ; la superficie des mosaïques à l'étage souterrain est de l'ordre de 200 m². Ce qui ramène la superficie totale des pavements à 550 m², dont 60 m² ont été réenfouis.

Une documentation exhaustive faite par les trois techniciens en mosaïque sur le site a été établie pour tous les pavements des mosaïques de la maison de la Chasse : les programmes d'intervention sont arrêtés en fonction de l'état de conservation des mosaïques.

Tous les pavements en mosaïque ont fait l'objet des opérations de documentation, de nettoyage, de stabilisation et de restauration et partiellement de réenfouissement.

La documentation

Le coût de la documentation de 1 m² de mosaïque est de 65 TND.

La documentation globale a coûté : 65 × 550 = 35,750 TND.

Le nettoyage

Le coût de 1 m² de nettoyage de mosaïque est de 24.5 TND.

Le coût global de nettoyage des mosaïques est de 24.5 × 550 = 13,475 TND.

Tableau 4 Coût du matériel pour stabiliser 10 m² de mosaïque

Désignation	Unité	Quantité	Prix unitaire en TND	Prix total en TND
Tamis (différentes tailles)	u	3	2.5	7.5
Truelle langue-de-chat	u	2	5	10
Niveau d'eau	u	1	12	12
Bulle d'air	u	1	10	10
Fil à plomb	u	1	5	5
Seau de maçon	u	2	3	6
Seau d'eau	u	3	5	15
Serpillières	u	5	1.5	7.5
Éponges	u	2	0.5	1
Gants en plastique	u	3	9	27
Pulvérisateur	u	1	11	11
Seringue	u	3	2	6
			Total	118

Le coût du matériel pour stabiliser 1 m² est de 11.8 TND.

Tableau 5 Coût de matériaux pour stabiliser 10 m² de mosaïque

Désignation	Unité	Quantité	Prix unitaire en TND	Prix total en TND
Chaux hydraulique naturelle CH N 6	sac	1	15	15
Chaux en pâte	sac	4	25	100
Sable	m³	0,1	45	4.5
Gravier	m³	0,25	50	12.5
			Total	132

Le coût de matériaux pour stabiliser 1 m² est de 13.2 TND.

Figure 7 Mosaïque au rez-de-chaussée de la maison de la Chasse.

Figure 8 Restauration des mosaïques.

Tableau 6 Coût de matériaux et matériel pour réenfouir 10 m² de mosaïque

Désignation	Unité	Quantité	Prix unitaire en TND	Prix total en TND
Sable	m^3	2	45	90
Gravier 4/15	m^3	1	50	50
Filet en plastique	m^2	12	2	24
Planche en bois	u	2	8	16
Outillages divers	F	1	15	15
			Total	195

Le coût pour le réenfouissement de 1 m² est de 19.5 + 4.8 + 20 = 44.3 TND.

La stabilisation-restauration

Le coût de stabilisation-restauration de 1 m² de mosaïque est de 69 TND.

Le coût global de stabilisation-restauration est de 69 × 550 = 37,950 TND

Le réenfouissement

Une partie de ces pavements du rez-de-chaussée de la maison de la Chasse sont actuellement réenfouis vu leur état critique de conservation. La superficie des pavements réenfouis est de l'ordre de 60 m² ; le coût pour réenfouir 1 m² est de 44.3 TND.

Le coût global de réenfouissement est de 44.3 × 60 = 2,658 TND.

Le coût global de conservation des mosaïques de la maison de la Chasse (550 m²) est de 87,175 TND, soit 37,700 USD.

NB : Ce coût ne couvre pas les frais de :

- la formation des techniciens des mosaïques assurée par le GCI ;
- l'encadrement de la part des experts du GCI, à raison de trois campagnes par an de un mois chacune ;
- l'encadrement des experts de l'INP.

Was It Worth It? The Display of Roman Mosaics in a New Civic Building

Susan Fox

Abstract: *This paper looks at the cost and benefit of a recent project to conserve and display a figured mosaic of high quality from one of the largest villas in Roman Britain. The project involved significant consultation with the local community and the mosaic was displayed in a new civic building intended to be at the heart of the social life of the community. The process of display was also one of negotiation in which the local authority, as the developing party, sought to obtain best value, not just in terms of cost of construction and development but also in terms of meeting community aspirations.*

The mosaics that were the focus of this project came from the Durley Hill Villa, on the edge of the town of Keynsham, some eight miles west of the city of Bath, in the United Kingdom. It is one of a dense concentration of Roman villas around Bath, north up into the Cotswolds hills, and south into the counties of Somerset and Dorset.

The site was first found in 1877 when graves were being dug for a municipal cemetery. In 1922, when an extension to the cemetery was under way, more of the villa was uncovered. Excavations over the next two years by a local antiquarian and clergyman revealed that the villa remains, including mosaic pavements, were not far below the surface (fig. 1). It was clear that the earlier graves and, later, the clearing for a main road had caused considerable damage to the remains (Bulleid and Horne 1926: 109–35). Nevertheless, much of the plan of a large courtyard-type villa with at least two wings was recorded; its dimensions, 64 × 62 meters, make it still the largest villa known from Roman Britain. Coin evidence dates it to the late third to early fourth century, comparable to the other villas in the region.

Nine mosaic floors were discovered. Most were traced and photographed, but only parts of two of the fourth-century mosaics, from the unusual hexagonal rooms on the corners of the main western range, were lifted and removed. From the Room J mosaic a panel with interlocking triangles and swastikas and the motif from the middle of the floor, with an exquisite flower, were rescued. The workmanship of the latter has been described as “exceptionally fine” by Stephen Cosh (Cosh and Neal 2005: 235). Seven panels from the Room W mosaic have mythological scenes intersected by bird motifs. Among them are Jupiter disguised as the white bull with Europa, whom he has abducted, placing a red garland around his neck (fig. 2); part of a panel probably showing Achilles in the court of King Lycomedes (fig. 3); and Minerva seated beside a pool, with an intriguing use of what seems to be her reflection in the water, listening as Marsyas plays his flute (fig. 4).

All the rescued pieces were cut roughly into panels following the mosaic design and mounted onto concrete reinforced by iron bars and packed in wooden boxes. This action was fortuitous as we know that the town council, which ran the cemetery, was actively encouraging the robbing of the Roman walls so successfully that by 1926 all visual evidence of the villa had disappeared (Witt 2008: 12).

This discovery coincided with another that took place only a kilometer away during construction of a new factory, the site of which was later to be known as Somerdale. Here the remains of a Roman town were discovered (recently identified as the town of Trajectus). The company that owned the site, Cadbury’s, offered to house the Durley Hill Villa mosaics in its new museum to complement the objects that had been found on its site. The mosaics were displayed individually and vertically, removing any context as to how they had been found. In 1988 Cadbury’s decided to close its museum, and the mosaics and all the other objects were transferred to a small and inaccessible store in the basement of Keynsham Town Hall.

Figure 1 Room W mosaic excavated in the Durley Hill Cemetery, 1922–24. Photo © Roman Baths, Bath & North East Somerset Council

Figure 2 Room W mosaic panel with Europa and the Bull. Photo © Roman Baths, Bath & North East Somerset Council

Figure 3 Room W mosaic fragment with Achilles. Photo © Roman Baths, Bath & North East Somerset Council

In 1996 ownership of the mosaics passed to Bath & North East Somerset Council, the local authority, and consequently came under the care of the Roman Baths Museum. Eager to make them more accessible to the public, we arranged for them to be displayed in a local church as part of the 2000 Millennium exhibition. One panel was lent to the Yorkshire Museum for its exhibition on the emperor Constantine. When not displayed, the only evidence of the villa and the mosaics was an information board in the municipal cemetery.

In 2011 the town hall was earmarked for demolition, to be replaced by two energy-efficient buildings containing the Council offices and a public building. The local community was consulted during the planning for the new public building that was to house a library, Council services, a café, and

Figure 4 Room W mosaic fragment with Minerva. Photo © Roman Baths, Bath & North East Somerset Council

space for displays about Keynsham's past, which include fossils from the local carboniferous stone, the Roman material, and evidence of the medieval abbey and the brass and chocolate industries. Local people were very excited about the chance to put objects on display, particularly the Keynsham Heritage Trust, which had spent over forty years campaigning for a museum in Keynsham.

We wanted to display all the mosaic panels and, in particular, reunite the seven panels of Room W's mosaic on a floor to convey the full size of the original room but were hampered by the need for the building to be flexible and adjustable in its uses. Most of the furniture was to be portable and on castors, to make it easy to rearrange and create open spaces for art events. We even considered putting the mosaic under a retractable floor, but this seemed too expensive. Eventually, we suggested the mosaic could be dropped into a pit and glazed over, which soon became the preferred design. We had installed glass viewing panels in walkways at the Roman Baths, so this is a technique with which we are familiar. Regrettably, the mosaic panel from the side of the floor opposite the others had to be left out of the design because it would not fit into the shape of the pit as defined by the architect.

We employed Cliveden Conservation to undertake a condition assessment of the mosaics, which showed there was very little damage to the panels, and they advised us how best to display the pieces. Prior to moving the panels, any fractures were faced with muslin and PVAC. The mosaics with their concrete backings and frames would not actually fit together due to the added border edges; therefore we were faced with the difficult task of cutting off the added parts that were extraneous while hoping the vibration along the iron bars would not shatter the panels. The trimming work, carried out in early 2014, was surprisingly easy. It was conducted by the conservators using small handheld grinders and die grinders supplemented with small sharp hand chisels that permitted them to get very close to the Roman mortar. Any hairline cracks noted during the survey were then filled with a hydraulic lime mortar. The larger cracks were reinforced by the insertion of 316 grade stainless steel rods set in structural epoxy resin, epoxy acrylate (Rechem® STF). The exposed iron bars were treated with proprietary rust inhibitor, loose tesserae noted were reset using acrylic resin, Paraloid® B72 (HMG). Cleaning was undertaken using primarily a solution of water and a nonionic detergent (Synperonic® A7). Prior to display the mosaic was protected with a coat of microcrystalline wax (Renaissance wax).

The specially constructed pit for the Room W mosaic was provided with ventilation holes to prevent buildup of condensation; as a contingency, there is space for fans to be fitted in the future. In August 2014 the mosaic panels were positioned in the display pit on a hydraulic lime-bound mortar bed. Some additional adjustments in level were made where necessary using inert spacing blocks and packers to rectify the differences in thickness of the twentieth-century concrete. Where each panel abutted the next, a mortar fill was inserted

Figure 5 Detail of Room J mosaic. Photo © Roman Baths, Bath & North East Somerset Council

in the gaps. The areas where there were no mosaic tesserae were colored to suggest opus signinum.

The pit is covered by glass, held in place by a metal framework that was designed to follow the geometry of the mosaic, and protective film has been fixed to the glass to reduce scratching. LED lights are positioned around the edge of the pit.

The panel with the flower motif from Room J (fig. 5), which weighs 300 kilograms, was mounted on the wall, halfway up a set of stairs in the public space, and held there by a steel frame border.

Our Council's department responsible for building projects, Development and Major Projects, managed all the building work, including the mosaic display. An architect with no experience working with historic material or museums controlled the design and all the details. A leading building contractor was responsible for carrying out the work. Costs were divided between the Roman Baths Museum (which covered the conservation) and the Development and Major Projects department, which paid for what was essentially the building work: construction of the pit, lighting and glazing, and transport of the mosaics (table 1).

Although the total cost of around £90,000 seemed high to us, it is only a fraction of the £34 million cost of the whole project of rebuilding the civic buildings, offices, and the associated town center regeneration.

Regrettably, we still are not displaying two of the mosaic panels (one from each floor): the remaining Room W panel,

Table 1 Costs of the Keynsham Mosaic Project

	£
Work by Conservators	
Conservation Survey	1,800.00
Conservators' time in project meetings	95.00
Conservation	14,000.00
Additional trimming of mosaics	905.00
Infill	887.00
Transport and installation	9,565.00 (MP)
Roman Baths Costs	
Museum staff costs	3,000.00
Photography of project	900.00
Touchscreen for interpretation	4,500.00
Building Work	
Construction of pit, glazing, and internal lighting	53,000.00 (MP)
TOTAL	**88,652.00**

Note: Costs marked "MP" were covered by the Development and Major Projects of Bath & North East Somerset Council; the rest were paid for by the Roman Baths Museum.

Figure 6 Room W mosaic panels as displayed. Photo © Roman Baths, Bath & North East Somerset Council

Table 2 Summary of the success of the project and future prospects

	Short Term	2015	Long Term
Preservation of mosaics	yes	yes	yes
Aesthetics of display	?	yes	?
Heritage	yes	?	?
Authenticity	yes	yes	?
Interpretation	?	yes	?
Public profile	yes	?	?
Community engagement	yes	?	?
Tourism	no	?	?
Ongoing costs	no	?	yes

because it would not fit; and the second panel from Room J, because the architect wanted the interior walls to retain their clean lines.

Although the project was completed in October with the opening of the new civic building, the full effects of this project may take months, if not years, to become apparent (table 2). Below is a summary of the pros and cons as they can be described at this time.

Aesthetics: Unfortunately, strip lights in the ceiling above the mosaic reflect onto the glass floor, making it impossible to take a good photograph of the mosaic. We hope that in time this will be addressed. Also, the very wide bars of the iron framework that holds the glass in place tend to dominate the visitor's view of the mosaic, especially because they are not aligned precisely to the panels (fig. 6).

Heritage: The display raises the profile of the villa mosaics and the other sites in Keynsham (see Profile below). The residents of Keynsham have been distressed by the gradual demolition of their historic town that began in the 1960s. This project has given them something to be proud of, which may promote the celebration of other parts of the town's heritage in the future.

Authenticity: The mosaics cannot be displayed where they were found, as the cemetery is still in use. What we have been able to do is convey to the public that these beautiful pieces of art were once floors, designed to be looked at from above. Visitors can enjoy the incredible panels as near to a Roman viewpoint as possible.

Interpretation: In a mixed-use site, which houses a library, tax collection offices, and the local constabulary, as well as the mosaic panels, adequate interpretation is difficult. We plan to organize lectures and events next to the mosaics, and the library has shown interest in bringing schoolchildren to the site, so we are planning some simple teachers' packs.

Profile: This project has raised the profile of the archaeological collection from Keynsham, not just the mosaics, but also the Somerdale site of Trajectus and the Abbey as well as our role in interpreting it. There have been many positive comments from visitors to the civic center. Given this local support, we plan to offer a number of events about the archaeology of the area in which we will involve the local community. We still have the unresolved question of what to do with the two mosaic panels and many other artifacts from Keynsham that are not on display. Our hope is that they can be stored nearby and made accessible on a regular basis.

Community: The support of the community, particularly the local heritage trust, has been crucial to the project. Volunteers have worked with the collection, put up posters, and informed their friends and local schools, and we hope to increase their number.

Tourism: It is debatable whether the mosaics will attract many tourists to the town. One concern we have is that the building will not be open on Sundays. Day to day, we are reliant on the library staff to answer questions. We offered to brief them before the building opened, but they were too busy to take advantage of this opportunity. We have already produced handouts on the mosaics and have a touchscreen covering all aspects of the town's history. Only time will tell.

Ongoing Costs: Generally, we hope future costs will be low. LED lamps are inexpensive to run and have a long life, but we hope to arrange in the future for the fitting of better lighting that is more sympathetic to the mosaics. The protective film that protects the glass from scratches will have to be renewed regularly. Currently, we are monitoring the humidity under the glass of the mosaic pit and gauging whether there is enough natural circulation of air through the small holes and grilles included in the mosaic pit design. If the humidity becomes too high, we will have to install fans to circulate the air, which will have running costs. In the long term, we hope the Room W mosaic may be raised to floor level.

Was it worth it? Yes. We are proud that after ninety years the mosaic panels from Room W are finally reunited and that they, together with the center of the Room J mosaic, can be enjoyed by the public six days a week.

Acknowledgments

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Conservation of the Mosaics at Um Al-Rasas: High- and "Low"-Cost Solutions

Stefania Chlouveraki and Basem Mahamid

Abstract: *A three-day workshop aimed at the protection of the mosaics of Um Al-Rasas was undertaken on-site, primarily for the local community and site personnel. This short and low-cost campaign allowed us to determine the time, labor, and budget required for the protection and regular maintenance of the mosaics. The cultural significance of the mosaics, their condition, and the financial and time constraints were the major factors in the decisions and compromises made in order to reach a feasible and acceptable solution for the protection of the mosaics using locally available materials and personnel. The evaluation of the mosaics one year later pointed out the effectiveness of the materials and methods used and the goals achieved during this campaign as well as the failures.*

The Site

The archaeological site of Um Al-Rasas (also spelled Um Er-Rasas or Um Ar-Rasas) is located at the southeastern steppe of Jordan, about 30 kilometers southeast of Madaba and about 12 kilometers west of the modern Desert Highway. The site occupies an area of 3 hectares and includes architectural remains from the Iron Age and the Nabataean, Roman, Byzantine, Umayyad, and Abbasid periods.

The majority of the architectural remains are associated with a large walled area measuring 150 × 120 meters and an open court of roughly equal size to the north. The excavations conducted by the Franciscan Biblical Institute in Jerusalem and the Department of Antiquities of Jordan provided epigraphic evidence that supported the identification of the site as Kastron (Fort) Mefea, a fortified Roman camp known from Roman and Arabic sources and the Bible (Piccirillo 1988; 1993: 232–33).

The site includes several basilicas, adorned with high-quality mosaic floors bearing several inscriptions, architectural representations, and a great variety of themes and motifs. To date, fourteen churches have been excavated; the majority of the site remains unexplored. The inscriptions on the mosaics date the churches to the late sixth to the eighth century, attesting to the continuity and prosperity of the Christian community in the steppe of Jordan at least 150 years after the Arab conquest.

The dominant monument on the site is the Complex of Saint Stephen, consisting of four churches and courtyards enclosed by a continuous wall (fig. 1). The main buildings of the complex are the Church of Bishop Sergius (late sixth century) and the Church of Saint Stephen (mid-eighth century). Other important late sixth-century churches with mosaics are the so-called Church of the Lions, the Twin Churches (Church of the Rivers and Church of the Palm Tree), the Church of Bishop Paul, and the Church of Priest Wa'il, all excavated in the 1990s. In 2004 the site was inscribed on the World Heritage List (World Heritage Committee [28th sess.]).

The Mosaics of Um Al-Rasas

The mosaic floors of Um Al-Rasas represent the tradition of mosaic making in the region of northern Jordan from the late sixth to the eighth century (Byzantine-Umayyad period) with strong influences from the classical tradition of the Hellenistic-Roman period. The workshops in the area of Madaba show a preference for figurative compositions and offer exceptional examples of topographic and architectural representations, as well as an especially rich repertoire of decorative themes (Piccirillo 1993: 23, 34–47).

Figure 1 General view of the site, including the complex of Saint Stephen with the new protective shelter. Photo: S. Chlouveraki

Figure 2 General view of the mosaic floor of Saint Stephen. Photo: S. Chlouveraki

The artistic quality of the mosaics of Um Al- Rasas and the wealth of inscriptions, architectural representations, motifs, and colors place this assemblage among the most important mosaics of Jordan.

The featured mosaic on-site, declared by the World Heritage Committee a "masterpiece of human creative genius," is that in the nave of the Church of Saint Stephen. It depicts twenty-eight representations of Palestinian and Egyptian cities accompanied by their Greek toponyms. The main frame of the mosaic comprises a continuous scene of the Nile and Egyptian cities, and the intercolumnar space of the floor is decorated with depictions of walled cities east and west of the Jordan River (fig. 2).

Architectural representations are used in the mosaics of three more churches at Um Al-Rasas that date to the late sixth century: the Church of Priest Wa'il, the Church of Bishop Sergius, and the Church of the Lions. The majority of the mosaics were defaced by iconoclasts during the Umayyad Period (Piccirillo 1993: 42).

Cultural Significance and Values

New approaches in the field of archaeology in the second half of the twentieth century enabled the interpretation of archaeological data in behavioral terms, strengthened the relationship between archaeology and social-cultural anthropology, and drew attention to the historical significance of cultural material and the need for the preservation of the meaning and the values attributed to it (Trigger 1984). Today cultural material is appreciated for the historical and social values reflected by the archaeological context and the material itself, as well as its artistic and aesthetic qualities. Conservation philosophies and principles are accordingly oriented to the preservation of both the material and the values represented by cultural assets.

The outstanding universal value of Um Al-Rasas is associated with the continuity of Christianity, the practice of monasticism, and the spread of monotheism in the region. The site is also acknowledged for the artistic and technical values attributed to the eighth-century mosaics of the Church of Saint Stephen, which testify to the prosperity of the Christian community well into the Umayyad Period. Christianity's coexistence with Islam during the eighth century is demonstrated throughout the extended architectural remains of the site, which cover a broad chronological period and bear equal cultural significance.

Conservation and Maintenance of the Mosaics at Um Al-Rasas: At What Cost?

The principle of conserving mosaics in situ has played a fundamental role in shaping new approaches and conservation practices at sites that were excavated in Jordan in the late 1990s. The site of Um Al-Rasas is a remarkable case of a large assemblage of Byzantine-Umayyad mosaics, all preserved in their original context.

The discovery of the mosaics of Saint Stephen immediately placed this complex among the most important monuments in Jordan. Piccirillo (1993: 6) compares this discovery to that of the mosaic map of Madaba one century earlier. Soon after their discovery, a shelter, provided with elevated walkways, was erected above the complex in order to protect the mosaics while offering public access to the best-preserved and most outstanding mosaics of the site. The shelter protected the mosaics effectively for more than fifteen years; in 2009 it was replaced by a new structure (see fig. 1).

Criticisms of the first shelter included its huge size and the resulting visual impact on the archaeological landscape, the height of the walkways, and the insufficient drainage, air circulation, and lighting conditions. Nevertheless, it is acknowledged that the shelter protected and kept the mosaics in remarkably good condition.

Several issues (environmental, structural, functional) were considered in the design of the new shelter. However, the analysis of risk factors pointed out that among the greatest risks to the mosaics are illegal excavation and theft, damage from uncontrolled visitor traffic, and water from condensation or the leaking roof (Ha'obsh 2008). All these risks are the result of human activities, ignorance or neglect, known to be the major causes of the deterioration and destruction of cultural material. These risks cannot be eliminated by the provision of a protective structure alone, especially when the development of a strategic plan for maintenance and management of the site is still pending.

The new shelter was erected in 2009 with funds provided by the European Commission as part of a wider program for the protection and promotion of cultural heritage in the Hashemite Kingdom of Jordan. The work was completed in accordance with revisions agreed to with the World Heritage Centre, and, apart from the shelter, they included a large visitors' center, security fencing around the whole site, and visitors' pathways.

The funds required for the implementation of large-scale site preservation and management programs are quite difficult to obtain. It is remarkable, therefore, to have achieved the construction of two successive permanent shelters for the same complex within two decades. This has been a success story, but does it reflect the general site conservation and management policy applied on-site today?

Evaluation of the Condition of the Mosaics, December 2012

The Complex of Saint Stephen, having attained outstanding universal value, stands as an isolated example of conservation practice on-site. Although detailed documentation and condition reports are not available, the high-quality images that have been published by Piccirillo (1993) offer an invaluable reference point for the condition of the mosaics before the installation of the first shelter. Judging from these images, one can conclude that despite the claimed disadvantages of the first shelter and the potential risk(s) to the mosaics, the immediate postexcavation actions protected the site adequately as of 2012.

While at this time the performance of the new shelter remained to be seen, some conclusions regarding the current condition of the mosaics and the conservation policy applied on-site could be drawn. The striking contrast between the condition of the mosaics of the complex and the rest of the site reflects the conflicting approaches in the conservation

Figure 3 Temporary reburial of the mosaics of the Church of the Lions, December 2012.
Photo: S. Chlouveraki

and protection of individual monuments and the unequal allocation of funds. Although the complex was sheltered twice and provisions were made for public access, the mosaics of the other churches were reburied or "roughly covered." Sacrificing visibility was a legitimate compromise to achieve the protection of the mosaics and the prevention of further damage at a low cost, yet this could only be effective if appropriate methods and materials were used and measures were taken to monitor and maintain the mosaics.

In December 2012, during an educational visit at Um Al-Rasas in the framework of the mosaic conservation training program of the European Center for Byzantine and Post-Byzantine Monuments (EKBMM) in the Dead Sea, the conservation team observed and recorded the inefficiency of the reburial practices over the mosaics and the resulting losses. Despite the multimillion-dollar program implemented on-site, the mosaics that were not part of the complex were covered by common plastic (polyethylene) sheets laid directly on the surface of the mosaics, and quartzite sand from the desert was added on top as bulk filling (fig. 3).

Not surprisingly, the polyethylene sheets were soon destroyed by UV radiation, and those that resisted the sun favored the condensation of water vapor. In areas where the plastic sheet shredded, the hard quartzite sand abraded the mosaic surface. Salt crystallization appeared to be active, sedimentation began to take place on the tesselatum, and flaking of the stone surface was also under way. Repair mortars had cracked or detached and were no longer protecting the edges of the mosaics. Although not extensive, vegetation was also present. It is apparent that the materials used for reburial were inappropriate, yet it is mostly the lack of maintenance that seems to have had a detrimental effect on the mosaics.

Illegal excavation seemed to be still active in this area, although it was quite limited. A major loss that was identified and recorded for the first time in the course of our program was the complete destruction of the beautiful gazelle (Piccirillo 1993: 213) depicted at the chancel of the Church of the Lions, a renowned mosaic motif of the site. The gazelle was found broken into hundreds of fragments mixed with sand and plastic sheeting in the lacunae. The looters were motivated by the depression that existed in the mosaic, which alluded to some treasure hidden underneath. Due to the lack of systematic maintenance it is not possible to examine records to determine how and when this action took place, but we can draft the actions needed to prevent such practices in the future. The damage can be recovered to some extent, but the cost of recovery is much higher than the cost of prevention and effective protection on-site. Lack of staff training, poor understanding, and incorrect perceptions of site preservation issues are the main factors that have led to an ever-increasing problem and to an alarming rate of loss. As a response to the problems attested on-site the authors undertook a low-cost emergency conservation project in the beginning of 2014.

Protecting the Mosaics of Um Al-Rasas: At What Cost?

The conservation and presentation of the numerous mosaics on the site involves considerable monetary cost, which was the main reason for the compromise of accessibility and visibility of the mosaics. The reburial of the mosaics, however, does not waive the need for maintenance by means of regular inspection and condition assessment as well as renewal of materials and rescue treatment when necessary (Roby 2004; Stewart 2004).

Financial constraints are indeed a serious issue, but they cannot justify neglect. When facing serious threats such as looting and mismanagement one must move from criticism to action and find solutions for the protection of the mosaics with the minimum possible financial cost, compatible with available resources. There are always low-cost or no-cost approaches to the problem, such as taking advantage of the human resources available on-site, raising the level of interest of the staff and the local community, and bringing awareness about the threats and the consequences of unintentional yet harmful actions such as uncovering and showing the mosaics to visitors, something that is characteristic of Arab hospitality. These are all actions that have no significant financial cost but can be significantly beneficial. We may not be able to conserve and present the mosaics to the public, but we can protect them more effectively, minimizing the losses and saving them for future generations. As noted by Mourato and Mazzanti (2002), even if a cultural asset is not being used at present, investing in its conservation and maintenance ensures its preservation and retains the possibility of use in the future.

Our emergency action plan entailed training of local personnel and involvement of the local community in a three-day workshop on-site. The experience gained in a series of training programs in the Middle East over the past decade has shown that conservation philosophy and practice can be better understood and applied when adapted to the cultural and educational background of the trainees and the community. Moreover, the output of such programs creates a resource for launching strategic plans that offer feasible and sustainable case-specific solutions to conservation and maintenance problems (Chlouveraki 2011).

The workshop took place on February 9–11, 2014. It focused on the cultural significance of the site, documentation, principles of preventive conservation, and a field demonstration of effective low-cost solutions for protection of the mosaics at the Church of the Lions with locally sourced materials.

The available resources were the personnel at the site and the Department of Antiquities (DoA) of Jordan, students and staff of the Mosaic School of Madaba, the members and volunteers of the EKBMM program in the Dead Sea, and the volunteers from the local community. The DoA appointed ten trainees to participate in the program, and five members of the EKBMM mosaic conservation team volunteered to participate as trainers. Training started with examination, documentation, and evaluation of the mosaics. Didactic material including handouts and examples of documentation were distributed and explained.

The first positive outcome of this initiative was the warm response of the local community and the participation of trainees from Madaba and Amman. At the completion of the first day of the workshop, which consisted of introductory talks for the local community focusing on the values of the site, its universal character as a World Heritage Site, and the importance of the conservation and protection of the mosaics, another seven people from the audience volunteered to participate in our campaign. Around twenty people, including trainees, volunteers, guards, and conservators, worked intensively for two days to uncover the partially covered mosaics, record their condition, and cover them with geotextile and bagged sand.

A custom crane (designed and constructed in the local aluminum workshops for €40 and adjusted to fit an existing photography tripod) was used instead of a professional one for the documentation and condition mapping of the mosaics, along with our personal equipment, such as cameras, projectors, and computers.

The Arabic glossaries and handbooks produced by the MOSAIKON program were a valuable teaching aid and provided record forms that can be easily adapted to the special needs of each case or region. The use of both Arabic and English versions during the field project was a catalyst for communication between Arabs speaking basic English and Greeks speaking basic Arabic (Alberti, Bourguignon, and Roby 2013).

Because of limited funding completion of the work was not possible; however, demonstration of the methodology was completed and materials were provided for the completion of the project by the staff of the site with the help of workers from the Department of Antiquities of Madaba. The information collected in this campaign provides the basis for future evaluation of the mosaics, assessment of their condition, and development of a maintenance plan, which will engage the staff in regular inspection of the mosaics.

Evaluation of the Reburial Materials and the Mosaics, December 2014

The parameters that determined the choice of materials and the method of reburial were primarily the budget and the

Figure 4 Condition of the mosaics of the Church of the Lions, December 2014, almost a year after the revision of the reburial. Photo: S. Chlouveraki

local availability of materials. The goal was to protect the mosaics from human activity and weathering while allowing regular examination of the mosaics and rescue interventions when necessary. Given the limitation of time and the alarming rate of loss, remedial conservation could not be carried out before reburial. Therefore, the reburial layer was intended to serve as a temporary protection measure that would allow easy access and gradual treatment of the mosaics.

Although in the recent literature the use of separation materials directly on the surface of the mosaics is not recommended (Roby 2004; Roby, Alberti, and Ben Abed 2010), when the mosaics are not stabilized before reburial it is advisable to place a smooth, medium-weight, nonwoven geotextile on the mosaic surface. Because of its permeability, if placed properly, in close and continuous contact with the surface of the tessellatum, this type of geotextile allows the smooth transportation of water through the body of the burial layer (Roby, Alberti, and Ben Abed 2010).

The burial layer consisted of a separation material (nonwoven geotextile, 280 gr/m^2) and a layer of sand, bagged in woven polyethylene sacks, capped with local soil. The soil was intended to integrate aesthetically the burial layer and to protect the bags from the action of UV radiation in order to prolong their life. The use of more durable burlap bags or long-lasting custom-tailored *geobags* was considered but not permitted by the budget. Therefore, the woven polyethylene bags were chosen as a low-cost alternative, easily and readily available in the local market; they are expected to last for a maximum two years if protected from the sun.

In December 2014, nearly one year after our campaign, the site was revisited in order to assess the condition of the reburial layer and the mosaics. The trainees were called to participate in the examination and to evaluate the effectiveness of their work. The major observations were the following:

- The reburial was not competed according to the initial plan. The soil capping was never laid, and as a result the woven polyethylene bags had deteriorated and ripped, and they no longer provided an aesthetically pleasing appearance, as did the original reburial, an important requirement for a site that is open to visitors and recorded on the World Heritage List (fig. 4).
- The chancel mosaic of the Church of the Lions is still being uncovered for viewing by visitors, as advertised on the Internet by tour operators, which means that a policy of close guarding and regular inspections of the mosaics had not been enforced.
- The geotextile was found in excellent condition.
- There was no vegetation growth on the reburial layer.
- The condition of the mosaic under the reburial seems to be stable as no further damage could be observed macroscopically.
- The condition of the mosaics under the reburial is in a remarkably better condition when compared to those exposed.

The overall assessment of the mosaics of the Church of the Lions in December 2014 points out that although the reburial was not completed according to the initial plan, it has been

Figure 5 Temporary reburial of the mosaics of the Church of the Rivers, December 2012.
Photo: S. Chlouveraki

Figure 6 Condition of the mosaics of the Church of the Rivers, as recorded in December 2014, after two years with no maintenance.
Photo: S. Chlouveraki

very effective in protecting the mosaics, especially when compared to the current condition of the mosaics of the nearby Church of the Rivers, where no further action was taken to protect the mosaics (figs. 5, 6).

Considering that the mosaics at the two neighboring churches were at a similar state of preservation in December 2012, we can conclude that the actions taken at the Church of the Lions—although far from optimal—have served their purpose well and have offered sufficient protection against natural risks. However, human activity continues to be the main threat that has to be reexamined as a priority.

Conclusion

The unequal allocation of funds for the preservation of the monuments of Um Al-Rasas is clearly reflected in the condition of the numerous mosaics of the site. The multimillion-dollar programs that have been implemented have targeted the protection of the Complex of Saint Stephen, while the rest of the mosaics have been poorly treated and have not been maintained. The outstanding value of this complex may justify this investment; however, the mismanagement and/or neglect of the other churches that exist at the same World Heritage Site is by no means an acceptable policy and needs to be addressed and resolved.

The emergency action program that was undertaken at the Church of the Lions pointed out that low-cost solutions to increase the protection of the mosaics are possible, provided that the correct approach is adopted. This short program allowed us to estimate the monetary cost, the equipment, and the human labor required for the protection of the excavated mosaics of Um Al-Rasas, all expressed per square meter. This estimate can, and will, be used by the DoA for the development of maintenance plans and protocols for the protection of mosaics found in similar conditions. Based on these estimates we are ready to proceed with planning and proposals to acquire funds for the completion of the project.

We believe that the entire project, which operated on a very low budget (€1,000) and was supported by the personnel of the DoA and several volunteers, establishes a paradigm of emergency action against human threats such as neglect, mismanagement, insufficient funding, lack of training, and the absence of public participation.

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The Basilica of Panagia Acheiropoietos in Thessaloniki, Greece: Presentation of a Comprehensive Restoration Project on Early Christian Mosaics In Situ

Despina Makropoulou and Electra Karagiannidou

Abstract: *This paper outlines the project and details of the cost-controlled financial planning for the conservation of the mosaic decoration of the Basilica of Panagia Acheiropoietos in Thessaloniki, which was carried out and supervised by the city's Ephorate of Byzantine Antiquities in 2012–2014 with funding from the Macedonia-Thrace Operational Programme 2007–2013. It describes the restored floor and wall mosaics and their presentation, with the projected cost, the timetable, and the positive effects the endeavor will have on local revenues, both during implementation of the project and after its completion, when the monument is returned to the local community.*

The Basilica of Panagia Acheiropoietos, one of the most important Christian monuments in the world, is located in the center of Thessaloniki and, together with the roughly contemporary Church of Hosios David of Latomou Monastery in the upper town of Thessaloniki, is the oldest church still in service in the city. The church was built sometime after the middle of the fifth century CE, over the ruins of a Roman bath that had been in operation until the Early Christian period (second–fourth centuries), very near the ancient Forum, the Byzantine Megalophoros, and the Via Regia, the city's main artery, later called the Leophoros and today Egnatia Street.

The basilica was called the Church of the Panagia Theotokos until the fourteenth century, but since at least 1320 it has been known as the Acheiropoietos ("not made with hands"), an appellation that probably derives from a devotional icon of the Virgin Mary that was created in miraculous fashion, without human intervention. It was the first of the city's churches to be turned into a mosque, by Sultan Murad II in 1430, and it remained the city's principal mosque throughout the period of Ottoman rule.

The Greek state listed the church as a protected monument in 1962, and in 1988 it was named a UNESCO World Heritage Site. Today the Acheiropoietos is a parish church in the Diocese of Thessaloniki and a monument that attracts large numbers of visitors (fig. 1).

Rescue operations were carried out immediately after the devastating earthquake of 1978 to shore up and underpin the monument, and the building was stabilized again between 1990 and 2008. The Ephorate of Byzantine Antiquities of Thessaloniki carried out extensive consolidation and repair work, cofinanced by the European Union under the 2nd and 3rd Community Support Fund.

After the structural stabilization was completed, all the decorative elements of the Acheiropoietos needed detailed documentation, systematic conservation work, and presentation to the public. Thessaloniki's Ephorate of Byzantine Antiquities therefore prepared a proposal for the conservation of the decorative elements, which, after formal approval by the Ministry of Culture, was included for realization under the European Union investment program for Greece, the Macedonia-Thrace Operational Programme 2007–2013, which is part of the National Strategic Reference Framework (NSRF).

Our project was titled "Conservation of Mural Decoration, Architectural Sculptures, and Flooring of the Basilica of Panagia Acheiropoietos in Thessaloniki." The work was carried out and supervised by the Ephorate in accordance with European Union provisions. Greece's participation in the NSRF is 20 percent, and a total of €647,215.15 was allocated for this project. Work began in January 2012, with a scheduled completion time of thirty-three months.

When we began the process of submitting this major restoration project for inclusion in the development program, with all the specifications dictated by contemporary science, we had in mind a series of benefits that would emerge once it was completed. These benefits included protection and presentation of the mosaics, an increase in the number of

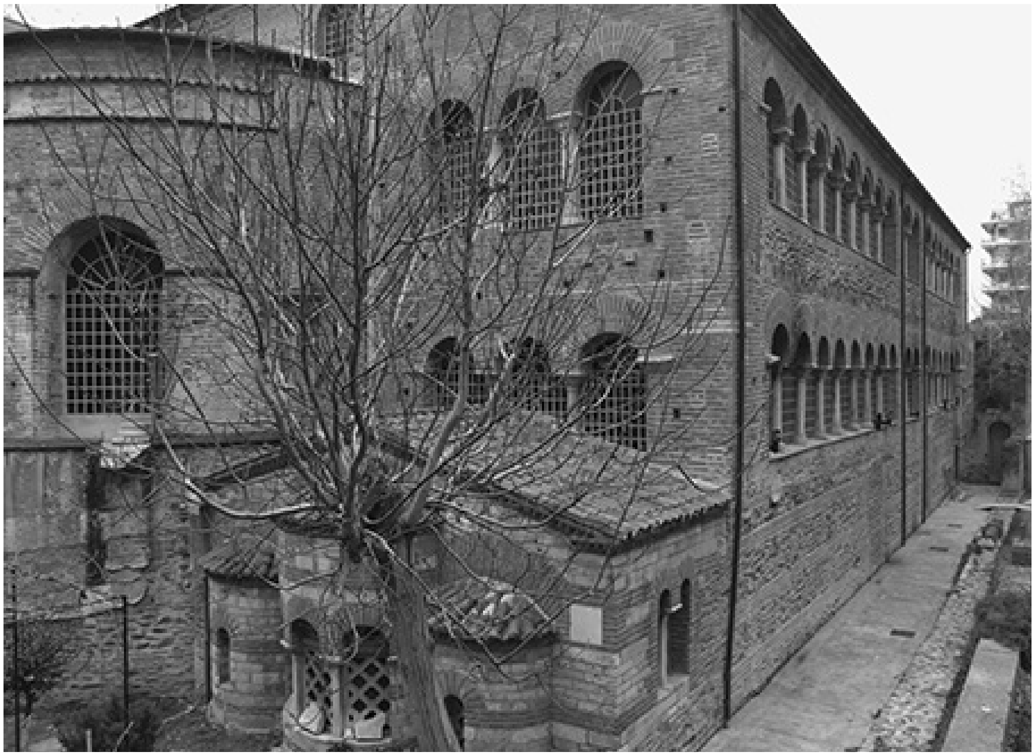

Figure 1 Northeast facade of the Basilica of Panagia Acheiropoietos. Photo: Courtesy Ephorate of Byzantine Antiquities of Thessaloniki

visitors, and enhanced appreciation by both the scholarly and nonscholarly communities. First, because the archaeological service operates under the Protection of Antiquities and the Cultural Heritage Act (Law 3028/2002), all interventions to a monument must fall within its provisions. As an action performed for the purpose of protecting the material substance and authenticity of a monument in its historical and natural environment, conservation comes under Articles 2 and 3 of the act. That is the starting point, and any action proposed and approved must comply with these articles.

Within this framework, all our interventions were carried out with respect for the aesthetic, historical, material, and structural integrity of the object of intervention, always bearing in mind the social character inherent in the use of the works of art that we restore, which includes, by definition, a wide range of users. Teaching these users to behave more responsibly with regard to the monument was part of the process—not an explicit element, but a natural corollary, as clergy, parishioners, and visitors watched the progress of our painstaking work. As one example, the church will no longer be heated by oil stoves during services, a practice that was considerate of the congregation but disastrous for the monument: the smoke of many years had blackened its unique and costly mosaics and marble cladding.

Making the Acheiropoietos more attractive to visitors was another of our goals. A priority of Greece's current tourism policy is to increase visitor numbers by enriching tourist sites with new images and ideas. Since monuments and cultural heritage sites are fundamental to stimulating tourism, maintaining and promoting them gives a country or a region a significant local competitive advantage in the global tourism market. In Thessaloniki cultural and religious tourism is growing by leaps and bounds, a very welcome development in this period of economic crisis, which of course is not over yet. The people who come to see the monument are intrigued by the conservation work being carried out as they watch, and afterward will enjoy the fruit of our labors on the priceless aspects of the church.

Our work—and this is something which we did not foresee—has had results that relieved the cold, urban austerity that previously characterized the church, making it more homely and welcoming. One such example is the unexpected discovery that around 1914 the church had been painted blue with red frames, in imitation of the blue background used for frescoes in the thirteenth century (fig. 2). This detail suggests that after liberation from Ottoman rule in 1912, the people had tried to bring back something of their lost Byzantine heritage. Archaeological science has also benefited from the conservation work. We have learned new things about the history of the monument, which we return to briefly below.

The financial program, which must be prepared before an application for funding is submitted, took into account first

Figure 2 The ground floor and gallery colonnades with the mosaic decoration on their intrados. The overpainting in blue with red borders done in the early twentieth century can be seen. Photo: Courtesy Ephorate of Byzantine Antiquities of Thessaloniki

of all the size and the requirements of the physical object, that is, all the necessary conservation work. It included projected costs for materials and the quantities required for the entire project; the necessary tools, machines, and equipment; the safety equipment for the protection of workers; and, of course, the preliminary costing of all these things, based on market prices.

The next step was to draft a timetable in conjunction with the necessary specialized personnel. The time required for the project was estimated at twenty-eight months, with the work scheduled to begin on September 1, 2011, and to be completed by December 31, 2013.

The different elements of the project and the cost of accomplishing each item were tabulated in four categories (table 1). How the physical object was to be realized was also described in tabular form (table 2). The financial program proved to be accurate, since no alteration to the budget needed to be made at any stage of the project. The timetable, on the other hand, had to be extended from twenty-eight to thirty-three months and rescheduled to begin later than originally planned due to minor delays in hiring and unexpected changes in staff at the start (table 3).

The conservation team began its work with the surviving mosaics on the intrados of the arches of the two ground-floor colonnades and the one in the south gallery, the two transverse arches of the ceiling of the entrance to the church (narthex), the arches of the west tripartite arch (tribelon), the trefoil window in the west wall, the west wall of the south annex, and the doorjambs in the south porch. The team also restored parts of the coarse mosaic and opus sectile flooring in the south aisle, the three layers of floor in the north aisle that belong to the older Roman bath, the marble floor in the center aisle, and the ancient part of the floor in the Chapel of Saint Irene. As part of the presentation of the project, glass floor panels were installed in the side aisles to allow a view of inaccessible areas of ancient flooring.

Conservation work was also carried out on all marble elements of the church, including the ground-floor gallery and the west tribelon columns with their bases and capitals, all the ante-capitals and corbels, the stylobates, the floor in the central aisle, and the thresholds and door frames.The painted decoration above the south colonnade and parts of other wall paintings, including those in the Chapel of Saint Irene, were also restored (fig. 3).

Singled out for discussion here is the conservation of the mosaics, namely, the mosaic wall decoration in the monument and its mosaic floors. The cost of this portion of the work was €132,183.84.

Today, as throughout the centuries, the visitor who enters the Acheiropoietos and lifts his or her eyes is enraptured by the peerless mosaics, with their freely embedded tesserae of brightly colored glass, gold, silver, and occasionally stone, aglow in the light. As part of a single iconographic program, their subjects are paired symmetrically in the north and south ground-floor colonnades, with minor variations between them; we suppose that the same was true in the galleries,

Table 1 Final cost estimate per category of related works

Category of Related Works	Quantity	Unit	Initial Cost Estimate	Time Schedule	
			(€)	Beginning	End
C. Infrastucture & Public Facilities	**0.2**	**% of the Budget**	**1,500.00**	**Sept. 1, 2011**	**Dec. 12, 2013**
Informational signs	4	Nr.	1,500.00	Sept. 1, 2011	Dec. 12, 2013
D. Protection & Promotion of Monuments	**84**	**% of the Budget**	**542,328.43**	**Sept. 1, 2011**	**Dec. 12, 2013**
Support and retaining work	2,500	M^2	17,220.00	Sept. 1, 2011	Dec. 12, 2013
Conservation work on mosaics, murals, and sculptures	45	M^2	36,951.86	Sept. 1, 2011	Dec. 12, 2013
Detachment of the mosaic	7	M^2	15,500.00	Sept. 1, 2011	Dec. 12, 2013
New construction on-site	33	M^2	57,970.00	Sept. 1, 2011	Dec. 12, 2013
E. Research, Documentation, Information	**6,8**	**% of the Budget**	**44,548.97**	**Sept. 1, 2011**	**Dec. 12, 2013**
Drafting, surveying	422	M^2	21,335.73	Sept. 1, 2011	Dec. 12, 2013
Photographic documentation	100	%	3,053.50	Sept. 1, 2011	Dec. 12, 2013
Informational material	1,000	Nr.	4,000.00	Sept. 1, 2011	Dec. 12, 2013
Laboratory analysis, humidity and temperature measurement equipment	10	Αρ.	16,159.74	Sept. 1, 2011	Dec. 12, 2013
F. Supplementary Works (material transportation/nonpredictable work)	**9**	**%**	**58,837.74**	**Sept. 1, 2011**	**Dec. 12, 2013**
Total			**647,215.15**		

Table 2 Specific costs of the realized project

Category Of Related Works	Payroll Cost (€)	Cost of Work Executed By Third Parties (€)	Cost of Material Supplies (€)	Total Cost (€)
C. Infrastucture & Public Facilities	**—**	**—**	**2,000.00**	**2,000.00**
Informational signs	—	—	2,000.00	2,000.00
D. Protection & Promotion of Monuments	**€411,563.99**	**€87,934.60**	**€77,467.20**	**€576,965.79**
Support and retaining work	—	15,867.00	—	15,867.00
Conservation work on mosaics, murals, and sculptures	391,683.25	—	74,411.24	466,094.49
Detachment of the mosaic	10,432.12	—	3,055.96	13,488.08
New construction on-site	9,448.62	72,067.60	—	81,516.22
E. Research, Documentation, Information	**€20,475.44**	**€12,976.00**	**€20,998.23**	**€54,449.67**
Drafting, surveying	20,475.44	—	1,055.34	21,530.78
Photographic documentation	—	1,476.00	3,559.72	5,035.72
Informational material	—	3,500.00	—	3,500.00
Laboratory analysis, humidity and temperature measurement equipment	—	8,000.00	16,383.17	24,383.17
F. Supplementary Works (material transportation/nonpredictable work)	**€1,000.00**	**€5,191.62**	**€7,608.07**	**€13,799.69**
Total	**433,039.43**	**106,102.22**	**108,073.50**	**647,215.15**

Table 3 Amended tabulation of final cost estimate per category of related works

Category Of Related Works	Quantity	Unit	Initial Cost Estimate	First Amendment of Cost Estimate	Time Schedule	
			(€)	(€)	Beginning	End
C. Infrastucture & Public Facilities	**0.2**	**% of the Budget**	**1,500.00**	**2,000.00**	**Sept. 1, 2011**	**Sept. 30, 2014**
Informational signs	4	Nr.	1,500.00	2,000.00	Sept. 1, 2011	Sept. 30, 2014
D. Protection & Promotion of Monuments	**84**	**% of the Budget**	**542,328.43**	**576,965.79**	**Sept. 1, 2011**	**Sept. 30, 2014**
Support and retaining work	2,500	M^2	17,220.00	15,867.00	Sept. 1, 2011	Sept. 30, 2014
Conservation work on mosaics, murals, and sculptures	45	M^2	36,951.86	466,094.49	Sept. 1, 2011	Sept. 30, 2014
Detachment of the mosaic	7	M^2	15,500.00	13,488.08	Sept. 1, 2011	Sept. 30, 2014
New construction on-site	33	M^2	57,970.00	81,516.22	Sept. 1, 2011	Sept. 30, 2014
E. Research, Documentation, Information	**6.8**	**% of the Budget**	**44,548.97**	**54,449.67**	**Sept. 1, 2011**	**Sept. 30, 2014**
Drafting, surveying	422	M^2	21,335.73	21,530.78	Sept. 1, 2011	Sept. 30, 2014
Photographic documentation	100	%	3,053.50	5,035.72	Sept. 1, 2011	Sept. 30, 2014
Informational material	1,000	Nr.	4,000.00	3,500.00	Sept. 1, 2011	Sept. 30, 2014
Laboratory analysis, humidity and temperature measurement equipment	10	Αρ.	16,159.74	24,383.17	Sept. 1, 2011	Sept. 30, 2014
F. Supplementary Works (material transportation/nonpredictable work)	**9**	**%**	**58,837.74**	**13,799.69**	**Sept. 1, 2011**	**Sept. 30, 2014**
Total			**647,215.15**	**647,215.15**		

but unfortunately only those in the south colonnade remain. Although the subject matter of each pair of columns corresponds, the artist adapted the design to the space available in each case, so that their dimensions are not precisely the same. The naturalistically rendered decorative motifs (branches, fruits, flowers, doves, partridges, fish in wreaths, baskets, and basins) have a religious symbolism that is accented by frequent depictions of the cross, and refer by association to the Christian Paradise. Similar motifs are found on the arches of the south gallery, the three arches of the tribelon, and the arches in the narthex windows. On the ground floor the subjects are treated more scholastically. With respect to composition, the ground-floor mosaics, especially those on the tribelon and in the narthex, are more elaborate and more naturalistic.

Various significant problems of deterioration threatened the whole set of mosaics, including loss or loosening of tesserae, detachment of the preparatory layers, and encrustation

Figure 3 The south colonnade and part of the fresco of the Forty Martyrs on its south face. Photo: Courtesy Ephorate of Byzantine Antiquities of Thessaloniki

with thick layers of soot and dirt. The state of preservation attests on the one hand to the consummate skill of the craftsmen who laid the mosaics and on the other to the tremendous stresses sustained by the monument over the course of its long history. Earlier conservation work in the twentieth century, especially in 1912, was generally of an emergency nature; that carried out after 1965 included an element of aesthetic restoration (see fig. 5a).

For the requirements of the conservation operations, the Ephorate hired highly specialized experts, selected to meet stringent criteria, whose salaries totaled €430,698.57. The site was equipped with state-of-the-art tools and equipment to enable the work to be done in the best possible manner. The total cost of tools and materials for the project was €115,711.47 (table 4). Seventeen people were employed for thirty-six months, and the number of jobs created over the course of the project is equivalent to twenty-eight man-years.

From the beginning we paid particular attention to ensuring that every intervention was carefully documented. Barring a very few general exceptions, the absence of such records from all the interventions undertaken since around 1960, when the archaeological service began to take an interest in the monument, obliged us to trace old conservation work that came to light only in the course of our current work.[1] Reams of texts, photographs, and drawings, now stored in the Ephorate's archives, cover every detail of the whole spectrum of the conservation work, interventional or otherwise (fig. 4). All this effort was made not only because projects cofinanced by the European Union have to be thoroughly documented step by step but also because one of the goals was to make the conservation of the Acheiropoietos a model project.

Wall Mosaics

First came the consolidation of loosened tesserae and their preparatory layers. From beginning to end of this work a record was kept of every injection point and the quantity of material injected. The operations revealed two, three, and sometimes four preparatory layers. The presence of a fourth layer may reflect an attempt to cover up imperfections in the bearing masonry before beginning to construct the mosaic. In general it was found that the differences between the arches as regards the thickness and number of preparatory layers were due to a need to correct the geometry of the bearing masonry. In the preparatory layers on many of the ground-floor arches bits of charcoal were found in the plaster, and on arch B1 there

Table 4 Final tabulation of the realized project

Category of Related Works	Payroll Cost (€)	Cost of Work Executed By Third Parties (€)	Cost of Material Supplies (€)	Total Cost (€)
C. Infrastucture & Public Facilities	**—**	**—**	**1,974.15**	**1,974.15**
Informational signs	—	—	1,974.15	1,974.15
D. Protection & Promotion of Monuments	**409,843.13**	**75,327.66**	**92,330.81**	**577,501.60**
Support and retaining work	—	15,867.00	—	15,867.00
Conservation work on mosaics, murals, and sculptures	389,962.39	—	77,488.37	467,450.76
Detachment of the mosaic	10,432.12	—	3,055.96	13,488.08
New construction on-site	9,448.62	59,460.66	11,786.48	80,695.76
E. Research, Documentation, Information	**20,475.44**	**10,333.23**	**18,889.26**	**49,697.93**
Drafting, surveying	20,475.44	—	—	20,475.44
Photographic documentation	—	1,476.00	3,559.72	5,035.72
informational material	—	862.23	2,023.50	2,885.73
Laboratory analysis, humidity and temperature measurement equipment	—	7,995.00	13,306.04	21,301.04
F. Supplementary Works (material transportation/ nonpredictable work)	**380.00**	**1,236.15**	**2,517.25**	**4,133.40**
Total	**430,698.57**	**86,897.04**	**115,711.47**	**633,307.08**

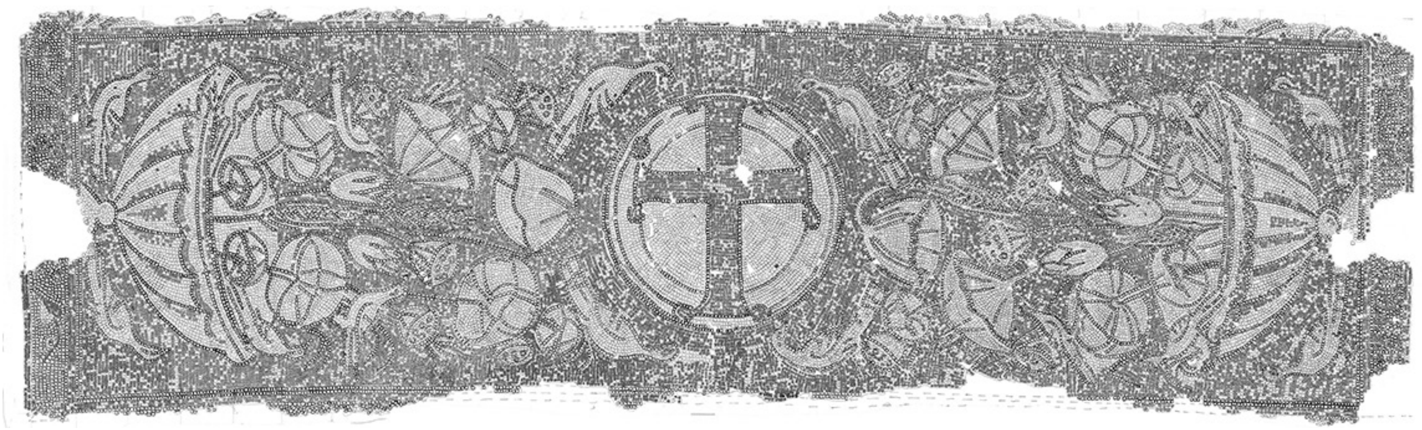

Figure 4 Artist's impression of the condition of the central arch of the tribelon.
Drawing: Courtesy Ephorate of Byzantine Antiquities of Thessaloniki

was dung as well as charcoal in the base coat that is in contact with the masonry. Metal pins were also used to secure the layers of mortar to the wall.

The surfaces of the mosaics were wet-washed and chemically cleaned (*pasta mora*), mortar (composed of calcium, sand, and pozzolana) was applied to secure the edges of the tesserae, and the gaps were filled with mortar of a neutral color (figs. 5a, 5b).

After systematic study and observation while the work was in progress, conclusions were drawn concerning how the tesserae were made and laid. The tesserae are made of natural white and light gray stone and of glass in burnt umber, rose, pale rose, bright yellow, light green, earth green, dark green, olive, dark olive, brown, violet (mauve), porphyry, orange, dark blue, ultramarine, petrol blue, turquoise, light blue, and black, as well as gold and silver. They vary in size and shape. Most are square, and some are triangular, while at the ends of the arms of the crosses in the center of the intrados of the arches there are round, oval, and teardrop tesserae of silver and gold. Larger tesserae, averaging 5 × 7 millimeters, are used for borders, outlines, and principal subjects; smaller ones, averaging 4 × 5 millimeters, are used for detail work. In general, the tesserae used in the Acheiropoietos are smaller than those in other monuments in Thessaloniki (e.g., the Rotunda and the Church of Hosios David). It is clear from a comparison of the entire set of materials that the decoration forms a single iconographic program and was carried out at one time.

Where tesserae had fallen out, colored patterns were found on the preparatory layer. Four colors were identified: red (*sinopia*), black, greenish-gray, and mauve. Sinopia was used, for example, to cover the undercoat where gold tesserae would be laid, and mauve was preferred for the outer ribbon borders. We assume that this was the case throughout, and served to guide the craftsman laying the mosaic, as well as help to achieve chromatic homogeneity. Extensive loss of tesserae was observed on the arches in the gallery, both on the east and on the west side toward the south; this is probably connected with the mechanical stresses imposed on the monument, or possibly with the early twentieth-century repairs. The same factors may have been responsible for the fall of plaster from the north face of the colonnade, which took with it the north edge of the mosaic scenes.

The tesserae were laid differently in the ground-floor mosaics than in the gallery. On the ground floor they are carefully aligned and leveled to create a smooth, flat surface, whereas in the gallery they are laid unevenly, creating a multiplicity of facets to reflect the natural light that streams in through the windows. Originally, the center aisle had a higher ceiling and there were far more windows than today. The light that bathed the interior beneath this soaring roof gave it an otherworldly dimension, and the mosaics heightened the sense of exaltation thus created.

Mosaic Floors of the South Aisle

In the south aisle, directly beneath the present floor, there are segments of mosaic and opus sectile work, which were not previously visible. One of these abuts the south stylobate and is decorated with large marble tesserae, which probably came from the level II Roman floor in the north aisle, while farther west there is a smaller area of opus sectile composed of a combination of squares and hexagons. These have been cleaned of surface dirt, repair mortar, and earlier in-fillings, re-pointed, and covered with walk-on glass so that everyone can see them. In the Chapel of Saint Irene, surface cleaning of the original coarse mosaic floor and removal of the mortar

Figure 5a Mosaic from arch B1 before conservation. Photo: Courtesy Ephorate of Byzantine Antiquities of Thessaloniki

Figure 5b Mosaic from arch B1 after conservation. Photo: Courtesy Ephorate of Byzantine Antiquities of Thessaloniki

that had been used to fill in the losses left when the communion table was relocated farther to the west produced a very satisfactory aesthetic result.

Roman Bath Mosaics of the North Aisle

Guided by the same considerations and using the same approach, we included in our program the conservation, presentation, and display of sections of three strata of floor mosaics from the Roman bathhouse that occupied the site before the basilica was built, which had been preserved for years in an open excavation pit in the north aisle. The first stratum (I) is a colorful geometric mosaic just 42 centimeters below the marble floor of the aisle. Directly beneath this, there is an older floor (II) of white and green marble slabs, which had been plundered before the mosaic floor was laid so that little remains but their imprint on the mortar. Beneath that again, at a total depth of 60 centimeters, is a Roman mosaic of black and white stone tesserae (fig. 6). A grave aligned east–west was dug roughly eight centuries later next to the north side of the north stylobate, destroying part of the Roman floor. One of the stones covering it was a recycled middle Byzantine panel decorated with bands and animals.

Possible ways of presenting the Roman baths mosaics were exhaustively explored and involved consideration at both the design stage and the market research and implementation

Figure 6 The three layers of flooring from the Roman bath (second to fourth centuries) under the north aisle. Photo: Courtesy Ephorate of Byzantine Antiquities of Thessaloniki

stages. Covering the excavation with walk-on glass proved to be the only way to accommodate the coexistence of the antiquities with the needs of present-day life. Thus, with the help of custom-designed electric lighting, the visitor, the churchgoer, the schoolchild, and the expert will be able to see not only the find but its construction details and colors as well (fig. 7). The bearing system for the glass panels was designed on the basis of a static study using geotechnical data collected for that purpose. Trapped and recurring humidity will be removed by a mechanical forced-air ventilation system. In order to regulate the humidity of the air in the trench, so as to protect the mosaics and prevent the glass panels from misting over, this microclimate was monitored for a year and a half, which led to the design and the incorporation of a ventilation and air circulation system in the installation. The whole structure is flush with the floor in the north aisle for unobstructed walking and creates no sense of insecurity. The solution is reversible and fully compatible aesthetically with the immediate archaeological environment. This part of the project cost €80,695.76. The positive impression this made led those

Figure 7 Walk-on glass installed over the exposed flooring of the Roman bath. Photo: Courtesy Ephorate of Byzantine Antiquities of Thessaloniki

responsible for the church to ask us to permit the replacement of the modern carved wood templon in the Chapel of Saint Irene, which hides the ancient tribelon and is in direct view from the glass floor, with a low barrier to allow the visitor to see the tribelon. This is the first time such a thing will be done in a church, in Thessaloniki at least.

Once the conservation work has been completed and in the context of the requirement for public information and education that is a precondition for funding, an instructive booklet will be published and distributed free of charge, thus enabling large numbers of people (visitors, students, professionals, etc.) to learn, through texts, drawings, and photographs, about the historical, archaeological, artistic, and aesthetic value of the monument and about the work of conservation and presentation that has been done (Makropoulou and Karagiannidou 2014). In addition, information panels in Greek, English, and Russian are about to be installed in selected places in the church. The cost of this part of the project was €4,859.88.

We believe that our care of the monument over three successive and different programming periods is now complete. From here on, without further circumspection or concern, it is a monument for all the world.

Note

1 Details of the conservation work carried out on the mosaics of the Acheiropoietos in earlier years may be found in the annals of the *Archaeological Bulletin* (*Αρχαιολογικόν Δελτίον*), in the archives of the Ephorate of Byzantine Antiquities, where reports and logs are kept, and in the Byzantine and Christian Museum in Athens.

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I mosaici di Nora: Dal restauro alla manutenzione programmata

Maria Rita Ciardi, Fabiano Ferrucci, e Elena Romoli

Abstract: *Nora e i suoi preziosi mosaici sono luogo di studio e laboratorio per comprendere e affrontare i problemi di conservazione, causati da fattori ambientali e dall'uso del ferro e del cemento impiegati nei restauri del Novecento. Alla campagna di interventi 2007–2011, segue il programma di manutenzione che qui presentiamo. Il progetto tiene conto dei dati registrati durante i lavori e degli elementi che determinano la maggiore vulnerabilità di alcuni mosaici, individuando specifiche operazioni da eseguire con frequenza programmata. Permetterà, inoltre, di valutare l'incidenza dei fenomeni di degrado e gli interventi conservativi in termini di costi, tempi e risorse umane.*

Abstract: *The city of Nora and its precious mosaics are settings for research and work aimed at understanding and addressing conservation issues caused by environmental factors and the use of iron and cement in restorations of the twentieth century. In this paper we describe the maintenance program that was carried out after the restoration campaign of 2007–11. The project takes into account data recorded during the restoration process, as well as those elements that cause the greatest vulnerability for some mosaics, highlighting specific procedures to be carried out on a frequent, scheduled basis. Furthermore, it will enable us to evaluate both the incidence of damaging events and the conservation measures in terms of cost, time, and human resources.*

Premessa sui mosaici di Nora e sugli interventi realizzati

La città di Nora, ubicata sulla costa meridionale della Sardegna, fu riportata alla luce intorno alla metà del secolo scorso. Gli scavi misero in evidenza rovine archeologiche della città fenicia, punica e romana. La città divenne, con la conquista della Sardegna da parte dei romani (238 a.C.) probabilmente la città più importante dell'isola. I resti attualmente presenti testimoniano dello sviluppo della città, in particolare nel II e III secolo d.C. L'abbandono dovette iniziare nel corso del V secolo, con l'occupazione da parte dei Vandali e la maggiore difficoltà dei traffici marittimi. Lo scavo sistematico venne condotto negli anni tra il 1952 e il 1964 dall'allora soprintendente, l'archeologo Gennaro Pesce.

Numerosi tra gli edifici emersi, in prevalenza pubblici (per esempio impianti termali, porticati, templi, teatro), ma anche importanti abitazioni private (per esempio Casa dell'Atrio Tetrastilo), sono arricchiti da decorazioni musive pavimentali, prevalentemente del tipo *opus tessellatum*, monocromi o policromi, in maggior parte geometrici.

Le maestranze antiche raggiungono livelli notevoli di esecuzione e di espressione, anche con l'inserimento, non comune, di scene figurate entro il ricco tessuto geometrico e decorativo di fondo, come avviene nel vano D della Casa dell'Atrio Tetrastilo, oggetto del recente restauro. Qui l'"Emblema", motivo centrale del mosaico, mostra una figura che cavalca un animale marino.

La particolare ubicazione di Nora in riva al mare innesca molteplici fenomeni di degrado da imputare sia a fattori ambientali, sia ai materiali utilizzati durante i restauri del Novecento. Dall'azione sinergica di alcuni elementi quali aerosol marino, erosione eolica, escursioni termiche, forte insolazione, si generano patologie che, da oltre un decennio, hanno fatto emergere la complessa problematica della conservazione *in situ* dei mosaici di Nora.

A seguito degli scavi, un vasto intervento di restauro sui pavimenti a mosaico venne realizzato negli anni Sessanta. Secondo la tecnica in uso veniva effettuato lo stacco radicale del manto musivo, la realizzazione di solette in cemento armato e la ricollocazione del mosaico sui massetti nuovi.

L'utilizzo di questi materiali, nelle condizioni espositive e climatiche del sito, posto su di un promontorio aperto sul mare, ha determinato, in breve tempo, gravi problemi di conservazione. La formazione di ossidazioni e rigonfiamenti del ferro ha provocato fenomeni di frammentazione e disgregazione dei tessuti musivi.

I mosaici di Nora possono essere suddivisi in tre categorie in base alle vicende conservative subite, ovvero in base alle caratteristiche degli interventi del Novecento (fig. 1):

a) pavimenti *in situ* mai rimossi;
b) pavimenti staccati e riapplicati su cemento armato negli anni Cinquanta–Sessanta;
c) pavimenti staccati dal supporto in cemento armato e riapplicati su solo cemento.

Attraverso le ultime campagne di intervento, sono stati restaurati tutti i mosaici del sito archeologico ancora posati sui massetti in cemento armato, che accusavano gravissimi problemi di degrado dovuti principalmente a fattori ambientali, alla frequentazione turistica e alla presenza di materiali non idonei, quali cemento e ferro (figg. 2, 3).

Le patologie che vanno prevalentemente imputate all'ossidazione dei metalli delle armature del massetto cementizio sono le seguenti:

- fratture/fessure e lacune sia del manto musivo sia delle vecchie integrazioni in malta;
- distacchi tra gli strati di preparazione;
- sollevamenti;
- depressioni;
- distacco e perdita di tessere.

Altri fenomeni di degrado sono invece da imputare a fattori ambientali come la presenza di aerosol marino, l'erosione eolica, escursioni termiche, l'attività vegetativa, che in connessione tra loro generano patologie quali:

- erosione e fratturazione delle tessere, più marcata su alcuni materiali costitutivi. Durante le operazioni di restauro si è potuto verificare che alcune tipologie (per esempio calcare nero e rosso) hanno subito una marcata erosione che ne ha ridotto lo spessore a pochi millimetri (da circa 1–1,5 cm originari a 7–8 mm). Una riduzione dello spessore del tessellato così rapida (circa il 50% di sezione in circa cinquant'anni) desta non poca preoccupazione per il futuro delle opere.
- efflorescenze saline, dovute sia all'esposizione ai cicli di condensazione e deposito degli aerosol marini ricchi di cloruri, sia alla migrazione di nitriti, nitrati e solfati dai massetti cementizi e dai terreni limitrofi;

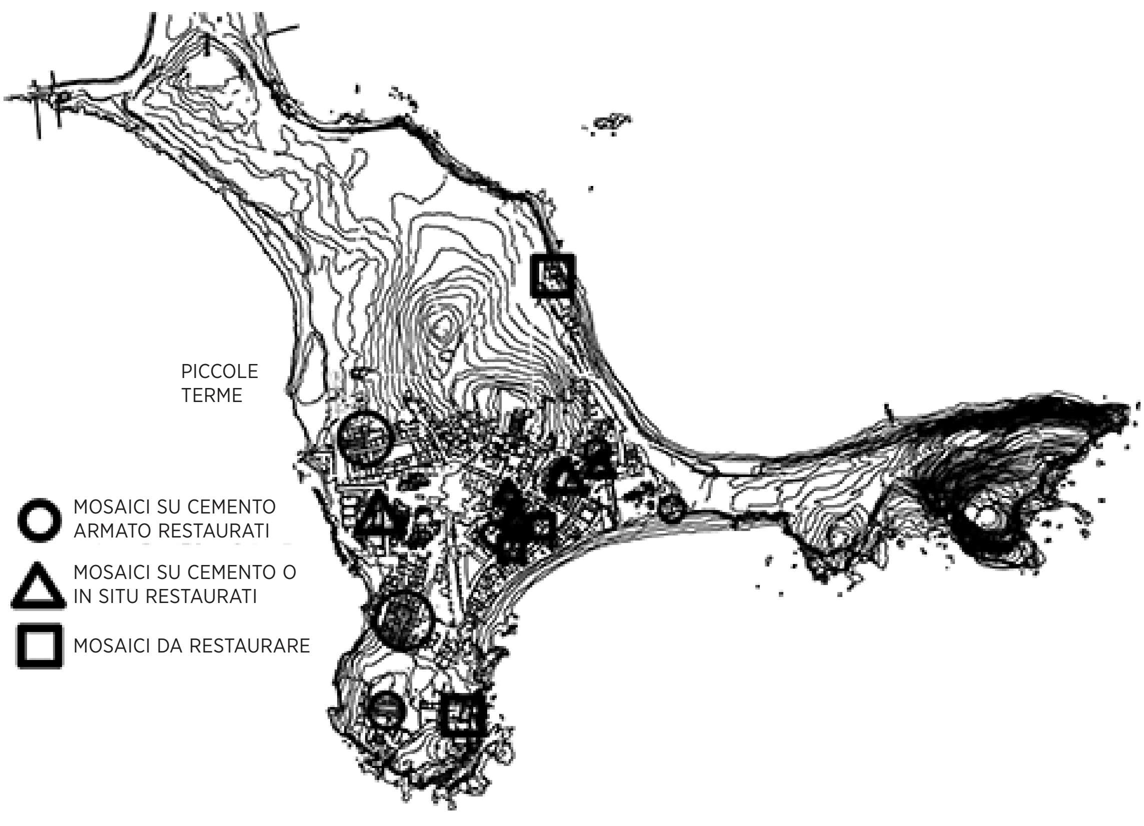

Figura 1 Pianta di Nora (il copyright è detenuto dagli autori e le immagini sono degli autori).

Figura 2 Piccole Terme Apodyterium: presenza di ferri ossidati (il copyright è detenuto dagli autori e le immagini sono degli autori)

- polverizzazione della malta tra le tessere e di allettamento delle stesse, dovuta anch'essa ai cicli di cristallizzazione salina e agli stress termici;
- crescita di vegetazione e di microrganismi (alghe, muschi, licheni);
- depositi superficiali. In particolare alcuni mosaici (per esempio nelle aree del Foro e della Casa dell'Atrio Tetrastilo) vengono deturpati dal guano dei gabbiani e altri volatili innescando fenomeni corrosivi delle pietre calcaree su cui esso permane.

L'approfondimento degli studi e delle verifiche relative ai fattori e ai meccanismi di degrado in atto nell'area di Nora, attivati in collaborazione con istituti di ricerca universitari nel corso degli ultimi anni, ha consentito l'elaborazione di progettazioni che hanno integrato le operazioni di conservazione dei mosaici con quelle delle superfici e strutture architettoniche e di altre tipologie pavimentali, fino a delineare le linee di contrasto all'erosione costiera e per le attività di manutenzione programmata che, da sole, consentiranno la sopravvivenza delle testimonianze materiali dell'antica città. Nello specifico lo "Studio e verifica dell'erosione costiera dell'Area archeologica di Nora", affidato dalla Soprintendenza per i Beni Archeologici di Cagliari al Centro Interdipartimentale di Ingegneria e Scienze Ambientali dell'Università degli Studi di Cagliari, coordinato dal professor Felice Di Gregorio ed eseguito nel corso del 2008, si è rivelato un efficace strumento di analisi per individuare i meccanismi di degrado innescati

Figura 3 Casa dell'Atrio Tetrastilo, vano D: deformazione del tessellato, presenza di lesioni, deformazioni (il copyright è detenuto dagli autori e le immagini sono degli autori)

dall'erosione costiera, sia direttamente sui resti archeologici sia sulla struttura geologica della penisola in cui sorge l'antica città. L'analisi si è articolata in un percorso di indagine e confronto dei dati ambientali, geologici, geomorfologici e materici, della dinamica costiera e del degrado delle strutture archeologiche, verificati sulla prospettiva storica degli ultimi cinquant'anni. La Carta del Rischio da Erosione Costiera individua le criticità in essere sui beni archeologici, suddivise in quattro gradi di rischio, che si traducono a loro volta nelle priorità d'intervento. Se ne deduce che la linea di costa è rientrata, in alcune zone, di oltre 1,5 metri, e che tale meccanicismo è in continua progressione, arrivando anche a lambire ambienti pavimentati a mosaico, e che in vari settori urbani vi è un elevato rischio di crollo delle strutture rocciose con compromissione degli edifici adiacenti.

Ad eccezione di alcuni lacerti di mosaico recuperati nell'area del Peristilio Sud, per i quali si è preferita l'esposizione in museo, tutti i tappeti musivi, dei quali si è reso necessario il distacco per eliminare il ferro ossidato, sono stati rimontati *in situ* nelle originali collocazioni, su nuovi massetti. Successivamente sono state completate le ultime fasi del restauro, che si è connotato per l'impiego di materiali ad alto tenore di reversibilità, compatibili con gli elementi originali in opera e adatti a contrastare la forte aggressività dell'ambiente marino circostante.

In particolare nel 2007–8 è stato effettuato un primo cantiere di restauro sul mosaico del *frigidarium* delle Terme Centrali.[1] Tra il 2009 e il 2011 si è intervenuti sui mosaici presenti in un ambiente del Foro, nella *cella* e nell'*adyton* del Tempio Romano, nelle Piccole Terme (*frigidarium, apodyterium*, corridoio), nella Casa dell'Atrio Tetrastilo (vani D, E, F, I, L), nel Peristilio Sud (frammenti ora musealizzati). Nel 2011–12 sono stati restaurati i mosaici del corridoio del Peristilio Orientale all'interno dell'isolato delle Terme Centrali e nel Teatro, già parzialmente allettati su soletta in cemento.[2]

La campagna di interventi 2007–11 ha interessato complessivamente sette vasti complessi architettonici e circa 500 mq di superficie musiva. Al momento è in corso una campagna di restauro sul mosaico dell'*apodyterium* e sulle strutture murarie delle Terme Centrali.

Nei recenti interventi (2007–11) il ferro è stato eliminato attraverso una complessa sequenza di fasi operative.[3] Il lavoro di restauro si è articolato nelle seguenti fasi lavorative:

- documentazione (Rilievo 1:1; redazione di tavole grafiche tematiche e di fotografie per registrare lo stato delle superfici e gli interventi effettuati);
- trattamento biocida;
- raccolta e ricollocazione delle tessere distaccate;
- pulitura della superficie;
- rimozione dei mosaici dal sito (velinatura delle superfici a mosaico mediante applicazione di tessuto, taglio dei blocchi, stacco, sollevamento e trasporto in laboratorio) (fig. 4);
- rimozione del cemento e dei ferri di armatura (fig. 5);
- realizzazione di nuovi massetti in calce idraulica, previa demolizione della struttura in calcestruzzo del sottofondo;
- riapplicazione del mosaico in situ sui nuovi massetti (fig. 6);

Figura 4 Casa dell'Atrio Tetrastilo, vano D: fase di stacco del mosaico (il copyright è detenuto dagli autori e le immagini sono degli autori)

Figura 5 Rimozione meccanica del cemento dal supporto con tagli regolari eseguiti da sega circolare (il copyright è detenuto dagli autori e le immagini sono degli autori)

Figura 6 Casa dell'Atrio Tetrastilo, vano D: fase di rimontaggio del mosaico (il copyright è detenuto dagli autori e le immagini sono degli autori)

- rimozione delle tele applicate e pulitura definitiva;
- integrazione delle lacune (fig. 7);
- ripristino della malta interstiziale ("boiaccatura");
- applicazione di un protettivo superficiale per limitare i fenomeni erosivi (fig. 8);
- consolidamento delle strutture murarie, ancora parzialmente rivestite di intonaco, marginali ai pavimenti mosaicati.

La manutenzione programmata nel contesto di Nora

In Italia il Codice dei Beni culturali e del Paesaggio definisce la manutenzione come "complesso delle attività e degli interventi destinati al controllo delle condizioni del bene culturale e al mantenimento dell'integrità, dell'efficienza funzionale e dell'identità del bene e delle sue parti" (D.Lgs. 42/04, art. 29, comma 3).

La conservazione programmata è volta a eliminare la criticità delle emergenze dei danni sui monumenti, attraverso controlli programmati e periodici, valutando la validità delle misure adottate nella fase di programmazione e registrando le eventuali trasformazioni subite dal sistema "manufatto-ambiente."

Nel caso dei mosaici di Nora la manutenzione programmata assume un ruolo fondamentale trattandosi di beni archeologici conservati all'aperto. Inoltre, la caratteristica ubicazione del sito che si apre come una penisola circondata dal mare su tre lati, particolarmente esposta ai venti e alla salsedine, favorisce la progressione del degrado dei materiali costitutivi.

Per le operazioni necessarie, si è previsto di impiegare squadre di operatori (Restauratore di beni culturali e Tecnico del restauro—DM 26 maggio 2009 n.86), composte prevalentemente da tecnici restauratori debitamente guidati, formati e in possesso di specifiche competenze nel restauro dei mosaici, preferendo, quando possibile, maestranze locali che già conoscono il contesto in cui operanno. La manutenzione programmata diventerà, quindi, anche il modo di veicolare competenze estremamente specialistiche nella conservazione del mosaico e specializzare personale in loco; personale che, in futuro, potrà rivelarsi prezioso supporto anche per enti locali, per gli organi del Ministero dei Beni e delle Attività Culturali e del Turismo e per le imprese di zona.

Il Programma di manutenzione dei mosaici restaurati è stato studiato considerando alcune particolarità, elencate di seguito, registrate durante gli interventi effettuati, che determinano la maggiore vulnerabilità di alcuni tra i mosaici analizzati rispetto ad altri:

Particolare vulnerabilità tipologica. Alcuni mosaici sono costituiti da tessere di piccole dimensioni (da qualche millimetro ad un centimetro di profondità della tessera) e, in particolare, sono localizzati negli ambienti della Casa dell'Atrio Tetrastilo (vani D, E, F, I); la riduzione dello spessore del tessellato, già esigua in origine, è drasticamente accentuata da fenomeni erosivi. Per mosaici di questa tipologia, se lo spessore delle tessere continua a diminuire a causa dei fenomeni erosivi, in futuro si dovranno sostituire la maggior parte delle tessere.

Particolare vulnerabilità di alcuni materiali costitutivi del tessellato. Va considerato che i materiali litoidi si degradano con velocità differente tra loro. I calcari neri, rossi, verdi e gialli sono i più degradati, mentre le tessere di calcare bianco resistono meglio. In particolare i litotipi rossi originali sono in gran parte persi, o ridotti a pochi millimetri di spessore. I mosaici sono prevalenti le tessere policrome sono quelli dell'Atrio Tetrastilo, mentre il degrado critico del litotipo nero interessa anche mosaici con tessere di maggiori dimensioni (Mosaici del Tempio, delle Piccole Terme, del Foro).

Particolare esposizione all'aerosol marino e all'erosione eolica. Alcuni mosaici si trovano più esposti a questi fattori, poiché ubicati a pochi metri dal mare e in punti particolarmente ventosi. Si tratta dei mosaici della Casa dell'Atrio Tetrastilo (vani D, E, F, I) e dell'area del Foro.

Particolare esposizione al guano dei volatili. Si tratta dei mosaici del Foro e della Casa dell'Atrio Tetrastilo (vani D, E, F, I, L).

Accentuata ricrescita vegetativa. Riguarda i mosaici situati nelle aree più riparate, dove maggiore è l'accumulo del terriccio che, depositato dal vento all'interno delle *insulae*, costituisce fertile terreno di crescita per le piante. Anche i muschi e gli altri microorganismi si sviluppano prevalentemente in aree riparate da muretti, i muschi in particolare nei punti di ombra. I mosaici più interessati dalla ricrescita vegetativa sono quelli presenti negli ambienti delle Piccole Terme (*frigidarium*, *apodyterium*, corridoio), della Casa dell'Atrio Tetrastilo (vani D, E, F, I, L), delle Terme Centrali (corridoio e mosaico del *frigidarium*).

Solo per alcuni mosaici particolarmente soggetti all'aggressione dei fattori ambientali (in particolare quello del Foro dove i gabbiani nidificano in cospicuo numero ricoprendolo di guano) si propone, già in questo programma, l'esposizione limitata ai periodi di maggior flusso turistico.

L'intervento di conservazione programmata dei mosaici, insieme agli altri interventi di manutenzione del sito in atto (per esempio sostituzione delle vecchie recinzioni in legno con nuove in acciaio) assicureranno una migliore tutela e fruizione dell'area.

Operazioni di verifica periodica e di manutenzione triennale

Il seguente programma di manutenzione ordinaria si articola in un arco temporale di tre anni; questa durata è stata deter-

Figura 7 Casa dell'Atrio Tetrastilo, vano F: integrazione di piccole lacune (il copyright è detenuto dagli autori e le immagini sono degli autori)

Figura 8 Casa dell'Atrio Tetrastilo, vano D: il mosaico dopo il restauro (il copyright è detenuto dagli autori e le immagini sono degli autori)

minata in relazione alle caratteristiche ambientali del sito. Il piano contiene le indicazioni della frequenza dei sopralluoghi di controllo da effettuare dopo l'intervento, la stima di massima delle operazioni necessarie nel caso si manifestassero nuovi fenomeni di degrado, con un calcolo di massima di tempistica (in ore-uomo), logistica (necessità di mezzi d'opera), materiali e attrezzature occorrenti. L'analisi permetterà una stima puntuale dei costi e dei tempi. Le operazioni in seguito descritte verranno effettuate da personale tecnico in possesso della qualifica di Restauratore di beni culturali/ Tecnico del restauro (DM 26 maggio 2009 n.86), ovvero da una squadra mista, costituita da un Restauratore di beni culturali e due Tecnici del restauro.

Gli interventi di manutenzione sono stati suddivisi in operazioni semestrali (capo A) e operazioni triennali (capo B). Questa differenza è dovuta al fatto che alcune operazioni possono ripetersi con una cadenza periodica più serrata, in quanto sono finalizzate ad arrestare fenomeni di degrado che sappiamo riproporsi in modo continuo nei casi di esposizione all'aperto, in particolare nelle condizioni microclimatiche dell'area archeologica di Nora.

Le operazioni semestrali, i sopralluoghi, le verifiche, sono da effettuarsi due volte l'anno, preferibilmente dopo l'inverno e alla fine della stagione turistica.

Le operazioni triennali sono invece indirizzate al ripristino di alcuni prodotti e materiali di restauro di cui si vuole riproporre la lavorazione in tempi utili prima della loro alterazione (es. stuccature e protettivi).

Le verifiche e operazioni al capo A) sono:

- verifiche e operazioni semestrali da effettuare due volte l'anno, indicativamente ad aprile e ad inizio ottobre;
- creazione e aggiornamento della schedatura conservativa informatizzata, ovvero la registrazione dei dati su supporto cartaceo e successivo trasferimento su supporto informatico. Ciò permetterà di valutare l'incidenza dei fenomeni di degrado al fine di monitorare il loro evolversi nel tempo e indirizzare gli interventi conservativi. Anche le operazioni effettuate ad ogni campagna di manutenzione verranno inserite in appositi campi in modo da aggiornare la schedatura conservativa informatizzata, che diverrà lo strumento per programmare anche in futuro gli interventi di manutenzione e di restauro dei mosaici di Nora e progettare interventi di restauro su contesti analoghi.

L'attività di controllo dello stato di conservazione delle superfici al momento dell'attuazione del programma e tutte le operazioni eseguite saranno registrate su basi grafiche e fotografiche. Inoltre, verranno create delle schede pre-formulate che costituiranno l'archivio dell'evoluzione conservativa dei manufatti, corredata di immagini fotografiche, annotazioni e mappature.

Le schede informatiche riporteranno i dati essenziali dei manufatti quali:

- anagrafica dell'opera;
- data di sopralluogo e intervento;
- insorgenza del danno, gravità e diffusione;
- interventi effettuati e materiali utilizzati;
- tempistica;
- annotazioni e registrazioni di eventi straordinari.

Per poter pianificare l'attività di conservazione è stata creata una scheda di manutenzione per ogni ambiente dove sono conservati i mosaici. All'interno di ogni scheda sono riportate la denominazione e le misure dei vani, le attività lavorative, il tempo stimato per ogni operazione e l'attrezzatura necessaria.

La descrizione delle singole voci del capo A, all'interno delle schede di intervento, è la seguente:

A1) Sopralluoghi di controllo periodico sui pavimenti musivi. Aggiornamento della schedatura conservativa informatizzata.

Verifica dell'insorgenza dei seguenti fenomeni di degrado sui mosaici:

- fessure e lesioni delle superfici;
- distacchi superficiali e profondi delle malte di restauro;
- distacchi di tessere o frammentazione;
- sollevamenti, rigonfiamenti, deformazioni del tessellato;
- decoesione dei materiali costitutivi;
- efflorescenze saline;
- sviluppo di biodeteriogeni;
- sviluppo di piante infestanti.

A2) Cantierizzazione (durante le ore di lavoro relative al singolo mosaico).

Delimitazione con barriere mobili e componibili dell'area di lavoro; installazione di segnaletica e cartellonistica di sicurezza durante l'intervento.

A3) Rimozione a secco di polvere, terriccio e detriti con pennelli, pennellesse, spazzole e aspiratori.

A4) Disinfezione di colonie di microrganismi autotrofi e/o eterotrofi mediante applicazione di biocida al 2% (due cicli di irrorazione), seguito da risciacquo delle superfici.

A5) Trattamento erbicida mediante applicazione a spruzzo e/o a pennello, attraverso due cicli di applicazione e successiva rimozione manuale.

A6) Lavaggio, rimozione del guano con acqua addizionata con un tensioattivo a blanda azione biocida (tipo NeoDesogen al 2%) da eseguirsi con spugne umide e spazzolini.

A7) Controllo e fissaggio di eventuali tessere mobili tramite consolidamento degli eventuali difetti di adesione e coesione delle superfici musive dagli strati preparatori, tramite stuccatura o iniezioni di malta idraulica.

A8) Controllo e stuccatura delle piccole lacune e **consolidamento di grandi stuccature**; si tratta di stuccatura d'urgenza con malta nei casi di fessurazioni, mancanze. Per le grandi stuccature di restauro, ove risultino distaccate o fratturate si prevede il consolidamento e fissaggio per evitare la formazione di grandi lacune.

A9) Rimozione dei sali solubili tramite lavaggi con acqua distillata.

A10) Fissaggio di materiali costitutivi eventualmente decoesi o esfoliati, mediante imbibizioni di prodotto aggregante.

A11) Riapplicazione del protettivo a spruzzo o pennello. Operazione finalizzata a integrare il film protettivo ove consumato o degradato (la rimozione dei residui di prodotto alterato e la stesura integrale di nuovo prodotto è prevista nella manutenzione triennale).
Solo per alcuni mosaici (Mosaico del Foro):

A12) Copertura del mosaico a ottobre con geotessuto e ghiaia previo lavaggio e disinfezione.

A13) Scopertura ed esposizione del mosaico all'inizio della stagione turistica.

Le operazioni al capo B) sono:

- **Operazioni triennali,** volte essenzialmente a ripristinare la funzione del protettivo superficiale e della malta interstiziale che costituiscono gli elementi di protezione dall'aggressione degli agenti atmosferici esterni. In particolare limitano e rallentano i fenomeni erosivi causati dagli aerosol marini ricchi di cloruri.

Oltre alla microstuccatura con malta, è utile ripristinare (rimuovere i residui e riapplicare integralmente) periodicamente un prodotto con proprietà protettive che favorisca il ruscellamento dell'acqua e garantisca al contempo la traspirabilità. Un prodotto con queste caratteristiche è stato già steso a fine intervento su tutti i mosaici (ad eccezione del mosaico del *frigidarium* delle Terme Centrali). La presenza del polisilossano impartisce ai manufatti trattati proprietà idrorepellenti; impedisce l'ingresso di acqua in fase liquida ma ne permette il passaggio in fase gassosa, garantendo la traspirabilità.

La presenza di un protettivo di questo tipo fa sì che la cristallizzazione dei cloruri avvenga al di sopra del film silossanico, dove gli accumuli di sali e inquinanti vengono successivamente dilavati dalla pioggia, grazie alle pendenze e ai sistemi di deflusso realizzati durante il restauro. Questo tipo di materiale ha una durata limitata nel tempo e va ripristinato periodicamente. In attesa di dati specifici sull'applicazione nella situazione specifica del sito di Nora, dobbiamo comunque escludere una durata superiore ai tre anni, pertanto si consiglia il totale ripristino ogni 3 anni.

Questo permetterà una maggiore durata nel tempo dell'intervento sulle superfici esterne poiché il protettivo limiterà anche fenomeni quali l'infestazione da biodeteriogeni, la formazione di macchie e i processi di decoesione, dovuti alla deposizione di cloruri e alla circolazione e cristallizzazione di inquinanti chimici nella porosità dei materiali litici. Si ridurranno quindi gli oneri di manutenzione futura e la necessità di frequenti restauri ed integrazioni del tessellato.

La descrizione delle singole voci del capo B, all'interno delle schede di intervento, è la seguente:

B1) Rimozione dei residui di protettivo alterato tramite appositi solventi e stesura di nuovo prodotto a spruzzo o pennello.

B2) Microstuccatura degli interstizi tra le tessere prive di malta ("boiaccatura") previa pulitura delle superfici dai depositi incoerenti mediante pennellesse, bisturi e aspiratore.

Esempio di scheda di manutenzione per ambiente

Il progetto ha previsto la realizzazione di schede dei singoli contesti musivi, nello specifico:

Scheda n.1: Foro
Scheda n.2: Tempio (vani: *cella, adyton*)
Scheda n.3: Piccole Terme (vani: corridoio, *apodyterium, frigidarium*)
Scheda n.4: Casa dell'Atrio Tetrastilo (vani *D; E; F; L; I*)
Scheda n.5: Terme centrali (vani: *frigidarium*, corridoio)
Scheda n.6: Teatro

A titolo di esempio si pubblica nel presente contributo la scheda n.1 relativa al mosaico del Foro.

1) MOSAICO DEL FORO (Tabella 1)
Dimensioni:
superficie Soletta 16,50 mq
superficie Mosaico 12 mq

Tabella 1 Scheda di Manutenzione del Mosaico del Foro

	Operazioni Semestrali	**Periodicitá**	**Stima Di Massima Delle Operazioni Necessarie**	
Operazione	**Specifiche tecniche sulle operazioni da eseguire**		**Tempistica ore/uomo**	**Materiali/attrezzature occorrenti**
A1) Sopralluoghi di controllo periodico sui pavimenti musivi Aggiornamento della schedatura conservativa informatizzata	Registrazione dei dati su supporto cartaceo e informatico Verifica dell'insorgenza di fenomeni di degrado: fessure e lesioni delle superfici Distacchi superficiali e profondi delle malte di restauro Distacchi di tessere o frammentazione Sollevamenti, rigonfiamenti, deformazioni del tessellato Decoesione dei materiali costitutivi Efflorescenze saline Sviluppo di biodeteriogeni (alghe, licheni) e piante infestanti	**6 mesi**	4	macchina fotografica, supporto informatico
A2) Cantierizzazione durante le ore di lavoro	Delimitazione con barriere mobili e componibili dell'area di lavoro; installazione di segnaletica e cartellonistica di sicurezza durante l'intervento; cantierizzazione.	**6 mesi**	2	Cartellonistica, segnaletica, cavi elettrici e impianto idrico
A3) Rimozione di terriccio e polveri	Rimozione a secco di polvere e detriti con scope, pennelli, pennellesse, spazzole e impianto di aspirazione.	**6 mesi**	4	Pennellesse, spazzole e aspiratori;
A4) Irrorazione a spruzzo con prodotto biocida	Disinfezione di colonie di microrganismi autotrofi e/o eterotrofi mediante applicazione a spruzzo di biocida al 2%	**6 mesi**	4	Preventol R80 o Rocima 103 al 3%
A5) Trattamento erbicida sulle foglie della vegetazione infestante	Trattamento erbicida mediante applicazione a spruzzo e/o a pennello, attraverso due cicli di applicazione e successiva rimozione meccanica manuale.	**6 mesi**	1	RODEO GOLD (Glifosate) al 3%
A6) Lavaggio e rimozione guano	Con acqua distillata e 2% di tensioattivo	**6 mesi**	4	Tensioattivo anionico, spazzole
A7) Fissaggio delle tessere mobili tramite stuccatura e consolidamento	Verifica della tenuta delle tessere e della malta di allettamento e dei piani pavimentali. Consolidamento dei difetti di adesione e coesione delle superfici musive dagli strati preparatori: stuccatura o iniezioni di malta idraulica.	**6 mesi**	4	Infiltrazioni di malta idraulica premiscelata Ledan TB1. Stuccatura tramite malta idraulica 5NHL
A8) Stuccatura delle piccole lacune e consolidamento grandi stuccature	Controllo ed eventuale stuccatura con malta nei casi di fessurazioni, fratturazioni, mancanze. Consolidamento dei difetti di adesione e coesione delle grandi stuccature di restauro, tramite stuccatura o iniezioni di malta idraulica.	**6 mesi**	2	Malta idraulica 5NHL; sabbia, spatole, guanti
A9) Verifica comparsa di efflorescenze saline e rimozione	Rimozione dei sali solubili tramite lavaggi con acqua distillata.	**6 mesi**	1	Acqua distillata, polpa di cellulosa, pennellesse
A10) Verifica della coesione dei materiali e consolidamento	Fissaggio dei materiali costitutivi decoesi ed esfoliati, mediante imbibizioni di prodotto aggregante dato attraverso impacchi di consolidante a base di silicato di etile.	**6 mesi**	4	Silicato di etile, pennelli, maschere, filtri
A11) Riapplicazione del protettivo a spruzzo o pennello	Riapplicazione del protettivo a spruzzo/pennello. Operazione finalizzata a integrare il film protettivo ove degradato (N.B.: la rimozione dei residui di prodotto alterato e la stesura integrale è prevista nella manutenzione triennale).	**6 mesi**	4	Solvente, spazzole, pennelli, maschere, filtri, polisilossano
Totale manutenzione semestrale			34	
A12) Copertura del mosaico	Copertura del mosaico a fine stagione turistica, con geotessuto e ghiaia, previo lavaggio e disinfezione	**6 mesi ottobre**	8	Geotessuto; ghiaia
A13) Scopertura del mosaico	Scopertura ed esposizione del mosaico a inizio stagione turistica	**6 mesi giugno**	8	Geotessuto; ghiaia
Totale manutenzione copertura/scopertura			16	
	Operazioni Triennali			
B1) Rimozione e stesura del protettivo superficiale	Rimozione dei residui di protettivo alterato tramite appositi solventi e stesura di nuovo prodotto a spruzzo o pennello.	**3 anni**	8	Solvente, spazzole, pennelli, maschere, filtri, polisilossano
B2) Microstuccatura tra le tessere ("boiaccatura")	Stesura di nuova malta liquida (boiacca) negli interstizi delle tessere	**3 anni**	10	malta idraulica 5NHL; spatole, guanti, spugne
Totale sole operazioni triennali			18	

Stima dei costi

Nella stima dei costi e della durata degli interventi si prevede una squadra mista, costituita da un Restauratore di beni culturali e due Tecnici del restauro/Assistenti restauratori. Si prevede inoltre il costo relativo a:

- materiali (biocida a base di sale di ammonio quaternario tipo Preventol R80 o Rocima 103, malta consolidante premiscelata tipo Ledan TB1, tensioattivo anionico, malta idraulica, acqua distillata, silicato di etile, polisilossano ecc.);
- attrezzature (spazzole, aspiratori, pennelli, spatole, macchina fotografica, computer, ecc.);
- opere provvisionali e cantierizzazione (cavi elettrici, impianto idrico, cartellonistica, segnaletica ecc.).

Per le figure professionali del Restauratore di beni culturali e Tecnico del restauro (DM 26 maggio 2009 n.86), l'analisi dei costi utilizza quale riferimento per il costo della manodopera la tariffa del prezziario DEI 2010 Beni Culturali (Restauratore di beni culturali M01035 prezzo comprensivo delle spese generali e utili d'impresa pari al 26,5% ora €38,28; Tecnico del restauro M01036 prezzo comprensivo delle spese generali e utili d'impresa pari al 26,5% ora €34,80).

I costi relativi ai materiali, alle attrezzature e alle opere provvisionali occorrenti sono stimati in percentuale del 10% rispetto alla manodopera.

Alla fine il totale del monte ore viene stimato secondo le tariffe in vigore e si può desumere il prezzo del piano di manutenzione suddiviso sia per ogni semestre sia su tutto il triennio.

La quantità di ore che si desumono dall'attività di manutenzione su tutti i mosaici restaurati (circa 500 mq) coinvolgerebbe una squadra di tre persone per circa 24 giorni lavorativi ogni 6 mesi. Questo tipo di lavorazioni consentirebbe di mantenere un'ottima fruibilità dell'area archeologica e un minimo impatto durante le operazioni di restauro in quanto ogni ambiente verrebbe trattato tra i due e gli otto giorni a seconda dell'estensione delle superfici. Il costo totale dell'intera operazione di manutenzione di tre anni è di circa 150.000,00 € su una superficie globale di circa 500 mq. (Tabella 2).

Stima dei tempi di intervento

I tempi di intervento della squadra **costituita da un** Restauratore di beni culturali e due Tecnici del restauro/Assistenti Restauratori sono stimati in giorni lavorativi (Tabelle 3, 4).

Note

1 Il restauro del *frigidarium* delle Terme Centrali è stato realizzato dall'impresa Carla Tomasi S.r.l.

2 Gli interventi effettuati tra il 2009 e il 2011 sono stati eseguiti da L'Officina Consorzio di Roma; Progettazione Definitiva ed Esecutiva e Direzione Lavori: Arch. Elena Romoli; Coprogettazione Definitiva ed Esecutiva e direttore operativo: Geom. Luciano Sotgiu; Ispettore di cantiere e assistente agli scavi: Dott.ssa Mariella Maxia; Assistente alle operazioni tecniche e di rilievo: Geom. Giuseppe Dessì; Direttore scientifico: Dott.ssa Maurizia Canepa; Direttori Tecnici: Maria Rita Ciardi e Fabiano Ferrucci.

3 Il Progetto Preliminare di restauro dei mosaici di Nora è stato realizzato dal Dott. Roberto Nardi nel 2003 su incarico della Soprintendenza archeologica di Cagliari.

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Tabella 2 Tabella Riassuntiva della Stima dei Costi

		Ore	**Ore**	**Ore**	**Ore**	**Ore**	**Ore**	prezzo	totale	materiali	
n.	**Denominazione**	aprile	ottobre	aprile	ottobre	aprile	ottobre	orario		attrezzature	
1	Foro	42	42	42	42	60	42				
2	Tempio — *cella, adyton*	56	56	56	56	82	56				
3	Piccole Terme — corridoio, *apodyterium, frigidarium*	110	110	110	110	174	110				
4	Casa Atrio Tetrastilo (Vani D; E; F; L; I)	173	173	173	173	255	173				
5	Terme Centrali — *frigidarium* — corridoio	172	172	172	172	256	172				
6	Teatro	34	34	34	34	56	34				
	Totale ore	587	587	587	587	883	587				
	I anno		**1,174**								
	Restauratore B.C.		391					€ 38.28	€ 14,980.24		
	Tecnico del restauro		783					€ 34.80	€ 27,236.80		
	Costo totale annuale								€ 42,217.04	€ 4,221.70	**€ 46,438.74**
	II anno				**1,174**						
	Restauratore B.C.				391			€ 38.28	€ 14,980.24		
	Tecnico del restauro				783			€ 34.80	€ 27,236.80		
	Costo totale annuale								€ 42,217.04	€ 4.221.70	**€ 46,438.74**
	III anno						**1,470**				
	Restauratore B.C.						490	€ 38.28	€ 18,757.20		
	Tecnico del restauro						980	€ 34.80	€ 34,104.00		
	Costo totale annuale								**€ 52,861.20**	€ 5,286.12	**€ 58,147.32**

Tabella 3 Tabella Riassuntiva della Stima dei Tempi

n.	**Denominazione**	aprile	ottobre	aprile	ottobre	aprile	ottobre
1	Foro	1.75	1.75	1.75	1.75	2.50	1.75
2	Tempio – *cella, adyton*	2.33	2.33	2.33	2.33	1.18	2.33
3	Piccole Terme – corridoio, *apodyterium, frigidarium*	4.58	4.58	4.58	4.58	7.25	4.58
4	Casa Atrio Tetrastilo (Vani D; E; F; L; I)	7.21	7.21	7.21	7.21	10.63	7.21
5	Terme Centrali – *frigidarium* – corridoio	7.17	7.17	7.17	7.17	10.67	7.17
6	Teatro	1.42	1.42	1.42	1.42	2.33	1.42
	Totale tempi di intervento in giorni di lavoro della squadra di intervento	**24.46**	**24.46**	**24.46**	**24.46**	**34.56**	**24.46**

Tabella 4 Cronoprogramma

Cronoprogramma triennale																																				
Operazioni																																				
	g	f	m	a	m	g	l	a	s	o	n	d	g	f	m	a	m	g	l	a	s	o	n	d	g	f	m	a	m	g	l	a	s	o	n	d
A1) Sopralluogo mosaici				x						x						x						x						x						x		
A2) Delimitazione aree				x						x						x						x						x						x		
A3) Rimozione terriccio				x						x						x						x						x						x		
A4) Aggiornamento schedatura				x						x						x						x						x						x		
A5) Irrorazione biocida				x						x						x						x						x						x		
A6) Trattamento erbicida				x						x						x						x						x						x		
A7) Lavaggio, rimozione guano				x						x						x						x						x						x		
A8) Fissaggio tessere				x						x						x						x						x						x		
A9) Stuccatura				x						x						x						x						x						x		
A10) Rimozione efflorescenze				x						x						x						x						x						x		
A11) Consolidamento				x						x						x						x						x						x		
A12) Riapplicazione del protettivo				x						x						x						x						x						x		
A13) Copertura mosaico Foro										x												x												x		
A14) Scopertura mosaico Foro				x												x												x								
B1) Ripristino protettivo																												x								
B2) Ripristino Boiaccatura																												x								

PART TWO

Methods of Survey and Documentation

The Use of metigoMAP Graphic Software for Survey, Conservation Planning, and Documentation of Mosaic Pavements

Julia Burdajewicz

Abstract: *This paper presents a new method for creating digital graphic documentation of mosaic floors that employs metigoMAP, a vector graphic software developed specifically for conservation documentation. MetigoMAP combines the most valued functions sought by conservators in CAD and GIS programs and allows one to create a clear map of various phenomena that are associated with precise quantitative values. Such quantitative data that show the exact scope of issues to be addressed by conservation treatments is also crucial for cost and time analysis in conservation planning. In this case, a vector drawing of the mosaic was used as a mapping base.*

Graphic documentation of mosaic pavements, usually in the form of a map of phenomena traced on a 90-degree bird's-eye image of the mosaic, is an efficient and common way to record and present a mosaic's condition. Different methods of graphic documentation of mosaics have been researched for years, and papers dedicated to it have appeared regularly at ICCM conferences since 2002 (e.g. De Felice 2005; Davidov and Neguer 2005; Işiklikaya 2008). The principles and standards are now established, and it is widely recognized that thorough and accurate documentation is not only a part of conservation treatment or planning, but a prerequisite.

However, graphic documentation of a mosaic is not a simple task. It requires appropriate tools, a well-considered approach, and significant allocation of time both in the field and in the office. Often, the main challenge of documenting mosaic floors is related to their large size. Not only is it difficult to photograph or draw a large mosaic in field conditions, but processing a large number of digital or digitized images needs proper equipment and software. Raster photomaps of mosaics, assembled from many detail images, have large file sizes, and in the case of large mosaics, it is nearly impossible to create 1:1 photo documentation that can be easily processed by a standard, average computer. Other programs, such as Photoshop, do not provide the possibility of professional-quality graphic documentation. The main reason Photoshop is used for documentation is that it is easily available, but it is not a professional tool for this purpose, and there are costs associated with advanced professional graphic documentation software.

Moreover, graphic documentation of mosaics should cover a large number of phenomena that are related to both the tesselatum layer and the structure of the mosaic. In addition to condition, conservation treatments, sometimes applied during numerous successive conservation campaigns, should be recorded. To keep the documentation clear and legible these various issues should be logically grouped by the subject they represent. If graphic documentation is one of the means of condition monitoring, it requires a system that allows for frequent and convenient updates of gathered information. In addition to visually representing conditions, graphic documentation should allow for analysis of data, for example, estimation of the costs of planned treatments. Although graphic documentation is often used to supplement written reports, it should also be possible to include written comments or other descriptive information. Finally, the outcome of the documentation project should be easily disseminated and shared.

Scheme for Graphic Documentation of Mosaics

A record of mosaic conditions in the form of a map of phenomena traced on a 90-degree bird's-eye image of the mosaic is called mapping. Mapping consists of two components: an image that serves as a mapping base and the condition map itself.

The mapping base may be scanned polyethylene foil, with a mosaic traced on it, or another kind of drawing. It may also be assembled digital photographs, orthophotographs, or images acquired via laser scanning. The latter technique, however, is still out of reach during most field conservation and documentation projects, and a standard digital camera usually serves as the basic tool for acquiring images of the mosaic.

The map itself should consist of independent layers, each one representing one type of issue and each one attributed its own color codes, outline types, and so on. That means that the more phenomena we record, the more layers for which we will have to create and assign color values. The map is usually executed in a graphic software. One of the most common programs applied in graphic documentation is Photoshop, a simple raster software. Also, some professional vector products for Geographic Information Systems (GIS) and for Computer Aided Design (CAD) have been adapted by conservators for purposes of condition mapping.

Although these methods and programs have long been applied to graphic documentation of mosaics, neither of them is free of certain drawbacks. For instance, Photoshop is handy for photo-editing, but as a raster program it gives only a visual representation of issues and does not allow precise recording or data analysis. GIS and CAD are professional products with advanced mathematical functions, but they may be too complicated for an average user to operate, they require substantial instruction and financial input, and, at the same time, they do not offer all the features sought by a conservator.

The method that is presented in this paper is based on two innovations that may meet the requirements of graphic documentation of mosaics. First, in order to decrease the file size of the mapping base, it was executed as a detailed drawing in a vector software instead of a photomap assembled from photographs. Second, the mapping was done using software called metigoMAP, which was designed specifically for conservation documentation and is said to combine the functions of Photoshop, GIS, and CAD, which are the most useful in condition mapping (Bayerova and Gruber 2011).

Graphic Documentation Method Selection Criteria

The goal of the undertaking in which metigoMAP was first applied was to record conditions and previous treatments of a mosaic floor from an early Christian church in Hippos-Sussita (Israel), one of the cities of the ancient Decapolis (Mlynarczyk and Burdajewicz 2005, 2013). The mosaics, excavated and treated in the years 2000–2008, remain reburied throughout the year. Their condition is checked each year during archaeological excavations that last four weeks, and any necessary treatments are applied at that time (Aniszewski and Burdajewicz 2005; Burdajewicz 2006, 2007; Burdajewicz and Radziejowska 2013). The documentation could be done only during this short period of archaeological excavations. Because of financial and time limitations it was not possible to carry out precise, detail-by-detail photographic documentation or tracing of the entire mosaic, which is 265 square meters. Moreover, the mosaic floor, which underwent only emergency stabilization treatments, has never been thoroughly cleaned, so photographs would not show all the details because of dirt still adhering to the surface. And there were no financial resources or the appropriate conditions for laser scanning.

Because the mosaic is checked annually, a type of graphic documentation system was required that could be easily updated. In order to monitor the condition it was also necessary to clearly separate any newly recorded phenomena from old phenomena to keep track of any changes occurring in the condition.

Creating the Mapping Base

First, it was necessary to create a mapping base for the condition mapping. Instead of trying to photograph an entire mosaic, a hand-drawn copy of the mosaic was prepared. All the necessary measurements, as well as many overall and detail photos, were taken on-site. All this information served as preparation for a vector drawing of the mosaic, which was carried out in the office. A common vector graphic software, CorelDRAW from the Corel Graphic suite, was used. The plan of the mosaic was embedded in a vector drawing of the architectural layout of the church. Although vector programs are not photo-realistic, they allow for the use of colors. When preparing the drawing of the pavement, colors reflecting the actual color palette of the mosaic were used, which helped to keep the plan legible. The final outcome was an accurate drawing in a small file size: only 3.6 MB in CorelDraw (cdr) file and 16 MB for the JPEG for the drawing executed at a scale of 1:20 (fig. 1). We were able to prepare such a drawing in a vector software because the mosaic is decorated almost entirely with geometrical, repetitive motifs. However, during the preparation of the drawing, the patterns were not treated as a stencil, but all irregularities in the decoration of the pavement were recorded and considered. Also, the areas that are not preserved and the hypothetical reconstruction of the patterns in these areas were included in the drawing, either in gray or marked with dashed lines.

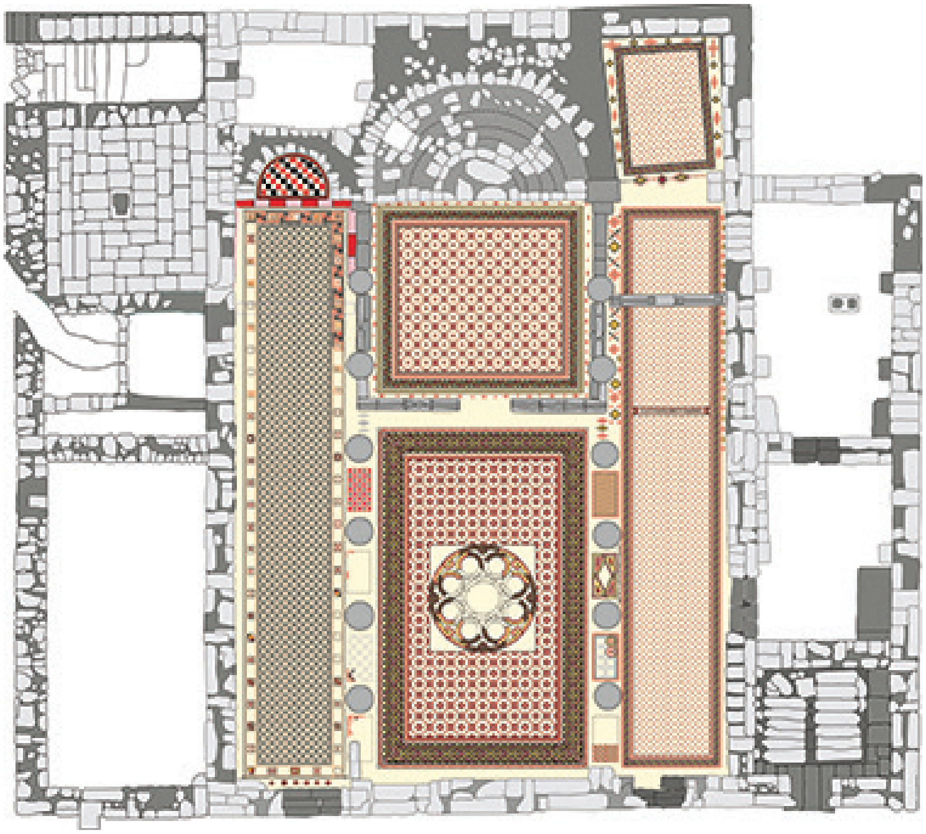
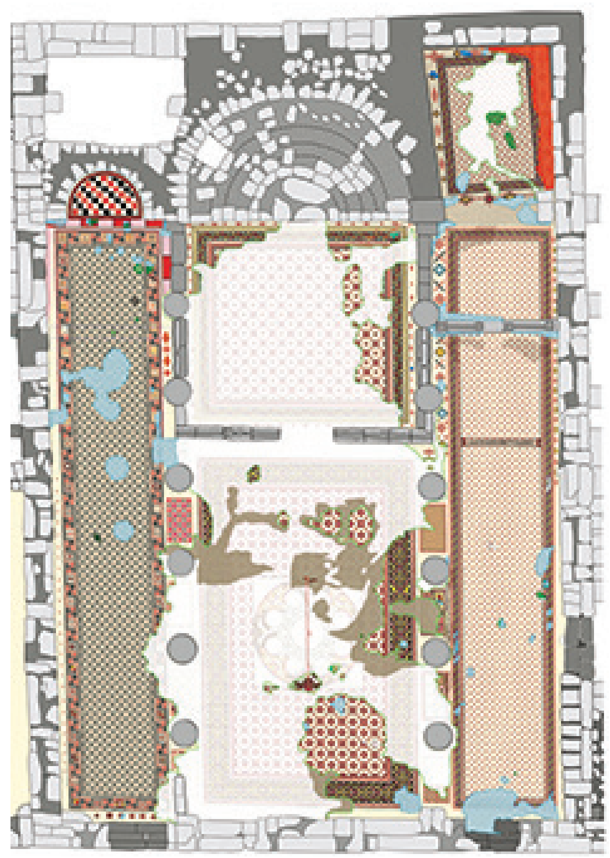


Figure 1 Vector drawing of the mosaic floor in the North-West Church in Hippos-Sussita executed in CorelDRAW.

Figure 2 Condition and treatment mapping of the mosaic floor in the North-West Church in Hippos-Sussita executed in metigoMAP graphic software.



Condition Mapping

The condition map was executed in metigoMAP software (version 3.0), a vector graphic software that was developed specifically for conservation planning, survey, and documentation (fig. 2). The software was designed and created by a German company, Fokus, in 2003, and since its first version has undergone a series of modifications and improvements to better suit the requirements of conservation documentation and projects. In order to achieve that, a number of functions characteristic only of CAD and GIS, as well as some raster features that are not common in vector programs, were combined in metigoMAP (table 1). Of the most prominent functions sought in graphic software, metigoMAP does not offer 3D imaging, which is available with CAD. While it is not a major drawback in the case of documenting mosaic floors, it would, however, be a useful function in the case of surfaces that are not in plane, such as the semi-dome of an apse or a niche decorated with a wall mosaic.

Below, the major steps of condition mapping of the mosaic floor from the North-West Church in Hippos-Sussita executed in metigoMAP are discussed in order to present the software's functions and possibilities.

Table 1 Comparison of some of the functions offered by CAD, GIS, Photoshop, and metigoMAP

Capabilities	**CAD**	**GIS**	**Photoshop**	**metigoMAP**
Image adjustments (color balance, contrast, brightness, sharpness, etc.)	No	No	Yes	Yes
Overlaying multiple images	No	Yes	Yes	Yes
Vector drawing tools	Yes	Yes	No	Yes
Raster drawing tools	No	No	Yes	Yes
Text editing	Yes	Yes	Yes	Yes
Rectification of mapping bases	Yes (with plug-in)	No	No	Yes
Annotations and data fields	No	Yes	No	Yes
Automatic legends and layout options	No	No	No	Yes
3D	Yes	Yes	No	No
Learning efforts	High	High	Moderate/low	Moderate

Rectification of the Mapping Base

Before beginning the condition mapping, the image that will serve as the mapping base needs to be entered into the metigoMAP software and rectified using the rectification tool included with the software. As discussed above, a mapping base could be a scanned drawing or a digital photograph (or a photomap) in JPEG or TIFF format or a vector file such as DWG. The rectification process tells the program what the dimensions of the mosaics are (the true size of the mosaic), which is a prerequisite for correct calculations of the extent of each phenomenon, which will be automatically executed by the software along with the condition mapping. The rectification should be based on either two or six dimensions, measured on the site. These dimensions could be provided by either the length and width of the mosaic or two lengths, two widths, and two diagonals if the mosaic is not a perfect rectangle. Moreover, if a photograph or a photomap is used as a mapping base, the rectification process will also eliminate any distortions of the picture that usually occur if it is not possible technically to take a 90-degree bird's-eye view photograph (figs. 3, 4). In the case of the mosaic pavements from the so-called North-West Church in Hippos-Sussita, which was the

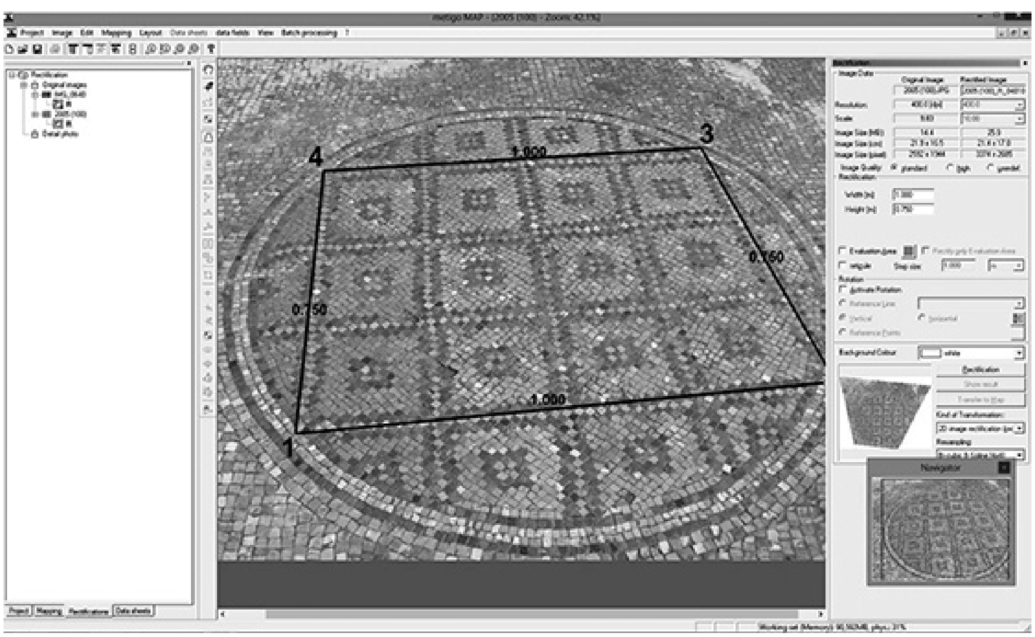


Figure 3 The simple "rectangle rectification" process uses two dimensions, which should be measured on-site. Four reference points (corners) are marked on the photograph, and dimensions measured on-site are entered into the software.

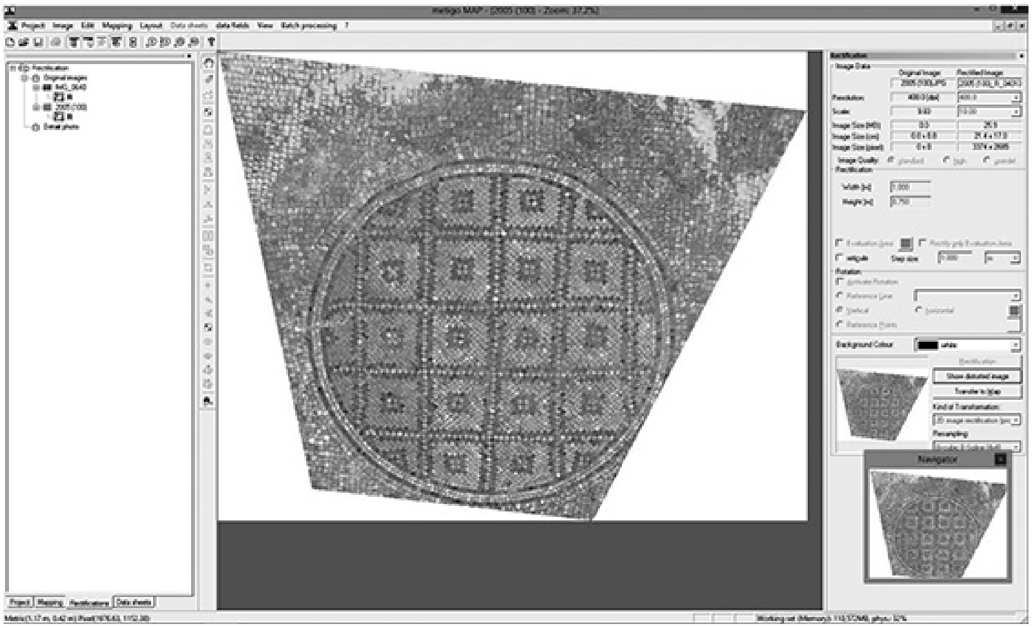


Figure 4 Result of the rectification. Note that the distortion of the photograph was eliminated.

subject of this documentation, a vector drawing, prepared previously in CorelDRAW and converted to JPEG, was used. Additional adjustments, such as the brightness, contrast, and color value, can be done along with the rectification process, as well as later during the mapping. It should be emphasized that the software allows for the overlaying of several images. This function can be extremely useful, for instance, if one needs to map a mosaic on top of both a contemporary photograph and an archival photograph in order to compare current and past conditions of the mosaic.

Mapping Classes and Mapping Groups

Before starting condition mapping it is necessary to create appropriate "mapping classes." A "mapping class" represents one particular phenomenon, for example, "lacunae," "cracks," or "sampling locations" (fig. 5). Mapping classes come in several categories, each using a different geometric shape for the phenomena within that class. An "area mapping" is used to enclose areas, for example, lacunae. For recording linear phenomena, such as cracks, there is "line mapping." "Signatures" mark single points (i.e., those with only one pair of X, Y coordinates), such as pinpointing exact sampling locations.

Each mapping class can be attributed its own type and color of outline/line, fill color, level of transparency of the fill color, hatching, and so on (fig. 6). For the signatures, there is a catalog of various graphic signs available in the software. Any of those graphic features of the mapping classes (colors, line types, hatching types, etc.) can be changed at any time during the documentation process.

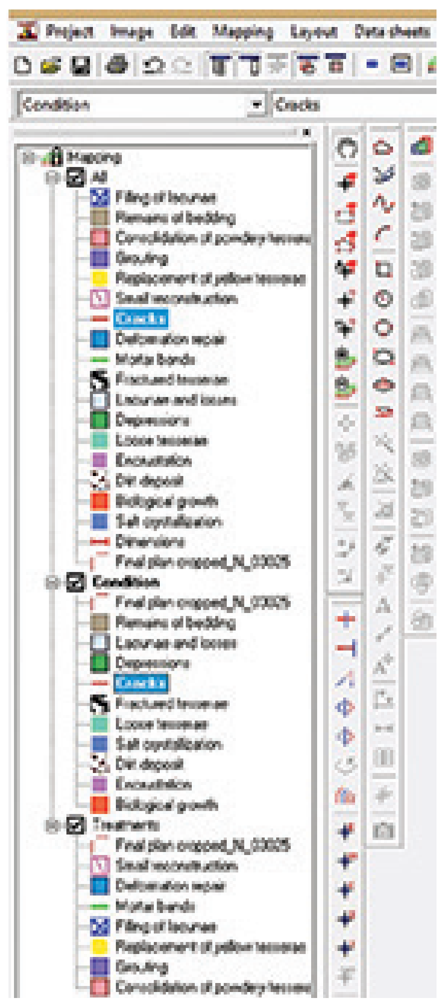


Figure 5 On the left-hand side of the program's interface, all "mapping classes" are displayed. Mapping classes can be sorted in "mapping groups" according to the subject they represent and either hidden from view or displayed. Their color values and names can be edited at any time during the mapping process.

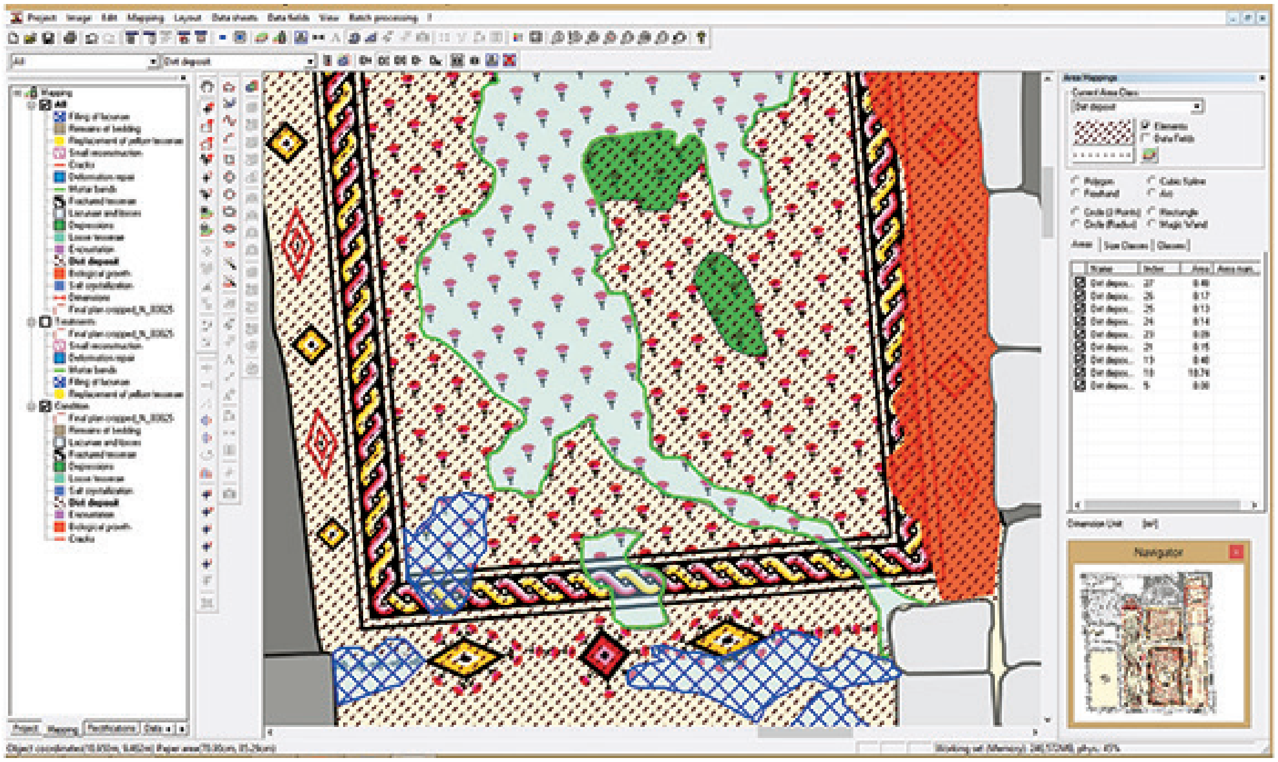


Figure 6 Detail view of the mosaic floor in one of the aisles of the North-West Church showing various types of mapped phenomena.

There is an unlimited number of mapping classes that can be created, and each mapping class can include an unlimited number of elements. For example, a mapping class "lacunae" will include a number of "elements," each element representing a different lacuna in the mosaic.

The drawing tools are very similar to those found in other graphic programs (see fig. 5, on the right). The software includes tools typical both for raster graphics (e.g., "wand") and for vector graphics (e.g., for cutting areas).

In order to keep the documentation organized, the software allows the sorting of the mapping classes into an unlimited number of "mapping groups," according to the subject they represent, such as "Condition" or "Treatments." For the documentation of the mosaic floors in Hippos-Sussita it was also necessary to keep records of treatments applied during each of the four-week conservation campaigns, so groups related to particular years were also created. It helped in comparing the extent of specific deterioration phenomena and in analyzing deterioration risks, the progress of treatments, and the efficacy of the work.

It should be noted that one mapping class can be assigned to more than one mapping group. For instance, the mapping class "Old Concrete Fills" can belong to groups named "Old restorations" and "Conditions" simultaneously. For the convenience of viewing and analyzing the mapping, groups can be displayed or hidden from view in the program's interface.

Once the names of mapping classes and mapping groups are defined and color codes for each class are selected, they can be easily transferred to other projects executed in metigoMAP. This is especially useful if one is surveying several mosaics at an archaeological site and one wishes to keep a consistent graphic code for documenting and representing their condition.

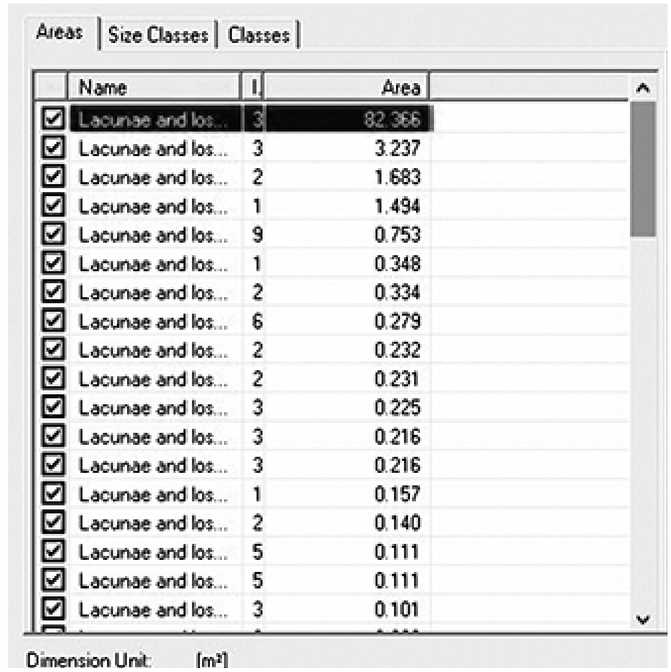
Moreover, various mapping projects (particular files in metigoMAP) can be grouped in a "hierarchy" of projects. This means that any changes made, for instance, to the color codes or to the names of mapping classes, in one of the projects will automatically appear in all other projects.

Measurements and Calculations

Graphic representation of phenomena is not the only function of metigoMAP. Another, extremely useful function of the software is the ability to perform measurements and calculations. This is possible because during the rectification of the mapping base the dimensions of the mosaic were entered.

The software is now able to calculate automatically any surface or any length of a line. The measurements are precise and accurate, and the units range from kilometers to nanometers. There are individual calculations for each particular element of a mapping class (e.g., the area of a particular lacuna) and collective calculations for the entire mapping class (the total area of all mapped lacunae) (fig. 7). The calculations are displayed directly on the map or hidden from view. All the elements of the map, together with their areas or lengths, are listed on the side of the interface. The software also provides tools for sorting the mapped elements, based on their size. Therefore, if requested, the software will show only those elements that match our indications, for example, cracks larger than 10 centimeters long.

Calculations made by metigoMAP can be entered into calculation software such as Microsoft Excel. Data that show the exact scope of issues to be addressed by conservation treatments are crucial for cost and time analysis in conservation planning or site maintenance. For instance, by mapping various types of damage accordingly to their severity and by knowing their total area or extent we can quite precisely calculate not only the time and overall cost of the conservation but also the amount of required conservation materials, which is especially crucial in regions where they are not easily available and need to be preordered.



Name	I.	Area
Lacunae and los...	3	82.366
Lacunae and los...	3	3.237
Lacunae and los...	2	1.683
Lacunae and los...	1	1.494
Lacunae and los...	9	0.753
Lacunae and los...	1	0.348
Lacunae and los...	2	0.334
Lacunae and los...	6	0.279
Lacunae and los...	2	0.232
Lacunae and los...	2	0.231
Lacunae and los...	3	0.225
Lacunae and los...	3	0.216
Lacunae and los...	3	0.216
Lacunae and los...	1	0.157
Lacunae and los...	2	0.140
Lacunae and los...	5	0.111
Lacunae and los...	5	0.111
Lacunae and los...	3	0.101

Figure 7 Tables displayed on the right-hand side of the metigoMAP interface showing results of calculations automatically carried out. This table displays areas of each element of the "Lacunae and losses" mapping class.

Including Additional Data

Graphic documentation in the form of mapping, however precise, needs to be supplemented with additional data. MetigoMAP allows the map to be linked with, for instance, a folder of photographs, such as detail photographs or microphotographs of various phenomena. In the case of the documentation of the mosaic floor in Hippos-Sussita, where the mapping base was not a photograph but a drawing, this feature was particularly useful for showing some of the mosaic's details. MetigoMAP also allows for the addition of annotation fields to the map, containing comments or relevant descriptive information. Linked photographs, as well as annotation fields, can be displayed in the map or hidden from view.

Layout and Sharing

The software has other useful features such as the automatic creation of legends, which provide an attractive layout for the map and a legible presentation of the results. A legend not only explains the color codes of particular mapping classes; it can also automatically display the measurements done by the software, such as extent and total area of a given phenomenon (fig. 8). The software updates these quantitative values in the legend as the mapping continues. The map can be printed out directly from the software, or it can be exported to several file types, including TIFF and some AutoCAD file formats. Both the printout and the exported file can include the entire map with all of the mapped phenomena, or it can be limited to particular subject groups or even to a single phenomenon.

Discussion and Conclusions

The project of documenting the mosaic floors in the North-West Church in Hippos-Sussita consisted of three parts: condition mapping, collection of photographs, and written reports. The method chosen for condition mapping combined the use of the vector software CorelDRAW for the preparation of the mapping base and metigoMAP software for the execution of the condition mapping. The method's first component, that is, the vector drawing used as a mapping base, seems to be a convenient and suitable solution in the case of large mosaics like the one presented here, which would otherwise become a very large file if documented in a raster technique such as photography. However, its main disadvantage is that such an image is not photo-realistic, and this method of mapping has be complemented with a catalog of reference photographs showing particular issues or details. Moreover, it

CONDITION

Class name	Number	Total	%M_M(A)
Remains of bedding	5	8.517 m²	6.03%
Lacunae and losses	67	93.602 m²	66.26%
Depressions	14	0.583 m²	0.41%
Cracks	3	1.480 m	1.40%
Loose tesserae	2	0.039 m²	0.03%
Fractured tesserae	3	0.066 m²	0.05%
Dirt deposit	9	12.374 m²	8.76%
Salt crystallization	5	1.679 m²	1.19%
Encrustation	5	0.684 m²	0.48%
Biological growth	2	2.005 m²	1.42%

TREATMENTS

Class name	Number	Total	%M_M(A)
Replacement of yellow tesserae	5	0.046 m²	0.03%
Filling of lacunae	51	7.294 m²	5.16%
Consolidation of powdery tesserae	5	0.443 m²	0.31%
Small reconstruction	5	0.597 m²	0.42%
Grouting	2	0.341 m²	0.24%
Surface cleaning	1	12.926 m²	9.15%
Deformation repair	3	0.069 m²	0.05%
Mortar bands	31	104.010 m	98.60%

Figure 8 Example of a legend. In addition to the color code and the name of the mapping class, other values can be displayed, such as the number of elements in each class and the total area or extent of each class presented as a percentage of all the phenomena.

is quite easy to prepare this type of drawing if the mosaic pattern is repetitive and geometric. In the case of figurative decoration it would take more time. Finally, for the preparation of a vector drawing one needs to have a software for vector graphics such as CorelDRAW, Adobe Illustrator, or AutoCAD.

MetigoMAP software is a very useful tool for mapping large surfaces such as mosaic pavements. Although the execution of this documentation project involved the preparation of hard copy drawings executed in the field, which were then entered into metigoMAP in the office, the use in the field of a laptop or a tablet PC with metigoMAP would eliminate the need to begin with "traditional" documentation.

MetigoMAP allows for the mapping of an unlimited number of conditions or elements, each as an independent layer ("mapping class") and with its own color and graphic symbol. This keeps the documentation very legible and clear. The software has a great number of useful features, such as the ability to sort the mapped elements into subject groups, to create mapping templates and transfer them to other documentations projects, and to automatically create legends that explain the mapping. Its many functions prove that the software is designed to meet the requirements of conservation documentation. However, one of the greatest advantages of metigoMAP is its ability to calculate area. This takes condition mapping to a different level: it is not only a visual representation of a mosaic's condition and current state but also a source of data that are critical for estimating time and cost for treatments, as well as for planning the conservation process. These data, alongside on-site evaluation of condition and severity of deterioration processes, can be a significant aid in planning the costs and time of conservation treatments.

The main drawback is that metigoMAP requires some time investment to learn, although it is not as complicated as GIS and CAD software, and anyone familiar even with Photoshop will manage to operate metigoMAP. Furthermore, the cost of the most recent version of the software (metigoMAP 4.0) ranges from €900 for an educational license up to €1,750 for commercial users (as of spring 2016). If additional licenses are purchased, the price decreases. These costs may seem high, but for professional-level dedicated graphic software they are not disproportionate.

Ultimately, the documentation project in Hippos-Sussita resulted in a set of clear graphic documents that is a combination of visual information and data derived from mathematic calculations automatically carried out by metigoMAP.

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Des aquarelles du XIXème siècle au système d'information géographique (SIG) : La documentation des mosaïques à Orbe-Boscéaz (canton de Vaud, Suisse)

Myriam Krieg, Noé Terrapon et Anjo Weichbrodt

Résumé : *Établie durant plus de cent soixante-dix ans, la documentation des mosaïques d'Orbe forme un corpus extraordinaire, mais sa richesse constitue également une contrainte quand il s'agit de rendre ces informations exploitables. Dans ce but, le glossaire et l'ontologie ont été présentés comme des outils efficaces pour convertir ces informations en une syntaxe adaptée aux bases de données et permettre leur analyse avec des applications SIG. Il est démontré que l'analyse et la modélisation des données par l'intermédiaire des SIG permettent de réaliser des diagnostics de l'état de conservation et de leurs facteurs associés et donnent une nouvelle dimension à la documentation.*

Abstract: *Compiled over a 170-year period, the records kept for the mosaics of Orbe constitute an immense corpus. However, the sheer wealth of information also poses a problem in terms of usability. To tackle this issue, the glossary and ontology were proposed as useful methods, both for converting these data into a format suitable for database use and for permitting their analysis using GIS applications. This paper shows that the analysis and modeling of data using GIS applications allow assessments to be carried out on the state of conservation and associated factors and add a new dimension to the recording of such data.*

Histoire de la *villa* romaine d'Orbe-Boscéaz

La *villa* romaine d'Orbe-Boscéaz occupait une grande terrasse dominant la plaine de l'Orbe. Un premier bâtiment fut construit à la fin du règne de Néron ou au début de la période flavienne, soit aux alentours des années 65 à 70 apr. J.-C. Il s'agit d'une résidence de campagne relativement modeste, qui a été remplacée par un nouvel édifice dès le début du IIe siècle. Dans les premières années du règne de Marc Aurèle, entre 161 et 170 apr. J.-C., une vaste résidence dotée de nombreuses mosaïques est construite à l'emplacement de la première *villa*. Il s'agit d'un immense complexe, édifié d'un seul tenant, s'étendant sur 250 × 90 m, qui connaît son apogée de 170 à 250 apr. J.-C., soit le temps de quatre générations environ (Paratte 2005 : 223). Dans la seconde partie du IIIe siècle, on assiste à une phase de déclin, suivie d'une réoccupation tardive au tournant des IVe et Ve siècles (Luginbühl, Monnier et Dubois 2001 : 24–28).

Histoire des mosaïques de la *villa* romaine d'Orbe-Boscéaz

Depuis la découverte du site, plus d'un siècle et demi s'est déjà écoulé ; en effet, les deux premières des neuf mosaïques aujourd'hui connues ont été mises au jour en 1841. C'est alors que commence une longue histoire de nouvelles découvertes et d'interventions. Les pavements ont été progressivement visibles à partir de cette date, et, en 1843, le premier pavillon de protection a été construit (M6 et M7) (tab. 1, fig. 1).

Les fouilles archéologiques ont démontré que la pose de l'ensemble des pavements est contemporaine de la construction de la résidence, vers 170 apr. J.-C. (Paratte 2005 : 223). Cela signifie que certaines mosaïques *in situ* dans leur abri se visitent depuis plus de cent soixante-dix ans, c'est-à-dire bientôt le double de la durée de leur visibilité à l'époque romaine ! Rappelons que les mosaïques d'Orbe constituent un cas exceptionnel dans l'histoire de la conservation au nord des Alpes : maintenues strictement *in situ* sous abri, elles n'ont pas été l'objet de déposes avant la fin du XXe siècle, interventions d'ailleurs limitées aux pavements dont l'état était le plus critique.

Tableau 1 Dates de découverte et de mise sous abri des différents pavements. Certains sont retombés dans l'oubli et ont été redécouverts des décennies plus tard.

Mosaïque	1re découverte	2e/3e découverte	Abri/présentation au public
M6 et M7 «du Cortège rustique» «aux Carrés et Losanges»	10–12/5/1841		1843
M4 «au Triton»	30/9–1/10/1845		Détruite entre le 15 et le 19/6/1846
M5 «du Labyrinthe»	30/9–1/10/1845	1930	1936
M8 «aux Divinités»	Février 1862		1862
M2 «à Feuilles de laurier»	11/10/1863	1915 et 1925	1927
M1 (partie NW) et M3	17/9/1925		1927
M1 (partie SE)	1987		1987 (abri provisoire/mise en valeur en attente)
M9 «Achille à Skyros»	1993		1993 (abri provisoire/mise en valeur en attente)

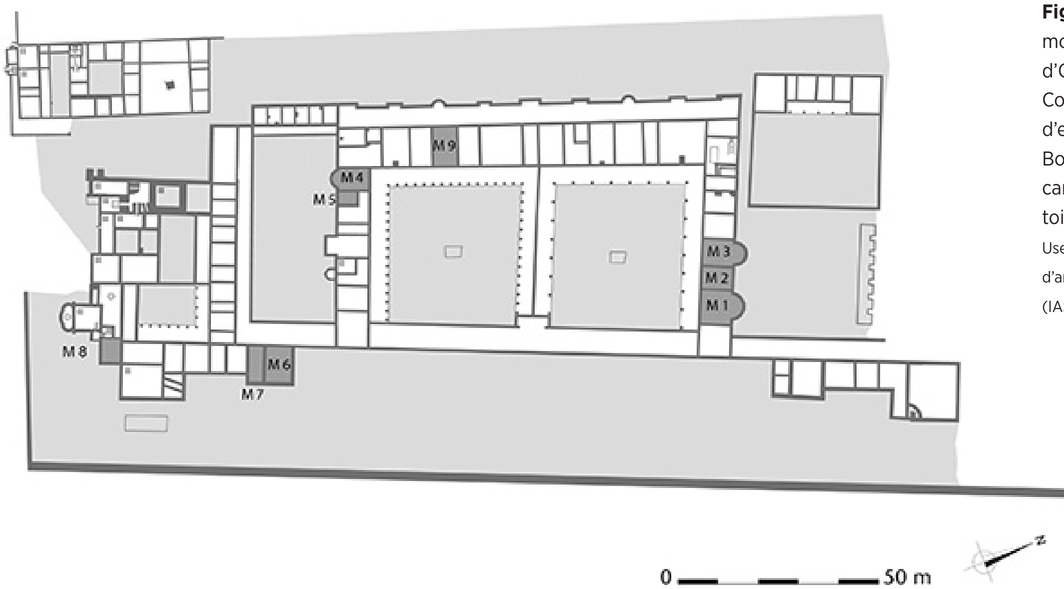

Figure 1 Localisation des neuf mosaïques connues de la *villa* d'Orbe-Boscéaz. (Plan: tiré de Collectif, «Vie de palais et travail d'esclave. La *villa* romaine d'Orbe-Boscéaz», document du Musée cantonal d'archéologie et d'histoire, Lausanne, 2001. Modifié). Used with permission of the Institut d'archéologie et des sciences de l'Antiquité (IASA) de l'université de Lausanne

Premières documentations

Cette longue durée d'exposition depuis leur découverte a pour effet que les mosaïques sont le sujet d'observations, de réflexions et d'interventions depuis déjà fort longtemps. Les plus anciennes documentations de travaux opérés sur les pavements d'Orbe remontent au milieu du XIXe siècle (mosaïque M6, dite «du Cortège rustique»): il s'agit d'informations manuscrites, sous forme de lettres, de devis, de factures et de bulletins de livraison, conservées aux Archives cantonales vaudoises (ACV), à Lausanne.

Les problèmes rencontrés alors sont analogues à ceux auxquels nous sommes encore confrontés aujourd'hui. À défaut de publications, ces documents nous permettent de suivre l'évolution de l'état de conservation des mosaïques ainsi que les différentes tentatives de traitement.

Le premier «rapport d'intervention» remonte à l'été 1843: «Le gypsier Zally, accompagné d'un ouvrier, se livre à des travaux de restauration sur les mosaïques pour prévenir leur dégradation et pour donner propreté et relief au dessin. Matériel utilisé: 12 seilles de mortier, 6 seilles de chaux, 4 quarterons de posière de marbre [*sic*][1], […]» (26–27.5.1843, 14–17.6.1843, 4.7.1843 [ACV, AMH A 126/8 A 8698]).

En juillet 1864, une grande campagne de restauration démarre. Les archives nous informent que David Doret, marbrier à Vevey, restaure « l'ancienne mosaïque » (ACV, AMH A 126/6 A 8676).

En 1898, un nouveau diagnostic (ACV, AMH A 126/8 A 8693) est établi par ce même Doret : « […] La mosaïque est très malade […]. » Doret préconise de traiter par injection les parties soulevées, de réparer les parties désagrégées, puis de lustrer. La méthode d'intervention est la suivante : « […] Certaines boursouflures doivent être soulevées et remises à leur place ; d'autres simplement doivent être soutenues au ciment métallique ; celles qui sont désagrégées sans soufflures d'humidité doivent être traitées au ciment à la cire. » Doret recommande enfin de renoncer aux lavages et de se contenter de balayer.

Les documents datant du XIX^e^ et du début du XX^e^ siècle sont malheureusement souvent imprécis : ils ne permettent pas d'établir des liens entre les dessins et les textes par exemple, ou encore entre les observations actuelles et les descriptions anciennes. Il y a toutefois quelques exceptions, comme l'illustrent les documentations réalisées par D. Doret à la fin du XIX^e^ siècle (figs. 2a, 2b, 5).

Dans une lettre du 17 novembre 1898 adressée à l'archéologue cantonal Albert Naef, il explique que « le travail a consisté tout d'abord dans la consolidation de la couche des cubes qui avaient été partout soulevés par le givre et tout à fait désagrégés dans l'angle nord-est. Par l'injection sous cette couche d'un ciment hydraulique, son adhérence avec le béton sous-jacent fut rétablie sur tous les points et le pavé rendu assez solide pour supporter sans danger la marche, qu'il sera toutefois prudent d'éviter » (AMH 126/8 A 8693).

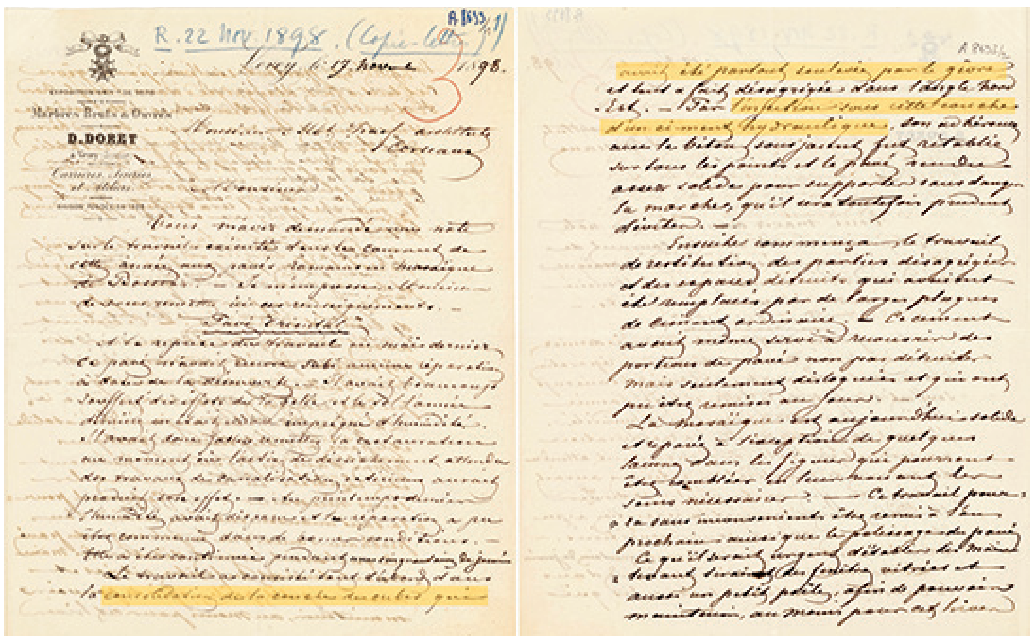

Figure 2a Exemple de documentation du XIX^e^ siècle (mosaïque « du Cortège rustique », M6) : lettre du marbrier D. Doret du 17 novembre 1898, adressée à l'archéologue cantonal Albert Naef. Document d'archives : Archive Cantonalese Vandoises, AMH, A 126/8 A 8693

Figure 2b Exemple de documentation de travail de conservation-restauration de 1898, effectuée sur la mosaïque « du Cortège rustique » (M6). On peut lire sur l'aquarelle : « Les hachures bleues indiquent les parties restaurées en 1898. Naef ». Document d'archives : Archive Cantonalese Vandoises, AMH, B 271, B 1060

Les problèmes de soulèvement sont apparus très vite après la mise sous abri et sont manifestement une constante à Orbe.

Nature, quantité et localisation des documents

Les documents concernant les mosaïques d'Orbe s'accumulent depuis cent soixante-treize ans. On trouve des dessins, aquarelles, lithographies et photographies datant de différentes périodes. Les lettres renseignent sur l'état des pavements et les interventions effectuées ; les factures donnent des indications sur la nature des matériaux mis en œuvre. Il n'y a que peu de documents qui se rapprochent véritablement de rapports de restauration. Ainsi, des interventions initiales jusqu'aux rares travaux effectués vers le milieu du XXe siècle, ne nous sont parvenues que des mentions dans les archives et non des rapports de travail à proprement parler.

À la fin des années 1970, à l'initiative de l'archéologue cantonal Denis Weidmann, le Service des bâtiments de l'État, propriétaire des constructions qui abritent les mosaïques les plus importantes, reprend en main la conservation du site. Une des premières mesures est la recherche et la compilation de l'ensemble des données relatives aux mosaïques, et, plus spécifiquement, aux interventions et restaurations réalisées (dossier établi par Fabienne de Bentivegni). Dans les années 1980 et 1990, D. Weidmann conduit une longue série d'analyses et d'études (climatiques, chimiques, hydrologiques, pétrographiques, etc.) afin de dresser le bilan de l'état des pavements et des conditions de leur environnement, d'identifier les causes des dégradations observées, avant de décider de la mise en œuvre de solutions et d'interventions particulières. Les bilans de ces analyses, démarches et réflexions, ainsi que des mesures prises, sont depuis lors régulièrement présentés dans le cadre des conférences de l'ICCM. Certains aspects documentaires ont déjà fait l'objet d'une présentation lors du Xe Congrès de l'ICCM, en 2008 (Weidmann, Fischbacher et Girardet 2014).

Dès la fin des années 1990, le laboratoire de conservation-restauration du Site et Musée romains d'Avenches a été associé à ces recherches et mandaté pour les travaux de conservation-restauration à Orbe. Des campagnes d'intervention importantes sur les différents pavements se sont succédé depuis 1997. Les premiers pavements traités ont été trois mosaïques à décor géométrique, M1, M2 et M3 (fig. 1). Dans les années 1998 à 2000, la mosaïque dite « du Cortège rustique » (M6) a été prélevée et replacée *in situ* sur un nouveau support (Fischbacher *et al.* 2003). À la même période, sa voisine à décor géométrique (M7) a été traitée *in situ*. De grandes interventions se sont également avérées nécessaires sur la mosaïque dite « aux Divinités » (M8), dans les années 2001 à 2004 (Weidmann 2008). Entre 2003 et 2006, une autre intervention, impliquant une dépose et remise en place, a été effectuée afin de sauver la mosaïque « du Labyrinthe » (M5).

Ainsi, depuis bientôt trente ans, une nouvelle génération de documents s'est constituée, issue de ces études et interventions et rassemblant des données hétérogènes, de plus en plus détaillées et volumineuses. Cette documentation comprend de nombreux relevés de terrain, des constats d'état et des notes accompagnant les différentes interventions. S'y ajoutent d'année en année des données climatiques, des contrôles acoustiques, des résultats d'analyses de matériaux, des rapports annuels, etc., les mosaïques et leur environnement étant en outre suivis par un monitoring permanent.

Ces archives et documents ne sont pas seulement hétérogènes par leurs contenus et leurs supports, mais aussi par leur localisation : ils sont en effet déposés dans des institutions éparses (Lausanne, Archéologie cantonale ; Lausanne, Archives cantonales vaudoises ; Orbe, Archives de la Fondation Pro Urba ; Avenches, Archives du Site et Musée romains d'Avenches).

En outre, l'accès aux informations nécessite souvent de contacter personnellement l'un ou l'autre participant aux travaux, avec le risque de perte de données qui en découle.

Adaptation des ressources documentaires à une syntaxe de base de données

Point de départ et objectifs

Notre but est donc de rendre exploitables les éléments pertinents de cette imposante documentation, non seulement dans l'intention de fournir les données comparatives nécessaires à des analyses d'évolution et à de futurs diagnostics, mais également de faciliter leur transmission à long terme. Les objectifs suivants sont envisagés pour atteindre ce but (fig. 3) :

- assurer l'accessibilité des informations en tout lieu grâce aux technologies de l'information, tout en évitant de dépendre de logiciels ou de systèmes d'exploitation ;
- « maximiser l'intégrabilité », c'est-à-dire permettre l'enrichissement futur du vocabulaire et le renouvellement des formats de données ;
- rendre les informations comparables pour permettre l'analyse des données, ce qui améliore également l'accessibilité du système ;
- assurer une compatibilité à long terme, fondamentale pour permettre la transmission de l'information à l'avenir.

Actuellement, la priorité de ce travail consiste à intégrer les informations provenant des documentations photographiques et cartographiques disponibles, dans le but

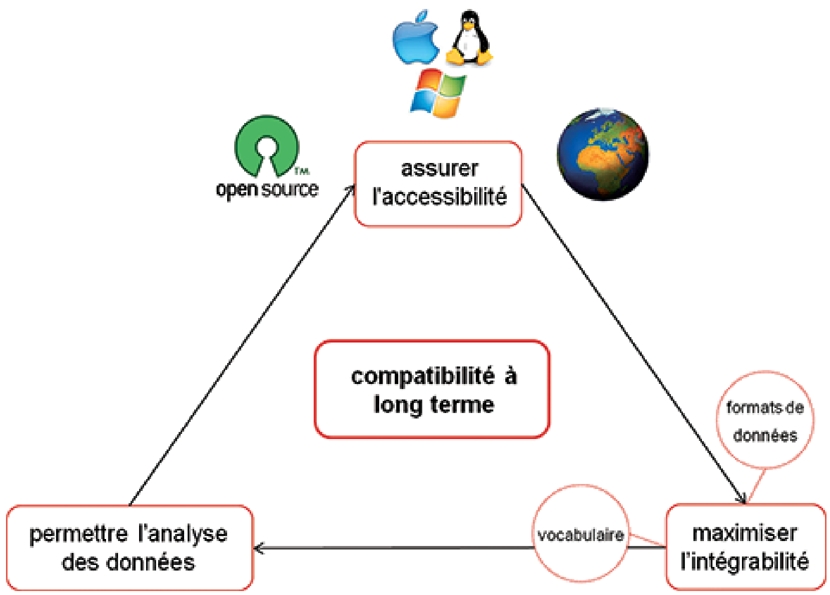

Figure 3 Représentation graphique des objectifs pour la gestion des ressources documentaires du site d'Orbe. Dessin : Anjo Weichbrodt, SMRA

d'obtenir une base pour l'analyse des données et, conjointement, pour la prise de décision à court et moyen termes. L'analyse des données est réalisée à l'aide d'un système d'information géographique (SIG), comme nous le présenterons plus loin.

Applications SIG, glossaires et ontologie

Les applications SIG offrent des possibilités pour le traitement des tâches de documentation complexes sur les sites archéologiques. Elles intègrent des éléments spatiaux auxquels sont attachés les attributs stockés dans les bases de données. Fondamentalement, ces dernières sont conçues pour fournir un accès aux informations. Il est important de souligner que, pour garantir leur accessibilité, ces informations exigent préalablement d'être mises en forme dans une syntaxe qui respecte la logique d'une base de données. La question centrale est alors de savoir comment adapter ces informations en vue de les intégrer dans une base de données pour les rendre accessibles et comparables. Ce processus peut être décrit comme la traduction d'un langage verbal dans un vocabulaire respectant la logique informatique. Cela signifie qu'il faut normaliser, hiérarchiser et établir des relations. Les outils permettant cette transformation sont les glossaires et l'ontologie.

Les glossaires sont des listes de termes, accompagnés de leur définition, développés pour un domaine spécifique. Ils sont essentiels pour partager un vocabulaire commun, compréhensible et comparable au sein de différents groupes de travail. Les glossaires à structure hiérarchique permettent des observations sur différents niveaux de détail, offrant d'une part une certaine flexibilité lors du processus de documentation et, d'autre part, la possibilité d'intégrer de nouveaux termes en cas de besoin. Dans le domaine de la conservation-restauration, les glossaires sont des outils permettant de réaliser une documentation compréhensible et structurée. Une présentation des différents glossaires, donnant un aperçu de leur évolution, est donnée dans *Conditions Glossaries as a Tool in the Survey Process* (Kopelson 2011).

L'ontologie est complémentaire aux glossaires, car elle établit des hiérarchies et des relations spécifiques entre les termes du glossaire. Son utilisation induit de l'itérativité durant le processus de création de la terminologie et permet d'adapter le langage verbal à une syntaxe compatible avec les bases de données.

Restructuration des informations

Pour notre travail, nous nous inspirons de glossaires créés pour le domaine de la conservation de la pierre, ICOMOS-ISCS – *Glossaire illustré sur les formes d'altération de la pierre* (Anson-Cartwright et Vergès-Belmin 2008) – et des mosaïques – *Illustrated Glossary : Mosaics In Situ Project* (Getty Conservation Institute and Israel Antiquities Authority 2003). À ces bases, nous avons ajouté des termes complémentaires et éliminé le vocabulaire dont nous n'avions pas besoin. Nous avons ensuite généré une ontologie afin de structurer la hiérarchie, d'étudier les relations possibles entre les différents concepts et de repérer les erreurs de logique.

À titre d'exemple, un des premiers cas que nous avons examinés concerne les concepts de *condition actuelle*, *intervention actuelle* et *intervention précédente*. Certains glossaires considèrent que *intervention précédente* est une sous-classe de *condition actuelle*, alors que *intervention actuelle* est proposée au même niveau hiérarchique que *condition actuelle*. Cela est pratique pour la documentation *in situ* mais représente une erreur logique lorsque l'information est enregistrée dans une base de données. Par exemple : dans le futur, *intervention actuelle* est appelée à devenir *intervention précédente*, passant d'un niveau de hiérarchie à l'autre tout en changeant de classe. Il serait difficile de faire suivre ces changements, en particulier avec la croissance de la base de données. Dans notre cas, la résolution du problème a été d'éliminer les adjectifs imprécis *actuelle* et *précédente* et d'introduire le champ *date*, qui contextualise les concepts *condition* et *intervention* dans le temps.

Nous avons pu affiner notre glossaire et notre ontologie selon des procédures analogues. Ces outils ont permis d'adapter les informations relatives au site selon une syntaxe propre aux bases de données. Les informations restructurées ont ensuite été introduites dans un tableau. Dans ce cas, la représentation de la structure de l'ontologie requiert huit colonnes (tab. 2).

Dans l'exemple du tableau 3, on peut lire : « Sur la mosaïque *07* en *1999* lors du constat d'*état* du *tessellatum* a été trouvé un *dépôt* qui semblait être un *micro-organisme* et qui a ensuite été identifié comme des *algues vertes*. » Il est important de souligner que le niveau de détail de la description peut être adapté aux besoins ou aux ressources disponibles, durant le processus de documentation ou plus tard.

Exploitation des données dans les applications SIG

Caractéristiques des applications SIG

La capacité des applications SIG à générer des pyramides d'images permet de travailler sans problème avec des images raster[2] de grandes dimensions, comme des orthophotographies ou des macrophotographies de haute résolution. Les SIG intègrent en outre des éditeurs d'images raster et vectorielles.

Un point fort des applications SIG réside dans leurs capacités de représentation des données, qui peut être faite par attributs simples, multiples ou conditionnels. Cela permet d'éditer des cartes représentatives de la surface de l'objet et de mettre en évidence les relations entre différentes données. Les applications SIG offrent également de vastes capacités d'analyse de données, qu'il s'agisse de rasters ou de vecteurs.

Les capacités de gestion, de calcul, d'analyse et de modélisation de données d'un SIG sont largement supérieures à celles offertes par les programmes couramment utilisés pour

Tableau 2 Représentation tabellaire de l'ontologie utilisée pour restructurer la syntaxe des observations propre aux bases de données

ID	Numéro	Date	Information	Position	Désignation	Type	Spécification
125	07	1999	État	Tessellatum	Dépôt	Micro-organisme	Algues vertes

Tableau 3 Exemple d'observations restructurées et insérées dans la base de données

Champ	Précision	Saisie	Exemple
ID	Attribué à chaque élément vectoriel par l'application SIG	Généré automatiquement	125, 354, 753
Numéro	Fait partie de la convention de nomenclature : chaque mosaïque a une identification numérique spécifique	Manuel obligatoire	01, 02, 03
Date	Contextualise l'*information* dans le temps	Manuel obligatoire	2009, 2010, 2011
Information	Décrit le type d'informations enregistrées : *information* est contextualisé dans le temps par *date*, dans l'espace par *position* et précisé par *désignation*	Manuel obligatoire	État, intervention, analyse
Position	Contextualise *information* dans l'espace	Manuel obligatoire	Intégral, couche de préparation
Désignation	Est un groupe ; il accueille les sous-classes *état*, *intervention* et *analyse* et précise *information*	Manuel obligatoire	Dépôt, consolidation, chromatographie ionique
Type	Est un groupe ; il accueille les sous-classes des membres du groupe *désignation*	Manuel optionnel	Efflorescence, micro-organisme
Spécification	Est un groupe ; il accueille les sous-classes des membres du groupe *type*	Manuel optionnel	Epsomite, algues vertes

la documentation[3]. Enfin, il offre une grande interopérabilité entre les supports documentaires et leur contenu.

Traitement des ressources documentaires

Les plans de base introduits dans l'application SIG vont du global au local et représentent des informations très variées. Pour le site d'Orbe, on y intègre le modèle numérique de terrain (MNT), le cadastre, le plan archéologique, les orthophotographies (fig. 4) ou toute autre donnée géographique pertinente. Ces images raster sont intégrées au système au format GeoTIFF[4]. Les images raster d'archives sont alors géoréférencées[5] à l'aide de points géodésiques connus dans la zone de l'image ou en choisissant des points précis sur des images déjà géoréférencées. Les géodonnées étant toutes exprimées dans un même système de référence, les images et plans d'époques différentes peuvent être superposés les uns aux autres et comparés entre eux (fig. 5).

Les informations contenues dans ces documents (cartographie sur le terrain, archives) sont ensuite redessinées avec un éditeur graphique vectoriel intégré dans les applications SIG. Les dessins peuvent être des polygones (fig. 5), des lignes ou des points. La base de données attribue un numéro d'identification unique pour chaque objet dessiné, auquel les informations restructurées selon l'ontologie décrite plus haut sont ensuite ajoutées. L'observation *in situ* est alors transformée en un groupe d'informations contextualisées qui peuvent ainsi être traitées et analysées.

Analyse et modélisation des données

La modélisation, l'analyse et la génération de données spatiales et géostatistiques à partir des documents et des données introduits dans le système, qu'il s'agisse de rasters ou de vecteurs, sont utilisées ici comme outil de diagnostic. L'analyse des données et leur représentation sont réalisées en appliquant des méthodes de statistique spatiale intégrées aux applications SIG. Nous donnons ci-dessous quelques exemples concrets illustrant les possibilités et les avantages de l'analyse des données.

On peut tirer un MNT de la photogrammétrie digitale. L'incorporation du MNT dans l'application SIG permet notamment de mettre le relief en évidence par ombrage ou par dégradé de couleur et d'en extraire des isolignes et des isosurfaces.

En croisant ces données avec d'autres, telles que celles des relevés acoustiques, on peut améliorer leur interprétation. Dans ce cas particulier, le MNT permet de mettre en évidence de façon beaucoup plus précise la limite et la typologie des détachements, qui sont très difficiles à identifier précisément avec le seul contrôle tactile-acoustique (fig. 6). Dans cet exemple, les zones qui sonnent creux et sans relief devraient

Figure 4 Orthophotographie digitale de la mosaïque dite « aux Divinités » (M8), géoréférencée dans une application SIG. Orthophoto : Anjo Weichbrodt, SMRA

Figure 5 Figure 4 à laquelle un document décrivant des travaux de restauration de 1898 est superposé. Les informations contenues sur le plan de 1898 ont été vectorisées dans une application SIG. Dessin : Noé Terrapon, SMRA, sur la base du plan Archive Cantonalese Vandoises, AMH B 271, B 1065

être des détachements, les zones qui sonnent creux et en relief devraient être des détachements avec soulèvement.

On peut pousser l'interprétation plus loin en ajoutant à ces informations le relevé des injections de mortier sous les tesselles. Les données deviennent alors plus pertinentes en utilisant une symbologie par attributs multiples (fig. 6). Dans cet exemple, la taille des points est proportionnelle au volume de mortier injecté, tandis que leurs couleurs correspondent à différentes années. On peut en déduire l'amplitude du phénomène et son évolution spatio-temporelle, comme ici, avec une zone particulièrement sensible formant une diagonale en haut à gauche. On voit alors l'importance de l'acquisition et de l'archivage des données lors des interventions de terrain. Dans le cas des injections dont le volume n'a pas été renseigné (points jaunes), les informations perdent une partie de leur potentiel documentaire. Elles ne peuvent alors pas être pleinement exploitées lors d'une approche analytique des phénomènes de dégradation.

L'interpolation est un moyen de générer de l'information dans les points de l'espace non échantillonnés. Les outils d'analyse géostatistique inclus dans les applications SIG permettent d'analyser des données sur la base de multiples informations (par exemple la valeur attribuée à un point) et sur leurs caractéristiques spatiales (localisation). Le krigeage est une méthode d'interpolation utilisant les données d'attributs simples (par exemple la température) pour prédire (interpoler) des valeurs de même type dans les zones non échantillonnées. Il tient compte de la distance entre les données et les points estimés ainsi que des distances entre les données elles-mêmes. Nous avons généré de nombreuses cartes avec cette méthode en utilisant comme base, par exemple, des mesures ponctuelles de la température prises avec un thermomètre infrarouge (fig. 7). La résolution de ces images dépend de la densité des points de mesure, et elles peuvent être produites sans que l'on dispose d'une caméra infrarouge. L'analyse géostatistique de ces données permet de générer de nouveaux documents, comme une thermographie de la surface. Sur cette base, on peut alors représenter des isolignes ou des isosurfaces pour mettre en évidence certains phénomènes climatiques, comme les zones où le point de rosée est atteint. Dans cet exemple, la thermographie superposée aux autres données met en évidence une relation entre la répartition de

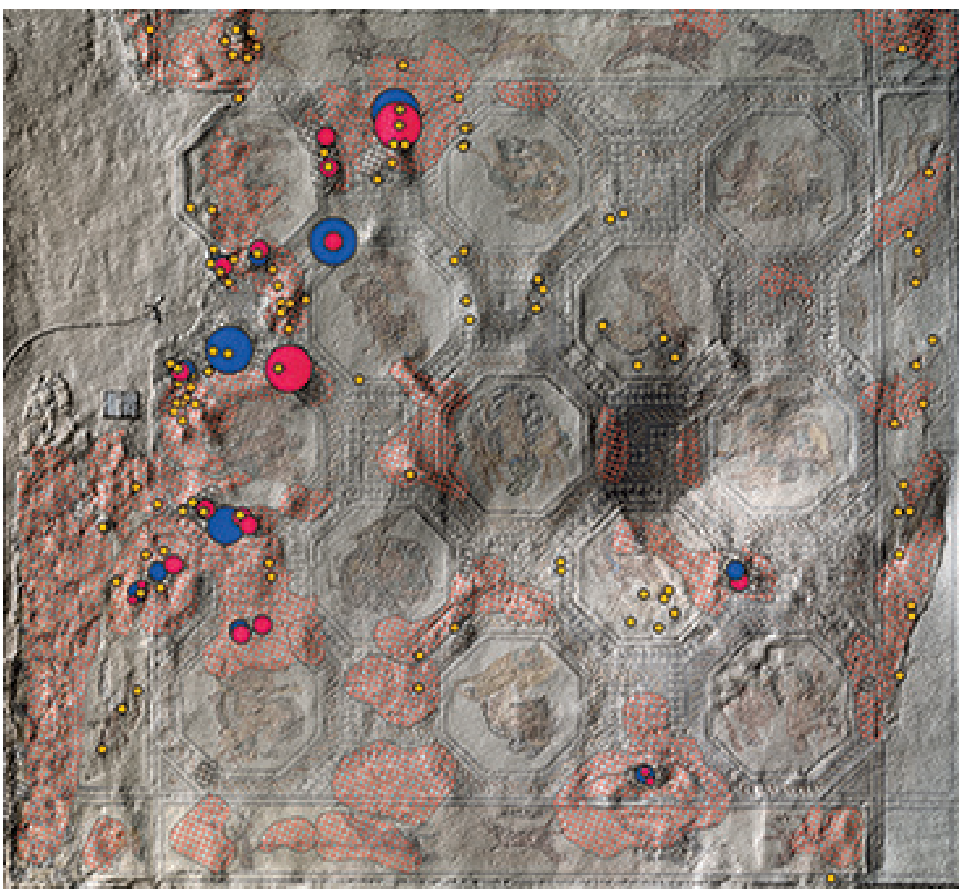

Figure 6 Figure 4 avec la superposition de son modèle numérique de terrain, du relevé des contrôles tactiles-acoustiques de 1989 (hachures rouges) et 2013 (hachures noires) et des injections de mortier fluide sous les tesselles, de 2004 (points jaunes), 2012 (points rouges) et 2013 (points bleus). Dessin : Noé Terrapon, SMRA

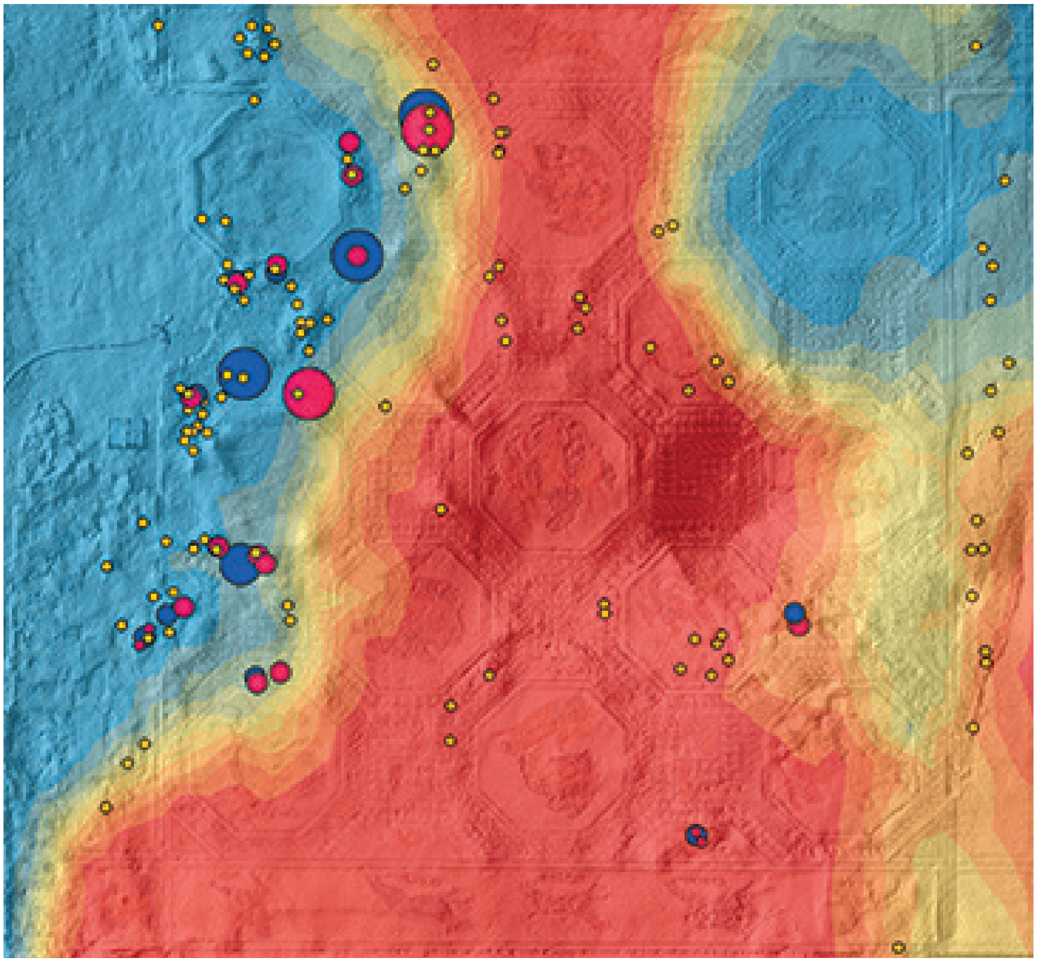

Figure 7 Figure 6 avec la superposition de l'image thermographique issue de l'analyse géostatistique des températures de surface. Dessin : Noé Terrapon, SMRA

la température de surface et la densité des détachements et des pertes du *tessellatum* (fig. 7).

Conclusion

S'étendant sur plus de cent soixante-dix ans, la documentation des mosaïques d'Orbe constitue un corpus extraordinaire, mais sa richesse est aussi une contrainte quand il s'agit de rendre ces informations exploitables. Dans ce but, le glossaire et l'ontologie ont été des outils efficaces pour convertir ces informations dans une syntaxe adaptée aux bases de données et permettre leur analyse avec des applications SIG. Le concept permet un développement du vocabulaire. L'ontologie explicite les termes et les relations du glossaire et renforce la compatibilité à long terme. Ces outils pourraient être utilisés comme médium entre conservateurs et professionnels des technologies de l'information et faciliter la migration des informations. L'analyse et la modélisation des données par l'intermédiaire des applications SIG ouvrent une nouvelle dimension à la documentation. Elles permettent de générer de nouveaux documents utiles pour la compréhension des phénomènes d'altération, telles les images thermographiques. Les phénomènes de dégradation peuvent être présentés de manière évidente et être mis en relation avec les résultats de ces analyses. L'application SIG n'est donc pas seulement un outil de gestion et de génération d'informations mais également de diagnostic. Le suivi radiométrique et l'analyse spatiale comparative des modèles numériques de terrain d'année en année nous semblent être des instruments potentiels de monitoring qui méritent d'être appliqués.

Les résultats des analyses des données sont encourageants. Il est cependant nécessaire de trouver des solutions au problème complexe de l'intégration de l'information contenue dans des documents tels que les rapports d'intervention, les photographies d'archives, les factures et listes de produits utilisés par exemple.

Notes

1 Il s'agit probablement de « poussière de marbre ».

2 Image dont l'unité de base est le pixel. Les valeurs décrivant leurs caractéristiques y sont associées, par exemple dans une image RVB, l'intensité lumineuse des couleurs rouge, vert et bleu. Dans un SIG, chaque pixel couvre une aire géographique donnée.

3 Des exemples d'applications et des possibilités offertes par certains de ces programmes sont par ailleurs présentés dans cette publication.

4 Images TIFF contenant des informations définissant leurs références spatiales et établissant le lien avec les coordonnées du système de référence national.

5 L'image est jumelée à un fichier de géoréférencement permettant d'établir le lien avec les coordonnées nationales (coordonnées du pixel supérieur gauche, taille en pixels dans les directions x et y).

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Mobile Platform Usage in Creating Conservation and Restoration Documentation

Vojin Nikolić, Nemanja Smičiklas, and Aleksandar Ilić

Abstract: *This paper describes the development and practical use of the COREDO application, designed for conservation documentation. This application is based on the Android platform and is optimized for use on tablet PCs with capacitive touchscreens. The purpose is to improve the collection and processing of documents in the field by taking advantage of the benefits offered by advanced technology. This paper describes the process of creating this application, its features, and the vision of further development through the implementation of tools for reading a hyperlink of the physical world and the integration of a new virtual network register of cultural monuments.*

Today we live in a world of information-communication technology (ICT). All work and indeed all of life's activities are connected, at least at some of its stages, and the field of conservation and restoration is no exception. The incredibly rapid progress in ICT is continually creating new opportunities and ways of performing business tasks. The number of devices and the amount of data in use today are stunning.

Conservation and Restoration Documentation: The Beginnings

As Michelle Moore notes in her article on conservation documentation, one cannot say with certainty when the first documentation for conservation and restoration was made. There are descriptions of conservation and restoration work dating to the sixteenth century, but they were provided by the observer, not the conservator. Pioneers of modern conservation science such as Rathgen, Scott, and Plenderleith do not mention the concept of documentation (Moore 2001: 2).

Even as recently as the 1970s only a few museums kept consistent records of conservation work. And it seems that the documentation that was done consisted primarily of reports, with few data. In the case of published articles, however, a conservator provided detailed documentation.

The advent of computers, digital cameras, and laptops greatly facilitated the development of conservation and restoration documentation. Options have become practically unlimited. High-resolution images, drawings, and presentations have become routine. Notebook computers or laptops have enabled documentation in the field. For this purpose, conservators have mainly used software that is not designed specifically for this purpose, such as Photoshop, Adobe Illustrator, or AutoCAD. With continued advancements in technology, specialized software began to appear that brings together in one place all the necessary tools for conservation and restoration documentation, such as photo editing, mapping, tracing, and describing conditions and interventions.

Given this situation, why do we still have such poor and inconsistent documentation of conservation and restoration work? The answer probably lies in the use of different software, different equipment, and, most important, the lack of computer literacy. Few conservators are trained in complex computer software, and most of those who use this software do not take advantage of its full potential. The conservator must purchase the software and undergo extensive training, including in the base operating system on which the software is used. This process is time consuming and very expensive. In addition, for documentation in the field it is necessary to take the proper equipment: a laptop with suitable features so that the software can function easily and smoothly, a digital camera, preferably a scanner, a printer, and of course cables and accessories. Traditional tools such as drawing paper and foil for making tracings are needed. Upon completion the documentation must be brought to the office and digitized, requiring additional hours to scan the drawings and photographs and finally store it on a server and media storage system.

The appearance of the final product is determined by the choice of software and the personal preferences of users. Currently conservation and restoration documentation consists of drawings of varying quality, size, and color.

From Idea to Realization

This project was launched at the beginning of 2012. It aimed to improve documentation for conservation and restoration, as well as connect with the Serbian central register of cultural monuments. To begin with, it was necessary to determine the kind of platform and equipment to be used. The Android platform was quickly determined to be the logical solution. The reason for this is the expansion of the types of mobile devices that run on the Android platform, their availability, intuitive handling, and hardware features.

Most of the world's major mobile phone companies and tablet computers have completely abandoned other systems and are based solely on the Android platform. It is estimated that currently over 60 percent of smart mobile devices in the world work on Android. The first version of the Android appeared four years ago, and the number of users is now in the hundreds of millions. Android owes this success to its open-source policy, the development of which is led by Google, as well as a number of free mobile applications available for its devices.

As for the device, we decided it should be a tablet. If we consider that documentation consists for the most part of writing, drawing, or photography, it was not difficult to conclude that the tablet computer is the ideal tool for this purpose. Fitting all our needs, it contains the appropriate application for text entry, drawing applications, and an integrated camera. Our job was to integrate these applications into one application that would have all the characteristics needed for conservation and restoration documentation. In order to do that we had to develop a clear strategy for the project and set the conditions that had to be met by the new application:

1. It should lead the user through the entire process of conservation and restoration documentation. In this sense, the application had to be intuitive and easy to use by those with no technical knowledge.
2. It should consolidate all our requirements: taking pictures of the object, conducting tracings, recording conditions, taking notes, and recording conservation interventions (figs. 1–5).
3. It should correspond with all accessories (e.g., printers, routers) and be fully compatible with other devices such as personal computers and mobile phones.

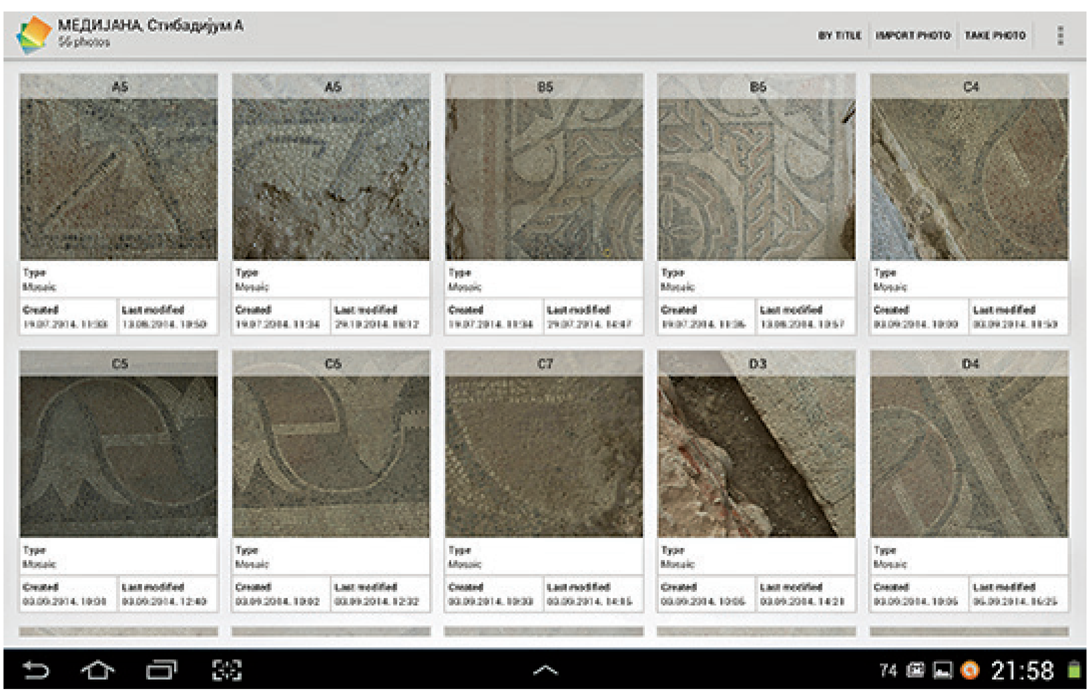

Figure 1 Session screen

Figure 2 Edit screen showing the Add Damage dropdown menu

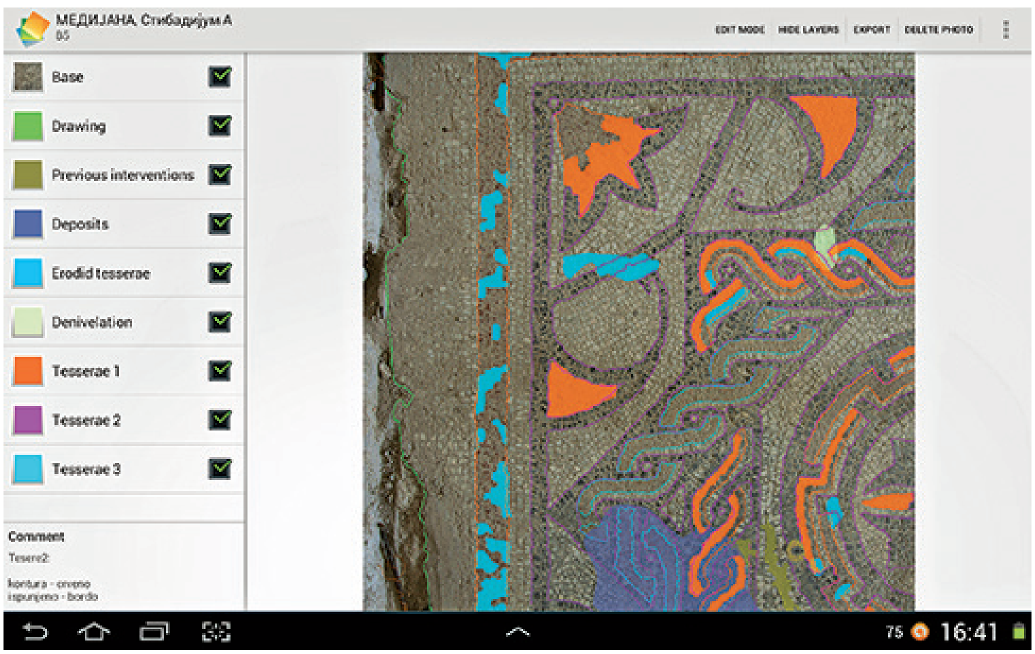

Figure 3 View mode screen with different layers

4. It should provide wireless connectivity to the remote servers of the Serbian central register of monuments, which further ensures the complete compatibility of data and the ability to upload and download files from the server.
5. It should be capable of interfacing entirely in the user's language, so that it can be used by people without knowledge of English or a language other than their own.
6. It should be clear and clean.

We hired a programmer, which aided the development of the project. In addition to meeting the ultimate aims of the application, it was necessary to select an appropriate methodology for software development, which allowed more control over the process itself and the possibility of rapid intervention if the development went astray. The choice was wide, from old-fashioned water flow models to extreme programming. However, only one software development methodology could meet the requirements: lean methodology. Lean methodology can be described by the following principles:

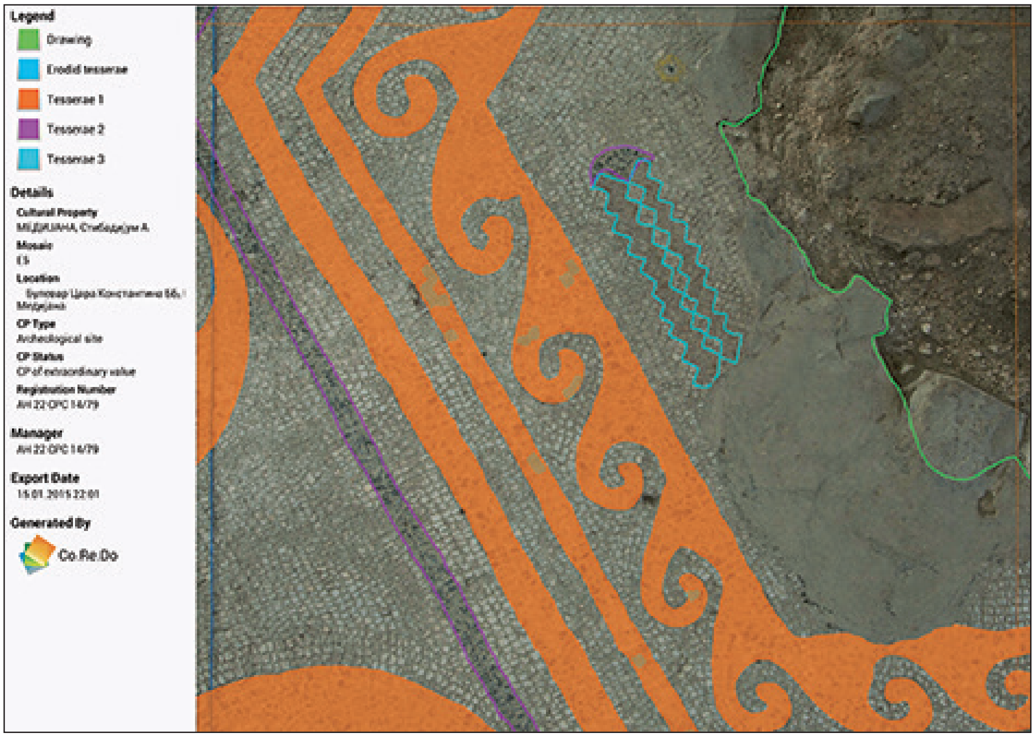

Figure 4 Exported document with a photo base layer

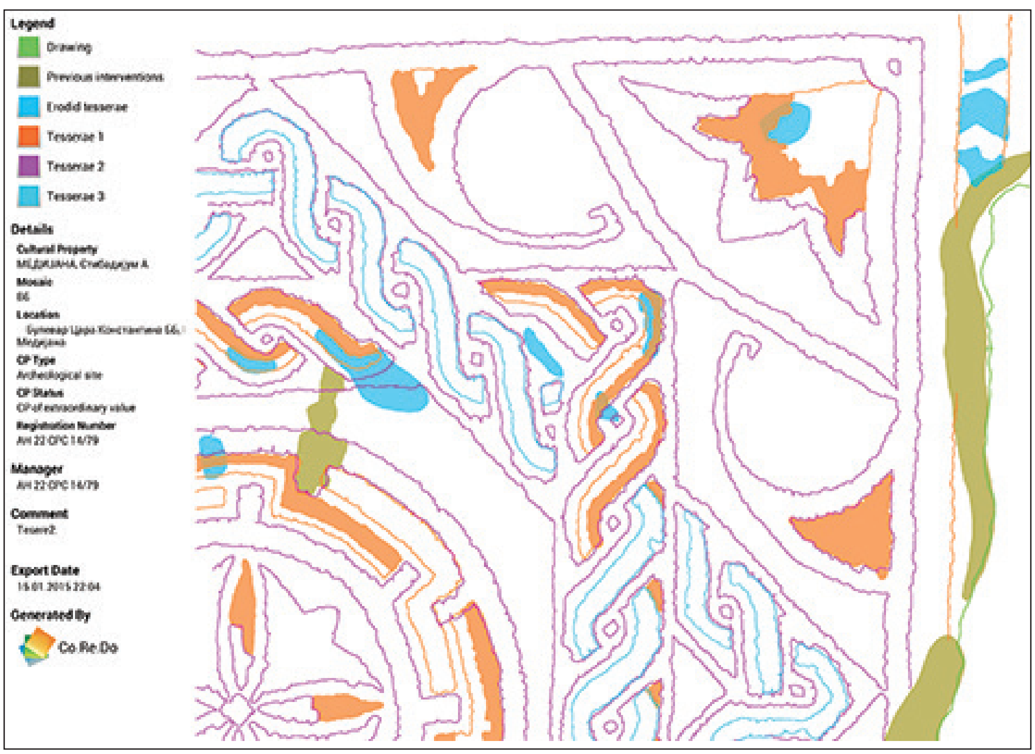

Figure 5 Exported document as a line drawing

- Elimination of waste
- Importance of understanding
- Taking time to make decisions
- Delivering for testing as soon as possible
- Developing integrity
- Looking at the bigger picture.

Future Vision

The strategy for further development is the creation of the technical and technological environment necessary for an easier user experience and absolute automation of the system. This involves setting up a server for the Serbian central register of cultural monuments that will hold data exported from the application. The current plan is that the server will be open to all experts from relevant institutions, giving easy access to the necessary information about a particular cultural monument that is of interest and enabling the uploading of the data they collect themselves. In this way a network will be created that makes it possible to share all information related to a monument. One part of the database would be open to everyone and would contain basic data about the monument, its history and a brief description of the conservation and restoration work undertaken. To ensure the availability of data, the plan is to set up a special board with Quick Response (QR) codes for the monuments.

A QR code is the trademark for a type of matrix barcode (or two-dimensional barcode) first designed for the automotive industry in Japan in 1994. The QR code system has become popular outside the automotive industry due to its fast readability and large storage capacity. A QR code consists of black modules (square dots) arranged in a square grid on a white background. Applications of QR code include product tracking, item identification, time tracking, document management, general marketing, and much more. QR codes storing addresses and URLs may appear in magazines and on signs, buses, business cards, and other objects about which the user could acquire information. Users who have a mobile phone with a camera and appropriate software installed can scan the QR code image and thus read data or connect to the appropriate server. This way of linking with physical objects is known as a hyperlink to the physical world. Since tablet PCs have an integrated camera, the application will be enhanced with a bar code scanner, and thus the user will be able to be in front of a monument, log in to the server, and get all the necessary information about the monument, including all previous conservation interventions. Logically, this information will be available only to users of the COREDO application, who are experts in the field; the ordinary visitor who scans the QR code with his or her mobile device will receive only basic information.

Augmented reality (AR) is a live, direct or indirect view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input such as sound, video, graphics, or GPS data. It is related to a more general concept called mediated reality, in which a view of reality is modified by a computer. As a result, the technology functions by enhancing one's current perception of reality. Augmentation is conventionally in real-time and in semantic context with environmental elements, such as sports scores on TV during a match. With the help of advanced AR technology (e.g., computer vision and object recognition) the information about the surrounding real world of the user becomes interactive and digitally manipulable. Artificial information about conservation and restoration work can be overlaid on real objects, such as mosaics. The conservator may in present time see all the former interventions on the object by pointing a tablet camera at the desired object. On the screen over the photographs will appear all of the mapping performed with the COREDO application, along with relevant information.

Further development of the system depends on the needs of the users themselves. Hardware and operating systems already provide enough options, and when you take into account certain improvements in these components, it is clear that the development of the system is limited only by the user and material resources. When the system is fully developed, possible future transfer to other platforms will depend only on the skill of the programmer.

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Material and Technique of Mosaics in Hagia Sophia, Istanbul: Reuse of Gold Tesserae and an Attempt to Estimate Age

Juni Sasaki

Abstract: *During surveys of the mosaics in Hagia Sophia carried out beginning in 2006, it was discovered that the sixth-century mosaics of the central dome have a higher quality with regard to both materials and techniques than the fourteenth-century mosaics. The characteristics of the mosaics were examined on the basis of the results of color spectral reflectivity research and verify previous hypotheses that the fourteenth-century mosaics contain some salvaged tesserae from earlier mosaics.*

Hagia Sophia, the present Ayasofya Museum, is one of the world's most famous cultural heritage sites because of its unique structural system and the various mosaics that were executed from the sixth to the fourteenth century (fig. 1). The present structure was built in the sixth century as a Greek patriarchal cathedral of Constantinople. In the fifteenth century Hagia Sophia was converted into an Islamic mosque, and in 1934 it was secularized and opened as a national museum. In the fifteen hundred years since its construction, this great monument has suffered many earthquakes, and restoration work has been performed at various points up to the present.

The huge central dome especially, approximately 56 meters high and 31 meters in diameter, had suffered serious earthquake damage and had partially collapsed. The present central dome consists of three parts, built in the sixth, tenth, and fourteenth centuries. The first collapse of the central dome occurred in 558, when an earthquake inflicted serious damage, and the central dome was entirely reconstructed in 562. The second collapse occurred in 989, and the last collapse occurred in 1346 (Mainstone 1988: 106).

The Hagia Sophia Surveying Project, conducted by a Japanese team from Tsukuba University, started in 1990. This survey comprises historical, structural, museological, and environmental surveys (Hidaka and Sato 2004). Also, from 1992 to 2010, the UNESCO international project for the conservation of the central dome mosaics was conducted (Ozil 2001). The 2009–2010 mosaic conservation project focused on the northeastern part of the central dome. My mosaic survey was started in 2006 and continued when I joined the UNESCO project as a Turkish government scholarship student in 2009.

An interesting subject for scholars is the date that the Hagia Sophia mosaics were made. Attempting to identify correlations between the materials and dates, differences in the execution materials and techniques of each era can be determined by visual observation, that is, measurement of the tessera size.

Through my investigations of the central dome mosaic, its characteristics were identified on the basis of color spectral reflectivity research, as well as visual observation (Sasaki and Hidaka 2011). It was possible to roughly divide the gold tesserae that were used in the sixth- and fourteenth-century mosaics into two groups according to the color trend. The color trend can be derived from the spectral reflectance in the wavelength region from 360 nm to 740 nm and the $L^*a^*b^*$ color space, which is defined by the International Commission on Illumination (CIE), based on one channel for Luminance (L^*) in the range of 0 to 100 and two channels for chromaticity (a^* positioned between red and green in the range of 0 to 10, and b^* positioned between yellow and blue in the range of 20 to 60). This color space includes all perceivable colors and assigns numerical values to color, allowing us to quantify color data with a three-dimensional model. Then, based on the frequency of use of each tessera group, it was possible to confirm the reuse of the sixth-century tesserae in the fourteenth-century mosaic, something that had not been fully verified in previous reports. By investigating several parts of the mosaics, including the central dome, and attempting to estimate the date of execution using the color measurement results, a correlation was discovered between the date of execution and the color of the tesserae.

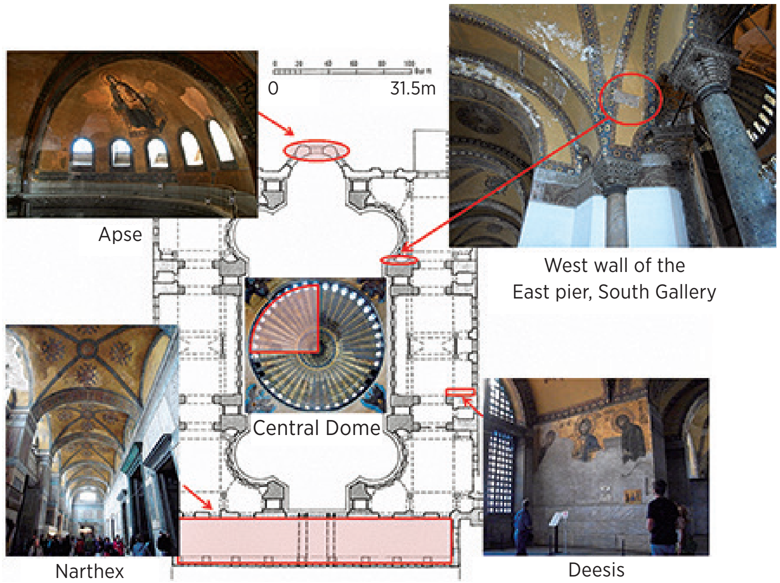


Figure 1 Plan of Hagia Sophia with locations of mosaics. The plan was modified after Mainstone 1988: 272. Photo: J. Sasaki

Research Methodology

The survey, observations, and measurements were focused on the northeastern part of the central dome, where the sixth-century mosaics are fanned out across the northern half (ribs 31–35) and the fourteenth-century mosaics are fanned out across the eastern half (ribs 36–40). For one tessera, photographs were taken at different magnifications and from multiple directions. The size was measured using a digital measure (Digital Caliper Model 19978, manufactured by Shinwa Co., Ltd.) to a tenth of a millimeter. Microscopic photos were taken at 500-fold magnification, and the color spectral reflectance was measured using a hand color spectrophotometer with an integrating sphere.

The differences between the materials and techniques of each era can be determined by visual observation. The sixth-century mosaics were very finely executed and smoothly embedded with fine undulations by small tesserae of substantially uniform size (fig. 2). The tesserae were aligned without gaps in an orderly manner in the horizontal direction. The decorative motifs of the ribs were rendered in opaque tesserae of red, blue, and green glass. The gold tesserae were very bright, with vivid saturation.

On the other hand, the fourteenth-century mosaics were less carefully executed, embedded irregularly, and lined with wide installation intervals (fig. 3). There was no uniformity in either the form or the size of the tesserae. The tesserae of the ribs are made of white marble and overpaint. The gold tesserae have a dull, reddish color.

Visual observations that depend on the subjective experience of the observer, as well as the viewing environment, have questionable objectivity. Therefore, I measured the color using a spectrophotometer to objectively record and verify the differences, and I considered the trends for each time period from the obtained spectral reflectance.

Color measurements were performed using a Konica Minolta CM-2600d spectrophotometer programmed with the following settings: measurement diameter area of 3 mm; standard illuminant D65, 8° lighting / diffused light receiving system; and standard observer (10° observer). This instrument was set horizontally with respect to each surface of a tessera and measured automatically three times. By analyzing the spectrum of the reflected light to quantify the exact color of the object, it is possible to record the objective color without external influences. I adopted the average value of the data obtained as the measurement result. Two types of colorimetric results can be obtained from a spectrophotometer: Specular Component Include (SCI), which includes positive reflected light; and Specular Component Exclude (SCE), which excludes positive reflected light. In this study, I adopted the SCI that shows the color of the object itself for color evaluation. The measurement results were graphed using the spreadsheet software CM-S100w Spectra Magic NX Basic.

Results of the Color Spectral Reflectivity Research: Reuse of Gold Tesserae

The average sixth-century mosaic tessera was 7.2 mm long × 6.4 mm wide (160 total points measured); that is, vertically long rectangular gold tesserae were mostly used. The average fourteenth-century tessera was 7.0 mm long × 7.3 mm wide (159 total points measured); that is, horizontally long rectangular gold tesserae were mostly used. These results suggest

Figure 2 Sixth-century dome mosaic, December 7, 2009. Photo: J. Sasaki

Figure 3 Fourteenth-century dome mosaic, December 7, 2009. Photo: J. Sasaki

that the workers deliberately selected the direction of the tesserae during execution.

In general, to arrange the tesserae on the mortar, workers pay attention to the flow and the joint of the tessera column. Similarly, workers consciously fill in the golden background using the tesserae columns and horizontal joint. In the background, so as not to disrupt the flow of the horizontal rows, it is necessary to install and align the lateral (upper or lower) side of the tessera first. To form the flow of the straight row in the horizontal direction, it is easier to use horizontally long rectangular tesserae such as those of the fourteenth-century mosaics rather than vertically long rectangular tesserae such as those of the sixth-century mosaics.

However, in the central dome of Hagia Sophia, the sixth-century mosaic has an orderly and regular installation compared to the fourteenth-century mosaic. To obtain the regularity and the horizontal and vertical directions of the tesserae, the vertical side, rather than the bottom row of the tesserae, was installed first. In the restoration work report (Berzobohaty, Jobst, and Gollman 1997: 10–11), it was indicated that there are differences in the installation density of the background tesserae between the sixth-century mosaics (180 tesserae/10 cm^2) and the fourteenth-century mosaics (140 tesserae/10 cm^2). The installation interval of the sixth-century mosaics is narrower than that of the fourteenth-century mosaics. This is influenced by the selection of the tesserae direction.

The present study mainly examines the characteristics of mosaics on the basis of the color spectral reflectivity research and proposes ideas to verify previous considerations. Compared to the color of the fourteenth-century mosaic tesserae (175 total points measured), that of the sixth-century mosaic tesserae (165 total points measured) has a high saturation corresponding to golden—specifically, reddish—yellow. From the comparison of the spectral reflectance of all measurement data, the brightness of the gold tesserae of the sixth-century mosaics is higher than that of the fourteenth-century mosaics (fig. 4). That is, the sixth-century mosaics have gold tesserae exhibiting a high spectral reflectance over the entire wavelength range with higher L^* value than 90, while those of the fourteenth-century mosaics exhibit entirely low spectral reflectance with lower L^* value than 60 and lower a^* value than 5. It is considered that the sixth-century mosaics were made with higher-quality and higher-purity gold than those of the fourteenth century.

I also found that the sixth-century and fourteenth-century mosaics had some tesserae with common colors; the latter had gold tesserae exhibiting the same reflectance (the spectral reflectance becomes gradually higher in the wavelength region from 500 nm to 700 nm; L^* value is between 60 and 80, and a^* value is between 5 and 10) as the earlier ones. Therefore, I classified the gold tesserae used in the sixth- and fourteenth-century mosaics into two types according to the spectral reflectance trend and $L^* \bullet a^*$ values as follows: type A has high spectral reflectance with L^* value between 60 and 80 and a^* value between 5 and 10; type B has low spectral reflectance with L^* value lower than 60 and a^* value lower than 5.

Then, by calculating the frequency of use of each tessera group in the northeastern part of the central dome, it was

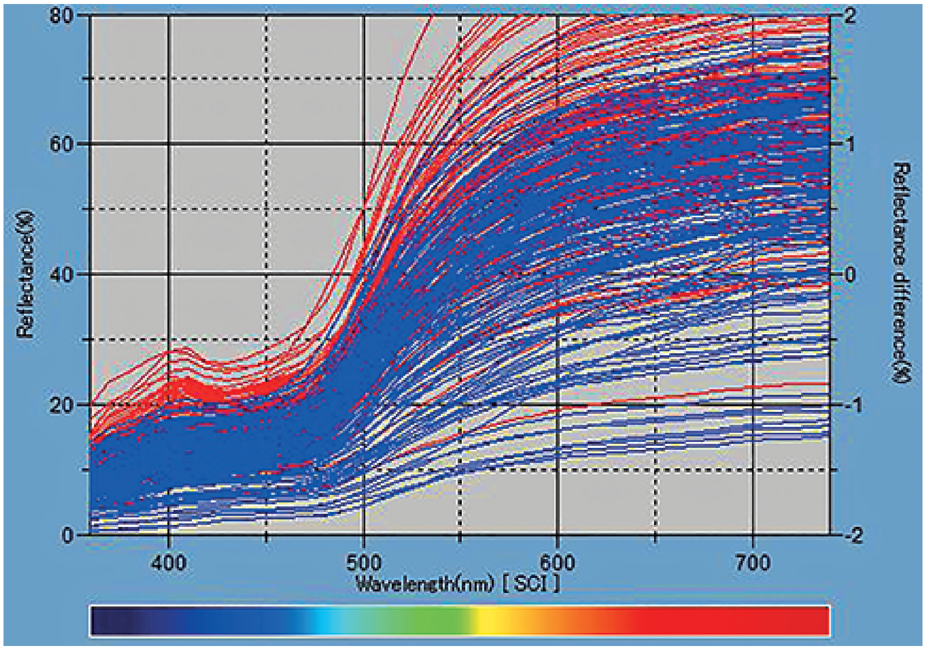


Figure 4 Spectral reflectance of gold tesserae (analyzed by author). Red represents the sixth-century mosaic; blue the fourteenth-century mosaic.

confirmed that there is a difference in the frequency of use of both types A and B gold tesserae between the sixth- and fourteenth-century mosaics (table 1). The frequency of use of Type A is higher in the sixth-century mosaics than in the fourteenth-century mosaics, while the gold tesserae of Type B are hardly used in the sixth-century mosaics.

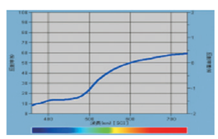
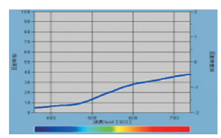
The quality and the rate of application of the gold tesserae prepared and used in the sixth-century mosaics indicate that they are of Type A. In the fourteenth-century mosaics, the use of Type A tesserae is frequently observed; therefore, it is possible that the collapsed tesserae from the sixth-century mosaics were reused in the mosaics from the fourteenth-century mosaics. The use of Type B tesserae in the sixth-century mosaics is limited to the junction with the fourteenth-century mosaic. Thus it is considered that the Type B tesserae were newly made in the fourteenth century and used in the junction area.

Here I consider the possibility of reuse. A previous report by UNESCO (Berzobohaty, Jobst, and Gollman 1993) identified the following three factors underlying the decrease in the quality of the fourteenth-century mosaics: (1) the reuse of tesserae from sixth- and tenth-century mosaics; (2) lack of time and money; and (3) reduction of work capacity (workers' technical capabilities).

Although it has been suggested that the fourteenth-century mosaics were made up of the reused tesserae from collapsed mosaics, this assumption has not been sufficiently verified. Using color spectral reflectivity, the reuse of the earlier tesserae and the application of new tesserae in the fourteenth-century mosaics can be assessed.

Finally, I attempted to estimate the age of the mosaics in Hagia Sophia. Some previous studies of the mosaics in Hagia Sophia estimated the date of their execution according to the techniques used. Specifically, Cyril Mango, the famous

Table 1 Classification by spectral reflectance of the gold tesserae in the dome mosaic

			Type A	**Type B**	
L* value			60.00～(80.00)	less than 60.00	Out of classification (Broken and dirty tesserae etc.)
a* value			5.00～(10.00)	less than 5.00	
Example of color spectral reflectivity					
6th-century mosaics	Rib.31		92%	2%	6%
	Rib.32		91%		9%
	Rib.33		95%		5%
	Rib.34		95%		5%
	Rib.35		97%	3%	
Points		165	150	6	9
14th-century mosaics	Rib.35		75%	12.50%	12.50%
	Rib.36		88%	8%	4%
	Rib.37		84%	13%	3%
	Rib.37–38		57%	43%	
	Rib.38		82%	12%	6%
	Rib.39		75%	20%	5%
	Rib.40		84%	8%	8%
Points		175	126	32	17
Total points		**340**	**276**	**38**	**26**

Byzantine scholar who conducted major research on the mosaics in Hagia Sophia, suggested that the date of execution might be estimated based on the paint of the setting bed: a red painted setting bed would indicate that the mosaic was from the sixth or ninth century, such as the mosaic in the bema of the apse (Mango and Hawkins 1972: 21). In addition, a dating has been based on the presence or absence of reconstruction, along with the presence of human figures and the installation angles of the tesserae. However, the estimated date of the mosaics in Hagia Sophia has not been scrutinized anew from multiple points of view based on methods cited in previous studies conducted there.

I have also been conducting surveys on other mosaics, for example, in the narthex, the Deesis, and the south gallery (approximately 4,000 total points measured on 18 mosaics). I attempted to estimate the age from the color of the gold tesserae in the mosaics. To look at the usage trend in each mosaic, I first categorized the color spectral reflectance of the gold tesserae into Types 1–10 (fig. 5).

As a result, it was possible to estimate these mosaics' date of execution according to the color spectral reflectance along with the dating methods cited in previous studies, such as the presence of human figures and the color of the paint of the setting bed (fig. 6). For example, the sixth-century mosaics were executed with Types 1, 2, and 3 tesserae on a red-painted setting bed; these have a high brightness and vivid saturation and could have been reused from the earliest sixth-century mosaics that were executed when the cathedral was built. Some gold tesserae of slightly lower brightness (Types 4, 5, and 6) and low brightness (Types 8, 9, and 10) were also used. These darker tesserae were installed at a downward angle. This installation technique is observed only on the mosaics from the sixth century, with the exception of the Deesis mosaic. In previous studies, this installation technique was identified as a traditional method used before 726 (Underwood and Majewski 1960: 209; Mango and Hawkins 1972: 3–4). The present study confirmed this theory.

Conclusion: An Attempt to Estimate Age

The materials and techniques employed in the Hagia Sophia mosaics from the sixth to fourteenth centuries, a period spanning approximately nine hundred years, changed in many ways. In the sixth-century mosaics executed when the cathedral was built, gold tesserae of high brightness (Types 1, 2, and 3) on a red-painted setting bed were used. Subsequently gold tesserae of slightly lower brightness (Types 4, 5 and 6) and low brightness (Types 8, 9, and 10) came into use along with gold tesserae of high brightness. The gold tesserae of low brightness were often installed at a downward angle.

The following mosaics likely have sixth-century origins: an uncovered part of the west wall of the east pier (fig. 7), an exedra in the east bay of the south gallery, a fan-shaped part of the vault ceiling in the narthex (fig. 8), and the lower part of the background in the north and south bemas of the apse. Of these, previous research dated only the exedra mosaic in the east bay to the sixth century (Underwood and Hawkins 1961: 199–201).

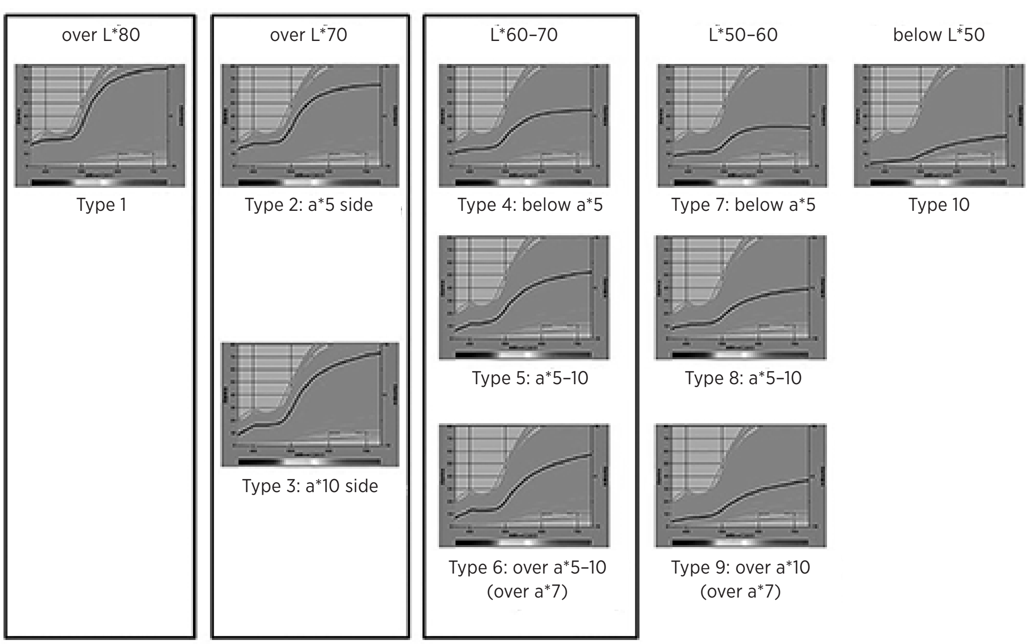


Figure 5 Color types of gold tesserae classified by spectral reflectance and L*a* value.

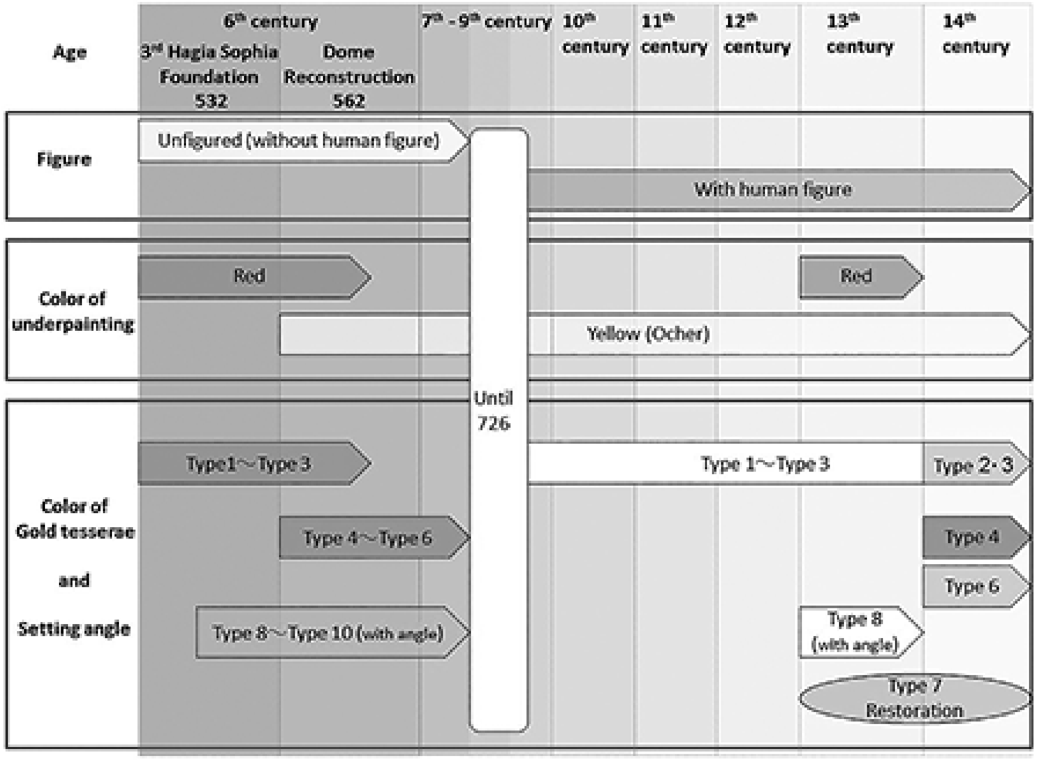


Figure 6 Correlation diagram for age estimate of mosaics based on material, techniques, and color.

Figure 7 An uncovered part of the west wall of the east pier, August 29, 2011. Photo: J. Sasaki

Figure 8 A fan-shaped mosaic in compartment F of the eastern side of the narthex vault ceiling, January 12, 2010. Photo: J. Sasaki

For an uncovered part of the west wall of the east pier, I conducted a preliminary analysis of the composition of a thin protective glass layer (the cartellina) covering the metal leaf in gold tesserae. In 2013 I obtained some samples of cartellina of gold tesserae that had fallen naturally. The analysis revealed that the cartellina of the gold tesserae in this mosaic is composed primarily of low-magnesia, low-potash natron-type soda-lime-silica glass. For example, the composition of one of the samples is as follows: SiO_2: 70.15 wt.%, Na_2O: 17.56 wt.%, K_2O: 0.87 wt.%, CaO: 7.93 wt.%, MgO: 0.15 wt.%, Al_2O_3: 1.44 wt.%, FeO: 0.43 wt.%, MnO: 0.77 wt.%, TiO_2: 0.17 wt.%, ZnO: 0.02 wt.%, PbO: 0.00 wt.%, Sb_2O_5: 0.01 wt.%; total: 99.50. This composition is similar to the Roman and earlier Byzantine glasses. Manganese oxide is used as a decolorant. It is noted that the transparent and colorless glass of gold tesserae in the early Byzantine sites in Italy and in the Middle Eastern sites and in the late Byzantine site of Dafni have a high content of manganese oxide (Vandini, Fiori, and Cametti 2006). From this result, the date of execution of this mosaic can be identified as the sixth century.

Finally, the fan-shaped part of compartment F in the narthex vault ceiling was studied. This type of fan-shaped execution is frequently found in Roman floor mosaics. The floor mosaics in the Great Palace of Constantinople, the present Great Palace mosaic museum, for example, also have backgrounds with a fan-shaped installation. This installation technique is very uncommon in Hagia Sophia, except for the golden background of the Deesis mosaic. From the presence of this fan-shaped installation, it is likely that the narthex mosaic was executed in the sixth century, as the previous study speculated the possibility of remaining part of the earlier mosaics (Whittemore 1933: 9–11).

The aim is to continue the survey of the mosaics in Hagia Sophia and further develop this technique for estimating age. I hope that the results of the present survey will be used for the effective protection of Hagia Sophia.

Acknowledgments

I express gratitude for the cooperation of the authorities of Ayasofya Museum and the Ministry of Culture and Tourism, Republic of Turkey. This study is supported by a Grant-in-Aid for Research Fellow of the Japanese Society for the Promotion of Science (Juni Sasaki, JSPS Research Fellow, No. 12J04728). I would like to express special appreciation and thanks to my supervisor, Prof. Dr. Kenichiro Hidaka, and my adviser, Prof. Dr. Takeshi Ishizaki.

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PART THREE

Conservation and Management

The Mosaics of the Daphni Monastery: A Discussion of the Dilemmas and the Decisions Made throughout the Ten-Year Conservation Program

Elisavet Anamaterou, Maria Deliprimi, Fotini Getimoglou, and Maria Krini

Abstract: *The 1999 earthquake in Athens caused severe damage to the nearby Daphni Monastery and its eleventh-century mosaic decoration. This triggered the beginning of a project, cofunded by Greece and the European Union, for an integral approach to the preservation of the monument, including the restoration and stabilization of the building and the conservation of the mosaics. This paper discusses the conservation program, which is due to be completed in early 2015, the conservation strategy, the documentation task, and the issues of aesthetics and authenticity.*

The Daphni Monastery, dated to the end of the eleventh century, is one of the most important monuments of the Byzantine era. It is inscribed on the UNESCO World Heritage Site list as an outstanding example of mid-Byzantine religious architecture, decorated with superb wall mosaics. Seismic activity in the late nineteenth century—two major earthquakes in 1889 and 1894—was catastrophic to the church and the mosaics, causing the collapse of large areas of the latter. The first attempts to restore the mosaics were made in 1891, when experts from Venice were invited to detach the endangered mosaic panels. The next year another expert from Italy was called to continue and finish the work, the mosaicist Francisco Novo, who in the next six years made large-scale interventions, detaching and restoring the majority of the mosaics and filling losses with either original or new tesserae (Kampouroglou 1920: 100–103). The mosaics were also conserved numerous times in the twentieth century. Today they cover an area of approximately 200 square meters on the walls of the church.

The Athens earthquake caused severe damage to both the structure and the mosaics and set in motion a project for a holistic approach to the preservation of the monument. This project, cofinanced by Greece and the European Union, dealt with the stabilization and the restoration of the monastery building and the conservation of its mosaics.

Conservation of the Mosaics

The conservation of the mosaics was planned and implemented in three phases. The first phase included first aid and preventive measures to minimize the damage. The second phase comprised various studies targeting characterization of the original materials used in the construction of the mosaics, as well as development of appropriate grouting systems. The third phase was the actual conservation treatment. During all phases, both graphic and photographic documentation was conducted.

First Aid

In the first phase, the damage to the mosaics was assessed and documented. They suffered from loss of tesserae (fig. 1), an extensive network of cracks; surface irregularities such as rises and bulges (fig. 2), loss of cohesion between preparatory layers; and detachment between mosaic layers and the wall. The first aid treatment included collecting loose tesserae and detached fragments and facing the areas of rises and cracks (fig. 3), along with the documentation process. The first dilemma arose when surveying for the structural strength of the building revealed that, in order to ensure the stability of the dome, metal supports had to be introduced in four vaulted areas that had mosaics. This meant that detachment of these mosaics was inevitable, as the stress to the mosaics between the metal supports and the walls might cause them further damage. Another mosaic panel was also detached, to repair the heavily damaged masonry underneath (Delinikolas et al. 2003).

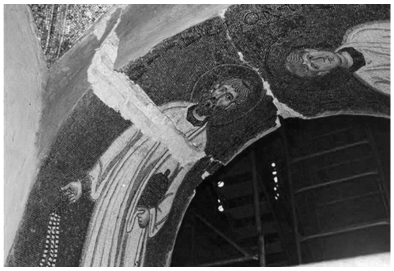

Figure 1 Large loss of tessellatum area after the earthquake. Photo: © Hellenic Ministry of Culture and Sports

Figure 2 Bulge in the mosaic surface after the earthquake. Photo: © Hellenic Ministry of Culture and Sports

Figure 3 First aid treatment to the Prophet Ionas mosaic. Photo: © Hellenic Ministry of Culture and Sports

With the completion of these urgent actions, the next phase of the project was planned, and a conservation strategy was developed involving several services from the Ministry of Culture: the 1st Ephorate of Byzantine Antiquities (project direction), the Directorate of Restoration of Byzantine Monuments (restoration of the building), the Directorate of Conservation of Ancient and Modern Monuments (conservation of mosaics), and the Directorate of Restoration Technical Research (research on grouting materials). Several national and international research centers were also involved in individual parallel research programs.

Research Projects

The second phase was based on several research projects. Thorough mapping of the monument, including digital photogrammetric images, which were used for the documentation of the mosaics, the damage, and the conservation interventions, was conducted by the National Technical University of Athens (NTUA) School of Rural and Surveying Engineering, Laboratory of Photogrammetry. They also created a 3D simulation model of the church.

Documentation, archival research, and optical examination were implemented by the conservation team of the Directorate of Conservation of Ancient and Modern Monuments. The research revealed new evidence of the original technique and materials, as well as of the methods and materials used, and the problems caused by previous conservation and restoration interventions. The mosaics had been restored and conserved in several periods. Apart from the large-scale restoration of the nineteenth century, conservation was also carried out in the 1950s, 1960s, and 1970s, unfortunately without full documentation of the interventions (Chrysopoulos 1997). This was an opportunity, then, to fully document all conservation actions since the nineteenth century. It involved archival and literature research, optical examination, and several analyses to identify the repair mortars. When the documentation project began, areas of mosaic loss were covered by colored mortar. It was decided to remove all renderings: this would facilitate examination of the substrates and the masonry, but it would also be useful for grouting purposes. The examination of the substrates revealed that the majority of the mosaics were on nineteenth-century hydraulic lime mortars and that there were fewer examples of cement-based mortars of the 1950s through 1970s. The original Byzantine substrates have survived in six parts of the seventy-seven in situ mosaics of the Daphni Monastery (Anamaterou et al. 2013).

Analysis of the substrates was the first step in the design of the injection grouts and intervention mortars. The research, conducted by the Directorate of Restoration Technical Research, focused on the quality of raw materials and the requirements of the grouts, as well as the special equipment and methods of application. After testing, a set of compositions for grouts and mortars was proposed (Miltiadou-Fezans, Kalagri, and Triantafyllou 2006). The effectiveness of the materials and methods was assessed by using nondestructive techniques on the masonry and mosaics: monitoring with ground penetration radar and the conventional examination of the acoustic emission by hand tapping. Before that, the reliability of the techniques was tested on laboratory samples. The research was coorganized by the Directorate of Restoration of Byzantine Monuments, the Directorate of Conservation of Ancient and Modern Monuments, and the NTUA School of Civil Engineering, Reinforced Concrete Laboratory. Monitoring of the grouting of the mosaics by ground penetration radar was implemented by Laboratoire Central des Ponts et Chaussées (LCPC), France (Cote et al. 2005).

Another set of tests conducted by the Directorate of Restoration of Byzantine Monuments; the Directorate of Conservation of Ancient and Modern Monuments; the Directorate of Restoration Technical Research; NTUA, School of Civil Engineering, Laboratory for Earthquake Engineering; and NTUA, School of Civil Engineering, Reinforced Concrete Laboratory, dealt with the masonry and mosaic strength resistance to seismic activity (Miltiadou-Fezans et al. 2006). A copy of a wall and a cross-vault in scale covered with mosaics were constructed with the traditional techniques and materials and then tested on a seismic simulation platform. The tests were carried out before and after grouting to evaluate the efficiency of the injections. Mosaics on different substrates were tested: lime mortar, as with the original Byzantine techniques; hydraulic lime mortar, as used in the nineteenth century; and cement-based mortars, used in the mid-twentieth century.

Finally, several analyses of the stone and gold tesserae were conducted to reveal the mechanisms of decay and the causes of corrosion of the material (Fiori et al. 2002; Anamaterou et al. 2013).

Conservation Implementation

The actual conservation treatments of the mosaics were implemented at the same time as the several research projects. The reason for this was that certain interventions to the mosaics had to be completed before grouting, such as sealing of cracks and losses, to ensure the efficacy of the technique. Although the mosaics had been detached and relaid on the walls and dome of wall and the dome of the monument, maybe more than once, our aim was to avoid additional detachment and instead work in situ.

Many areas of tessellatum, mainly near large cracks, were detached from the masonry and had to be treated as soon as possible. The majority of the bulges were leveled in situ. The area was faced and partially lifted without being fully detached; the substrate was cleaned, new mortar was inserted, and the lifted part was relaid with controlled pressure. In some cases, though, partial detachment was inevitable. From a total of thirty mosaics, fifty-three fragments were leveled in situ and nineteen fragments were detached and relaid. The small cracks were sealed, the old mortar surrounding the mosaics was removed, and the edges were repaired.

Grouting was a slow procedure; it lasted fourteen months, with simultaneous documentation of the penetration of the grout and the filling of the gaps. The tubes for grouting were inserted through existing cracks and losses in the mosaics (fig. 4) and in the masonry. In addition, metal poles were set against the mosaic in order to prevent detachment of the tessellated surface during the grouting process.

The aesthetic presentation of the mosaics motivated a discussion about whether or not to color the interstices between tesserae where new mortar was introduced. Taking into account that the majority of the mosaics had already been restored in the nineteenth century and that many losses were refilled with original or new tesserae, it was decided to proceed with limited restoration, with mortar (colored or not) to small losses (figs. 5, 6), with respect to the authenticity of the mosaics and the historic restoration, and with color to interstices in areas with dark tesserae (Anamaterou et al. 2013). The masonry will not be covered with mortar in the area of losses, except in the case of the dome, which will be covered for structural purposes.

Figure 4 Introduction of the tubes and sealing before grouting. Photo: © Hellenic Ministry of Culture and Sports

Figure 5 Detail of a loss before restoration. Photo: © Hellenic Ministry of Culture and Sports

Figure 6 Detail of a loss after restoration. Photo: © Hellenic Ministry of Culture and Sports

Toward the end of the project, it was decided to insert extra metal rail supports in the arches of the building to ensure the strengthening of the structure. The upper part of the mosaics in the arches had been removed at the beginning of the project to insert the metal structures. Eventually, the lower part of the mosaics had to be removed as well. The detachment procedure had to be carefully planned to ensure minimum strain on the mosaics.

The last intervention that was performed was the re-laying of the mosaic panel depicting the prophet Ionas that had been removed in the first phase because the substrate had suffered great damage or had collapsed. After the masonry was consolidated and supported the detached and treated mosaic panels were put back in their original place.

The cleaning, retouching, and covering of the dome's losses with mortar are the final elements of the work that will reveal and enhance the mosaics' splendor. By the end of the project in 2015, we will be able to offer to the public a new presentation of the mosaics and the monument.

The Documentation Archive

Documentation of the conservation was carried out simultaneously with every phase of the conservation project. An effort was made to include every detail and piece of information available. Four series of graphic documentation sets were prepared for each mosaic. The first series is the mapping of historical interventions (fig. 7), the second is the survey of damage on the mosaic's surface, the third is the survey of the preparatory layers (fig. 8), and the fourth is the new conservation interventions. A fifth set of documentation is based on archival research and includes all available written evidence for conservation work on each mosaic panel of the Daphni Monastery, either published or archival. The conservation documentation archive now has significant value for the history of the monument and the mosaics, as it revealed many new historical facts and details on the manufacture, technique, and protection of the mosaics.

Dilemmas and Decisions

The major dilemma that the team dealt with was the detachment of several mosaics in order to allow for the strengthening of the building. The need for permanent support in certain areas could not be overcome, and the metal support and rails will remain in the monument. The mosaics of the arches, with a total area of 13 square meters, that have been detached and treated in the laboratory cannot be relaid in their original place. Several solutions are being examined, and every effort is being made to exhibit them in the church.

The work began in 1999 right after the earthquake in Athens and has continued uninterrupted up to today. In spring 2015, the project is expected to be completed. For a ten-year period the conservation project of the Daphni Monastery was cofinanced by Greece and the European Union through the 2nd and 3rd Community Support Framework and the National Strategic Reference Framework; for the remaining five years, financing came from Hellenic national funds. The

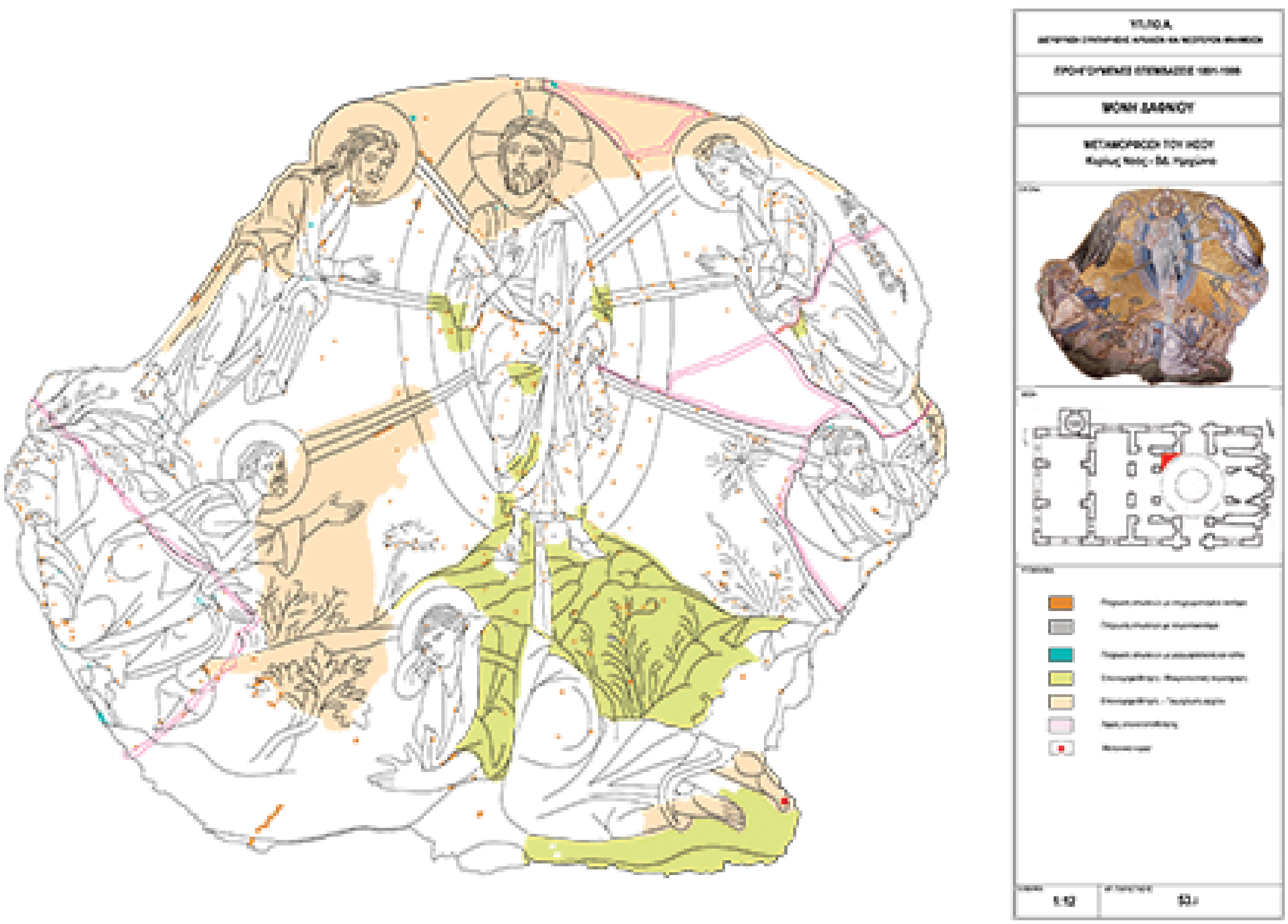

Figure 7 Mapping of a historical intervention. Photo: © Hellenic Ministry of Culture and Sports

conservation was projected to take fifteen years, with the estimated cost expected to reach €1.5 million. In total, seventy people worked on the conservation of the mosaics during these years, including conservators, conservation technicians, researchers, and scientists.

The coordination of the work of the diverse and interdisciplinary teams, which worked together on tight schedules, was a challenge. In spite of the difficulties, the project is about to conclude in time, and we hope that soon the Daphni mosaics will reveal their beauty to the public.

Acknowledgments

We would like to thank all the involved services of the Ministry of Culture, all the research centers, and all our project colleagues and staff.

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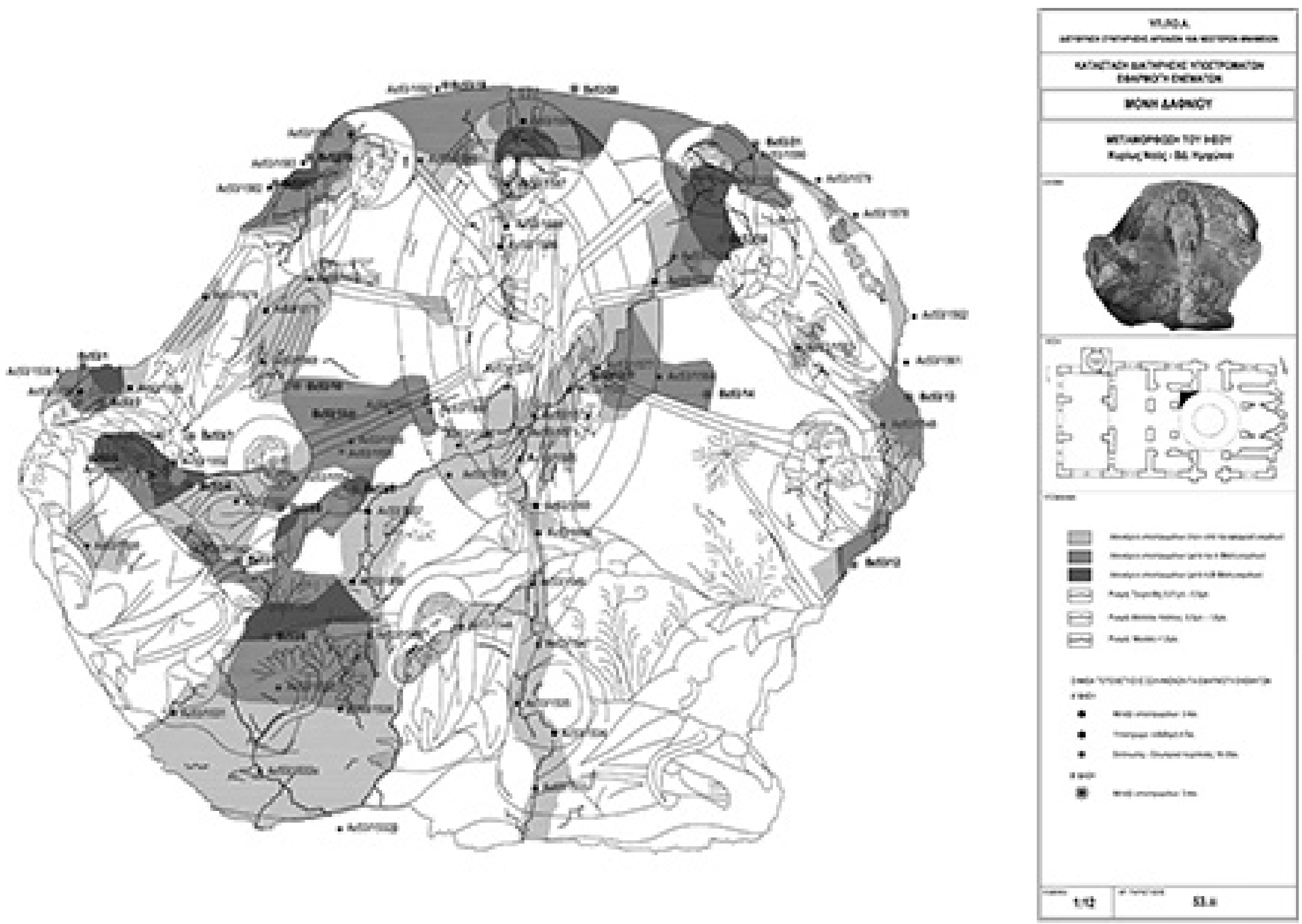

Figure 8 Condition survey of the preparatory layers. Photo: © Hellenic Ministry of Culture and Sports

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History of the Conservation of the Mosaics at the Archaeological Site of Mediana

Vesna Crnoglavac

Abstract: *The archaeological site of Mediana is a unique complex built during the reign of Constantine the Great and his sons, situated in southern Serbia about three miles from the modern town of Nis. Archaeological excavations show the existence of three main building horizons, which lasted from the end of the third century* CE *to the invasion of the Huns in 441. During the research the presence of twenty buildings was confirmed, some of which had mosaics. These include the villa with peristyle, the villa with octagon, the villa with conches, and the Early Christian church. The conservation of the mosaics was undertaken gradually upon the completion of the archaeological excavations in 1967 and continues to the present.*

The archaeological site of Mediana is located in southern Serbia, in the territory of the modern city of Nis (antique Naissus). It was built on an elevated loess plateau on the left bank of the Nisava River, along the route of the ancient road to Serdica (Sofia). Mediana is a unique complex built during the reign of the Roman emperor Constantine the Great and his sons. It is well known that Constantine the Great was born in Naissus, that he was brought up there, and that he magnificently embellished the town.

Historical sources mention Mediana on two occasions. The first mention is made by the Roman historian Ammianus Marcellinus (XXVI.5.1), who notes Mediana as the place of the short sojourn of the brothers Emperors Valentinian and Valens in 364 and as the suburb of Naissus and locates it three miles from the town, which facilitated the identification of the settlement. The second mention is recorded in the writings of Procopius (*De aedif.* IV.4.123.2), who, having identified newly constructed military fortifications in the surroundings of Naissus, stated that one was also built in Mediana.

The archaeological discoveries that have been made in the past testify to the size and luxury of the structures in Mediana. The first explorer of Mediana was Felix Kanitz, who, believing that he was on the site of ancient Naissus, began the first archaeological research in 1864. He discovered an octagonal building with remains of a mosaic floor (Kanitz 1892: 77). Many years later this building and the surrounding area were excavated in several campaigns, and new remains of mosaic pavements were found. The mosaics were in bad condition from years of plowing and cultivation of the area. Only two small mosaic panels (50 × 50 cm and 60 × 45 cm) are preserved, and they are housed in the National Museum of Nis (fig. 1).

From the Kanitz excavations in 1864 until the 1930s, the buildings at Mediana were constantly subjected to destruction. The ancient building material was carried away, and valuable artifacts became the property of collectors who gave them away as gifts or sold them. When the National Museum of Nis was established in 1932, it began systematic excavations at Mediana that have continued to the present (Petrovic 1994: 80).

Mediana is an open-type settlement that stretches across an area of 80 hectares. An ancient and modern road divides it into two parts. The northern part of the site has been categorized as a monument of great importance and protected, and it is located on the property of the Nis Waterworks and the National Museum of Nis. The southern part of the site is occupied by the buildings of the former electrical industry, private houses, and storage facilities and is not protected.

Results of previous archaeological, architectural, and geophysical examinations suggest the existence of three main building horizons of antique Mediana:

Horizon 1: end of the third to the beginning of the fourth century

Horizon 2: approximately 330–78

Horizon 3: approximately 383–441

The most important period is horizon 2, in which a complete structure was discovered as part of a large suburban villa of Constantine the Great (so-called villa with peristyle), including a large complex of appended buildings. Within this unit, each building had a specific purpose. The various functions that were combined under one roof in many other luxury villas were performed in Mediana in separate, spacious buildings. Some of the buildings were for economic purposes, while others housed the many servants. The third type of building was the most important; these were luxurious residences or office premises. Excavations showed that the complex was built in stages in horizon 1 and in horizon 2, and it underwent certain changes depending on the needs of the owner. The owner of all these buildings and the entire Mediana complex was one person, so this horizon has to be viewed as a unique whole, regardless of the phases of construction. Until the Gothic incursion in 378, structures of various purposes had been built at Mediana (for example, the villa with an octagon, military barracks, and a *horreum*, or winery). The end of horizon 2 was marked by a big fire and the initial destruction, which can be linked to the attack by Gothic tribes after the battle at Adrianopolis in 378. Subsequently, a completely new type of settlement was erected on the ruins. In horizon 3, new buildings were built around the villa, and some sections of the villa itself underwent changes. Along the eastern row of barracks, two churches were also built during horizon 3. This settlement had the characteristics of a village community. The settlement was destroyed during the invasion by the Huns, probably early in 441, when Naissus was seized (Vasić 2013: 99–101).

Mediana was an imperial villa built for enjoyment and for managing state affairs, but it was also an agricultural property (fig. 2). The largest and most prominent part of Mediana is an enclosed complex containing a villa with peristyle, covering a total area of 4.7 hectares (fig. 2, no. 1). This complex was separated from the rest of the settlement by an enclosure wall (fig. 2, no. 8), which forms a large and spacious courtyard to the north and two smaller lateral courtyards to the south.

The villa with peristyle comprised an area of about 6,000 square meters (94 × 62.5 m), facing a north–south direction (fig. 3). The central part of the villa comprises a garden with a large pool (fig. 3, no. 4), surrounded by pillars that form the peristyle or porch (*peristilium*). The porch gave access to many rooms, approximately of the same size, arranged in two rows at the eastern and western ends of the courtyard. The entrance to the courtyard is indicated with two massive pylons, as part of a monumental semicircular construction. Located opposite the entrance, on the peristyle axis, on the north side, is a great hall (*aula*) with a semicircular-apsidal end reinforced by pilasters (fig. 3, no. 6). The hall was accessed by means of a platform (*podium*), elevated by the height of three steps (fig. 3, no. 5). Situated to the east and west of the hall are fourteen rooms of irregular sizes and shapes. To the northwest and northeast of the hall, there are two small dining rooms (*stibadii*), which were designed for intimate receptions and banquets (fig. 3, nos. 7 and 7a). At the northwestern end, the villa was connected to the private baths (*thermae*) (fig. 3, no. 9) (Milošević 2013: 121–22).

Figure 1 Mosaic from the villa with an octagon.
Photo: V. Crnoglavac, 2015

The villa was magnificently decorated with numerous marble and porphyry sculptures, bronze railings, and floor and wall decorations, suggesting that the building was residential during the second phase of construction (horizon 2). The new organization of the villa clearly marked the direction of movement along the ceremonial access way (fig. 3, no. 1) through the monumental ancient gate to the southern part of the villa (fig. 3, no. 2). For the purpose of introductions (*vestibulum*) and waiting, a four-sided room in the front of the villa and the southern portico was used (fig. 3, no. 3). The ceremonial access way led through the peristyle to the halls for holding audiences (*consitorium*) and banquets (*trichorum*).

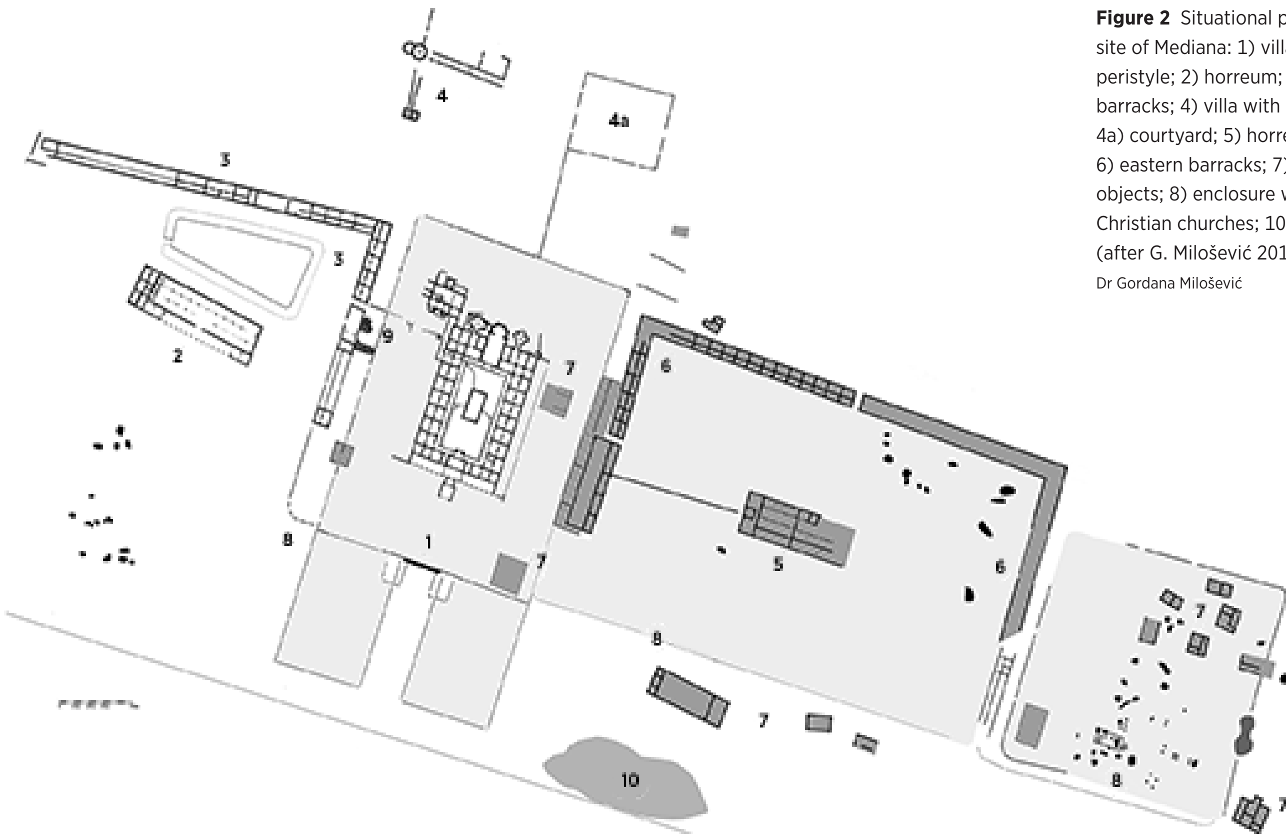
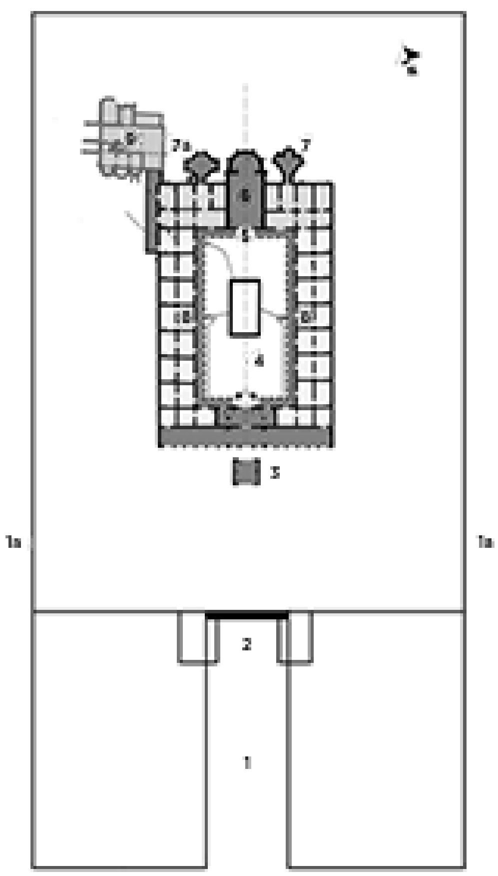


Figure 2 Situational plan of the site of Mediana: 1) villa with peristyle; 2) horreum; 3) western barracks; 4) villa with octagon; 4a) courtyard; 5) horreum; 6) eastern barracks; 7) other objects; 8) enclosure wall; 9) Early Christian churches; 10) necropolis (after G. Milošević 2013). Photo: Dr Gordana Milošević



Two adjacent smaller dining rooms, as well as some rooms in the northern part and their connection with the thermae, accentuate the private and representative nature of these buildings. In contrast, the rooms in the lateral wings retained a more modest appearance and arrangement, since they were secondary in both character and architecture and were used for the administrative business of the imperial office (*officium*) (Milošević 2013: 125).

Historical Overview of the Conservation of the Mosaics

The mosaic floors in the villa with peristyle covered a surface of about 1,000 square meters, including the porch in the peristyle, the great hall, two stibadii, the western porch leading to the *balneum* (or thermae), as well as certain spaces within the balneum. It is assumed that about 70 percent of the original surface has been preserved.

Figure 3 Plan of the villa with peristyle: 1) ceremonial access way; 1a) surrounding wall; 2) ancient gate; 3) vestibulum; 4) peristyle; 5) podium; 6) hall for audiences (consitorium); 7, 7a) hall for banquets (stibadii); 8) officium; 9) thermae (after G. Milošević 2013). Photo: Dr. Gordana Milošević

The conservation of the mosaics was implemented gradually upon the completion of the archaeological excavations in 1967, and continues to the present. The first recorded conservation efforts were carried out in 1967 in the area of the balneum and in the northern part of the western porch. The mosaic in the balneum on the floor of the palaestra was made of opus segmentatum, with irregular polychrome stone slab fragments. The northern part of the western porch was also paved in opus segmentatum, but here are inserted two emblemata made of opus tessellatum, one with a preserved chessboard motif (fig. 4).

The excavations in 1969 brought to light the northern peristyle of a large luxury villa decorated with mosaic floors. A great percentage of the mosaics were preserved but needed urgent conservation treatment; a project was developed for the excavation of the remaining part of the peristyle and the conservation of the mosaics. This project was a collaboration of the National Museum in Nis and the National Museum in Belgrade. The chief of the project was Milorad Medic, conservator from the National Museum in Belgrade, and his assistant was Nikola Antov, conservator from the National Museum in Nis.

The project started in 1971 with preparatory work, such as drawing the four mosaic carpets in the northern part of the peristyle and their examination, construction of storage and protective roofing, making of four wooden rollers, and purchase of tools and equipment. It was decided to lift the mosaics using traditional animal glue facing and a rolling method, because in that way it was possible to lift a larger part of the mosaic in one piece (approximately 19.2 square meters of mosaic per roller). Figural mosaics were lifted in smaller segments. After cleaning, mosaics were relaid on a new lime-mortar bedding in their original locations on site.

In 1972 the peristyle of the villa was fully excavated and conservation of the mosaics began, which lasted until 1974. The floor of the peristyle was decorated with different polychrome mosaic carpets, made of opus tessellatum. Geometric compositions prevail, except in one pavement on the podium entering the great hall, where there is a figural mosaic representing the river deity at the eastern corner and a mythological scene with Leda and the Swan in the western corner (fig. 5).

Excavations and conservation of the great hall, or aula, were carried out from 1975 to 1977. The great hall was paved with a polychrome mosaic made of opus tessellatum. The mosaic was approximately 50 percent preserved. The parts that remain consist of geometric ornaments and a figural representation of the head of Medusa (fig. 6).

On the completion of this huge conservation project, the mosaics were covered with a layer of sieved sand. In the instructions for the maintenance of the mosaics Milorad Medic emphasized that the mosaics could be open only partly and seasonally and that a light roof construction over

Figure 4 Mosaic from the western porch.
Photo: V. Crnoglavac, 2015

the peristyle should be installed for their protection. These instructions have been accepted, and over the course of many years only a small part of the mosaic in the eastern peristyle and the Medusa and river deity mosaics have been presented to visitors. The eastern part of the peristyle was uncovered for a few days in 2004, just for the needs of orthophotographic recording. The protective roof, made of wooden beams and brick tiles, that covered part of the mosaic in the eastern peristyle was removed in 2005, when it was decided to no longer uncover the mosaic seasonally.

Excavations in the northwestern part of the villa with peristyle in 2010 and 2011 revealed a new dining room (stibadium B). It had a polychrome mosaic pavement made of opus tessellatum with a geometric pattern. Although it had been destroyed in a few places, the main part was well preserved. After the excavations preventive conservation treatment was

Figure 5 Mosaic from the peristyle representing the river deity and Leda and the Swan. Photo: Dr. Gordana Milošević

Figure 6 Mosaic from the audience hall representing the head of Medusa. Photo: Dr. Gordana Milošević

carried out, and it was covered with geotextile and sandbags; above this a removable cover with a pitched roof was installed.

In 2011 preventive conservation treatment was carried out on the mosaic in the western porch, which had been reburied several times. The mosaic is polychrome, made of opus tessellatum, with a motif of overlapping scales. For several years the mosaic was protected by an enclosed temporary shelter, but the shelter had to been removed when, in summer 2014, a permanent shelter above the villa with peristyle was constructed. The mosaic was then covered with sandbags.

The last conservation treatments were carried out in 2014, on the mosaic in stibadium A (fig. 3, no. 7) and on the mosaic from the Early Christian church (fig. 2, no. 9). The mosaic in stibadium A was fully excavated in 1935, and in 1936 the mosaic was protected with a permanent shelter. The shelter served as the site museum and had a small archaeological exhibition until 2013, when the Institute for Protection of Monuments in Nis decided to excavate inside the museum building. The mosaic in stibadium A is polychrome, made of opus tessellatum, with geometric and floral motifs (fig. 7).

The polychrome mosaic in the Early Christian church (60 × 50 cm) was discovered in 2000. It was made of opus tessellatum with a Christogram motif. After the church was completely excavated in 2004, an enclosed shelter with a saddle roof was installed. The conservators from the Republic Institute for Monuments in Belgrade decided to lift the mosaic for safekeeping and to make a replica that will be placed onsite (fig. 8).

The total cost of the conservation of the mosaics at the Mediana site in the period from 1971 to 2014 is approximately US $162,000. To that sum must be added the cost of the conservation done in 1967 on the balneum mosaic, which is unknown.

Unfortunately, the lack of regular maintenance of the conserved mosaics over the past thirty-five years has caused new problems that call for an active response. The most obvious example is a mosaic from the villa with conches, which was lifted during a rescue excavation in 1975. Exposed to environmental conditions for years, it suffered extensive structural damage. For that reason the mosaic was detached in sections in 2011 and put in storage, until there were funds for its conservation. The Ministry of Culture approved funds for this project in 2014, and the mosaic was conserved in 2015. The cost of that is estimated at US $26,000.

Conclusion

From an archaeological point of view, Mediana is a very important ancient site, representing the imperial domain of Constantine the Great's dynasty. Thanks to the construction

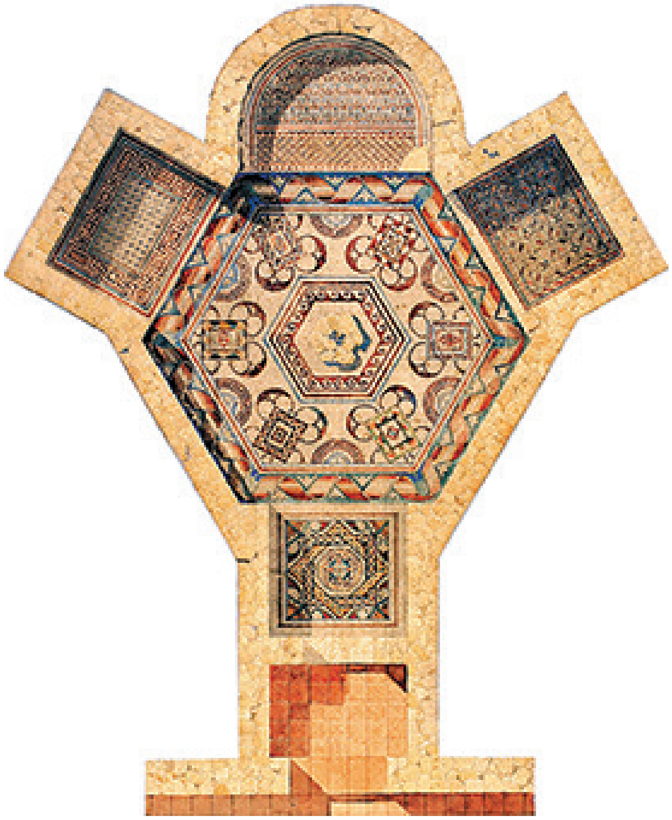


Figure 7 Mosaic from stibadium A (plan after R. Bratanić 1938)

Figure 8 Mosaic from the Early Christian church. Photo: V. Crnoglavac, 2015

of the museum in 1936, the position and importance of this site were permanently established. Although the construction of the museum had broken up the physical connection of stibadium A with the rest of the villa, the museum has now become an integral part of the cultural landscape. Its construction is witness to the development of a philosophy of preservation in Serbia between the two world wars. For many years the site was presented as the "monument in ruins," with a shelter protecting the uncovered remains of the Roman architecture (Milošević-Jevtić 2014: 22–25).

Ideas for the presentation of the site of Mediana as an archaeological park have been put forward, but due to political circumstances this has not been realized. Unfortunately, the lack of a management plan as well as the lack of regular maintenance have already been reflected in the generally poor condition of the site. The ongoing project of sheltering the villa with peristyle is a prime example of the lack of coordination between institutions in charge of Mediana. Such a huge project should have been managed by an interdisciplinary team, involving people who have the necessary experience and knowledge. However, we are now faced with new construction, and we have to focus on finding adequate solutions for good site management and maintenance policies.

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Discovering and Safeguarding the Mosaics at the Pont del Treball Roman Villa in Barcelona

Sílvia Llobet i Font, Montserrat Pugès i Dorca, and Anna Bertral i Arias

Abstract: *The construction of the high-speed rail line through the city of Barcelona, which began in 2008, made it possible to conduct an archaeological impact assessment on a 3.7-kilometer tract of land, the largest site ever excavated in the city. The construction of La Sagrera Station uncovered the remains of a Roman villa and several pavements, including an early fifth-century opus tessellatum. This paper reflects on the cost of progress at the expense of heritage conservation and illustrates the social dimension and positive impact the discovery could have for the district, despite its physical disappearance.*

It is safe to say that, nineteenth-century pioneers aside, modern urban archaeology in Barcelona emerged in the early twentieth century with the construction of Via Laietana, a street that traverses the medieval city and connects the port with the city's Eixample district. To build it, 2,200 houses along the 900 meters comprising the street were demolished. Construction also uncovered the Roman wall. Mindful of the magnitude of the destruction to part of the medieval city, there arose a "moral necessity" to preserve as many vestiges as possible: the first archaeological interventions involved fragments of historical buildings or even relocating entire medieval palaces, in accordance with a methodology and patrimonial objectives aimed solely at recovering and safeguarding remains of the past.

The origin of urban archaeology in Barcelona, the main premise of which is to study the city, dates to more recent times. The discovery of Roman remains under the Plaça del Rei in 1943 prompted the creation of the Barcelona City History Museum, where visitors can view layers of subsoil. This represents a pioneering work in museum displays. From the outset, the museum established a department to carry out archaeological research, the Archaeology Service.

Today the Servei d'Arqueologia de Barcelona is managed by the city council, under the Barcelona Institute of Culture. Its purpose is to study the origin and evolution of the city's territory through its material remains. The area of study encompasses all the land within municipal territory—90.4 square kilometers—though 80 percent of our archaeological interventions take place within the Ciutat Vella (Old City) district due to the potential for finding cultural remains and the intense urban development occurring there. Thus we regard the city as one single multi-strata archaeological site dating from prehistoric to contemporary times.

Internally, the Archaeology Service is divided into two areas: Prevention and Documentation, and Intervention. The latter includes the Department of Interventions in Heritage, which is responsible for preserving and conserving archaeological remains that fall within the Archaeology Service's area of activity. The department's work concerns both built heritage and activities subsidiary to archaeological interventions, such as the conservation and restoration of both movable and immovable heritage.

Construction of the High-Speed Rail and Excavation of the Pont del Treball Roman Villa

The archaeological excavation in question is related to the construction of the stretch of a high-speed rail line through the northern sector of Barcelona. One of the most significant excavations in Barcelona in recent years, or rather, the most notable excavation in terms of duration and magnitude, regarding both expanse—40,000 square meters—and amount of earth moved, the project involves laying railway tracks and constructing a large central station that will become an interchange hub between several rail, subway, and bus lines.

In terms of organization, construction of the high-speed rail line has been taken up by the state-owned company Administrador de Infraestructuras Ferroviarias (ADIF), which is responsible for managing railway infrastructure (tracks, stations, etc.). ADIF subcontracts with external companies to execute the work or, in our case, carry out the archaeological excavation and conservation and restoration work, in accordance with plans drawn up by the Archaeology Service and authorized by the Government of Catalonia, our autonomous government.

Construction of the rail line began in 2008. As required under both Spanish and Catalan law, archaeological and heritage impact assessments were conducted on the 3.7-kilometer tract of city land, making it the largest site ever excavated in Barcelona· So far, roughly three million cubic meters of earth have been removed from the area, and numerous archaeological remains dating to a broad range of time periods, from the Neolithic Period to the twentieth century, have been discovered.

One of these sites is the Pont del Treball Roman Villa, from which the mosaics discussed in this paper were recovered. The mosaics and wall paintings have been removed, and all structures unearthed during construction of the rail line have been dismantled. Indeed all archaeological remains have been excavated and documented, and though some have been examined, the study of others are still pending. The archaeological levels at all sites have been exhausted, and all material remains have been dismantled and removed. For this reason, in the section on lifting the pavements, we refrain from entering into ethical, social, or cultural considerations. We reserve our thoughts on the significance of losing archaeological remains for the conclusion. This incredibly important issue, which prompted an extremely difficult and traumatic debate within the neighborhood and city as a whole, represents the true cost we have had to pay for these mosaics—a cost that cannot be calculated in monetary terms but, in our case, has been compensated by the in-depth knowledge we have acquired on this part of the city.

The Pont del Treball Roman Villa and the Recovered Mosaics

In the summer of 2011, during construction of the abovementioned high-speed rail line (HSR), the Pont del Treball Roman Villa was discovered by archaeologists while monitoring the building of the new Sagrera intermodal station. The excavation was carried out in two phases: the first phase took place between July and November 2011, during which time roughly 1,100 square meters was excavated, and part of the villa's *pars urbana*, as well as earlier Iberian structures, were discovered (Alcubierre 2012: 76–79). The second phase lasted from June 2012 to December 2014 (fig. 1), during which 8,000 square meters was excavated. Additional areas of the *pars urbana* and part of the *pars rustica* and *fructuaria*, including a large wine-producing complex, were documented (Ardiaca and Alcubierre 2014: 99–102; Alcubierre, Ardiaca, and Artigues 2015). At present, work on the HSR is still under way, and part of the villa is yet to be excavated. The subsequent

Figure 1 View of the site during the archaeological excavation, with the city of Barcelona in the background. Photo: Sílvia Llobet

restoration and documentation work, among other tasks relating to the archaeological report, is also pending completion.

Based on the villa's chronological sequence, initial construction dates to the latter third of the first century BCE. Both residential and industrial structures dating to this period have been found. Toward the end of the first century CE, the wine-producing complex underwent a major transformation, leading to increased economic activity, a development reflected in a series of reforms and changes to the residential complex (Alcubierre, Ardiaca, and Artigues 2015: 78–80).

Between the first and fourth centuries CE, new living quarters were built and the central peristyle was embellished. None of the pavements lining the rooms during those phases have been preserved, having been destroyed during the early fifth century in a new building campaign. The only surviving remnants are the almost fifteen hundred glass tesserae—green and blue, with some red—recovered from the destruction levels.

The villa's transformation culminated in the early fifth century when the residential complex was split into two distinct areas, one to the north and one to the south (fig. 2). In the northern section, the old chambers were transformed into a private area comprising a series of rooms paved in opus signinum, except for an area preserving the remains of an opus sectile mosaic. Of the latter, only the preparatory layers remain, consisting of marble and ceramic shards used to level and support the mosaic, which has not been found, likely stolen in ancient times. In this layer of the floor's preparatory substratum, the mortar presents traces of opus sectile panels, making it possible to partly reconstruct the floor's original layout, the perimeter of which was arranged

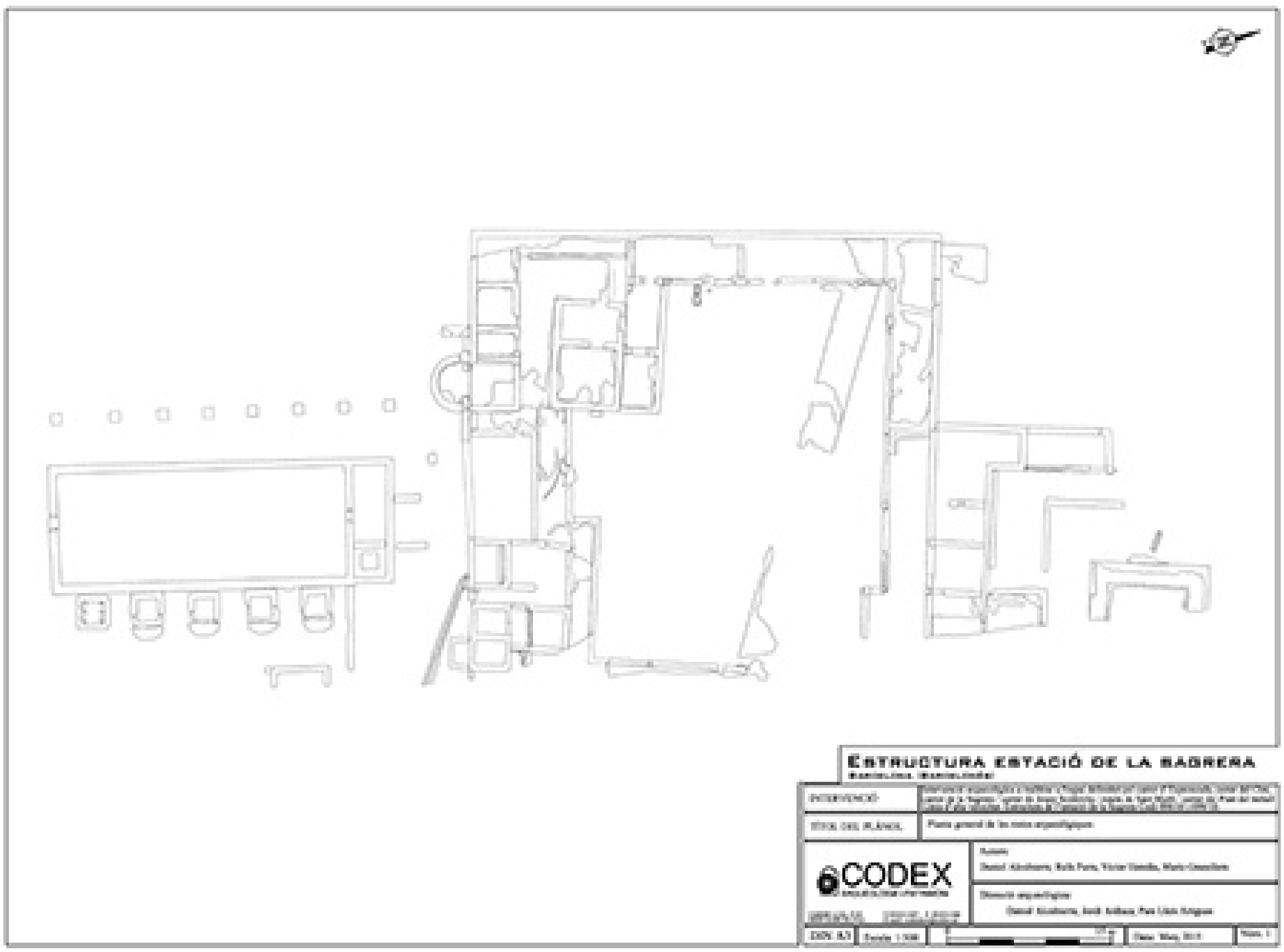

Figure 2 Ground plan of the Pont de Treball Roman villa during the phase dating to the fifth century.
Drawing: Daniel Alcubierre

in a U-shape. From this layout, as well as other information, we can infer that this room was a triclinium. Aside from the pavement, we also managed to confirm that the skirting boards, traces of which are extant, also displayed this marble decoration.

Our first course of action was to document the preparatory layers beneath the opus sectile floor. The remains of the walls and mosaic were scanned to create a 3D image and an orthophotograph was taken and subsequently used to number all remaining marble and ceramic shards; these records were used during the lifting and packaging stages. Back at the laboratory, we took detailed photographs and cleaned the surface of each shard, preserving their original mortar for later study. Last, they were stored in polyethylene boxes, pending completion of the lithological study.

Separated from this private area by a porticoed corridor, the southern part of the villa was transformed during the fifth century into a reception area (fig. 2). This area annexed land from the central courtyard, in which several *cubicula* (small rooms, often bedrooms)—all paved in opus signinum—and the villa's most opulent rooms were built. These included the baths, an apsidal reception room, or *oecus*, and a large hall, which was the only one paved in opus tessellatum and is easily the most significant of all the recovered mosaics.

The opus signinum floors were scanned to create a 3D representation, to which photogrammetric imagery were applied. Prior to producing the graphic documents, we performed cleaning tests to help support the archaeological research and collected samples for future studies. We also collected representative "macro-samples" from the villa's pavements and facings, for example, from the opus signinum paving the frigidarium of the baths. These samples were subsequently reset onto a rigid honeycomb support with a view to creating graphic material for possible exhibitions on the site.

Opus Tessellatum: The Symbol of a Villa That No Longer Exists

Because of its singularity and historical, archaeological, and artistic relevance, the entire opus tessellatum from the large reception hall was lifted when it was determined that the building was to be dismantled. The eastern half of the mosaic is in precarious condition. It presents numerous lacunae that are almost certainly the result of plow damage sustained after the land on which the villa was built became farmland. Based on the original measurements, the pavement has a surface area of 55 square meters, of which, unfortunately, only about 60 percent remains (fig. 3). Nonetheless, what does remain is

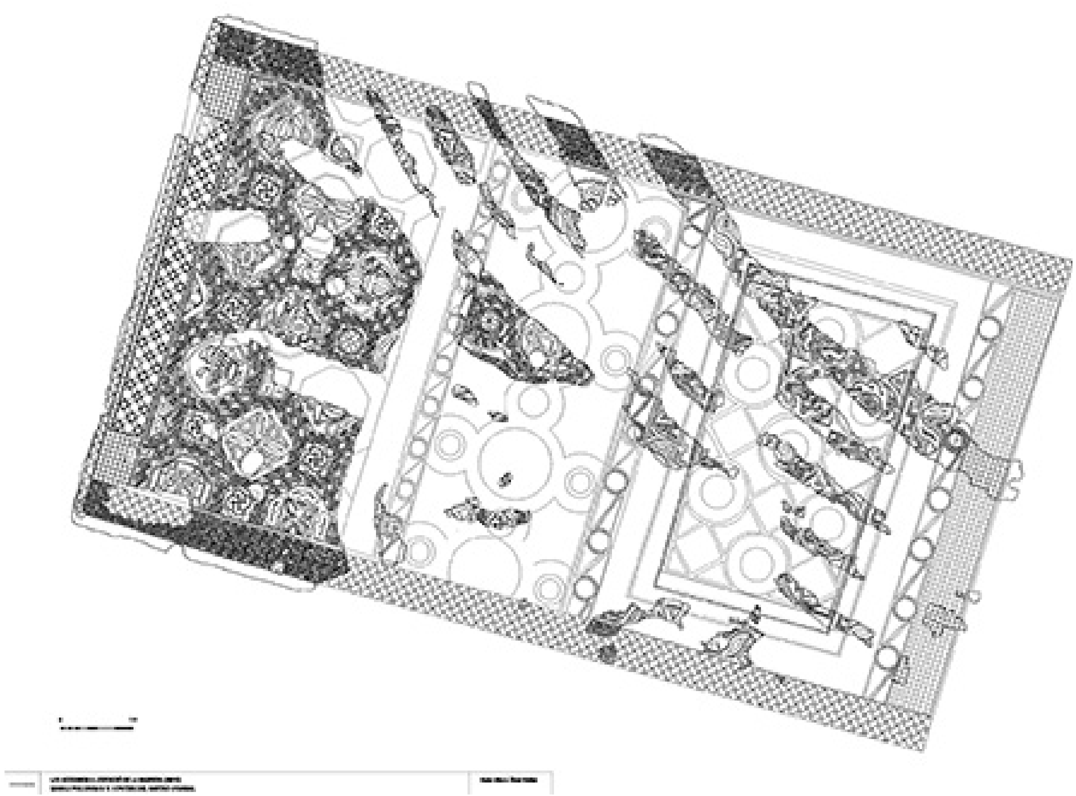

Figure 3 Original design of the opus tessellatum template.
Drawing: Àlvar Mailan

highly compact, and only the borders of the fragments damaged by plowing display any sort of significant alteration: loss of mortar supporting the tesserae and insignificant cracks and fractures. The tesserae, despite being in generally good condition, present a layer of encrustation that makes it difficult to distinguish the colors and see the mosaic's decorative motifs. Some ceramic tesserae are disaggregated.

The mosaic's color scheme features a combination of fourteen different types of tesserae, three of which are ceramic and eleven, stone. At the time this paper was written, the lithological identification of these tesserae was still under way. The predominant color is white, mixed with earth tones, grays, and reds, as well as black pieces. In terms of stratigraphy (fig. 4), the upper layer is composed of 1 × 1 cm tesserae inserted into lime mortar containing a small amount of very fine-grained sand aggregates, forming a thin, even layer 0.06 to 0.08 cm thick. Beneath the bedding layer lies a 5 to 5.5 cm-thick layer of mortar of lime, sand, and crushed ceramic. We must note the good adhesion and compaction between these layers, as well as the quality of the mortar; despite the damage caused by farming, the extant fragments display remarkable cohesion and durability.

Though Roman mosaics were normally built atop initial preparatory and leveling layers known as the *rudus* and *statumen*, that is not the case here, as the bottommost preparatory layer consists of an opus signinum pavement with a clearly distinguishable rudus and statumen. This has two possible explanations: either the mosaic was built atop an earlier pavement or the opus signinum was built as a preparatory layer for the mosaic. Lifting the tessellatum gave us broader insight into the underlying signinum. It also made it possible to document widespread signs of chiseling and a leveling layer of sand that had been applied to form an even, flat work surface. From such evidence, we can infer that they are two overlapping pavements.

As for decoration, the tessellatum presents three panels with different decorations (fig. 3). A guilloche mat, however, is common to all. The first panel features geometric motifs forming an orthogonal pattern of circles and squares tangent to the vertex, with Solomon's knots and quatrefoils inside. This central part is edged by several bands: undulating and twisted ribbons with a trifid calix, fractionated meanders, a simple guilloche, and a border featuring an orthogonal pattern of adjacent squares. The central band displays a pattern of intersecting circles with star- and flower-shaped motifs inside. The room also includes an octagonal honeycomb pattern, the center of which is decorated with quatrefoils and a group of five craters with birds and peacocks flanked by swastikas, as well as a vase with flowers.

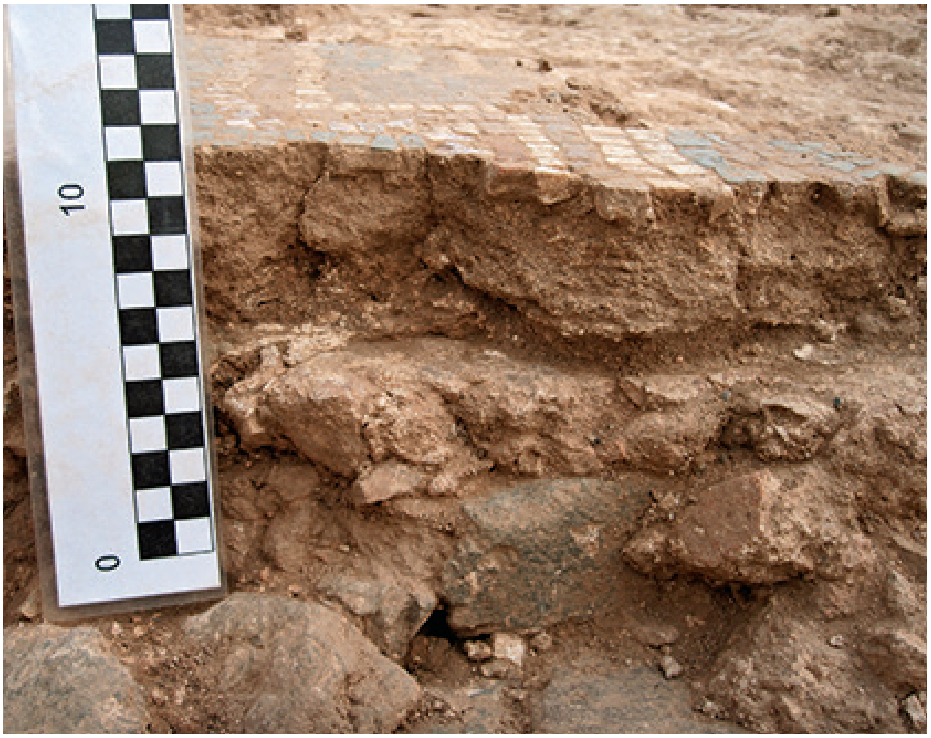

Figure 4 Detailed view of the stratigraphy of the opus tesellatum atop the earlier opus signinum pavement. Photo: Sílvia Llobet

Lifting the Opus Tessellatum: Fieldwork

Recovering something as unique and sizable as a mosaic is bound to interfere with the rate at which the archaeological excavation is carried out. And if the excavation takes place in an urban setting, with varying local sentiments, this interference takes on social dimensions that must be taken into account. Such was the case with this intervention. Yet, far from trying to hide it, we seized the opportunity to offer the press and local residents a glimpse at the archaeological and restoration work being performed during the lifting process. As we mentioned earlier, the site had been exhausted and dismantled, but on several occasions during the intervention the press was invited to visit the site and watch the work unfold firsthand. Our aim was to provide information about archaeology and the methodology being used. It was thus necessary to develop a visitation protocol—with clearly distinct hours and routes to the area housing the mosaic—as well as a work protocol ensuring that the process would be conducted in an orderly and effective manner.

The excavation and discovery of the mosaic was the result of a joint effort of the restoration and archaeology teams (Llobet and Mailan 2012: 153–56). The room was first divided into 1 square meter quadrants, which were excavated one by one in an effort to thoroughly clean the layer of encrustation covering the mosaic surface. The cleaning process, which was much quicker immediately after the mosaic was discovered because the ground moisture made the encrustation easier to remove, also allowed us to monitor the drying process (fig. 5). During that time we recovered 32 fragments of different sizes, each of which was identified with a letter. The excavation also unearthed 140 fragments or groups of small fragments whose position had shifted—likely due to the plowing—each of which was assigned a coordinate. By sieving the soil from all the m^2 quadrants, we recovered approximately 25,000 detached tesserae, which were assigned the number of the quadrant in which they were found (Llobet and Molinas 2015).

Following the discovery and excavation phase, photogrammetry and laser scanners were used to produce the graphic documents. Based on aerial shots of the pavement and measurements taken using control points gathered during the topographic survey, the mosaic was digitally reconstructed using photogrammetric methods. Digital applications helped draw correlations between the digital model and the photographs, producing an orthophotograph with megapixel quality resolution (2 mm/pixel) that could be used to measure distances and calculate areas. A powerful graphic working document, this orthophotograph was used for collecting data relating to the mosaic's condition (fig. 6), numbering fragments, and plotting cut lines prior to lifting, among other

Figure 5 Aerial view of the cleaning work on the part of the opus tessellatum excavated in 2014.
Photo: Sílvia Llobet

Figure 6 Documenting the condition of the opus tessellatum on the orthophotograph. Photo: Maria Molinas

Figure 7 Lifting fragments of the opus tessellatum during the 2014 campaign. Photo: Daniel Alcubierre

uses. The elongated mosaic fragments discovered in 2011 and corresponding to the part of the mosaic damaged by the plow were mostly lifted in their original shape and hardly cut.

In terms of facing, polyester gauze was used instead of traditional cotton gauze because, while just as strong, it is also transparent, enabling the mosaic to be more easily observed and monitored. The gauze was adhered to the surface of the tesserae using polyvinyl acetate.

When lifting the mosaic, we made sure to also lift all preparatory layers, that is, the tesserae plus the layers of mortar, because all this was considered an integral part of the piece. To lift the mosaic, we cut between the last layer of mortar and the opus signinum, enabling us to examine this layer following extraction. We applied the normal protocol: steel rods were inserted into the interstices between the tesserae to open cut lines, then the mortar was undercut—which proved quite simple—by inserting chisels between the last layer of mortar and the signinum (fig. 7). Last, we used steel plates to lift the mosaic and placed each fragment (of mosaic) inside a custom-made, stackable wood box.

The Opus Tessellatum: Laboratory Work

At the time this paper was written, only half of the mosaic lifted during the initial excavation phase had been treated in the laboratory (Llobet and Mailan 2014: 198–200). Nonetheless, we have cleaned and consolidated the mosaic, and reset each fragment onto new supports capable of ensuring adequate storage conditions until the entire mosaic is restored and a decision regarding the mosaic's final location is made. The decision about its location forced us to halt restoration during the reintegration phase. Due to the nature and characteristics of the volumetric reintegration of the lacunae, various factors must be taken into consideration; it is a large (55 m²), heavy piece presenting substantial losses and ornate decoration that will be displayed out of context. Still unknown are factors such as where it will be displayed, lighting, the distance at which it will be viewed, and whether or not it will be displayed on the floor or vertically on a wall.

The first step of the restoration process was to treat the reverse side of each fragment. Due to the weight of the fragments and to facilitate handling, the thickness of the tesserae—plus the original mortar and intervention layer—was limited to 2.5 cm, requiring us to remove some of the original mortar. The cracks, fractures, and damaged edges made it advisable to consolidate the reverse side of each fragment. To do so, we injected mortar made of 1 part slaked lime, 2 parts pozzolan, and 1 part ceramic powder. The weight of the fragments forced us to reinforce the cracked and fractured areas by adhering fiberglass strips using a second type of mortar made up of 7 parts hydraulic lime, 2 parts crushed ceramic, and 5 parts marble powder.

Last, we created the intervention layer, that is, the stratum between the original mortar and the new support. This consisted of a fiberglass mesh adhered using a 0.3 to 0.5 cm-thick layer of mortar. The mortar was made with 7 parts hydraulic lime, 2 parts crushed ceramic, 5 parts marble powder, 7 parts river sand, and an acrylic emulsion added to the mixing water at 2%.

The fragments were stored at the Archaeology Service's headquarters for one month until the new mortar had set properly. They were then turned over, at which point treatment on the front side, that is, the tesserae, began. We used steam to remove the gauze facing and cleaned away any remaining soil or adhesive, as well as any leftover encrustation.

Prior to transferring the mosaic fragments to a new support, we had to create a design template for the mosaic (fig. 3). Using the orthophotograph of the mosaic as a basis, we established a hypothesis for the lacunae and replicated the missing decoration, obtaining a complete picture of the mosaic. A 1:1 scale copy of this sketch enabled us to correctly arrange the mosaic fragments and, where necessary, adjust the position of any fragments that may have shifted while underground. This was an extremely delicate process, since, as explained earlier, the mosaic fragments correspond to disjoined diagonal bands.

Parallel to this, we determined the shapes that the new honeycomb backing panels would have to have. Let us recall that at the time the mosaic was lifted we opted not to reshape the mosaic's irregular fragments. As a result, we were forced to transpose this irregularity onto the honeycomb panels, requiring us to carefully plan the order and sequence in which the panels would fit together so as to make them easier to assemble and disassemble in the future.

Once the panels were finished, the mosaic fragments were transferred to the new support and adhered by applying small dots of epoxy resin between the intervention layer and panels. Re-laying some fragments proved quite difficult, having been discovered out of context. Three factors played a key role in correctly arranging the fragments on the new support: information concerning the area in which they were discovered, the fragment's decoration, and the design template based on the orthophotograph.

The final step involved adding the detached tesserae to the mosaic. As a result of the large amount of lacunae in the first recovered mosaic fragment, in order to improve readability,

Figure 8 Re-laying the fragments and tesserae recovered from the opus tessellatum onto the new honeycomb support. Photo: Sílvia Llobet

we decided to fill small lacunae in between fragments and finish certain decorative lines with the tesserae, making the parts of the mosaic that had sustained substantial loss and the overall piece easier to understand. The entire re-laying process has been exhaustively documented (fig. 8).

Conclusion: The Price of Resignation

In urban archaeology there exists an almost constant tug of war between developing and modernizing the city and commemorating the past. In the summer and autumn of 2011, the press caught wind of the findings after the area's residents raised concerns about the dismantling of the villa, lending the archaeological excavation a genuinely significant social dimension and, let's not be naive, a political dimension as well. The city and Catalan autonomous governments engaged residents, archaeological professionals, and site managers in efforts to find a solution to the problem. They arranged site visits and conferences, took part in radio talk shows, and ultimately, following a series of commitments on the part of the site developer, reached a consensus. The commitments included exhausting the site's stratigraphy, conducting a comprehensive analysis of the remains, and subsequently publishing or restoring and exhibiting all uncovered materials.

We should not, however, overlook the economic implications of conserving this mosaic.[1] Nonetheless, we feel that, in our case, the economic cost of restoring the mosaic was never an issue, particularly when the cost of the construction project in question was estimated at millions of euros. The problem stems from the need not only to lift the mosaic, but to sacrifice the archaeological remains that lend it meaning. How do we calculate the heritage value of the villa that has been destroyed? How can this value be recuperated? Would it have been worth it to conserve the archaeological remains and decide not to build the station?

In this sense, conserving the walls does not ensure a heightened interest in history, nor would it remedy cultural, social, or urban planning deficiencies. In contrast, we feel the investment required to maintain the archaeological structures, which were in a poor state of conservation, would not compensate for eliminating the plans to build the station. Though attempts were made to modify the project, further archaeological remains could have been uncovered elsewhere, or the construction could have encroached on homes.

Nonetheless, if everything goes according to plan, the Sagrera neighborhood will soon see its mosaic gracing the entrance to the station—as emblematic as Miró's mosaic at the airport, and a testament to a villa that became the area's first industrial settlement. This is a day the residents eagerly await! The methodical dismantling of the site has enabled us to deepen our understanding of the villa, which, at present, is Barcelona's most well known site.

Note

1 2011: €4,545.36 (Lifting the mosaic from the station's access points) / 2012: €56,621.71 (Restoring the mosaic from the station's access points) / 2013–14: €11,340 (Lifting the mosaic from the station).

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In Situ Conservation and Presentation of Submerged Mosaic Pavements Located in the Underwater Archaeological Park of Baiae (Naples)

Sandra Ricci, Barbara Davidde Petriaggi, Gian Franco Priori, Carlotta Sacco Perasso, Filomena Lucci, and Gabriele Gomez de Ayala

Abstract: *The Marine Protected Area, Underwater Archaeological Park of Baiae (Naples), preserves the remains of the submerged Roman city of Baiae. In this paper we describe the conservation, prevention procedures, and biological studies conducted on the white mosaic pavement situated in the Villa dei Pisoni, restored in 2004 and monitored until 2014. Specific protection methods have been implemented; in particular, mosaic pavements were covered with geotextile sheets in order to prevent bioerosion phenomena and to easily allow scuba divers to visit the site. The results highlight the efficacy of geotextile covers and the need to perform periodic monitoring to assess the state of conservation of these structures of great value.*

The natural marine parks, reserves, and protected marine areas comprise sites of archaeological, historical, and naturalistic interest. The establishment of underwater archaeological parks is proving to be an effective instrument in safeguarding underwater heritage (Davidde 2002, 2004), in full agreement with UNESCO's Convention on the Protection of the Underwater Cultural Heritage (UNESCO 2001).

The protection and conservation of a submerged archaeological site is complex, because it is devoid of surveillance and specific restrictions, such as the banning of navigation, anchorage, fishing, and unsupervised diving. In fact, actions of clandestine operators are frequent. Additionally, in order to prevent biodeterioration and bioerosion phenomena, biologists and conservators have to study the marine environment and the micro- and macroorganisms responsible. It is necessary to make choices, and very often, above all in the case of wrecks of wood-constructed crafts, the policy is usually to recover or rebury the artifacts.

The Underwater Archaeological Operations Unit (NIAS) of the Istituto Superiore per la Conservazione ed il Restauro (ISCR; Rome, Italy) has been involved since 1999 in a research and experimentation program involving the in situ conservation of underwater archaeological heritage. Within the framework of this project, archaeologists have been involved in the study and assessment of conservation methods and protection systems for wrecks and submerged sites.

The NIAS project, Restoring Underwater, launched in 2001, resulted in developing appropriate methodologies and techniques for the in situ conservation of some structures located in the Marine Protected Area of Baiae. These structures were selected with the Soprintendenza Speciale per i Beni Archeologici di Napoli e Pompei, which has the regional responsibility for its management (Davidde 2002, 2004; Petriaggi and Davidde 2012; Petriaggi and Mancinelli 2004).

The purpose of this research is to highlight the need to protect archaeological submerged mosaics, evaluating the effectiveness of protective covers and the damage caused by marine biological colonization. The use of geotextile (Terram® 2000) allowed the protection of artifacts from both degradation and bioerosion. Geotextiles can be easily removed and repositioned on the seabed and are easily maintained. Obviously the reburial of the artifacts is still the most effective method for an optimal conservation, but it prevents both visitors and researchers from making full use of the submerged heritage.

Study Area: Villa dei Pisoni

The Underwater Archaeological Park of Baiae (Naples) is an area of about 176.6 hectares that safeguards the archaeological remains of the Roman town of Baiae and the infrastructure of Portus Iulius (fig. 1). These archaeological structures range from luxurious maritime villas, private *thermae* (baths),

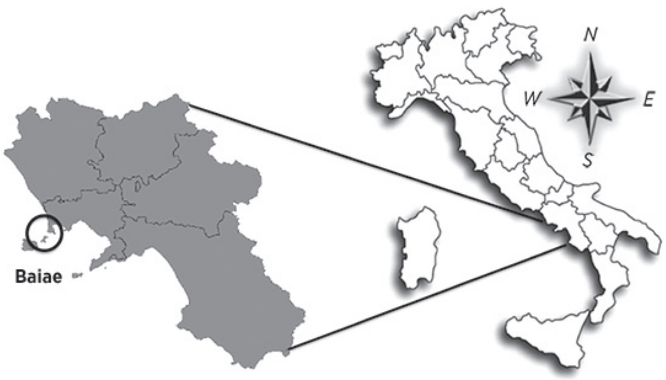

Figure 1 Location of Baiae (Naples) in the Campanian region, Italy. Photo: ISCR

and *tabernae* (shops) to imperial buildings that still preserve some ancient wall paintings and pavements. It represents an underwater area of great historical interest and environmental value.

The Soprintendenza Archeologica di Napoli is responsible for the management of the area. This study has been carried out in the Villa dei Pisoni (zone A, Marine Protected Area of Baiae), a large residential complex that lies some 139 meters southeast of Punta Epitaffio, at about 5 meters below sea level. The complex was given the name Villa dei Pisoni as a result of the discovery of a *fistula aquaria* (water pipes) bearing the name of the proprietor, *Lucius Calpurnius Piso*, lying in its original position in the south corner of the courtyard.

The powerful Piso family of the first Imperial era had their property confiscated in 65 CE, probably as a consequence of a failed conspiracy against Nero. Classical sources provide further evidence to confirm that this villa had once belonged to the Piso family. A passage from Tacitus (*Annals*, XV.59) is of particular interest. His account of the conspiracy names the plotters led by Gaius Calpurnius Piso and identifies the place where the plot was hatched as the villa of Gaius apud Baias.

The residential quarters were protected from the forces of wind and sea by a man-made barrier of 25 pillars (*pilae*) and reticulated work (opus reticulatum). (This discovery indicates that in Roman times the shoreline was some 370 meters farther out to sea than it is today.) The villa later became state property and underwent significant development in the Hadrian era (117–38 CE), when the large central rectangular courtyard was added. It measured some 60 × 100 meters and boasted richly decorated porticos on each side, some with curvilinear alcoves framed by half columns in brick. The marina area on the south side of the courtyard had two mooring quays, water storage cisterns, and fish farms, probably dating to the earliest phases of construction at the turn of the first millennium.

This study focuses on the calcareous mosaic floor adorning one of the rooms of a building complex lying beyond the southwest edge of the *viridarium* (garden) of Villa dei Pisoni. A 1997 archaeological map (Scognamiglio 1997: 40, fig. II) identifies the complex as thermal baths. The mosaic measures 6 × 3.5 meters and is composed of white tesserae. Little more can be said about the room where the mosaic is found, given its fragmentary state and the nondescript nature of the walls.

Conservation Program

A program of conservation and maintenance work has been undertaken on the mosaic by ISCR under the direction of Roberto Petriaggi and Barbara Davidde Petriaggi. The pavement showed several types of damage, such as detachment of the preparatory layers, erosion and alveolization of the tesserae, erosion of the bedding layers of the tiles, and gaps in the preparatory layers. The absence of the layers caused precarious stability of the mosaic, which tended to fragment especially in the peripheral areas (fig. 2). Furthermore, the loss of the mortar between the tesserae resulted in their detachment. Bioerosion phenomena are widely present.

The first operation, in 2004, saw substantial reinforcement of the flooring, filling the voids under the foundation of the edges by hydraulic mortar, filling lacunae with mortar, and consolidating edges using movable panels of aluminum to contain the new mortar (fig. 3). Then a protective geotextile manufactured from polypropylene/polyethylene fibers (Terram® 2000) was positioned to cover the mosaic (fig. 4). This choice permitted easy removal of the cover for viewing the mosaic.

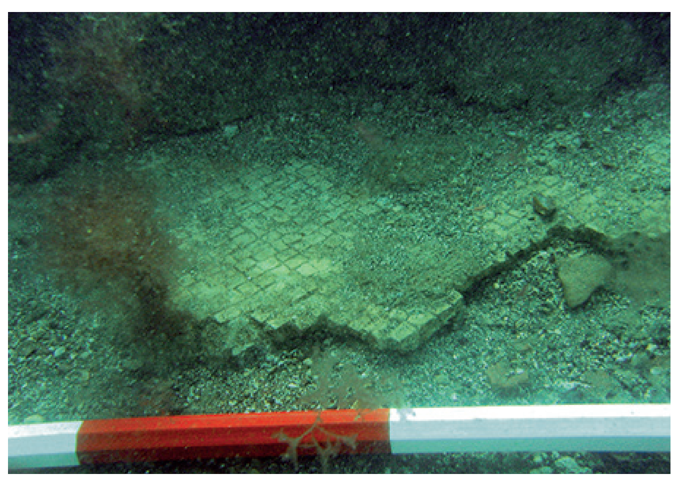

Figure 2 Damage of the mosaic pavement, showing loss of the preparatory layers. Photo: ISCR

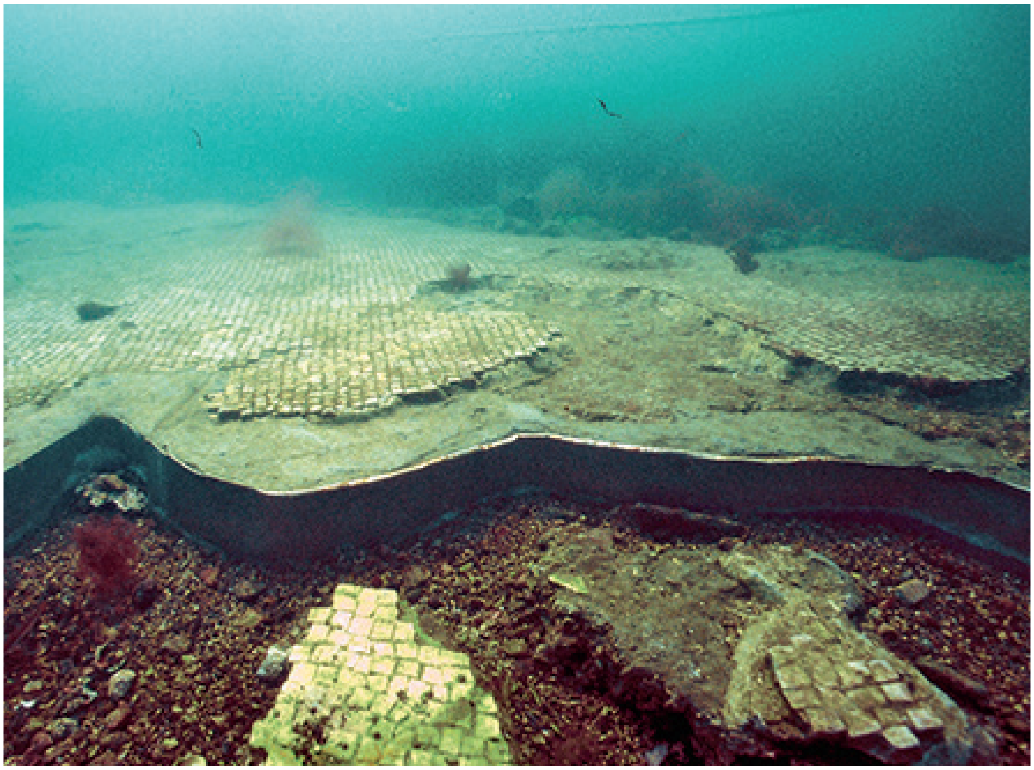

Figure 3 Restoration work completed, 2004. Photo: ISCR

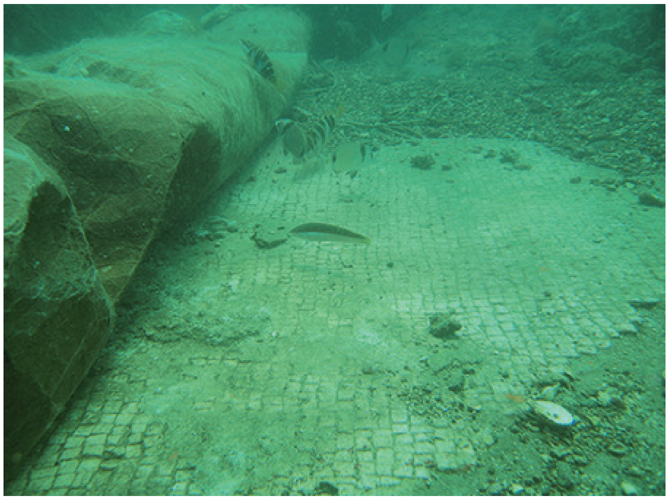

Figure 4 Covering with geotextile after restoration work in 2004. Photo: ISCR

In 2005 routine maintenance was carried out on the 2004 restoration work. Further work took place in 2008, when the protective covering was replaced with a new one. It had to be replaced again in 2009 after high seas had torn it away. A different kind of specially designed padded geofabric was laid in sections, like a military tortoiseshell formation. The stability, adhesion, and overall state of the perimeter grouting work of 2009 were checked the following year. The perimeter grouting was patched and replaced as necessary in 2011, and surfaces where the covering had come away were cleaned. The old covering was replaced with new geofabric weighted down with gravel-filled woven nylon bags. A small section of the covering was then cut out to create a window through which the flooring could be inspected on dives.

Monitoring Activities and Biological Studies

Because of the importance of this floor, it has been chosen as a case study. It has been periodically monitored and studied from a biological point of view in order to evaluate the state of conservation, to identify marine species causing the biodegradation of the tesserae, and to establish full methods to protect the site while allowing it to be visited by divers.

At the beginning of the project, in 2004, the mosaic pavement showed bioerosion phenomena related to the epilithic colonization due to zoobenthos and phytobenthos and to the endolithic colonization caused by boring Porifera (fig. 5). As described in the previous paragraph, the more extensive damage was caused by the loss of the screed layer below the mosaic, due to marine erosion that removed this portion of the structure and also to to marine bioerosion (Ricci et al. 2009; Davidde et al. 2010). The mosaic surface was almost completely covered by a thick layer, in some cases up to 5 cm, of phytobenthos and zoobenthos.

Figure 5 The evident revitalization of boring Porifera. Photo: ISCR

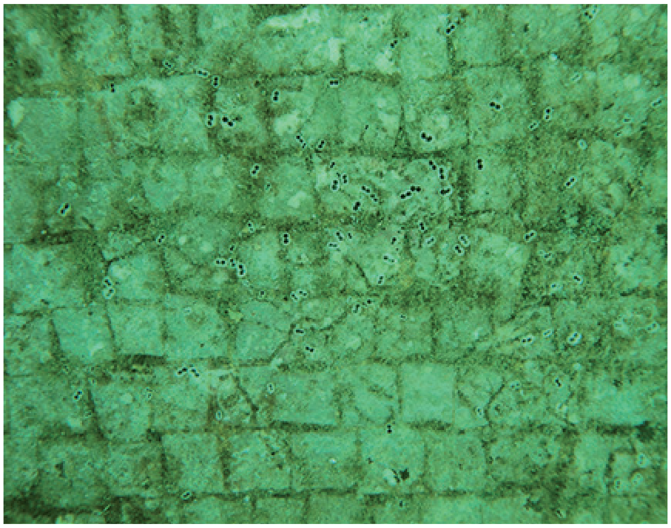

Figure 6 Dense biological colonization of the pavement caused by the endolithic bivalve *Rocellaria dubia* (Pennant, 1777). Photo: ISCR

The main taxa were identified as Chlorophyceae (*Caulerpa prolifera*, *Acetabularia acetabulum*, *Dasycladus clavaeformis*, *Udotea petiolata*), Phaeophyceae (*Ectocarpus* sp., *Halopteris scoparia, Dictyota dichotoma, Padina pavonia*), Rhodophyceae (*Peyssonnelia squamaria, Polysiphonia* sp.), and several specimens belonging to the family Corallinaceae.

Regarding encrusting animals, most frequent taxa were Serpulidae (*Spirorbis* sp.), Crustacea (*Balanus* sp.), Briozoa, Hydrozoa, and epilithic bivalves (*Anomia ephippium, Chama* sp.).

Visual analyses showed the presence also of boring Porifera, noticeable as separated or clustered circular holes. SEM observations allowed the identification of the species *Cliona celata* Grant as the borer responsible for this kind of biodegradation (Ricci, Priori, and Bartolini 2007).

In 2007 the state of conservation of tesserae and mortars was good, thanks to the correct repositioning of the geotextile and the correct management of the site. Biological colonization was absent, and previous sponge growth was no longer alive. Restored portions showed good adhesion of mortars and stability of the movable panels of aluminium that were to consolidate the edges.

The effectiveness of the geotexile covers has been also verified by analyzing the colonization present on its external surface. The material was used by several organisms as a growth substrate. In fact, they colonized fibers, forming a dense organic layer consisting of microorganisms, cyanobacteria, algae, and encrusting and nonencrusting animals, remaining on the geotextile layer rather than on the surface of the mosaic (fig. 5).

Some years later, in 2013, significant worsening of the pavement condition was detected. This was due to lack of coverage for about one year when several coastal high seas had removed the geotextile. The mosaic was characterized by evident biological growth that completely covered the tesserae. The growth (with an average thickness of 2 cm) was largely constituted by epilithic algae (*Dictyota dichotoma*, *Cladophora* sp., *Acetabularia acetabulum*, and Corallinaceae). Cleaning tests performed by soft brushes have been conducted by our team of underwater conservators. Tesserae appeared widely covered by encrusting thalli belonging to Rhodophyta and colonial Bryozoa species.

The worst situation observed was related to the evident revitalization of boring Porifera and to the new endolithic growth of the bivalve *Rocellaria dubia* (Pennant 1777) (fig. 6). The apertures of the tunnels produced by this species are visible through siphons having a typical figure 8 shape (Ricci et al. 2015). The frequency of holes ranged from one to seven holes for each tessera in colonized areas of the pavement.

Laboratory analyses have been conducted to study the microboring and the degradation of the stone material (Ricci et al. 2013). To identify the microboring traces, a selection of tesserae has been treated with a resin-embedding and casting technique to produce replicas of the bioerosion patterns. Samples were impregnated with polyester resin (Styrene Styrol 2S, LEICA Microsystems, Srl) and subsequently dissolved, to obtain the casts of borings and galleries (ichnotaxa). The casts were sputter-coated with gold for SEM analysis. SEM images show resin casts of borehole “negatives” of the actual traces, that is, boreholes inside the carbonate. The procedure

Figure 7 Photomosaic of the studied area. Photo: ISCR

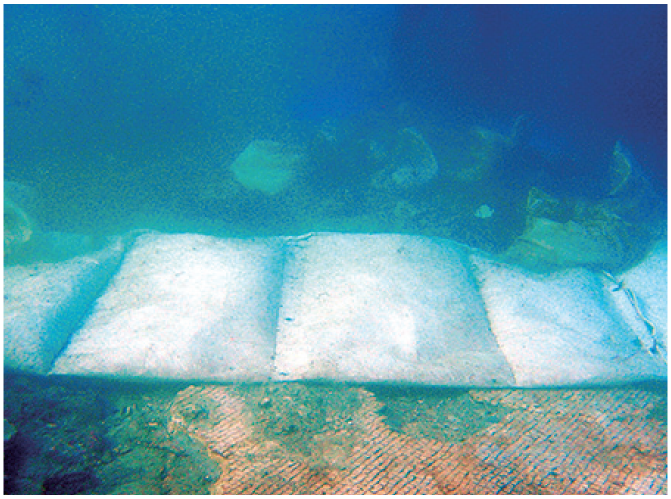

Figure 8 The new geotextile cover in 2014. Photo: ISCR

achieved good resin penetration inside the tunnels and voids of the sample (Golubic, Brent, and Le Campion-Alsumard 1970; Ricci et al. 2013).

In light of the situation observed, it was determined that total cleaning was needed. In 2014 cleaning of the mosaic surface was carried out using brushes and scalpels to clean the mosaic surface, followed by new placement of geotextile in order to devitalize new endoliths growth and to retard the new colonization. A photographic survey also permitted the elaboration of a photomosaic of the studied area (fig. 7).

Finally, at the end of biological studies, the mosaic floor has again been protected with geotextile (Terram® 2000) (fig. 8). At the time of this writing, the protection is working well.

Conclusion

This study has provided important information that can be applied to other artifacts located in the Marine Protected Area. Marble and calcareous artifacts have to be constantly covered by geotextile or other kinds of protection because of their petrographical composition, which makes them subject to bioeorosion phenomena. Monitoring and laboratory analyses showed that stone material regressed to a condition very similar to the one observed at the time of the first conservation treatment. This indicates that the exposure conditions and the nature and state of preservation of the material make it extremely susceptible to biological colonization.

Studies have highlighted three types of colonization. The first type, not readily evident to the naked eye, is characterized by biodeterioration phenomena produced by endolithic microorganisms. It consists of a large variety of species ranging from cyanobacteria and microalgae to marine fungi. This kind of bioerosion makes the stone material less compact and more easily erodible by chemical and physical action of the marine environment, and by both epilithic and endolithic colonizers that find a suitable growth substrate in relation to the greater discontinuities present in granulometry characterizing the substrate (Ricci et al. 2013).

The second type is caused by endolithic boring porifera (Clionaidae). They quickly (within a few months) colonize new substrates and often use existing cavities, extending the internal volumes (Calcinai, Bavestrello, and Cerrano 2004; Sacco Perasso et al. 2015). As is known, the action of clionaids causes severe damage that can result in the almost total loss of the internal volume of the tesserae, leaving intact only a few millimeters of the external layer. It is clear that artifacts with this type of deterioration are susceptible to disintegration, even from slight pressure exerted by anthropic impact and from the main marine agents.

The third type is characterized by a fast endolithic growth due to the bivalve *Rocellaria dubia* (Pennant 1777). This mollusk colonized the mosaic with several individuals on each tessera. The damage produced by this species is extremely dangerous for archaeological artifacts (Ricci et al. 2015).

This study allowed the detailed documentation of the biological colonization of submerged mosaics and also defined the time it takes for different marine organisms to become established. The degraded material is more easily susceptible to bioerosion compared to a stone material in good condition. This consideration requires careful evaluation of the bioerosion levels in order to determine times and modes of intervention.

The artifacts already bioeroded by marine organisms require cleaning interventions and conservation that ensures good adhesion of the tesserae and the closure of the great number of cavities inside which new colonizers can settle. These artifacts should also be covered by layers of sand (or by geotextile) to ensure maintenance of their current state.

This study also highlights the need to perform periodic monitoring on submerged objects. It is only this knowledge of the state of conservation that can prevent subsequent damage.

We appeal to conservators responsible for archaeological artifacts and to divers entitled to visit submerged sites to collaborate on the monitoring of underwater artifacts and inform authorities about possible damage and the lack of protection systems. Of course, guidelines provided by the competent authorities must be respected. Archaeologists and conservators need to develop new technologies to present underwater cultural heritage to the public while limiting the continuous exposure of original limestone artifacts because of their susceptibility to bioerosion phenomena.

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Conservation Planning for Excavated Mosaics at the Site of Bulla Regia, Tunisia: A Component of the MOSAIKON Initiative

Thomas Roby, Leslie Friedman, Hamida Rhouma, Moheddine Chaouali, Livia Alberti, Ermanno Carbonara, Cristina Caldi, Ascanio D'Andrea, and Daniele Sepio

Abstract: *A major component of the Bulla Regia model field project is developing a planning methodology and producing a long-term conservation plan for the almost four hundred excavated mosaics at the site. The first step in the planning process was to survey all the mosaics, assessing their condition, significance, and degree of exposure. A survey form was created that enabled the assignment of overall conservation priority ratings, as well as an estimation of work time for conservation interventions. An additional aid in the planning process has been the creation of a new topographic plan for the site and a geographic information system (GIS). The decision was made to rebury many of the exposed mosaics while maintaining and presenting selected others without allowing visitors to walk on them.*

The MOSAIKON Bulla Regia Model Field Project is a tripartite collaboration of the Getty Conservation Institute (GCI), Institut National du Patrimoine (INP) of Tunisia, and the World Monuments Fund (WMF). The project builds on fifteen years of GCI-INP collaboration in the training of site personnel (mosaic conservation technicians and site directors) in the conservation of in situ mosaics and the management of archaeological sites (Roby et al. 2005; Roby et al. 2008; Dardes 2009). There are two components of the project that are the focus of the GCI's activities: (1) the conservation, protection, and presentation of mosaics and other architectural remains in at least one entire house at the site; and (2) the conservation and maintenance planning for the almost four hundred excavated mosaics throughout the site. This paper focuses on the model planning component, which is producing a methodology and long-term mosaic conservation plan for Bulla Regia.

Experience from past GCI-INP training courses for future site directors in Tunisia in the conservation and management of archaeological sites with mosaics demonstrated that the course participants would have benefited didactically from case study examples of in situ mosaic conservation planning. The decision to produce a sitewide planning document at Bulla Regia responds to the general need in the field for replicable conservation planning models, as well as the particular need at Bulla Regia to approach mosaic conservation in a holistic, programmatic manner.

The planning process at Bulla Regia was carried out in three phases: information gathering, analyzing the data, and planning of conservation work based on the sitewide analysis or assessment. The first phase was lengthy, as a great deal of basic site documentation was lacking despite the long history of excavation. In particular there was no accurate, detailed plan of the site, including its topography and all excavated and above-grade ancient structures. There was also no inventory or corpus of mosaics at the site.

Phase 1: Information Gathering

Site Topography and Mapping

The production of a new site plan for Bulla Regia has been the starting point for accurately positioning spatial data for mosaics throughout the site in their archaeological context. The site plan has been produced using a network of georeferenced GPS points laid previously by project partner World Monuments Fund. The field survey was carried out using both a total station (Leica TCR 703) and a 3D laser scanner (Leica Scan Station C10) in order to collect the maximum amount of data in a relatively short time. In particular the laser scanner was used along the ancient streets to survey the building faces and the underground floors, and the total station was used to survey all the mosaics and to broaden the network of survey benchmarks on the ground. Through the creation of the new site plan, the field survey identified many new archaeological features (buildings, pavements, etc.) and evidence of human activity in the northeastern part of the site that had not been previously recorded.

Part of the topographic survey was the acquisition of elevation data needed to obtain a digital model of the site terrain, a useful tool for evaluating the hydrogeological profile of the area and for producing contour maps with drainage lines, thereby facilitating water management of the site in the future. The collection of 3D data by laser scanning the underground rooms allowed detailed information to be obtained about the surfaces of the preserved mosaics. For example, elevation maps of mosaic pavement surfaces were produced using color gradation visuals, which are useful for identifying pavements at risk of water pooling and for planning eventual interventions to prevent surface water accumulation.

Mosaic Rapid Survey

The first step in any site conservation planning activity is the gathering of information about the site's elements and their context in order to make an assessment of condition, significance, and risk. Although archaeological publications on Bulla Regia have produced documentation of selected buildings and their mosaics (Beschaouch, Hanoune, and Thebert 1977; Hanoune 1980; Dunbabin 1983), there is no official inventory of mosaics or published corpus volume, despite Bulla Regia's significant and large in situ collection of ancient Roman and Byzantine mosaics. Therefore, the initial action taken was to carry out a preliminary, or first-level, survey of the site to inventory and document all excavated mosaics, which total almost four hundred. Given this large number and the limited resources of the site, the planning challenge was being able to assign relative priority of action to each mosaic, so that decisions can be made about the phasing of mosaic conservation activities over a multi-year period.

A rapid survey form was developed for this planning purpose (Roby et al. 2012). In the first section (green), data are compiled about the mosaic itself: inventory number, type, and square meters of surface (table 1). The inventory numbering system follows that developed for GCI technician training courses, which consists of the mosaic's location in a numbered room, of a named building (abbreviated), at a named site (abbreviated) (Alberti, Bourguignon, and Roby 2013).

In the second section (blue), the extent of the most significant or critical structural and surface conditions is recorded. This rapid assessment is the basis for determining a condition rating for each mosaic. In the third section (yellow), the form calculates the number of workdays required to carry out

Table 1 Rapid Survey Form, page 1

Rapid Survey Form Mosaic Conservation Planning for Archaelogical Sites									Site:									Date:						Part 1
									Building:									Recorded by:						
Identification									Condition									Intervention						Notes
									Micro-organisms		Critical tessellatum		Critical structural areas						Complete stabilization for exposure			Stabilization for reburial		
																			Workdays			Workdays		
																				1		70%	30%	
Mosaic ID	Room/Space (m^2)	Mosaic (m^2)	Lacunae (m^2)	Mosaic in room (%)	Mosaic typology	Lacunae type	Reinforced concrete	Type of exposure	m^2	%	m^2	%	m^2	%	Total critical areas (m^2)	Total critical areas (%)	Overall condition rating (1–5)	Workdays per m^2	Tessellatum stabilization	Micro-organism removal	Total workdays	Long-term	Short-term	
Total																								
Average																								

Table 2 Rapid Survey Form, page 2

Rapid Survey Form **Mosaic Conservation Planning for Archaelogical Sites**									**Site:**					**Date:**		**Part 2**
									Building:					**Recorded by:**		
	Condition		**Significance**						**Exposure**					**Priority**		**Notes**
Evaluation Scale	1–5		1–5	1–5	1–5	1–5	1–5		1–5	1–5	1–5	1–5		6–150	0–100	
Weighting		4						2					1			
Mosaic ID	**Overall condition rating**	**Weighted overall condition**	Archaeological-iconographic value	Technical-artistic value	Integrity	Authenticity	**Overall significance rating**	**Weighted overall significance**	Environment	Visitation	Structural collapse	**Overall exposure rating**	**Weighted overall exposure**	**Synthesis weighted ratings**	**Overall priority rating**	
Building Average																

stabilization work for each mosaic, based on the percentage of critical areas of the tessellatum, recorded previously in the blue section, and whether the mosaic will be left exposed or reburied. The workday evaluation is based on the experience of the GCI-trained technicians at the site since 2008 and their demonstrated pace of work. With this third section of the form, an approximate time line and work plan of conservation activities can be produced. The survey form is therefore more than an assessment method; it is a planning tool in itself. Not only can conservation work over the site be prioritized using this form, but the tasks can be programmed over time using the workday estimates requested on it. As conservation experience is required to accurately assess both the condition and the number of workdays, it is recommended that a conservator or experienced mosaic conservation technician fill out certain parts of the form.

On the second page of the survey form (table 2), the condition rating is carried over (blue), and the significance (yellow) and degree of exposure (orange) of each mosaic are assessed. The assessment of archaeological and art historical significance should normally involve an archaeologist knowledgeable about the history of mosaics, both locally and in a broader context. The assessment of degree of exposure seeks to provide a rating for how much a mosaic is exposed to the environment, considering factors such as whether the mosaic is in the open air, sheltered, or reburied, in addition to other factors such as aspect and slope. The degree of exposure to visitation is also part of the assessment: the estimated number of visitors that pass by the mosaic and whether or not they are free to walk on the mosaic. In the case of Bulla Regia, this also includes the accessibility of the mosaic to grazing animals, which will walk on the mosaic surface.

These three categories of mosaic assessment are then combined to arrive at an overall conservation priority rating for each mosaic, from 0 to 100 (pink). Rather than simply adding the three ratings together, which would produce an average among them, it was decided that a more correct method of calculating a conservation priority rating was to multiply the exposure rating by the sum of the condition and significance ratings. In this way, the ratings that represent characteristics of the mosaic itself (condition and significance) are treated differently from the rating of the external factors (degree of exposure) that act on the mosaic.

The overall conservation priority rating calculation also involved using a weighting system in order to give additional importance to the condition of the mosaic in relation to the other assessment categories. Weighting the condition rating higher was appropriate in our case because the priority rating is a basis for conservation planning, whereas in a broader management planning context, with its different objectives and emphasis on values, significance would possibly be weighted higher than condition. For conservation planning at Bulla Regia, it was decided to give condition a weighting of 4; significance, 2; and degree of exposure, 1. This weighting system also reflects the poor condition of many of the mosaics at the site. The weighting can be changed according to the aims and objectives of the survey as well as the conditions on-site. For example, for the purposes of management planning or at a different site where the mosaics are generally stable and in good condition, significance could be weighted higher than or equal to condition, resulting in very different overall priority ratings.

An instruction manual and glossary of terms to accompany the survey form was also developed in order to ensure consistency in the field data collection by the project team and as a reference document in the future. It is recognized that survey data collection can produce different results depending on the knowledge and experience level of the surveyor. In this case survey team members regularly compared their initial survey results with each other to make sure that they were consistent. Despite the internal checking, some priority rating results seemed out of balance or sometimes incorrect compared to other mosaic priority ratings. In these cases, the survey data were verified on-site and adjusted as needed.

The survey data collected on paper on-site were transferred in digital form in Excel, as it is a simple and efficient calculation software. Once finalized, the survey data were then transferred to Access software and ultimately incorporated into the Geographical Information System (GIS) developed for the site.

Mosaic Survey Photography

An important part of the survey process was the photographic documentation of each mosaic. A lightweight adjustable-length aluminum monopod pole was used to take one or more photographs of each mosaic for inventory purposes (fig. 1). Where multiple photographs were needed for a mosaic they were stitched together using Adobe Photoshop software. Later, these same images were linked to the mosaic data in the GIS and modified for use by the INP conservation technicians as photographic bases for their documentation work (fig. 2).

The time required for the survey per mosaic was not more than one hour with two people, including the photography. So while the survey form requires considerable data to be collected, and time to understand the terminology and become efficient in its use, it is still considered a rapid survey. The survey methodology was developed for a large site with many mosaics and was considered a pilot project of its own. Because of its complexity, and concerns about the uniformity of the data obtained, the collection was carried out by a restricted number of the GCI project team. Our experience showed that this type of extensive survey data collection should be done by a small but multidisciplinary team that includes, in addition to conservators, specialists from other professions, namely, archaeologists and conservation architects or engineers.

Figure 1 Photographic survey of site mosaics using a lightweight extension pole. Photo: Scott Warren © J. Paul Getty Trust

Figure 2 Survey photograph modified for use by the conservation technicians as a base photo for manual documentation

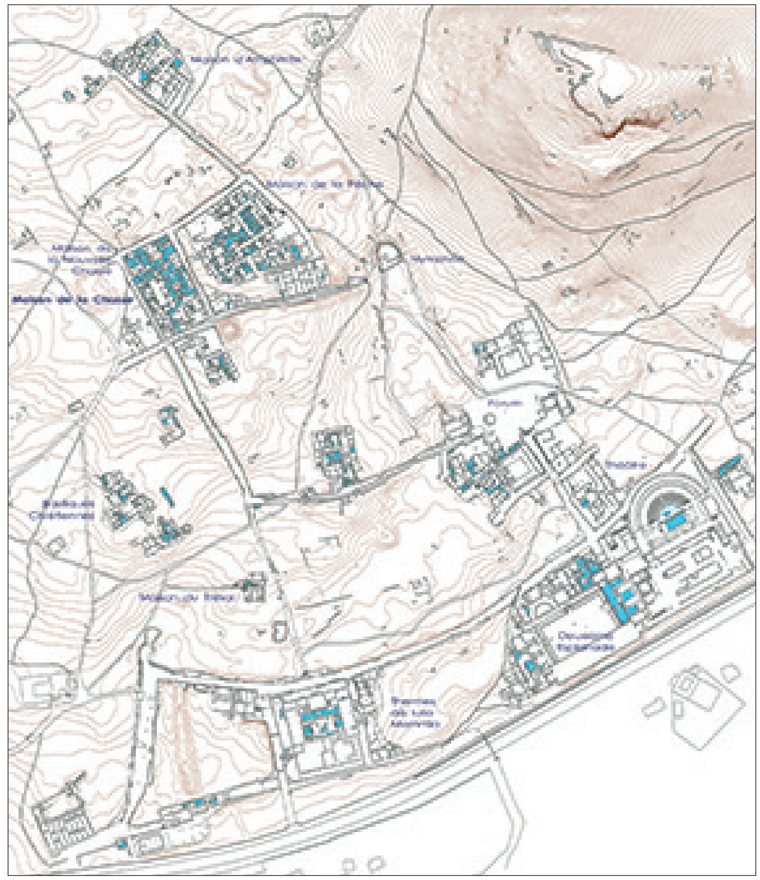

Figure 3 GIS plan of Bulla Regia showing locations of mosaics

Phase 2: Analyzing Data

The transfer of field survey data from Excel to Access software enabled the data to be queried and analyzed in different ways by means of the production of Survey Data Reports, which could list mosaics, for example, in order of their conservation priority rating, both sitewide and by building. Reports could also be produced listing mosaics by their typologies or other characteristics useful to consider during the planning process.

To further facilitate the mosaic conservation and maintenance planning, as well as the future management of the site, a GIS for the site was created. The two main types of site information, spatial data from the site topographic and metric surveys of the mosaics and buildings and qualitative and quantitative data from the mosaic survey, were joined together inside the GIS in a single geo-database to organize and visualize data at different scales and to provide answers to questions useful for the conservation planning work.

The base site plan was structured to be able to show not only archaeological features but also a three-dimensional topographic model of the entire site (fig. 3). The database of information produced by the mosaic survey was incorporated in the GIS structure, making possible the production of different thematic maps that provided a graphic aid for developing planning strategies for future conservation interventions. These maps could visualize the location of mosaics according to their different assessment categories, condition, significance or degree of exposure, or their overall conservation priority rating (fig. 4).

A series of graphic interfaces has been created for the management of data within the GIS to facilitate its regular updating, to assist editing existing data and adding new information. The GIS can and should receive new, updated information about the mosaics, as well as data on other architectural and site features and, for example, the geology and hydrology of the site. All previous documentation regarding the site, including that carried out by the conservation technicians, can also be archived within it. In this way the GIS becomes a repository of information, both archival and dynamic in nature. Introductory training is being provided to INP site personnel to ensure that the GIS continues to be used and updated so that it can remain an accurate tool for conserving and managing all aspects of the site in the future.

Figure 4 GIS map of mosaics according to their conservation priority rating

Phase 3: Planning

The analysis of the mosaic survey data has resulted in an initial proposed plan of emergency conservation work over a period of five to six months, aimed at stabilizing and protecting the sixty mosaics at the top of both the overall Priority List and the Condition List. Including those mosaics identified as being in the worst condition ensured that they received needed conservation care in the short term. The proposed actions in this initial, urgent phase include protection of mosaics with temporary coverings of cushions of sand, first-aid stabilization, and stabilization followed by short- or long-term reburial. Sheltering of selected mosaics is also a part of the proposed actions in cases where mosaics could not be protected safely by reburial because of structural problems or their re-laying on reinforced concrete. The installation of perimeter fencing of eight selected buildings that have a large number of mosaics with high priority ratings or that pose serious risks to visitor safety are planned; two of these fencing projects have already been completed.

At the same time, decisions are being made about which excavated buildings on-site will be presented to the public and which ones will be preserved by reburial, based on a variety of sitewide assessment criteria, including significance, threats, and location (fig. 5). Within this presentation framework a longer-term program of interventions is being formulated, including monitoring and maintenance cycles every six months and treatment work in buildings to be reburied or presented, while continuing work on priority mosaics

Figure 5 Site plan with buildings to be presented to the public

throughout the site. Conservation intervention protocols have been developed for the principal interventions, both preventive and remedial, for future reference. They include different interventions to be carried out by conservation personnel on mosaics, non-mosaic pavements and walls, and preventive measures such as reburial, fencing, and vegetation control to be carried out by site workers (fig. 6).

After having identified the conservation priorities and developed the intervention protocols, the technicians were provided with an initial five-month work program that was discussed and prepared with the *conservateur* or manager of the site (fig. 7).The program entails the work location, the operations to be carried out by each technician, and the approximate time needed. The technicians are those trained by the GCI who are capable of carrying out documentation and conservation interventions on mosaics, as well as walls and wall plasters.

Planning at Building Level

The first building-level project has been the conservation and presentation of the Maison de la Chasse, where all types of remains—mosaics, wall plasters, and walls—have been stabilized, mostly by the technicians, and selected pavements


STABILIZATION OF TESSELLATUM FOR EXPOSED MOSAICS

Aim / Definition: Surface cleaning and stabilization of tessellatum and preparatory layers with mortar (to satisfy both functional and aesthetic needs), in order to leave the mosaic exposed.

Benefits:
- long-term intervention
- stop or limit loss of original material
- reduce vegetation growth
- re-treatable

Limitations:
Time intensive

Appropriate Personnel:
Conservation technician or Conservator

Materials/ Special Equipment:
- lime
- gravel, sand and crushed ceramic/ brick

Personal Safety Equipment:
Rubber gloves when handling lime

Documentation Procedure:
- photographic documentation before and after intervention
- written documentation
- graphic documentation
- documentation archive

Intervention Procedure:
- cleaning of the surface with water
- mechanical removal of the old damaged infilling
- vegetation removal
- resetting tesserae with lime-based mortar
- filling interstices between tesserae with mortar
- consolidating voids between detached preparatory
- layers using hydraulic lime-based injection grouts
- infilling of lacunae and/or edging repair

Monitoring / Maintenance:
- decide next inspection date
- if needed, perform mosaic maintenance SEE PROCEDURE FOR MOSAIC MAINTENANCE (PAGE 09)

1

Figure 6 Example of a conservation intervention protocol

SITE : BULLA REGIA — WORK PROGRAM — Year : 2015

JANUARY 2015

	Rooms	Operation	Days of Work: Habib	Sami	Mond.	Mona	Fathi
MAISON DE LA PECHE	BR/MP/00 (calotte)	Complete documentation, cleaning and complete stabilization (including injections)	4				
	BR/MP/00 (calotte)	Remove vegetation, dry cleaning, small fills and interstices		4			
	BR/MP/04	Complete documentation, cleaning and complete stabilization	4				
	BR/MP/04	Remove vegetation, dry cleaning, small fills and interstices		4			
	BR/MP/31	Complete documentation, dry cleaning and partial stabilization	12				
	BR/MP/31	Remove vegetation, dry cleaning, small fills and interstices		12			
	BR/MP/02 BR/MP/03	Complete documentation, cleaning and complete stabilization			1 5	1 5	
	BR/MP/33	Complete documentation, dry cleaning and partial stabilization			8	8	
	BR/MP/35+threshold	Complete documentation, dry cleaning and partial stabilization			6	6	
M. CHASSE	BR/MC/18a Stone paving	Remove earth and roots in depth between the pavement slabs					7
	BR/MC/18b BR/MC/20 BR/MC/21 BR/MC/10a	Maintenance : remove vegetation, cleaning, small fills, edging, and interstices	Document Form M-C Plan IR				13
TOTAL Days of Work		JANUARY	20	20	20	20	20

FEBRUARY 2015

	Rooms	Operation	Days of Work: Habib	Sami	Mond.	Mona	Fathi
MAISON DE LA PECHE	BR/MP/32+threshold	Complete documentation, dry cleaning and partial stabilization	7				
	BR/MP/32+threshold	Remove vegetation, dry cleaning, small fills and interstices		7			
	BR/MP/30	Complete documentation, dry cleaning and partial stabilization	8				
	BR/MP/30	Remove vegetation, dry cleaning, small fills and interstices		8			
	BR/MP/17 BR/MP/26a	Edging and documentation (Form 1-D + Plan IR)	2 1	2 1			
	BR/MP/37	Complete documentation, dry cleaning and partial stabilization			9	9	
	BR/MP/36+threshold	Complete documentation, dry cleaning and partial stabilization			6	6	
	BR/MP/41	Edging and documentation (Form 1-D + Plan IR)			2	2	
M. CHASSE	BR/MC/25a BR/MC/28a Stone paving	Remove earth and roots in depth between the pavement slabs					7
	BR/MC/07a, 07b BR/MC/08 BR/MC/09 BR/MC/10d BR/MC/24a, 24b BR/MC/27a, 27b	Maintenance : remove vegetation, cleaning, small fills, edging, and interstices			Document Form M-C Plan IR		12
	BR/MC/39	Maintenance of reburial					1
TOTAL Days of Work		FEBRUARY	20	20	20	20	20

Figure 7 Conservation technician work program, including maintenance activities

have been reburied for their protection. In view of the large number of tourists who visit the site and come to the house, and the lack of both visitation control and protection from the environment, a program for the building's visitation and protection has been developed. The basic principle of this program is that for conservation reasons visitors will not be allowed to walk freely and directly on mosaics. Nor will visitors be forced to follow a prescribed route through a building. Visual access will be provided to virtually all parts of a building while preventing visitors from walking on mosaics, either by means of shallow reburial, access barriers, or coverings with protective mortar layers, matting, or walkways (fig. 8).

Building Planning Form

Based on the experience in the Maison de la Chasse, a new building planning form was developed for planning the work of site personnel to conserve an entire building elsewhere at the site. Once a decision has been made by the project partners about whether a building will be presented to visitors or protected by reburial, a visitation and protection plan is drawn up, defining the areas of public access, the location of visible mosaics, and the mosaics to be reburied or protected by a shelter. The Building Planning Form is then used as a tool to collect and organize data in order to estimate the

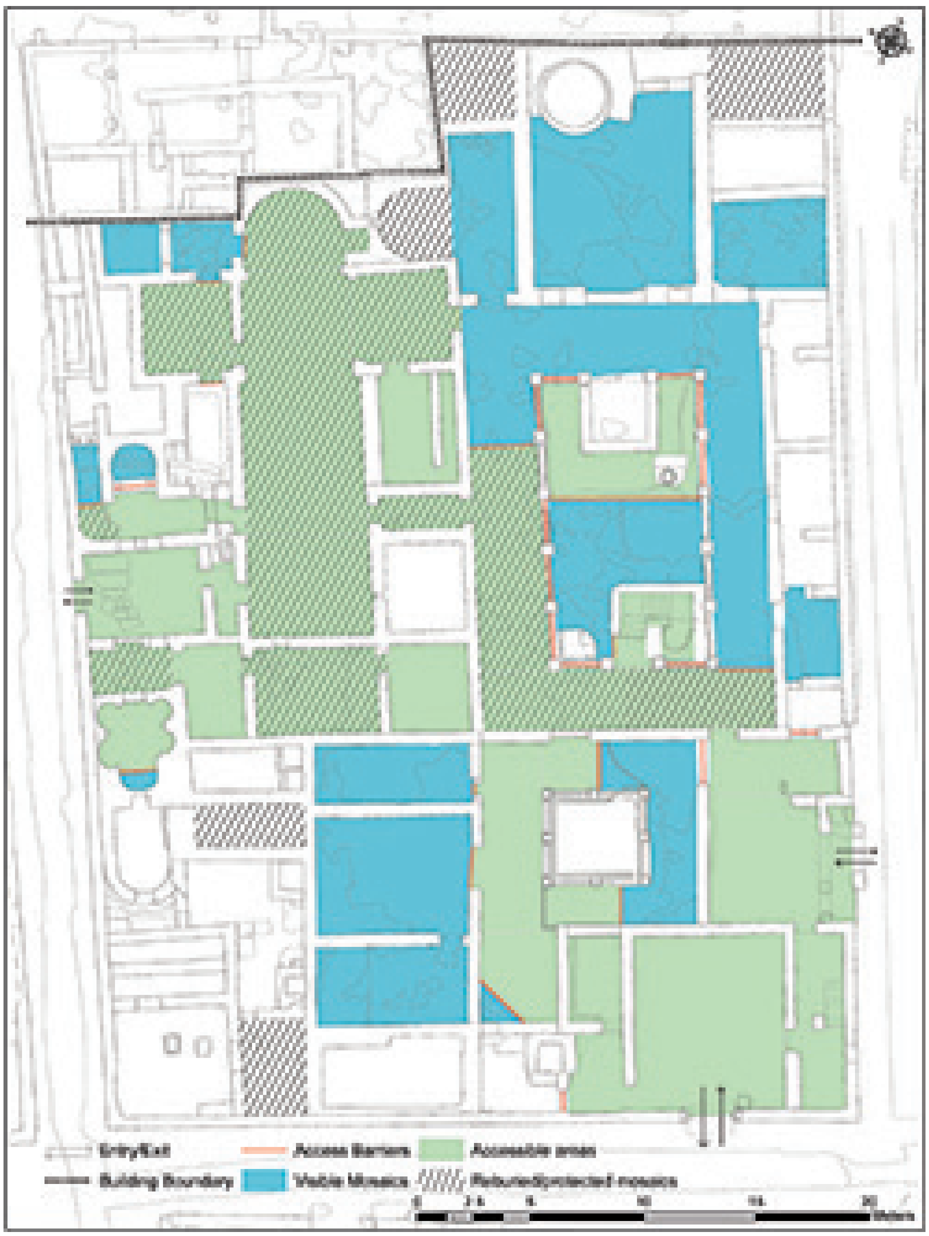

Figure 8 Maison de la Chasse: proposed areas of visitor access (green); pavements that should be protected from being walked on by reburial or otherwise protected because they are not visible to visitors (lines); visible mosaics (blue); location of access barriers (red line); rooms without mosaics (white).

workdays and materials necessary for the conservation interventions and general presentation of a whole building. The first page deals with rooms with mosaics, including the treatment of large lacunae; the second, rooms without mosaics, such as *cocciopesto* pavements, stone slab pavements, or other flooring. The third page considers the stabilization of walls and wall plasters and other operations that can be carried out by workers and technicians available at the site. Conservation work requiring other types of personnel are also listed on the third page. These "Specialist Projects" include structural interventions, water drainage, shelters, and conservation of wall paintings, among others. The fourth page of this Building Planning Form summarizes all the work to be carried out (normal projects and Specialist Projects) and the time needed for site personnel to complete the work (tables 3–6).

Conclusion

Conservation planning at the building level is needed to then carry out longer-term sitewide planning, which will map out conservation activities for all the mosaics over more than a ten-year period and will be integrated with the visitation strategies for the site. This long-term planning will take into account the management context and the resources available. Consequently, a majority of the mosaics on-site will be programmed for reburial, thereby reducing the mosaic main-

Table 3 Building Planning Form, page 1

Building Name: **Date:** **Part 1**

[data from GIS and Rapid Survey Form (RSF)] / **Mosaics to Be Presented**

Room ID	m² Room	m² Tessellatum	m² Lacunae	From RSF ÷ 2: Tessellatum stabilization W/D 2 technicians	From RSF ÷ 2: Micro-organism removal W/D 2 technicians	Tessellatum stabilization + micro-organism removal W/D 2 technicians	Lacunae Treatment Type: m² infilling	Lacunae Treatment Type: m² gravel	Lacunae Treatment Type: m² other	Lacunae Treatment W/D 1 Technican + 2 Workers: W/D infilling (0.7)	W/D gravel (0.25)	W/D for drainage or other	Lacunae treatment total W/D 1 technician + 2 workers
				0.0		0.0				0	0		0
				0.0		0.0				0	0		0
				0.0		0.0				0	0		0
				0.0		0.0				0	0		0
				0.0		0.0				0	0		0
Totals	**0**	**0**	**0**	**0.0**	**0**	**0.0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Mosaics to Be Reburied

Room ID	L-T = Long-term S-T = Short-term		Tessellatum stabilization for reburial W/D 2 technicians	Lacunae treatment for reburial W/D 2 technicians	Reburial area m²	Reburial Materials: Sand m³	Reburial Materials: Gravel m³	Reburial Materials: Geotextile m²	Barriers m: Wooden planks	Barriers m: Cement mortar	Barriers m: Stone blocks	Reburial W/D 1 techinican 2 workers	Barrier construction W/D 1 technician 2 workers	After Short-Term Reburial: Long-term reburial	After Short-Term Reburial: Presentation	After Short-Term Reburial: Other	Notes
	L-T→		70%	0.20		0.2	0.1	25%				0.16					
	S-T→		30%			0.1	0.05					0.08					
	L-T	☐	0	0		0	0	0				0		☐	☐	☐	
	S-T	☐	0	0		0	0	0				0					
	L-T	☐	0	0		0	0	0				0		☐	☐	☐	
	S-T	☐	0	0		0	0	0				0					
	L-T	☐	0	0		0	0	0				0		☐	☐	☐	
	S-T	☐	0	0		0	0	0				0					
	L-T	☐	0	0		0	0	0				0		☐	☐	☐	
	S-T	☐	0	0		0	0	0				0					
	L-T	☐	0	0		0	0	0				0		☐	☐	☐	
	S-T	☐	0	0		0	0	0				0					
	Totals		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**				

Table 4 Building Planning Form, page 2

Building Name: **Date:** **Part 2**

Other types of pavements to be presented or reburied

Room ID	m² from GIS: Room	m² from GIS: Pavement	m² from GIS: Lacuna	Surface Treatment W/D: Coccio-pesto (1 Technican 2 Workers): Original material	Coccio-pesto: Lacuna	Stone Slab Pavements (2 Workers): Original material	Stone Slab Pavements: Lacuna	Prepar. Layers (1 Technican 2 Workers): Original material	Prepar. Layers: Lacuna	No Pavem. (4 Workers): Cleaning	Drainage or Other (1 Tech. 2 Work.)	Reburial W/D and Materials: Reburial area m²	Material required: Sand m³ (0.05)	Material required: Gravel m³ (0.1)	Material required: Geotextile m² (25%)	Barriers m: Wooden planks	Barriers m: Cement mortar	Barriers m: Stone blocks	W/D: Reburial W/D 4 workers (0.07)	W/D 1 tech, 2 workers Barrier construction	Total work days 1 technician 2 workers	Total work days 2 workers	Total work days 4 workers	Notes
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
Totals	**0**	**0**	**0.0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.0**	**0.0**	**0.0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	

Table 5 Building Planning Form, page 3

Building Name:												**Date:**			**Part 3**
Other types of remains													**Specialist Projects**		
		Walls	**Columns**		**Carved Stones, Capitals**		**Plasters**	**Other**							Brief description of the work beyond technicians and workers activity to be carried out at room level
Room ID	Room m²	Work days 2 workers	Quantity	Work days 2 technicians	Quantity	Work days 2 technicians	Work days 2 technicians	Work days 1 technician	Work days 1 worker	Other types of remains Total work days 2 technicians	Other types of remains Total work days 2 workers	**Notes**	✔		
										0	0				
										0	0				
										0	0				
										0	0				
										0	0				
Totals	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**				

Table 6 Building Planning Form, page 4

Building Name:										**Date:**			**Part 4**
Summary			**Materials**							**Work Days**			
Conservation work in the building		**Quantity in the building**	**Sand m³**	**Gravel m³**	**Geo-textile m²**	**Wooden planks m**	**Cement mortar m**	**Stone blocks m**		**Team 2 tech.**	**Team 1 tech. + 2 workers**	**Team 2 workers**	**Team 4 workers**
Mosaics to be presented: (from Form Part 1)	Tessellatum stabilization of in situ mosaics + in situ stabilization mosaics on concrete panels									0			
	Lacunae treatment										0		
Mosaics to be reburied: (from Form Part 1)	Tessellatum stabilization									0			
	Reburial		0.0	0.0	0.0	0.0	0.0	0.0			0		
Other types of pavements: (from Form Part 2)	Cocciopesto										0		
	Stone slab											0	
	Preparatory layers										0		
	No pavement												0
	Drainage or other										0		
	Reburial		0.0	0.0	0.0	0.0	0.0	0.0			0		0
Other types of remains: (from Form Part 3)	Walls											0	
	Columns									0			
	Carved stones									0			
	Plasters									0			
	Other									0		0	
	Total material for reburials		**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**					
									Teams' work days	**0**	**0**	**0**	**0**
												Total work days/1 technician	**0**
												Total work days/1 worker	**0**

Specialist Projects	✔	**At room level**	✔	**At building level**
		Room		Shelter design and construction
		Room		Structural stabilization
		Room		Access barriers and info panels
		Room		Other

tenance needs of the site, allowing the site conservation technicians sufficient time to adequately maintain those mosaics left exposed, and saving hundreds of Bulla Regia's mosaics from abandonment and eventual loss. While the planning activities described above were a response to conservation challenges facing the site of Bulla Regia in particular, this component of the project is intended to provide examples of practical planning forms and a methodology that can be used to manage other large sites with significant numbers of mosaics throughout the region of the MOSAIKON initiative.

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Shelters of Mediana: The Great Challenges of the Moment

Elena Vasić Petrović

Abstract: *Mediana, one of the most significant archaeological sites in Serbia, dating to the third through fifth century* CE*, was built as a suburban residence and has been researched for more than one hundred years. Several of the excavated buildings have mosaic floors. From 1936 to the present numerous protective shelters have been built there. This paper compares similar challenges of presentation and protection of mosaics from different time periods and points out the importance of planning and decision making, not according to the needs of the moment, but according to the significance of the heritage itself.*

The city of Nis, located in southeastern Serbia, has exquisite sites from late antiquity (second–fourth centuries CE) Naissus, as the city was known in Roman times, and is well known as the birthplace of the Roman emperor Constantine the Great.

Numerous remains, including architecture, roads, aqueducts, cisterns, and a necropolis, are found across the territory of modern-day Nis and its immediate vicinity. The majority of the seventy-eight registered sites from this period are grouped into three large archaeological sites: Naissus, the Roman town; the Early Christian necropolis of Jagodin Mala, located next to the Roman town; and Mediana, the settlement in the countryside three miles to the east (fig. 1). Some of the world's most famous finds and artifacts were discovered here (e.g., the bronze head of Constantine the Great, and the silver plates minted in honor of the tenth anniversary of the reign of the Roman emperor Licinius). In spite of their obvious scientific value, the unearthed architectural remains have been unexplored and unprotected, in some cases for more than one hundred years (Vasić Petrović 2013). Until recently, none of the archaeological sites in Serbia, except for Mediana, had in situ mosaics available for public display.

Mediana is an archaeological site of outstanding significance for the Republic of Serbia. Dating from the third to fifth century CE, it was built as a suburban residence consisting of villas and numerous buildings of various uses. Some of the residential buildings, several of which had mosaic floors, were the focus of research in the past. The most important building is the so-called villa with peristyle, positioned in the central part of the site. It is a magnificent Roman residence containing 945 square meters of floor mosaics but also the remains of wall paintings and many other important architectural elements and forms (Jeremić 2006).

Villa with Peristyle

The villa was built in three phases, consistent with the periods of residence of Constantine the Great, his sons, and his successors. It consists of a central corpus with an inner courtyard and *peristilum*, a porch with an *impluvium*, or shallow pool, as a central point, and surrounded with forty-nine *cubiculae*, or rooms. The entrance of the villa, together with a separate porch, is on the south side of the site, but the space between this part and the excavated large entrance structure, in the form of a gate located farther to the south, remains buried. On the north side the central corpus turns into a large triclinium, a reception hall with an apse; and on the east and west sides there are two small symmetrical *tricliniae*. The large *thermae*, or baths, are on the northwest side (fig. 2).

Although the site and the mosaics were recorded for the first time in the nineteenth century, the first organized excavations were not undertaken until the 1930s. These first excavations were done in the small triclinium, also known as *stibadium* A, or nympheum, where the mosaic with geometric and floral motifs was found (fig. 3).This first excavated

Figure 1 Contemporary city of Nis with the position of three main sites and buildings with mosaic floors. Courtesy of Institute for Cultural Heritage Preservation Nis (ICHPN)

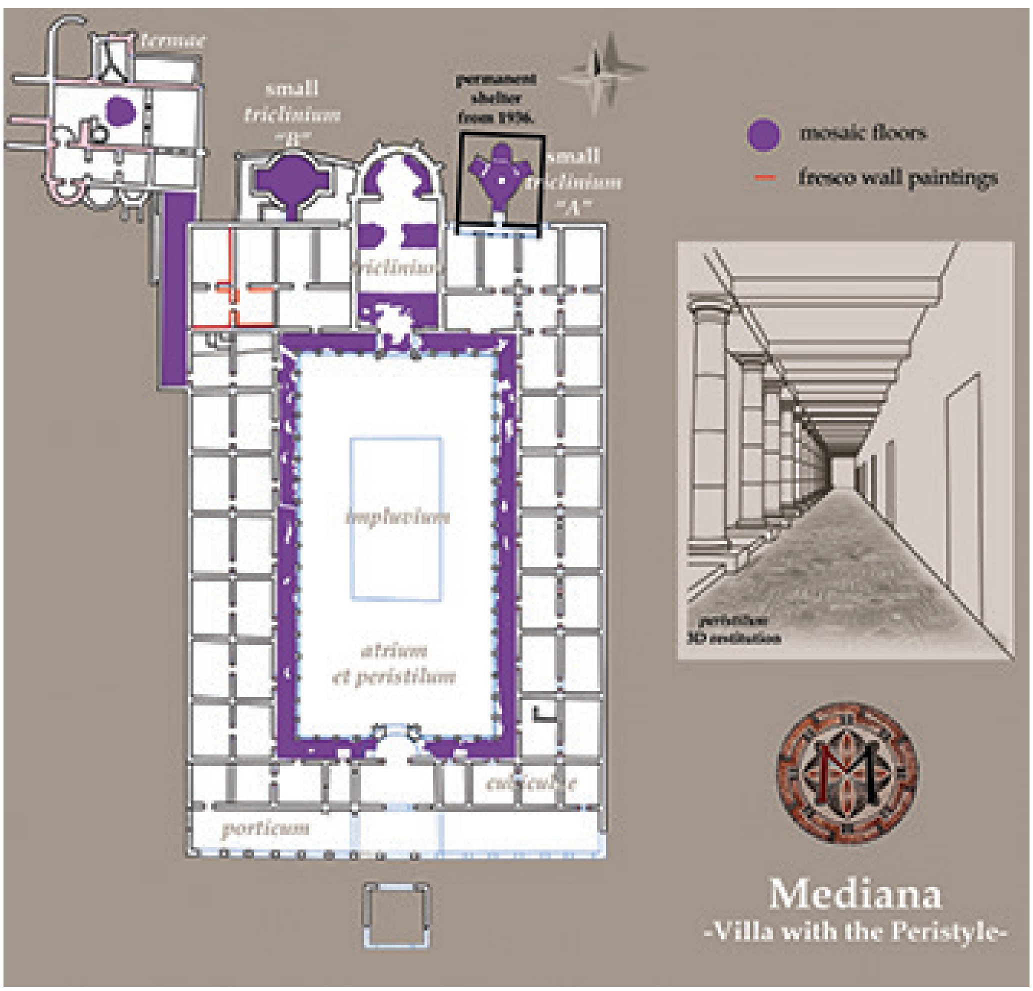

Figure 2 Villa with peristyle showing the position of the mosaic floors and 3D restitution of the peristyle. Courtesy of Institute for Cultural Heritage Preservation Nis (ICHPN)

Figure 3 Photogrammetry of the mosaic from the small triclinium A and its shelter from 1936.
Courtesy of Institute for Cultural Heritage Preservation Nis (ICHPN)

area was also considered part of the oldest phase of the villa. Concurrently the excavations that resulted in the discovery of the mosaic floors took place in the Central Baths and in the long corridor connecting the bath building with the villa.

Mosaics from a later date belong to the large triclinium, the peristilum, and the corridor between the villa and the thermae. Through the porch flows the geometric mosaic, while the visitors at the entrance of the reception hall were greeted with a panel containing the figural representation of a river divinity and a so far unknown river, parts of another human figure, and a wildfowl. In the center of that same room the head of the Medusa occurs as part of a circular medallion within a large square field. The baths were excavated for the first time in 1932, but all the mosaic floors were reburied, so we cannot be sure of their position or their current state (Jeremić 2006).

The northwest part of the villa, with the corridor that connects it to the baths, was recently excavated completely, together with another newly discovered small triclinium, known as stibadium B.

In addition to identifying two time horizons, it can be noted that there were two workshops making mosaics, each under different artistic influences. The older mosaics reveal a strong influence from the western Roman Empire, and it is possible that the masters came from this part of the empire; the later mosaics, dating to the 340s and 350s, were probably made by artisan groups from the eastern Mediterranean (Jeremić 2006).

Like many other archaeological sites in the world that are incorporated into modern urban spaces or used intensively for purposes such as agriculture or infrastructure, Mediana has suffered from a variety of destructive influences. The degree of preservation of the architectural structures is therefore very low, especially in the vertical plane, which makes the preservation and presentation of the mosaics even more important in this case, as they are one of the main assets of the site.

Shelters

Archaeological remains left in situ after excavations are exposed to numerous influences and risk factors. Many of them are very fragile and their preservation must be thoughtfully planned and carried out. Very often research and excavation are not followed by conservation. Even when conservation is done in an appropriate way, it does not include the necessary presentation aspects. The presentation of architectural remains must be done in a way that extends the positive effects of conservation. This sometimes involves setting up permanent or temporary shelters that should reduce the number and influence of harmful factors to a minimum. Even if one decides to build a shelter that eliminates certain negative impacts, it is necessary to understand that the challenge of good presentation and preservation doesn't end there. Mosaics presented under some kind of sheltering structure are no longer in their original context, even though they are still in situ. The lack of architectural forms (walls, doors, parapets, etc.) that frame the mosaic and contribute to the overall experience of the site can be a major problem with this kind of presentation project (Mirić and Vasić Petrović 2012).

The excavations at the site have continued to the present day, but most of the villa's mosaics are reburied and unavailable to the public, and some parts of the complex are still not completely excavated, defined, or presented.

In general we can divide protective interventions done so far on the villa's mosaics into four categories:

1. permanent shelter for complete protection and presentation of a particular mosaic;
2. temporary shelter for seasonal presentation of particular parts of mosaics;
3. "short-term provisional shelter";
4. reburial.

The first protective structure at Mediana was built in 1936 over one part of the villa (small triclinium A), as a permanent solution, although at the time of its design and construction it was clear that the mosaic that was covered was only a part of a much larger corpus. Conservation treatments were carried out on the mosaic and surrounding structures, including walls that were permanently covered by concrete and mortar. The shelter itself was partially supported by the original walls of the villa on the south side, and by new foundations on the other sides. The shelter was constructed thanks to the engagement of numerous supporters of the Mediana Museum Association. In addition to financial support from the local authorities, funds came from donations made by the citizens of Nis and from the proceeds of surcharges on the streetcar ticket from Nis to Mediana.

A temporary shelter for the seasonal display of particular parts of mosaics of the peristilum was built in the 1980s over its northeast side following a design from 1980, done by an architect from the Institute for Cultural Heritage Preservation Nis (ICHPN). The original idea basically relies on reconstruction of the peristilum forms using materials different from the original. From the three proposed designs, the one that was selected has columns made of wood instead of stone that sit on stone blocks or original walls, and the cover is made of ceramic roof tiles placed over timber beams (fig. 4).

In the meantime, beginning in 2000, several so-called short-term provisional shelters were built, but they stayed in place for a very long time, not only over the parts of the villa with peristyle but over other buildings on the site as well. The shelter that was built over the small Early Christian church,

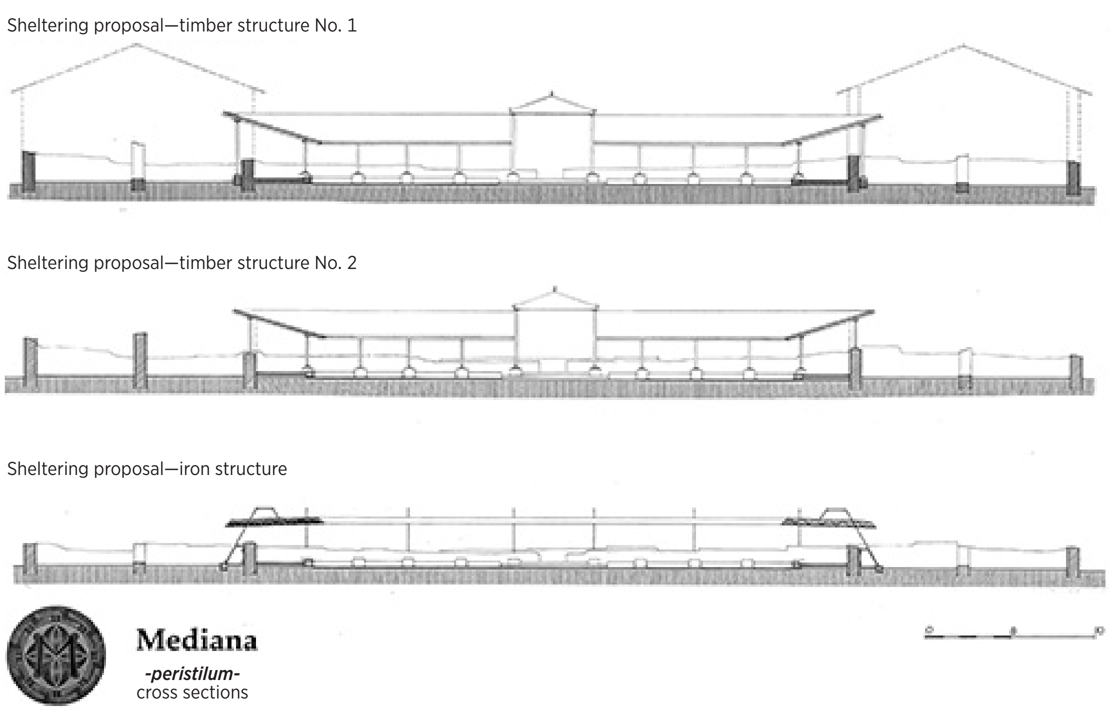

Figure 4 Designs for shelters from 1980. Courtesy of Institute for Cultural Heritage Preservation Nis (ICHPN)

positioned very close to the villa on the west side, kept the mosaic in good condition, but others, such as the structure that was supposed to protect the part containing fresco paintings and newly discovered fragments of the mosaic floor from the corridor, actually caused damage. The positioning of the roof slopes caused water to pool at the middle of the shelter rather than move to the outside. Also, the reuse of roofing panels that were pierced by nails allowed the ingress of water. Both structures were conceived as enclosed shelters and were made of metal scaffolding elements covered with corrugated asbestos roofing panels; the improvised wall screens were made of expanded polystyrene and waterproofing foils, attached to wooden frames. After the excavation of the second small triclinium (stibadium B) another "short-term provisional shelter" was added to an already existing collection of failures in 2011, covering this part of the villa. It comprised timberwork with corrugated asbestos roofing panels covering the mosaics that were not properly reburied (fig. 5).

The Presentation and Sheltering Project for the Villa with Peristyle

Presenting the villa with peristyle in a way that it would be more acceptable to visitors has been a long-standing goal of various institutions, professionals, and governments. However, this turned out not to be feasible.

In 2004, after a hiatus of more than twenty years, a sheltering project came up as a solution. The first real steps in this direction were taken in 2008 when the Serbian Ministry of Culture gave about half a million euros to the ICHPN to start Project A, "The Presentation and Sheltering Project for the Villa with Peristyle." The preliminary design, influenced by the shelters at the archaeological site of Kourion in Cyprus, was made and the process of obtaining permits begun. At the same time archaeological excavations were undertaken where the foundations would be placed, and the design for a partially enclosed shelter continued to be revised. The shelter was supposed to protect the entire building, but design defects soon became apparent, including large openings that would allow rainwater to enter inside the villa. In 2009 the Ministry of Culture halted the project, and approximately half the financial resources were redirected to another project, "Constantine's Villa at Mediana–Presentation Project 2010–2013," or Project B. This was for the same site but completely different in scope, with no planned shelter for the villa. Instead, its aim was mainly to reconstruct the walls and other architectural elements and to construct a complex of completely new buildings, some of them in the position of original architectural structures. This project was prepared by a private company from Belgrade. Only two parts of the project were realized and only after it was returned to the jurisdiction of the ICHPN. The first part is a project for the entrance

Figure 5 Short-term provisional shelter from the beginning of the twenty-first century. Photo: Zoran Radosavljević

building, and the second part dealt with the conservation of the villa's walls.

The entrance building, originally named the Gate of Constantine's Mediana, was constructed after the ICHPN provided the designs and licenses needed for obtaining building permits. The investors were the City of Nis, Municipality of Mediana, and the Serbian government. The building was finished in 2011.

By the end of 2012, the Serbian Ministry of Culture reactivated the shelter project to coincide with the anniversary in 2013 of the Edict of Milan, promulgated in 313. As part of the large national project called "The Edict of Milan—Serbia, 313–2013," the Serbian government allocated additional funds of approximately €1.1 million for the Mediana shelter project.

In phase 1 of the new shelter project, the ICHPN formed a new team to complete the work in a very short period of time. The review of all available documents and administrative procedures was done, but we had to organize the extension of protective archaeological excavations in order to finish the research on the positioning of the foundations. What we learned from this first phase was not very encouraging: the project did not have official technical review control, the procedure for the building permit was only half done and could not be finished without technical control, and the tendering process could not be done without the building permit. As for the design itself, we realized that there was no water management provided for the design, some of the foundations were placed in the location of existing structures, and some parts of the villa could remain unprotected even after the shelter was completely built.

The shelter was designed as a laminated wood structure composed of a central building covering the villa and a small annex over the baths with a polygonal plan (fig. 6). The whole structure is covered with PVC membrane. With a total area of 10,000 square meters and the clear span of the shallow arch of 72.5 meters, the structure was to shelter the villa complex completely, except for the entrance that was separated from the excavated corpus of the building.

We have also considered very carefully the special requirements of the site:

- It is a cultural property with the highest level of protection by law;
- It is an area with many environmental restrictions due to the fact that the archaeological site also contains a complex of nine pools that collect water for one of the supply systems of drinking water for the City of Nis; and
- Last but not least, the span of the structure was more than 50 meters, and only companies with special licenses can design, approve, and build such structures in this place.

In phase 2 we finished almost all of the archaeological excavations that were planned, redesigned the shelter based

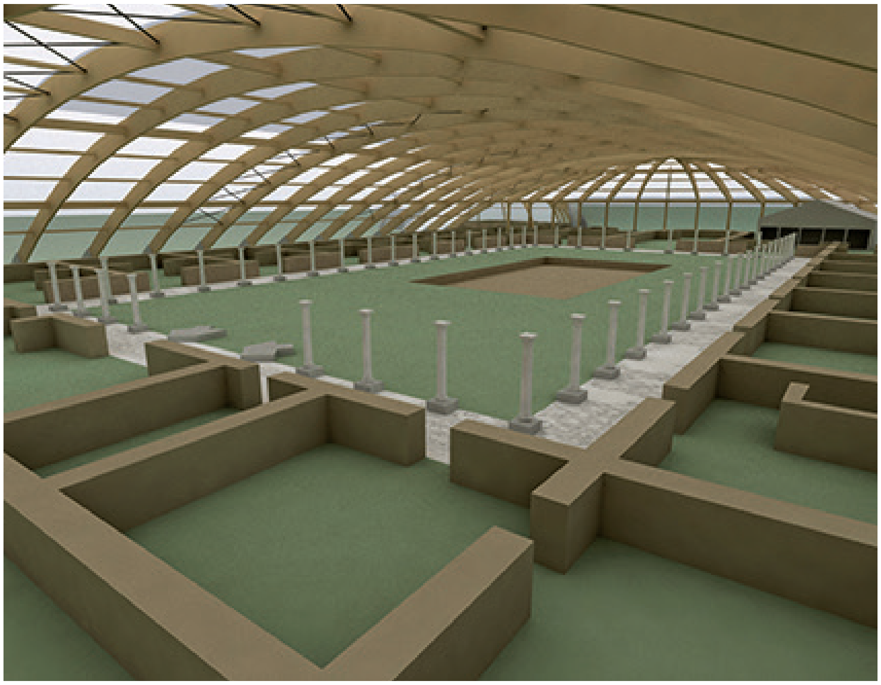

Figure 6 3D model of the shelter from 2008. Courtesy of Institute for Cultural Heritage Preservation Nis (ICHPN)

on the results of the phase 1 research, and recalculated costs. In addition, a technical review control was done, the building permit was obtained, and the tendering process was finished.

In phase 3 we had to organize this very complex and unusual construction site with its many restrictions on the positioning and use of special and heavy machinery and on the number of personnel and machines. We had to protect all the fragile parts of the villa (mosaics, paintings, walls, floors, unexcavated parts, excavated structures, the existing permanent shelter, etc.) and then proceed to the assembling and erection of the structural elements and roof covering for the shelter.

In order to prevent any possible damage caused by the construction work we redesigned and remodeled existing short-term shelters and carried out short-term reburial of one of the mosaics. The space inside and close to the existing permanent shelter was further excavated and reexcavated, and then the structure was stabilized. Once all the preparatory work was done and most of the foundations were positioned, the assembling and erection of the structural elements started. This was not done in the usual way, with a big crane positioned in the middle of the construction site, but by a special technique of putting together the arches two by two in front of the villa and then moving them along temporary structures, placed on concrete pathways, to the final position. It took ten hours for the first arch to travel from the starting point to its final point, and then this was repeated in the same way for the rest of the arches (fig. 7). This was the first time it was ever done in this way for such a structure, so a team of engineers working with the ICHPN had to invent and design all the devices and methodology specifically for this project.

Conclusion

Everything about this project was very challenging, but the final goal was to protect and preserve our site. We took advantage of the opportunity and managed to use it in the best way, learning from each other and from many different experiences from other sites. Everything that was done was discussed in advance within multidisciplinary teams, it was recorded, and we always looked at least three steps ahead before making final decisions.

The work is still in progress and is expected to be completed by the end of 2015 (fig. 8). Some conclusions that came out of our work might be helpful for those who deal with similar problems:

- When we think about design, we should be aware of the fact that the main and only purpose of the structure is to preserve and protect; it is not supposed to be an architectural masterpiece and must not compete with anything that is around it.

Figure 7 The assembling of the structure for the shelter. Photo: Zoran Radosavljević

Figure 8 The shelter at the end of 2014; work in progress.

- When it comes to archaeology, whatever is discovered has to be understood and only then can decisions be made regarding what is to be sheltered and how.
- Even if we have every record of archaeological remains, when it comes to conservation allowances must be made for future changes. No matter what kinds of analyses have been done in advance, it is only monitoring over a period of time that can give us the precise information on the effect of our work on the site and all of its parts.
- There must be funds allocated for maintenance before a project proceeds.

Guided by these conclusions, we continue to work toward the ultimate goal.

Acknowledgments

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L'*opus sectile* della Villa romana di Sant'Imbenia: Dal frammento alla fruizione

Daniela Rovina e Chiara Zizola

Abstract: *La Villa romana di Sant'Imbenia presso Alghero, Sassari, scavata dalla Soprintendenza per i Beni Archeologici delle Province di Sassari e Nuoro negli anni 1994–2005, ha restituito innumerevoli reperti relativi ai rivestimenti parietali e pavimentali di due ambienti dell'edificio. Tra questi si trovano migliaia di frammenti di materiali lapidei frutto del crollo di un ambiente riccamente decorato, originariamente situato al primo piano. Nel 2010 il Centro di Conservazione Archeologica di Roma è stato incaricato di eseguire lo studio, il restauro e la musealizzazione dei reperti. In quest'articolo si presenteranno la villa, e le fasi dell'intervento relative al restauro e alla musealizzazione del pavimento in opus sectile.*

Abstract: *The Roman villa of Sant'Imbenia near Alghero, Sassari, excavated by the Soprintendenza per i Beni Archeologici delle Province di Sassari e Nuoro (Superintendency of Archaeological Heritage of the Provinces of Sassari and Nuoro) from 1994 to 2005, has yielded countless finds of wall and floor coverings in two rooms of the building. Among these are thousands of fragments of stone material, the crumbled remains of a richly decorated space that was originally situated on the first floor. In 2010 the Centro di Conservazione Archeologica di Roma (Rome Center for Archaeological Conservation) set out to study and restore the findings and prepare them for museum display. This paper describes the villa as well as the stages of restoration and museum preparation for the* opus sectile *floor.*

I resti della villa romana di Sant'Imbenia si affacciano sulla baia di Porto Conte, in territorio comunale di Alghero (Sassari-Italia), in una zona ad alta densità di siti archeologici, dalla preistoria all'alto medioevo. Il golfo, compreso all'interno del Parco Naturale omonimo istituito dalla R.A.S. nel 1999, è da identificarsi con il *Nymphaion limèn* (Porto delle Ninfe) citato dal geografo Tolomeo nel II secolo d.C. La villa è stata oggetto di numerose campagne di scavo a partire dagli anni 1959–60, poi riprese tra il 1979 e il 1980, e quindi con cadenza quasi annuale dal 1994 al 2005, con un ultimo intervento nel 2009.[1] Sono stati effettuati anche lavori di consolidamento, strappo di mosaici e protezione delle murature a mare, gravemente danneggiate dalle mareggiate. Il vasto complesso, messo in luce solo parzialmente, conta finora oltre cinquanta ambienti, probabilmente distribuiti intorno a una corte centrale e con un fronte parallelo alla linea di costa di quasi 150 ml (fig. 1).

Gli scavi hanno interessato finora soprattutto le fasi di riuso della villa che si collocano tra V–VI e VII secolo d.C.[2] Allo stato attuale delle ricerche questi riutilizzi sembrano aver comportato la totale distruzione della stratigrafia della fase romana e per questo motivo la datazione della costruzione e delle fasi originarie di vita della villa è ancora incerta: gli studi finora condotti le collocano, infatti, tra I e III–IV secolo d.C. esclusivamente sulla base dei dati provenienti dagli strati di abbandono e sulla base dei caratteri delle numerose decorazioni architettoniche presenti *in situ* e nei crolli degli ambienti (Manconi 1999; Colombi 2011).

Anche l'organizzazione strutturale del complesso risulta ancora dubbia; tuttavia, proprio la ricchezza delle decorazioni architettoniche presenti nell'area lungo tutto il fronte-mare indica la funzione residenziale di questa parte. Diversi ambienti erano, infatti, dotati di pavimenti musivi e di rivestimenti parietali realizzati con *crustae* marmoree, con stucchi e intonaci dipinti; alcune strutture, tuttora *in situ*, conservano resti di questi ultimi con riquadrature in rosso su sfondo bianco avorio.

Le stesse decorazioni architettoniche, per la loro particolare raffinatezza e per la preziosità delle materie prime utilizzate, indicano la villa di Sant'Imbenia come la più ricca

Figura 1 Veduta degli scavi della villa di Sant'Imbenia. Foto: Soprintendenza per i Beni Archeologici per le province di Sassari e Nuoro

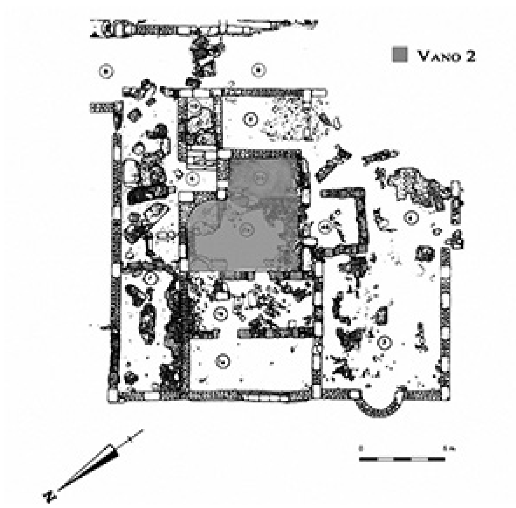

Figura 2 Planimetria della parte settentrionale della villa con il vano 2 in evidenza. Disegno: R. Accorrà, rilievi R. Accorrà, F. Satta, L. Serio, Soprintendenza per i Beni Archeologici per le province di Sassari e Nuoro

ed importante tra le strutture coeve dell'Isola, ed il suo proprietario come un personaggio di altissimo rango. Della sua identità, ad oggi, non abbiamo purtroppo indicazioni, né dai dati archeologici, né dalle fonti storiche.

Il vano 2, da cui proviene l'opus sectile oggetto di questa comunicazione, si trova nella zona settentrionale della villa, ed è uno dei pochi ambienti nei quali l'indagine archeologica, condotta dal 1994 al 2005, è stata completata: ha pianta quadrangolare di circa m 5,50 per 7,50, con un'abside decentrata sul lato nord (fig. 2). Il vano si conserva per un elevato variabile da circa un metro ad un massimo di m 2,40. Sulla superficie interna dei muri perimetrali si osservano tracce del sistema di isolamento e preparazione dei rivestimenti realizzato con grandi frammenti di pareti di anfore in uno spesso strato di malta; durante lo scavo sono stati rilevati resti di *crustae* marmoree alla base di alcune murature. Nell'ultima campagna di scavo sono emersi pochi lacerti del pavimento a mosaico originale, che presenta motivi floreali entro cornici esagonali allungate (Colombi 2011).

Anche questo ambiente ha avuto diverse fasi di riutilizzo, riconducibili a due momenti distinti: una prima rifrequentazione, lunga ed articolata, è avvenuta direttamente a partire dai piani pavimentali originari, con successivi rialzamenti e con la realizzazione su questi di un muro tramezzo in senso NE–SO, che separava un ambiente rettangolare absidato ad ovest (2A) da uno più piccolo rettangolare ad est (2B): entrambi mostrano resti di altri successivi battuti pavimentali, anche con focolari.

In un secondo momento il piano superiore e la copertura di questa parte dell'edificio dovettero collassare, sprofondando all'interno del vano 2: in entrambe le parti di questo ambiente si trovavano infatti potenti strati di crollo contenenti porzioni di murature e di embrici della copertura ancora in connessione, oltre ad un gran numero di frammenti di intonaci dipinti, di stucchi e, soprattutto, di lastre di marmo di diversa tipologia, pertinenti sia a rivestimenti parietali sia a un pavimento in *opus sectile*. Un'ultima frequentazione del vano 2 si attesta infine al di sopra di questi strati, assestati e sistemati con battuti e focolari.

Da questi crolli sono state recuperate circa ottanta cassette di intonaci dipinti, ventisei di stucchi e sessantadue di marmi. La documentazione fotografica e grafica delle parti ancora in connessione realizzata in cantiere è stata di aiuto fondamentale per la ricostruzione dei diversi elementi.

La prossima ripresa degli studi sul contesto, anche con l'analisi sistematica dei reperti di cultura materiale, potrà chiarire in maniera più puntuale la dinamica e soprattutto la sequenza cronologica degli abbandoni e dei riutilizzi. Per ora si può solo evidenziare come le caratteristiche di giacitura dei vari elementi rivelino in alcuni casi la caduta in blocco di porzioni di pavimento, di intonaco e anche di tetto, e la loro conservazione *in situ* dal momento del collasso strutturale; altre parti di rivestimenti apparivano invece rimaneggiate e utilizzate come riempimento per rialzare i piani: questo potrebbe spiegare anche la diversa distribuzione quantitativa dei vari elementi (intonaci, stucchi, marmi) nei due vani A e B.

Le stesse caratteristiche di giacitura dei crolli mostrano chiaramente come le decorazioni architettoniche in essi contenute dovevano appartenere non allo stesso vano 2, bensì ad un ambiente situato sopra di esso al piano superiore.[3] Questa stanza dovette crollare insieme alla copertura dopo che la villa ed il vano 2 erano stati nuovamente occupati e trasformati dopo il loro abbandono: infatti parti del crollo dell'*opus sectile* ancora in connessione poggiavano su lacerti di battuti secondari e su una rudimentale pavimentazione a grandi lastre naturali visibile nel vano 2 (fig. 3).

Nel 2008 il progetto per la realizzazione del Museo civico archeologico di Alghero, ormai nelle sue fasi conclusive, ha offerto l'occasione per avviare, a distanza di molti anni dallo scavo, il restauro dei numerosissimi frammenti di intonaci, stucchi e marmi recuperati nel vano 2.[4]

I lavori hanno permesso di proporre la ricomposizione di ampie superfici della decorazione marmorea parietale e della pavimentazione a *opus sectile* dell'ambiente del piano superiore.[5] La prima comprende lastre di marmo ed elementi decorativi quali capitelli e basi di lesene; la seconda è formata da lastrine di forma quadrata e triangolare di piccolo modulo, che compongono un motivo geometrico policromo di rombi contornati da triangoli. I *sectilia* del pavimento, prevalentemente marmorei, comprendono anche elementi di calcare e di lavagna.[6]

Gli studi e le indagini archeometriche condotte sui materiali hanno evidenziato la straordinaria varietà dei marmi, molti dei quali di provenienza orientale, confermando per la villa algherese un livello paragonabile alle più importanti residenze coeve del continente.

D. R.

L'intervento di conservazione e restauro delle decorazioni architettoniche recuperate durante gli scavi del vano 2 della villa romana di Sant'Imbenia, realizzato dal Centro di Conservazione Archeologica di Roma (CCA) negli anni 2011–14, è stato finalizzato alla conservazione, ricostruzione,

Figura 3 Veduta del vano 2 in corso di scavo. Foto: Soprintendenza per i Beni Archeologici per le province di Sassari e Nuoro

applicazione su nuovo supporto e alla musealizzazione del maggior numero di frammenti possibile, per restituire dignità formale, estetica e archeologica a degli insiemi decorativi altrimenti destinati al deposito. Circa 10.000 frammenti lapidei costituivano l'insieme di partenza da cui tentare la ricostruzione delle lastre marmoree che decoravano in origine le pareti dell'ambiente distrutto e la ricomposizione della pavimentazione in *opus sectile* dello stesso ambiente.

L'intervento è stato progettato e realizzato tenendo conto di una serie di requisiti irrinunciabili e di alcune costrizioni oggettive:

- il rispetto assoluto dei principi di reversibilità e compatibilità dei materiali e delle tecniche d'intervento con i materiali originali;
- la raccolta di evidenze tecniche dallo studio dei reperti;
- la completa documentazione e rintracciabilità dei singoli frammenti, montati o non montati su supporto;
- la semplicità di manipolazione, trasporto, musealizzazione e futura manutenzione dell'opera ricostruita;
- l'adattabilità del sistema di ricomposizione agli spazi museali disponibili.

Nella prima fase sono state realizzate la pulitura preliminare, una prima campagna di documentazione fotografica, la ricerca degli attacchi tra i frammenti, la ricomposizione e l'incollaggio.

La pulitura iniziale è stata svolta per rimuovere i depositi di terra che ricoprivano i frammenti rendendo difficile una loro corretta lettura. Sono state utilizzate acqua addizionata con blandi detergenti, e cicli di esposizione ad acqua nebulizzata. La maggiore visibilità delle superfici dopo la pulitura è stata propedeutica a una prima campagna di documentazione fotografica e a una prima generale classificazione e quantificazione del materiale disponibile per la ricostruzione dell'*opus sectile*. Una divisione preliminare è stata realizzata separando dall'insieme dei frammenti le lastrine marmoree e in ardesia integre e i frammenti che, per forma e dimensione (triangoli, quadrati e rettangoli), potevano essere attribuiti con certezza alla decorazione pavimentale. Ultimata questa fase, che ha determinato la formazione dei primi gruppi compatibili, si sono creati, man mano, insiemi di frammenti coerenti, per tipologia marmorea, in prima istanza, e, successivamente, per tipologia decorativa, arrivando a distinguere i frammenti appartenenti alla decorazione parietale da quelli sicuramente attribuibili alla decorazione pavimentale.

La ricerca degli attacchi tra frammenti combacianti è stata eseguita secondo metodiche tradizionali, basate sull'attenta osservazione dei frammenti: l'analisi visiva delle diverse tipologie marmoree; l'analisi della forma, delle dimensioni, dello spessore dei frammenti; studio dei segni di lavorazione originale, degli strumenti utilizzati, degli elementi residui delle malte di allettamento; studio delle alterazioni, della tipologia di frattura.

A conclusione del progressivo approfondimento del processo, fatto di divisione, sottrazione e accostamento dei frammenti in base alle caratteristiche riscontrate, è stato possibile ricostruire 333 elementi dell'*opus sectile* (lastrine triangolari, quadrate e rettangolari, un elemento circolare e le rispettive cornici quadrangolari) per un totale di circa mille frammenti riadesi.

L'incollaggio è stato realizzato con resina epossidica bicomponente, previa stesura su ambedue le superfici di attacco tra i frammenti di uno strato di reversibilità di resina acrilica in soluzione ad alta percentuale.

La seconda fase dell'intervento è stata dedicata interamente allo studio, alla catalogazione, alla documentazione dei frammenti ai fini della pianificazione del montaggio su nuovo supporto e alla messa a punto del sistema più idoneo per ottemperare ai requisiti di totale reversibilità, semplicità di manipolazione, trasporto, adattabilità agli spazi museali, musealizzazione e futura manutenzione.

Il primo indispensabile passaggio è stato lo studio della documentazione di scavo.

Durante il recupero del materiale lapideo di Sant'Imbenia, limitate porzioni dell'*opus sectile* sono state ritrovate ancora in connessione tra loro, in una sorta di istantanea del crollo (fig. 4). Gli elementi recuperati nella loro posizione di crollo sono stati documentati con fotografie e rilievi al momento dello scavo, fornendo la chiave di lettura dell'originaria decorazione, nella sua unità disegnativa di base ripetitiva, fondamentale per formulare un'ipotesi attendibile per la

Figura 4 Veduta del crollo dell'*opus sectile in situ*. Foto: Soprintendenza per i Beni Archeologici per le province di Sassari e Nuoro

ricostruzione della stesura pavimentale secondo uno schema formale definito. Dalle evidenze archeologiche è risultata una composizione modulare quadrata realizzata con elementi semplici, lastrine triangolari e quadrate di marmi diversi e ardesia, combinati in alternanza di toni contrastanti (chiari/scuri).

La conferma indiretta dei dati di scavo è stata fornita dai risultati quantitativi raggiunti a conclusione della ricostruzione delle lastrine, dai quali è emersa una prevalenza di lastrine triangolari e quadrate rispetto alla quantità di lastrine di forma rettangolare. I frammenti di crollo documentati *in situ* non hanno chiarito tuttavia l'originale orientamento dei moduli rispetto alla planimetria dell'ambiente di provenienza di cui non sono note forma e dimensioni.

Durante il lungo periodo dedicato alla ricomposizione delle lastrine, sono emersi dati importanti riguardo alla varietà delle specie marmoree utilizzate e alle caratteristiche tecniche di lavorazione originale.

I dati più significativi sono rappresentati, da un lato, dalla ricchezza delle specie marmoree presenti, nelle quali figurano, tra gli altri, marmi pregiati come il pavonazzetto, il giallo e il verde antico, l'alabastro; dall'altro, dall'evidente reimpiego dei marmi, su molti dei quali è stato possibile osservare, sia sul fronte sia sul retro, tracce di lavorazioni precedenti, veri e propri abbozzi scultorei di elementi architettonici quali capitelli di lesena e modanature (fig. 5). È stato inoltre osservato che alcune lastrine quadrate sono state ottenute attraverso connessione di elementi frammentari, in genere dello stesso materiale, rilavorati lungo i bordi in modo da farli combaciare e formare così l'elemento voluto.

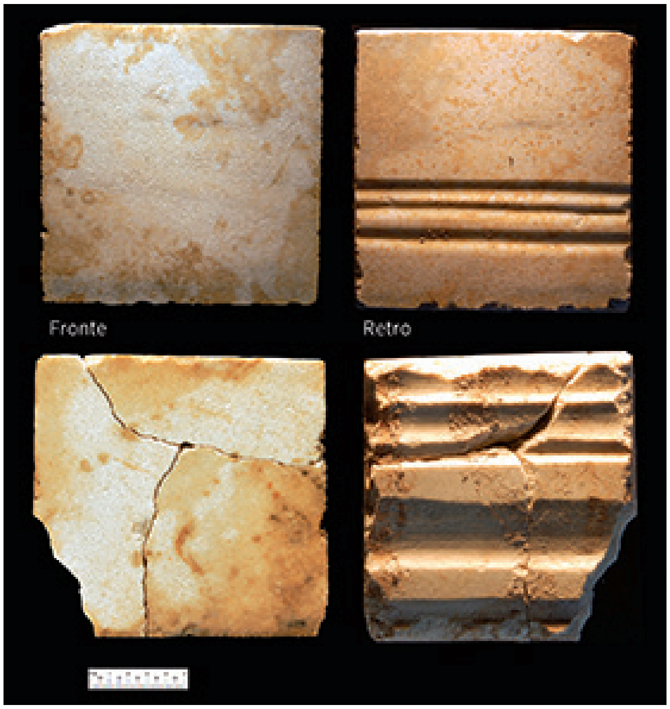

Figura 5 Lastrine quadrate dell'*opus sectile* prima del montaggio, fronte e retro. Sul retro sono presenti segni di lavorazioni precedenti. Foto: CCA, Centro di Conservazione Archeologica—Roma

Altri fattori che denunciano un utilizzo secondario di questi marmi sono la grande varietà di spessori riscontrati tra i singoli elementi; la variabilità nella finitura del retro delle lastrine, a volte reso perfettamente piano, a volte lasciato appena sbozzato a subbia o scalpello.

Prima di affrontare la ricomposizione del pavimento su nuovo supporto, che avrebbe naturalmente impedito una futura lettura di questi dati, soprattutto se posti sul retro delle lastrine, è stato indispensabile mettere in atto un articolato processo di documentazione e catalogazione che consentisse non solo la registrazione dei dati rilevanti ma anche la loro agevole rintracciabilità futura.

Il sistema di documentazione adottato, oltre alla normale registrazione grafica su mappature tematiche dello stato di conservazione e dell'intervento eseguito, realizzata soltanto a montaggio concluso quando è stato possibile avere l'immagine dell'*opus sectile* ricostruito, include:

- la creazione di un catalogo fotografico e grafico di tutte le lastrine disponibili, raggruppate per tipologia geometrica e tipologia marmorea e non marmorea, attribuendo a ciascuna una lettera di riferimento e un numero progressivo;
- la documentazione fotografica dei dettagli tecnici osservati sul fronte e sul retro;
- la trascrizione delle sigle di ogni lastrina sul disegno individuale dei moduli pianificati per il montaggio;
- la creazione di un database finale, in cui sono riportati, in modo sintetico, per ciascuna lastrina utilizzata nel montaggio, le probabili specie marmoree di appartenenza, la numerazione del pannello di destinazione, la presenza o meno di dettagli tecnici rilevanti e le fotografie disponibili.

Dato l'ingente numero di elementi originali da gestire per una corretta pianificazione dell'intervento e l'indispensabile necessità di assicurare la futura fruizione delle informazioni, nonché la completa reversibilità, questo sistema di documentazione ha consentito di tenere sotto controllo il processo, dall'inizio alla fine dell'intervento, mettendo in evidenza eventuali omissioni, assicurando, al contempo, una puntuale rintracciabilità delle informazioni raccolte e della collocazione finale delle singole lastrine (fig. 6).

La terza fase dell'intervento è stata finalizzata alla ricostruzione, all'applicazione su nuovo supporto, e ai trattamenti volti alla presentazione estetica finale.

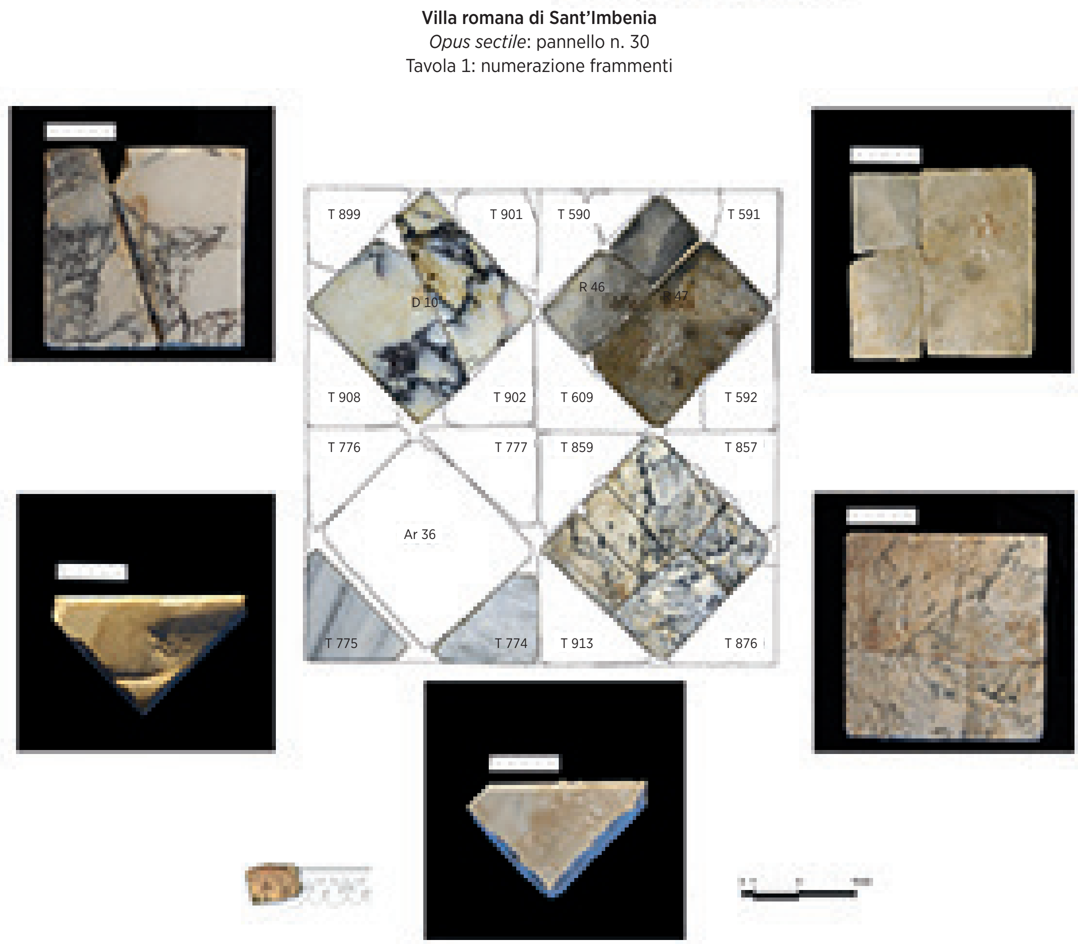

Figura 6 Esempio della documentazione grafica eseguita con le fotografie dei dettagli tecnici presenti sul fronte e sul retro delle lastrine. Foto e disegno: CCA, Centro di Conservazione Archeologica — Roma

Individuato il modulo di base per la ricomposizione secondo le modalità descritte, gli accoppiamenti tra le lastrine sono stati provati e verificati, fino a esaurire le lastrine disponibili per ottenere moduli quadrati che avessero una loro coerenza estetica finale individuale e generale, cioè a pavimento.

La ricostruzione dei moduli, proposta in via del tutto ipotetica, segue uno schema compositivo diagonale, nella forma rettangolare che si adatta agli spazi museali.

Il sistema adottato per la ricomposizione dei moduli e l'applicazione su nuovo supporto trae origine dal sistema di prefabbricazione delle lastre geometriche in *opus sectile* utilizzato in antico.

Data la grande varietà di spessori delle lastrine dell'*opus sectile* di Sant'Imbenia e le esigenze di trasporto e musealizzazione, si è scelto di seguire una procedura del tutto assimilabile a quella antica, con il sistema "indiretto", ricomponendo i moduli al rovescio, entro casseforme quadrate di dimensioni e altezza standard. Si sono scelte dimensioni ridotte anche per contenere il peso finale dei singoli pannelli montati, peso che oscilla tra i 10 e i 15 kg ciascuno (fig. 7).

Sono state realizzate 49 casseforme in multistrato bi-laminato di 41 × 41 cm di lato, con un bordo perimetrale in legno alto 5 cm, equivalenti alla ricostruzione di quattro piccoli moduli quadrati, ottenuti assemblando, per ciascuna delle casseforme, quattro lastrine quadrate inscritte diagonalmente e sedici elementi triangolari. Altre due casseforme sono state realizzate con misure diverse, rispettando tuttavia il multiplo e il sottomultiplo di quelle già realizzate, per assemblare gli elementi marmorei trovati ancora in connessione dopo il crollo durante gli scavi e mantenere così memoria dell'originale composizione dell'*opus sectile* così come restituito dal sito archeologico.

Una volta assemblate le lastrine dentro le casseforme secondo l'ordine pianificato, si è applicata malta di calce con proprietà idrauliche sugli elementi lapidei posti a testa in giù.

Sono state utilizzate due miscele: la prima, con granulometria fine, è stata applicata allo scopo di sigillare gli spazi di connessione tra una lastrina e l'altra; la seconda, con un impasto più resistente, a granulometria maggiore, destinato ad accogliere il supporto finale. La malta è stata livellata creando

Figura 7 L'*opus sectile* durante la fase di accoppiamento delle lastrine dentro le casseforme. Foto: CCA, Centro di Conservazione Archeologica — Roma

un sottolivello di 5 millimetri rispetto alla cornice perimetrale e lungamente lavorata per renderla perfettamente aderente agli elementi lapidei sottostanti. Su questo strato, trascorso il tempo dell'asciugatura e della presa, sono stati incollati, con resina epossidica, i corrispettivi pannelli di Aerolam, tagliati a misura, incastrandoli all'interno della cornice della cassaforma.

Solo a questo punto delle lavorazioni, a supporto montato, è stato possibile ribaltare i pannelli, rimuovere le casseforme e vedere il risultato finale del montaggio.

Il metodo utilizzato presenta la controindicazione di non consentire il controllo visivo costante durante le lavorazioni fino alla fine del montaggio, con la conseguente incertezza sugli esiti finali ottenuti. In secondo luogo non permette la lavorazione delle malte sul fronte, normalmente plasmate per ottenere il giusto sottolivello e la corretta finitura estetica.

Offre però numerosi vantaggi tecnici. Risolve, per esempio, la difficoltà di applicazione diretta su malta di calce fresca di lastrine dagli spessori molto variabili che rendono difficoltoso il livellamento orizzontale del montato, causando una progressione del lavoro a piccoli passi e la preparazione progressiva della malta, che avendo un tempo limitato di utilizzo, superato il quale comincia ad indurirsi, non può essere preparata in un'unica soluzione. Offre anche il pregio di rendere le operazioni più veloci, realizzabili quasi a catena, se ben pianificate e organizzate.

Complessivamente, l'intervento ha portato alla ricomposizione di circa nove metri quadrati di *opus sectile* (fig. 8).

A conclusione del montaggio sono state realizzate operazioni volte al miglioramento della leggibilità delle superfici e alla loro protezione. In primo luogo si è voluto dare rilievo alla policromia dei marmi, realizzando una pulitura chimica con impacchi di una miscela solvente debolmente alcalina, seguiti da risciacqui ed estrazione dei residui con acqua distillata.

Si sono poi asportate le malte utilizzate per il montaggio affiorate sulla superficie negli spazi di lacuna e negli interstizi tra le lastre, per realizzare le stuccature finali.

La fase finale dell'intervento è stata dedicata alla predisposizione di materiali didattici, al trasporto e alla musealizzazione.

L'intero intervento ha avuto come presupposto fondante e obiettivo finale la musealizzazione dei reperti ricostruiti nel nuovo Museo civico archeologico di Alghero, per la completa diffusione al pubblico.

L'intervento ha riguardato, oltre alla pavimentazione in *opus sectile*, anche le lastre marmoree parietali, le decorazioni ad affresco del soffitto dell'ambiente andato distrutto, nonché alcuni stucchi di grande finezza e il mosaico detto della Medusa, provenienti da altri ambienti della villa. I risultati raggiunti hanno superato le aspettative iniziali, consentendo di poter offrire alla comunità, intesa come destinatario finale di questo recupero, uno spaccato dell'arte dei rivestimenti di

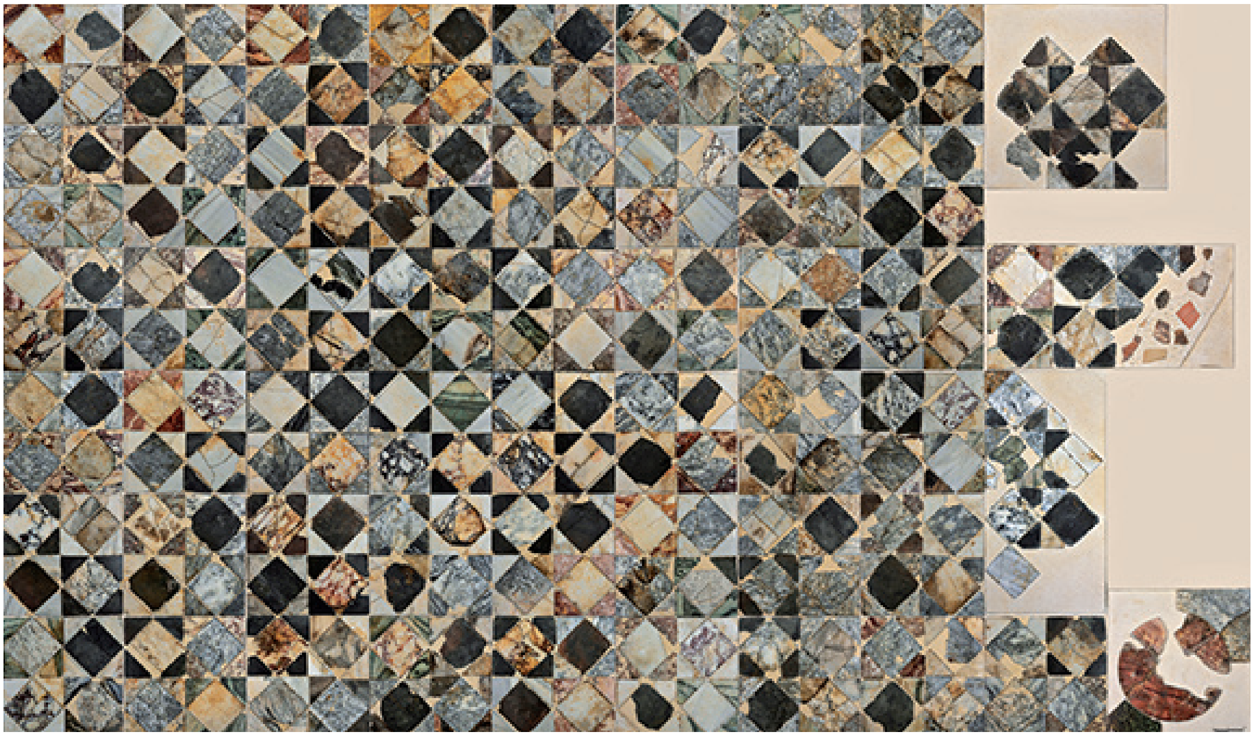

Figura 8 L'*opus sectile* dopo il restauro. Foto: CCA, Centro di Conservazione Archeologica — Roma

epoca romana e una molteplicità d'informazioni di carattere tecnico, archeologico e storico prima non disponibili.

Particolare attenzione è stata quindi dedicata, non solo all'allestimento dei reperti ricostruiti, che ripropone uno spaccato della stanza con i rivestimenti collocati nella posizione che originariamente occupavano nel vano andato distrutto – pareti, soffitto e pavimento – ma anche alla predisposizione di materiali didattici, utili alla comprensione delle tecniche di lavorazione originali, alla conoscenza dei materiali e delle informazioni raccolte durante la prolungata manipolazione, osservazione e studio dei reperti.

Tre pannelli didattici sono stati interamente dedicati al marmo in generale, e all'*opus sectile* in particolare. Per trasmettere il pregio e la varietà dei marmi rappresentati a Sant'Imbenia, in aggiunta alle caratteristiche di reimpiego, si è preferito far parlare direttamente gli originali piuttosto che affidarsi a fotografie e disegni. Lastrine con lavorazioni precedenti sul retro, lastrine di particolare bellezza e finitura ed elementi che conservano porzioni delle malte di sottofondo originali, sono stati applicati su pannelli, protetti con fogli di plexiglass, corredati da testi e disegni esplicativi.

Sempre utilizzando lastrine originali e frammenti ceramici recuperati nel corso dello scavo è stato realizzato e posto in mostra un modello didattico con la sequenzialità dei vari strati preparatori a malta e materiali ceramici, per illustrare le tecniche antiche di applicazione dell'*opus sectile* sul battuto pavimentale.

Conclusioni

Conservare e presentare: a quale costo? In questo intervento si è posto un problema etico legato alla nostra professione e le scelte operate sono state il risultato di approfondite discussioni, tra i funzionari della Soprintendenza e l'équipe del Centro di Conservazione Archeologica. Normalmente chi opera in questo settore è chiamato a conservare, applicando il principio del minimo intervento nella consapevolezza che ogni intervento diretto si può tradurre in una manomissione dell'originale ed entra a far parte della storia materiale e culturale delle opere. Il pavimento, oggi ricostruito dopo un lungo intervento, è nella sua composizione attuale, frutto di un'ipotesi, dunque di un'interpretazione. Si è cercato, tuttavia, di dare a questa interpretazione il maggior sostegno possibile sia dal punto di vista archeologico, attenendosi alle informazioni ricavabili dalla documentazione di scavo, sia dal punto di vista della documentazione, assicurando la completa rintracciabilità delle informazioni e dei singoli elementi montati, sia, infine, dal punto di vista tecnico, utilizzando materiali e tecniche di applicazione totalmente e facilmente reversibili.

In questo intervento, che senz'altro ha rappresentato non solo una sfida tecnica, ma costituisce probabilmente un caso limite, si è voluto privilegiare l'aspetto della trasmissibilità delle valenze archeologiche, storiche e materiali dei reperti, sottraendole allo stato di frammento e all'oblio dei depositi, nella convinzione che, oltre l'aspetto formale e di autenticità, questi materiali siano messaggeri di una storia tutta da recuperare e valorizzare.

C.Z.

Note

1 Sui primi scavi cfr. Maetzke 1959–61; gli interventi 1979–80 sono stati diretti da Francesca Manconi, così come quelli dal 1994 al 1999, condotti da Antonella Pandolfi (Manconi 1999). Gli scavi degli anni 2000 sono stati condotti da Rossella Colombi, e diretti dalla scrivente (Colombi 2011).

2 I riutilizzi degli ambienti della villa sono probabilmente legati alla stessa comunità che aveva costruito un piccolo villaggio con necropoli, attivo nello stesso periodo, nell'area immediatamente adiacente verso nord–est, oggi sede di un parco comunale (Lissia 1989; Rovina 1989).

3 Alcuni resti del piano superiore nella villa si conservano ancora *in situ:* La pavimentazione di una vasca sopra un ambiente voltato nella parte centrale del complesso, e la prima rampa di una scala posta alle spalle del vano 2.

4 Si tratta di un finanziamento regionale gestito dal Comune di Alghero di 350.000 €, di cui 258.000 impegnati per i lavori di restauro e musealizzazione dei rivestimenti provenienti dai crolli di due vani della villa, il 2 e il 7. Il progetto preliminare della Soprintendenza per i BB.AA. (arch. Patrizia Tomassetti) è stato appaltato al Centro di Conservazione Archeologica che ha eseguito la progettazione definitiva e il restauro, tra il 2011 e il 2014 con la direzione di P. Tomassetti (collaboratori Daniela Rovina, Luigi Piras e Franco Satta). In corso d'opera è stato inserito anche il restauro di parte di un pavimento a mosaico di pasta vitrea con *emblema* con testa di Medusa: i frammenti si trovavano in uno strato di crollo in un vano prospiciente la linea di costa (Colombi 2011) e sono stati recuperati per motivi di tutela dal momento che la loro superficialità li rendeva esposti all'azione del mare e ad eventuali atti di vandalismo.

5 Le problematiche legate alla ricostruzione e alla musealizzazione dei rivestimenti, discusse e condivise tra Soprintendenza e C.C.A. sono trattate più avanti da C. Zizola.

6 Formelle di lavagna sono presenti in s*ectilia* misti di diverse epoche (Guidobaldi 1993). Lo schema dell'*opus sectile* di Alghero, riconducibile al tipo Q2 di piccolo modulo di Guidobaldi 1985, è piuttosto diffuso con una serie di varianti dal I al IV secolo d.C. In attesa di conferme stratigrafiche, il pavimento di Sant'Imbenia, per la presenza di elementi di riutilizzo, sembra databile non anteriormente al II–III secolo.

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PART FOUR

Case Studies

I mosaici delle Terme Pallottino a *Turris Libisonis*, Porto Torres (SS): Restauro e fruizione

Gabriella Gasperetti, Francesca Condò, Alba Canu, Maria Graziella Dettori, Giovanni Antonio Chessa e Antonino Secchi

Abstract: *Le Terme Pallottino di Porto Torres (fine III–inizi IV sec. d.C.) furono scavate negli anni Quaranta del Novecento. L'area è stata a lungo chiusa al pubblico per problemi di sicurezza. Nel 2012 la Soprintendenza ha intrapreso un restauro volto alla conservazione delle strutture e dei rivestimenti musivi e alla fruizione pubblica, operando consolidamenti di murature e superfici, in un'ottica di compatibilità e riconoscibilità dell'intervento, ma anche gli scavi necessari per collegare il complesso al tessuto urbano alle sue spalle. Il risultato è frutto di un lavoro tra professionalità diverse con un continuo scambio per il raggiungimento del risultato migliore.*

Abstract: *The Terme Pallottino di Porto Torres (Pallottino Thermae of Porto Torres) (late third to early fourth century* CE*) were excavated in the 1940s. Due to security issues, the area was long closed to the public. In 2012, the Superintendency launched a restoration project aimed at conserving the structures and mosaics and making them available to the public. This work entailed reinforcing walls and surfaces to ensure the restoration's compatibility and recognition, while also performing the necessary excavations to connect the complex to the fabric of the city behind it. The outcome is the fruit of labor shared among various professionals working together continuously to achieve the best possible results.*

La città di Porto Torres sorge sui resti della *Colonia Iulia Turris Libisonis*, l'unica città della *Provincia Sardinia* costituita da cittadini romani (Plinio, *N. H.*, III, 85), fondata nella seconda metà del I secolo a.C. alla foce del Rio Mannu lungo un tratto di costa ottimale per l'approdo.

Fin dal I secolo d.C. la città era dotata delle principali infrastrutture: un impianto viario regolare, il porto, l'acquedotto. Il ponte che attraversa il rio Mannu verso le campagne della Nurra e le miniere dell'Argentiera è il maggiore tra i ponti romani della Sardegna, con 7 arcate per 135 metri di lunghezza.

L'economia di *Turris Libisonis* si basava sui traffici marittimi, sulla pesca, sulla cerealicoltura, sull'allevamento, sull'attività estrattiva e artigianale. Nello sviluppo urbanistico e monumentale tra il II e il III secolo furono realizzati anche lavori a difesa del porto dai venti di nord-est, magazzini e altre strutture relative alle attività portuali, alle quali era preposto un funzionario, il *procurator ripae turritanae*. Nel porto di Ostia è attestata la presenza di una sede dei *navicularii turritani*, citati nel celebre mosaico del Piazzale delle Corporazioni (Boninu, Le Glay e Mastino 1984; Mastino 1992: 5–74; Mastino e Vismara 1994; da ultimo Boninu e Pandolfi 2012 con ampia bibliografia; per i lavori nell'area portuale Villedieu 1984; Gasperetti 2009: 266–77; Mastino, Zucca e Gasperetti 2014: 151–82).

Tra il III e l'inizio del IV secolo d.C. fu costruito un tratto della cinta muraria urbana lungo la sponda destra del rio Mannu, furono completate le Terme Centrali, note popolarmente come Palazzo di Re Barbaro, le Terme Maetzke e le Terme Pallottino, che prendono il nome rispettivamente da Guglielmo Maetzke, Soprintendente Archeologo negli anni Sessanta, e da Massimo Pallottino, Soprintendente durante la Seconda guerra mondiale, che le riportò in luce tra il 1940 e il 1941 assieme al vicino peristilio, interpretato come area del foro (Pallottino 1947: 227–32; per la localizzazione del foro, Azzena 1999: 369 ss., Azzena 2002: 1099–1110, ripreso da Mastino 2005: 242).

Lavori pubblici eseguiti tra la fine del XIX e l'inizio del XX secolo hanno gravemente danneggiato i resti della colonia. I collegamenti ferroviari hanno tagliato in più punti la città, rendendo difficile la comprensione del tessuto urbanistico antico.

Negli anni Novanta del XX secolo il Comune di Porto Torres ha espropriato un'ampia area (oltre sei ettari) tra le Terme Centrali, via Fontana Vecchia e via Ponte Romano per destinarla a Parco Archeologico. Qui, nella parte bassa della collina del faro, vi sono ambienti residenziali, la cd. *Domus* dei mosaici marini, le mura occidentali, il peristilio e le Terme Pallottino.

Queste ultime, lungo via Ponte Romano, sono oggi a circa un chilometro di distanza dalla costa; in epoca antica erano più vicine all'area portuale e, con ogni probabilità, erano pubbliche. Risparmiate dai lavori ferroviari, sono state tagliate dal passaggio della strada moderna. L'impianto ha orientamento est–ovest; oltre la strada sono stati ritrovati altri ambienti sicuramente pertinenti al complesso, il maggiore dei quali con pavimento a mosaico geometrico, con motivo decorativo a ellissi che trova riscontro nell'esemplare Rép. 447, finora non noto fra i mosaici della Sardegna. Un secondo ambiente presenta un mosaico con motivo a canestro, con riscontro diretto in quello della vasca occidentale delle Terme Centrali, datato al III secolo d.C. (Boninu, Gasperetti e Pandolfi c.s.).

La costruzione delle Terme ha dovuto tenere conto sia dell'andamento del pendio naturale sia di strutture più antiche, presenti a monte. In sequenza, da est, sono visibili: un primo ambiente che aveva il pavimento a mosaico su *suspensurae*, oggi perduto (fig. 1); un ambiente semi-ipogeo a pianta quadrata (m 5,15 × 5,05) a sud del primo, rivestito in cocciopesto, con pavimento a mosaico geometrico e gradinata di accesso dal lato nord, che definiremo *frigidarium*; un ambiente absidato sul lato sud, con pavimento su *suspensurae*, che conserva lacerti di rivestimenti marmorei, ampie porzioni del pavimento musivo e grossi blocchi dei crolli delle pareti e delle volte infissi nel pavimento, definito *tepidarium*; un grande ambiente rettangolare totalmente in laterizio, anch'esso riscaldato, absidato sui lati sud e nord (planimetria generale fig. 4). Il principale elemento di datazione per questo edificio è fornito dalle pavimentazioni musive delle vasche, collocabili cronologicamente, sulla base di confronti stilistici, allo scorcio del III–inizi IV sec. d.C. (Angiolillo 1981: 186–89).

Tra il 2009 e il 2010 sono stati condotti scavi archeologici a monte del complesso, nell'ambito del "Progetto *Bubastis*", in collaborazione tra le Università di Cagliari e Sassari, la Soprintendenza e il Comune di Porto Torres. Gli scavi hanno individuato una serie di vasche digradanti sul pendio, collegate tra loro, che servivano all'approvvigionamento idrico delle terme, un vicolo all'esterno del complesso e alcune sepolture di epoca tarda (Cicu e Pianu 2012: 339–46; Carboni et. al. 2012: 2636–43).

Dopo gli scavi degli anni Quaranta il complesso termale è rimasto in vista. Nonostante la manutenzione delle essenze spontanee, eseguita dai tecnici della Soc. ALES assegnati a Porto Torres, la carenza di interventi specifici di restauro ha comportato gravi danni agli ambienti e soprattutto alle decorazioni musive.

Per recuperare il monumento e consentirne la visita in sicurezza, il Soprintendente Bruno Massabò ha promosso nel 2012 la realizzazione di un progetto di sistemazione dell'area, costato poco più di 100.000 €, svolto tra la fine del 2012 e la primavera del 2013[1].

In particolare, il *frigidarium* presentava disgregazione del cocciopesto delle pareti, specie sul lato esposto a nord; il mosaico pavimentale, invece, con piccole lacune, appariva

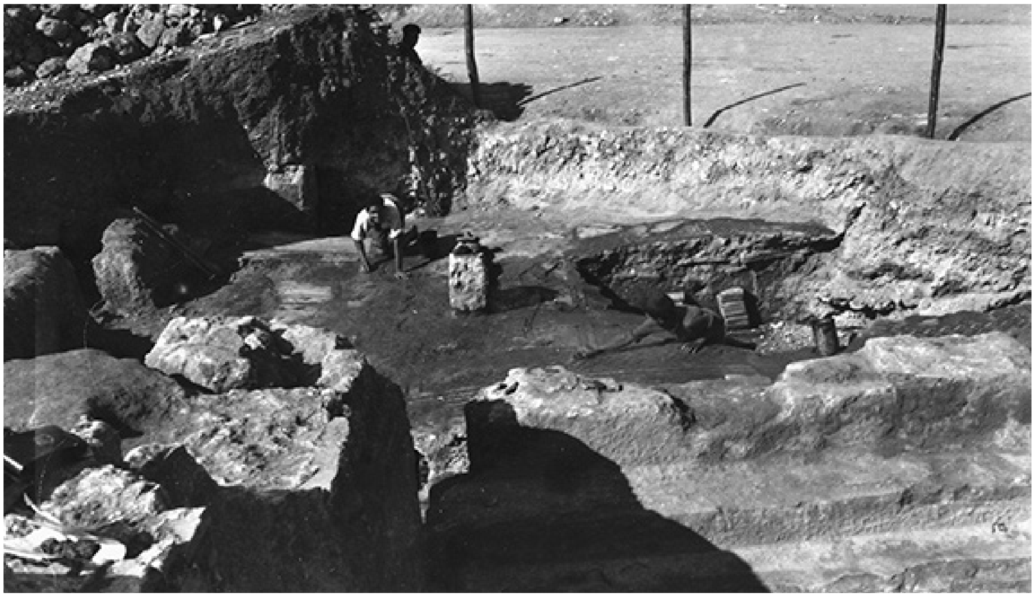

Figura 1 L'ambiente con pavimento a mosaico, oggi perduto: "Il pavimento della grande sala a suspensurae, distrutto nel centro e sull'intero lato occidentale, consisteva in un grandioso mosaico policromo, verosimilmente quadrato, misurante più di cinque metri su ciascun lato. Il bordo è formato da una fascia continua con motivi di quadrati inseriti in svastiche. Nel centro, sopra un fondo a treccia, si aprono emblemata quadrati regolarmente disposti . . . soltanto di uno di essi è riconoscibile con evidenza il soggetto (un delfino)" (Pallottino 1947: 232).

in discrete condizioni, eccetto il ristagno delle acque piovane causato dall'occlusione della *fistula* di scolo.

Nel *tepidarium* il pavimento era in più punti sfondato dai crolli, con deformazione del rivestimento musivo e ampie zone di distacco, aggravate dalla vegetazione (figg. 2, 6). Per poter restaurare e mettere in sicurezza il rivestimento musivo era necessario rimuovere parte del crollo, soprattutto nella porzione nord dell'ambiente, conservando comunque le porzioni di maggiori dimensioni, testimonianza del collasso della struttura.

Nell'ultimo ambiente a ovest non erano conservati rivestimenti; qui era necessario consolidare le murature, in particolare in un sottile lacerto murario lungo l'abside meridionale, dovuto a un varco praticato nella muratura dopo la defunzionalizzazione delle Terme.

Contestualmente al restauro sono stati realizzati due interventi di scavo archeologico: grazie al primo, all'interno del *tepidarium*, si è individuata una diversa sistemazione della parte absidata, che ha il piano rialzato con rivestimento in marmo, e si è restaurato il sistema di riscaldamento delle

Figura 2 Il *tepidarium* prima degli interventi di restauro; è visibile lo stato di deformazione del solaio e del pavimento musivo che ha portato, assieme ai crolli e all'effetto degli agenti meteorici, alla perdita di parte del rivestimento.

Figura 3 Il saggio di scavo alle spalle delle Terme. È visibile il condotto coperto, che si lega a destra all'abside del grande ambiente in laterizio e si appoggia a sinistra al corpo di fabbrica in opera quadrata. Sul fondo l'impronta delle *fistulae*.

pareti dell'ambiente, realizzato con *tegulae mammatae* rivestite da lastre di marmo, di cui si sono trovate e riposizionate le porzioni inferiori.

Il secondo intervento aveva lo scopo di mettere in sicurezza il settore a monte delle Terme. Il completamento del saggio, rimasto in vista dal 2010, ha restituito una sorta di vano, delimitato a est da una struttura muraria in *opus africanum*, posteriore alle Terme, e, a ovest, da un condotto ammorsato alle strutture termali e caratterizzato da una copertura a doppio spiovente in laterizio, appoggiato a un corpo di fabbrica in opera quadrata di calcare, sormontato da una vasca e caratterizzato da un prospetto con arco a tutto sesto.

La sequenza stratigrafica ha rivelato le fasi di abbandono delle Terme in epoca tardo antica, con strati di bruciato che coprivano piccole vasche formate da pietrame e malta idraulica, ritrovate sul fondo del saggio. Qui sono presenti anche le tracce del sistema di scarico delle acque dell'impianto termale, ovvero il negativo delle *fistulae* in piombo sulla malta di allettamento, dirette verso il condotto a doppio spiovente (fig. 3).

All'interno del condotto una vasca più antica in blocchi di calcare, in fase con la struttura in opera quadrata, era tagliata dal condotto stesso. La tecnica costruttiva è ampiamente diffusa a *Turris Libisonis* ed è distintiva delle prime fasi edilizie della città, come è confermato dal materiale rinvenuto a contatto con il piano della vasca demolita, ancora in fase di studio, databile al I secolo d.C.

G.G.

L'intervento di restauro e valorizzazione: criteri generali

Stato dell'area nel 2012

Le strutture delle Terme Pallottino hanno paramento in mattoni, con porzioni del rivestimento a intonaco o marmoreo, e nucleo interno costituito da pezzame prevalentemente calcareo, malta di calce e inerti di diversa natura e granulometria.

Nel marzo 2012 la situazione era compromessa sia per lo stato delle strutture, sia per la sicurezza e comprensibilità per il pubblico. Nel novembre 2012 si sono avviati i lavori di restauro e sistemazione dei percorsi (fig. 4). Gli ambienti presentavano un diffuso degrado delle murature, causato dalle infiltrazioni di acqua meteorica alla sommità dei muri, per ristagno alla base e a causa dell'aggressione di agenti chimici e biologici.

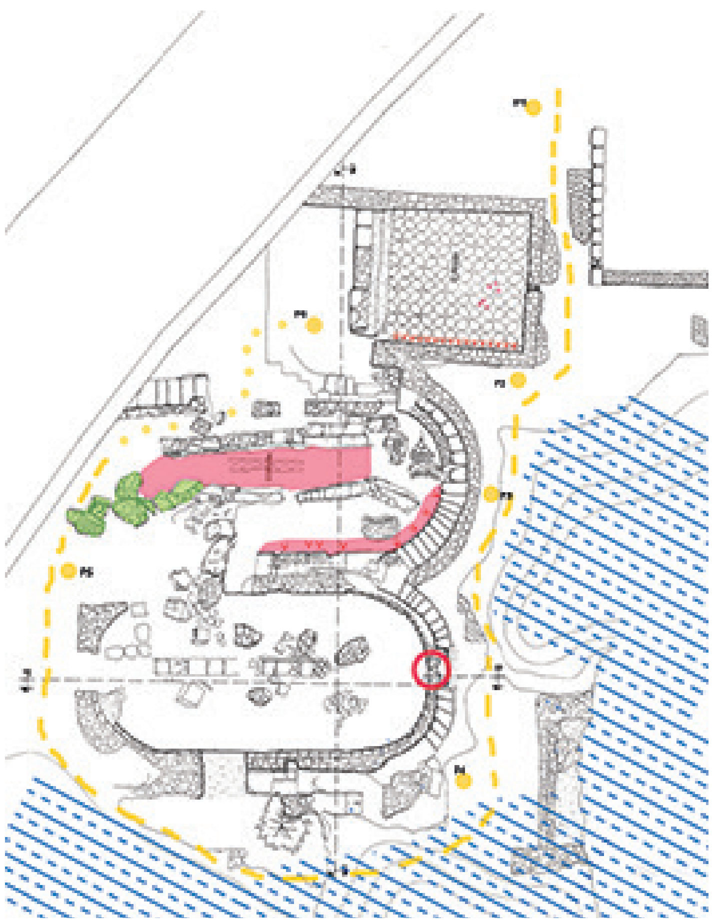

Figura 4 Planimetria orientata a est, su rilievo della Soprintendenza n. 519 del 1981, con l'indicazione dei fenomeni di degrado e degli interventi previsti. Le fasce blu individuano le aree di terreno instabile e accidentato per l'accumulo di terreno di riporto e per la presenza di saggi scoperti; le aree evidenziate in rosa individuano mosaici e rivestimenti in lastre marmoree bisognosi di consolidamento. Il cerchio rosso indica il lacerto murario da consolidare. I percorsi tratteggiati in giallo sono stati modificati in corso d'opera per evitare il passaggio all'interno degli ambienti.

Sussisteva, inoltre, il pericolo di caduta e di smottamento delle pareti di terra a causa del dislivello, anche superiore ai 2 m, tra la sezione di terra a sud degli ambienti termali, gli ambienti stessi e il saggio di scavo rimasto in luce dal 2010.

Gli interventi operati

Dopo il diserbo e la pulitura da depositi e detriti, un rilievo fotografico di dettaglio dello stato di fatto, si sono eseguiti gli scavi all'interno del *tepidarium* e a monte degli ambienti termali. Sono stati messi in sicurezza i cigli di terra, regolarizzando i detriti accumulati da scavi precedenti; a questo intervento è seguita la ricostituzione del piano di calpestio alle spalle degli ambienti termali, che ha coperto le fondazioni e restituito le quote necessarie a una migliore comprensibilità e percorrenza.

Le murature presentavano lacune, elementi fessurati e mancanza di uno strato di protezione in sommità. Per le integrazioni sono stati utilizzati elementi simili a quelli dei paramenti originari o del nucleo della muratura, legati con malta compatibile rispetto a quella antica, con allineamento leggermente arretrato rispetto al filo originale o con altro sistema per distinguere l'intervento. Si è scelto di utilizzare come leganti materiali già testati, quali malte di grassello di calce e pozzolana o cocciopesto, evitando l'aggiunta di cemento, resine o materiali premiscelati, di maggior costo, non necessari nonché incompatibili dal punto di vista della permeabilità e meccanico, per la loro maggiore resistenza rispetto al materiale originale. Per le lacune delle murature si è impiegata una malta composta da grassello di calce, pozzolana di granulometria assortita (8–0,5 mm) e altro inerte (frammenti calcarei, cocciopesto) nelle proporzioni di 1:2–1:3 fino al raggiungimento di un colore compatibile con quello del tratto murario, impastando senza aggiunta di acqua, a mano o con uso di betoniera, senza molazza per evitare la polverizzazione dell'inerte. Le lacune di maggiori dimensioni sono state integrate con frammenti di pietra o laterizi in sottosquadro. La pozzolana garantisce l'idraulicità della malta e una certa riconoscibilità dovuta alla sua minore diffusione in Sardegna rispetto ad altre regioni italiane.

L'intervento sul *tepidarium:* scelte di presentazione

Nell'ambiente il pavimento sopraelevato era collassato sotto i crolli di volte e murature, con la generale deformazione del massetto e del rivestimento musivo e con distacchi aggravati dalla vegetazione. Per sanare la situazione si sono consolidate le tessere nello stato attuale, senza prevedere distacchi e rimontaggi con regolarizzazione del supporto, se non per porzioni limitate.

La conservazione del crollo degli elevati è la traccia del passaggio del monumento attraverso il tempo. Sarebbe stato comunque impossibile proporre una ricostruzione, anche parziale, degli elevati e dei pavimenti, vista la frammentarietà delle porzioni conservate. Il mantenimento del crollo nello stato attuale ha permesso anche di osservare da vicino la tecnica costruttiva utilizzata per le volte.

In una fase iniziale si era ipotizzato di rimuovere alcune porzioni del crollo nella parte nord dell'ambiente nord, per creare un passaggio in sicurezza per la visita; in seguito, considerato che si prevede di estendere lo scavo sotto e oltre la strada, vista la delicatezza del rivestimento pavimentale, si è optato per una leggera modifica del percorso di visita e per la conservazione del crollo, a testimonianza dell'evento oltre il quale non si proseguì l'uso dell'impianto.

Durante i lavori sono state rimosse alcune porzioni di muratura pregiudicanti la sicurezza nel margine sud dello scavo. I blocchi murari rimossi sono stati riposizionati in un'area a breve distanza dagli ambienti a cui appartengono. Una piccola porzione del crollo nella parte nord dell'ambiente è stata invece comunque rimossa, in quanto del tutto decoesa.

Un'estesa demolizione di porzioni di muratura crollate, operazione irreversibile e accettabile solo in caso di effettiva necessità, sarebbe risultata dannosa per la conservazione del monumento, inutile per la conservazione della materia sottostante, e poco utile per la ricomposizione di un'immagine unitaria del pavimento. La completa "liberazione" del pavimento avrebbe privilegiato gli aspetti figurativi e decorativi rispetto a quelli della complessità dell'opera e della comprensione della sua storia. Il progetto si è posto invece come priorità quella di mostrare l'evento "crollo", in una lettura più complessa della struttura nel suo insieme e delle sue vicende storiche.

Fruizione e prospettive future

Sono stati effettuati in tutta l'area la costipazione del terreno, la messa in sicurezza dei percorsi di visita e la realizzazione delle relative attrezzature (barriere, sottofondi permeabili, drenaggi, fig. 5).

Il mantenimento del complesso è garantito dalla manutenzione con controlli periodici di murature e rivestimenti a cura del personale della Soprintendenza, con piccoli consolidamenti e diserbo manuale. La continuità di tali operazioni è garantita dall'esistenza, in seno all'Amministrazione, di personale stabile esperto.

Per garantire la migliore comprensione da parte del pubblico si prevede, in vista del riallestimento dell'*Antiquarium* Turritano prossimo agli scavi, la realizzazione di una ricostruzione virtuale, utile anche a vagliare alcune ipotesi sugli elevati del monumento e sulla dinamica del crollo.

F.C.

Figura 5 L'aspetto dell'area dopo gli interventi. Si è scelto di utilizzare materiali a basso impatto visuale (paletti di legno, corda, grigliati permeabili per le rampe) che non distolgono l'attenzione del visitatore dal monumento e che è possibile con facilità rimuovere o spostare secondo le esigenze dello scavo, nell'ottica di un futuro approfondimento delle ricerche nelle parti ancora non scavate.

Il restauro dei mosaici

L'analisi dello stato di conservazione del mosaico pavimentale del *tepidarium* ha comportato un'attenta riflessione sull'opportunità di riposizionare e far riaderire correttamente alla malta di allettamento le tessere sollevate dal dilavamento delle acque meteoriche, dalle erbe infestanti che sviluppano le radici negli interstizi tra le tessere e la malta, e infine dal crollo di parte delle *suspensurae* e di parte degli elevati, con conseguente deformazione del pavimento musivo.

Grazie alla terra depositatasi sulle porzioni di mosaico e alla preclusione ai visitatori di transitare nell'area interessata, la maggior parte delle tessere staccate è stata ritrovata nella posizione originale, ancora a comporre il motivo decorativo.

L'intera area è stata documentata fotograficamente, graficamente e con rilievi "a contatto" del mosaico. Inoltre, sono state eseguite riprese aeree con l'ausilio di un drone, finalizzate alla successiva rielaborazione planimetrica e alla ricostruzione virtuale in 3D degli ambienti.

La prima fase di intervento ha previsto la pulitura superficiale dal terriccio e la sterilizzazione delle erbe eseguita con sali quaternari di ammonio. In concomitanza, è stata effettuata la riadesione delle tessere sulla malta originaria, avendo cura di non spostarle dalla loro posizione.

Per tale operazione è stato utilizzato, in strato sottilissimo e come riempitivo degli interstizi, il prodotto premiscelato *Ledan Stuc Forte Fina*.

Si è fatto riferimento a soluzioni adottate in altri contesti, per esempio per i mosaici di Aquileia, dove si è preferita la delimitazione delle piccole aree risarcite con filo di piombo e si è realizzata una base neutra per le lacune ampie.

Figura 6 Particolare del mosaico del *tepidarium* prima dell'intervento.

Pertanto alcune zone di estensione limitata, in cui il mosaico appariva particolarmente sconnesso e dove era difficile individuare la posizione originaria di ogni tessera, sono state perimetrate con una piattina sottile di piombo, limitando i risarcimenti alla necessità di garantire la coesione delle tessere (fig. 7).

La scelta dei materiali per l'integrazione tra le porzioni del mosaico e per la stuccatura dei bordi ha richiesto la valutazione di problematiche legate sia alla conservazione complessiva dell'area, sia alla definizione delle tecniche di conservazione.

Il tema è stato affrontato tenendo conto che la vasta area archeologica di cui fanno parte le Terme Pallottino è costituita da *domus*, riccamente decorate con mosaici pavimentali, sulle quali si interverrà con il restauro degli elevati, anche affrescati, e delle pavimentazioni.

I futuri interventi di conservazione dovranno essere omogenei per l'intero sito e assicurare un'impostazione coordinata delle tecniche e dei materiali adoperati.

Si è dunque operato con materiali già sperimentati, che hanno dimostrato buona resistenza e facile asportabilità, per eventuali successive modifiche delle attuali decisioni tecniche.

Perciò le integrazioni superficiali, utili a rendere esteticamente gradevoli le lacune tra le porzioni di mosaico e, soprattutto, a consentire una minore penetrazione dell'acqua piovana nella malta nuda sottostante, sono state realizzate con un impasto di sabbia lavata, scelta nella tonalità compatibile, ed emulsione acquosa di resine acriliche nella percentuale del 10%. L'impasto così ottenuto è facilmente lavorabile, una volta asciutto presenta una sufficiente resistenza superficiale, una bassa permeabilità all'acqua e non costituisce un substrato utile all'insediamento di erbe.

Già ampiamente sperimentato sin dagli anni Novanta per le integrazioni in strutture archeologiche e monumentali all'aperto, sia con l'utilizzo delle sabbie lavate, sia con la terra del posto setacciata, l'integrante ha dato prova di resistenza nel tempo e nessuna interazione fisica o chimica con i manufatti di diversa natura e composizione (Pirasa e Demartis 1996: 63–92).

L'applicazione di tecniche di restauro con l'uso delle terre crude, anche con l'aggiunta di elementi naturali o composti sintetici, è stata oggetto di studio da parte dell'Università di Cagliari nell'ambito della ricerca sulle terre crude e sulle terre stabilizzate per la conservazione delle architetture tradizionali presenti nel sud della Sardegna (Achenza e Sanna 2009).

Nel *tepidarium*, le porzioni del crollo sono state rimosse solo in minima parte, al fine di mettere in luce un tratto di mosaico ancora in buono stato di conservazione e dare così continuità all'insieme del manufatto.

Figura 7 Il mosaico del *tepidarium* durante il restauro.

Il cedimento di molte *suspensurae* e lo schiacciamento del pavimento, causato dal peso dei crolli degli elevati, hanno provocato la deformazione del piano. La conseguente debolezza strutturale dell'intera pavimentazione ha pertanto suggerito una particolare attenzione al drenaggio delle acque. Solo attraverso le poche lacune che consentivano di accedere agli spazi vuoti sottostanti è stato possibile intervenire, inserendo sotto il piano appositi canali per il drenaggio delle acque piovane.

La delicatezza dell'insieme del sito ha portato alla scelta di ridurre al minimo la presenza degli operatori durante i lavori sulla pavimentazione e al divieto di accesso al pubblico, per il quale è stato predisposto un percorso di fruizione alternativo.

Nel *frigidarium* è ancora *in situ* la pavimentazione musiva, sostanzialmente integra e in buono stato. Le limitate lacune, che non compromettono la stabilità complessiva del mosaico, sono state integrate con l'impasto di sabbia lavata ed emulsione

Figura 8 Veduta generale dopo il restauro.

acrilica già descritto. Le poche tessere staccate dall'azione delle radici o perimetrali alle lacune sono state fissate alla malta di allettamento originale con il prodotto *Ledan S.F.S.*

La vasca ha pareti realizzate in mattoni e intonacate con malte ricche di cocciopesto. I crolli di parte degli elevati e gli stacchi di porzioni di intonaco hanno messo in luce i laterizi. Il dilavamento meteorico e l'erosione eolica hanno compromesso la conservazione delle superfici esposte, tanto che della disgregazione dei mattoni di argilla cotta resta traccia sulla pavimentazione sotto forma di polveri rosse depositate. Il fenomeno è reso ancor più visibile a causa dell'otturazione del canale originale di scarico delle acque del *frigidarium*, che determina il ristagno delle acque e la sedimentazione della terra e delle polveri stesse. In occasione dei recenti lavori di conservazione non è stato possibile ripristinare la funzionalità del sistema antico di scarico e si dovrà attendere l'ampliamento dello scavo archeologico fuori dall'ambiente, così da intercettare e liberare il condotto.

In attesa del ripristino del drenaggio, si provvede alla pulitura sistematica del mosaico e delle pareti, oltre che alla sterilizzazione degli organismi vegetali insediati. Con l'obiettivo di stabilizzare e consolidare i laterizi e gli intonaci degli elevati, è stato eseguito il consolidamento con acqua di calce, nelle parti prevalentemente a base calcarea, e con silicato di etile nei manufatti contenenti argille. I mattoni erosi e indeboliti sono stati integrati con impasto di sabbia lavata e cocciopesto a granulometria fine, in proporzione di 2:1, ed emulsione acquosa di resine acriliche al 10%, con le modalità già descritte.

L'impasto applicato, una volta essiccato, ha acquisito una tonalità esteticamente compatibile con il resto della muratura, una buona resistenza e reversibilità, garantendo protezione ai manufatti antichi.

Le aree archeologiche interessate dagli interventi di conservazione e restauro descritti, completati nel maggio 2013, sono oggetto di monitoraggio programmato da parte dei restauratori della Soprintendenza e di piccoli interventi di manutenzione, entrambi indispensabili per un'efficace azione di salvaguardia del patrimonio archeologico (fig. 8).

A.C., M.G.D., G.A.C., A.S.

Note

1 Staff: Gabriella Gasperetti, responsabile del procedimento, co-progettista e direttore scientifico; Francesca Condò, progettista e direttore dei lavori; Alba Canu e Graziella Dettori, co-progettiste e responsabili dei restauri dei rivestimenti; Antonio Chessa, Antonino Secchi, assistenti di restauro collaboratori alla progettazione ed esecutori degli interventi, con il supporto di Antonio Fiori; Franco Satta, assistente al R.U.P., alla progettazione e direzione dei lavori; Luca Angius, responsabile della documentazione scientifica. Collaboratori ai lavori, sede operativa di Porto Torres: Gavino Canu, Giantonello Sanna, Luciano Serio, Salvatore Borra; impresa Castelli Piera, Sassari. Fotografie e grafici di proprietà della Soprintendenza Archeologia della Sardegna.

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Scavo, conservazione e protezione dei mosaici delle Piccole Terme di Nora

Bianca Maria Giannattasio e Elena Romoli

Abstract: *Le Piccole Terme di Nora sono dotate di un notevole apparato musivo, recentemente oggetto di restauro; è stato così possibile effettuare saggi di scavo, recuperando parti di mosaico in giacitura originale. Lo stato di fragilità di questo mosaico ne ha richiesto la protezione, prevedendo l'esecuzione di una struttura di copertura che lo proteggesse e ne consentisse la visibilità. Questo ha comportato la riconsiderazione di problematiche archeologiche con nuove attività di scavo per valorizzare l'edificio, nell'ottica della sua comunicazione/fruizione da parte dei visitatori, e lo studio della compatibilità paesaggistica della struttura collocata in un contesto ambientale di particolare bellezza.*

Abstract: *The Piccole Terme di Nora (Small Thermae of Nora) are adorned with a remarkable complex of mosaics, which were subject to a recent restoration that made it possible to perform sample excavations and recover portions of mosaics in their original layouts. The fragile state of these mosaics necessitated protection in the form of a sheltering structure that would protect them while still allowing visibility. This meant finding a way to address archaeological problems through new excavations that bring value to the structure and make it accessible to visitors, as well as to study the structure's compatibility with the surrounding landscape, a setting of extraordinary beauty.*

Lo scavo

Il quartiere nord–occidentale o del porto della città di Nora-CA (fig. 1) ha essenzialmente una funzione abitativa e commerciale, essendo costituito da case-bottega a due piani che si affacciano sui tratti viari, che conducono rispettivamente al porto (G–H) e fuori città (E–F). Si inizia a costituire con l'ampliamento augusteo della città occupando parzialmente gli spazi disponibili, a cui segue in età severiana un forte impulso costruttivo che investe tutto l'impianto urbano con la monumentalizzazione di diverse aree e con la creazione, anche in questa zona più periferica, di strutture a carattere pubblico: un *horreum* e un edificio termale, che si impostano su precedenti *domus*. Le terme, per la loro dimensione modesta, potrebbero essere rivolte al servizio solo del quartiere e si articolano in due fasi costruttive (fig. 2); la prima di III secolo d.C. vede una struttura semplice formata esclusivamente dai vani caldi (*tepidaria*) e da un *frigidarium* fornito di *labra*. Di questa originaria costruzione, già indagata da G. Pesce (Pesce 1972: 81–82), restano poche testimonianze: alcune murature e tracce di un pavimento musivo che doveva decorare il *frigidarium*. Il recente restauro ha consentito di avviare un'indagine negli strati sottostanti (2009–10), che, anche se limitata per motivi di tempo, è servita a chiarire meglio la cronologia stessa dell'apparato musivo, ora riposizionato. Infatti, datato per tipologia e motivi stilistici da S. Angiolillo al IV secolo d.C (Angiolillo 1981: 29–30), può essere forse attribuito alla fase severiana, anche per la ricca policromia - normalmente a Nora si ha bicromia – e per la misura delle tessere (Salvetti 2011). Un ridotto frammento rinvenuto ancora *in situ* permette di individuare la quota antica del posizionamento (2,81 s.l.m.), che risulta a livello inferiore rispetto al piano di resa attuale. Invece un frammento di cornice più cospicuo, è stato recuperato durante gli scavi qui effettuati nel 2010, in uno strato di riempimento relativo a un'azione di spoglio delle murature, probabilmente avvenuta nel V secolo d.C., allorché a Nora si assiste a una serie di queste azioni di recupero materiale. Al riguardo ci si deve interrogare su come rendere visibile e fruibile al pubblico sia l'edificio termale sia il suo apparato decorativo, rispettando il più possibile l'aspetto

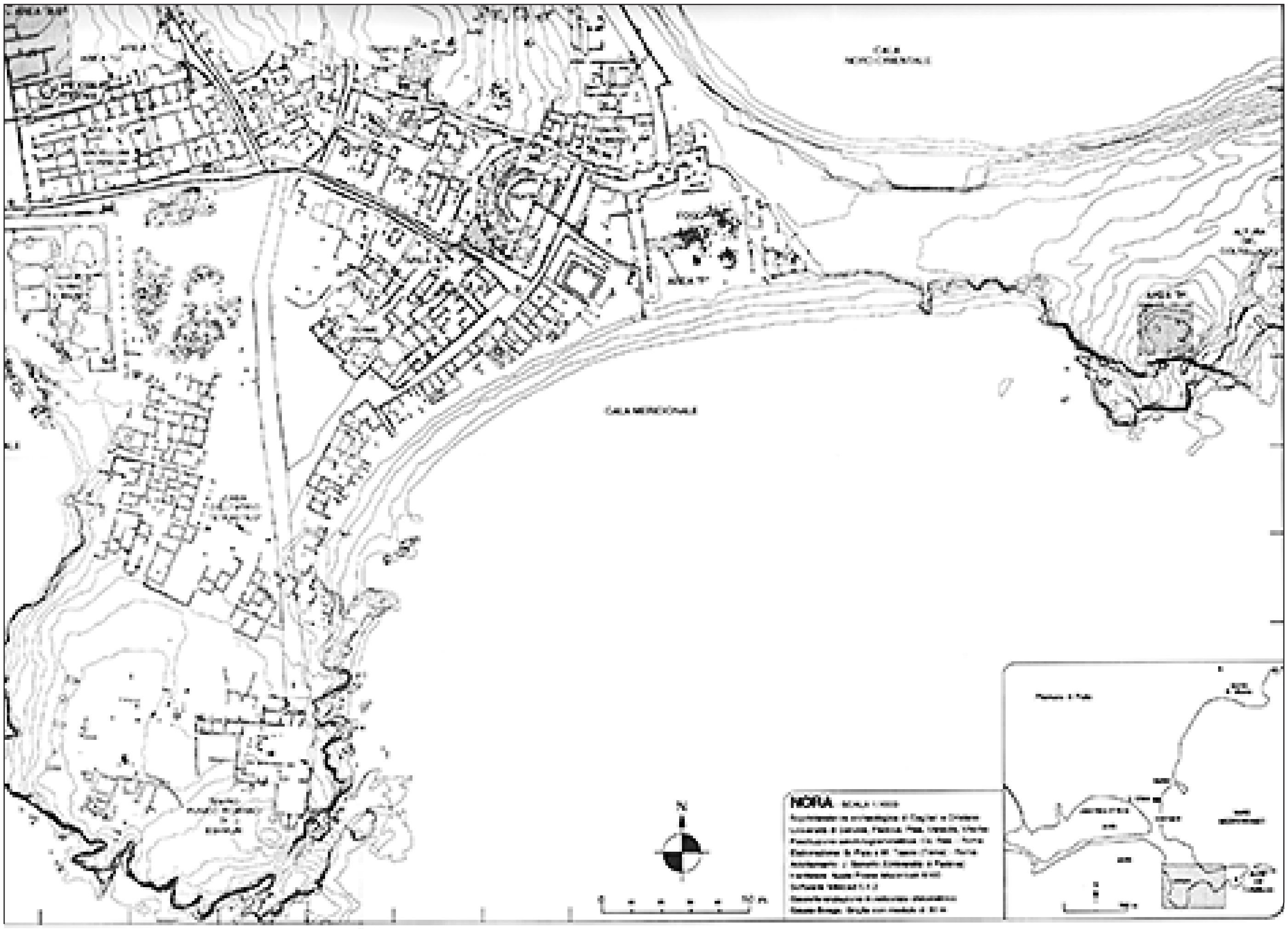

Figura 1 Pianta di Nora.

originario in una fruizione filologica del sopravvissuto. L'attuale frammento, recentemente restaurato, è stato obbligatoriamente riposizionato dove l'aveva posto il primo restauro degli anni Sessanta–Settanta del secolo scorso per essere ben visibile, ma decontestualizzandolo, ponendo in stretto rapporto questa pavimentazione della prima fase dell'edificio a funzione termale con una delle ultime pavimentazioni fatta utilizzando i sesquipedali dei vani caldi (quota 2,99 metri s.l.m.) (fig. 3), quando nella tarda antichità la struttura aveva ormai perso la sua mansione originaria ed aveva subito una serie di pesanti ristrutturazioni, trasformandosi di nuovo in zona abitativa e in area artigianale.

Se dal punto tecnico e conservativo le informazioni e le relative osservazioni dell'arch. E. Romoli e della dott.ssa R. Ciardi della ditta "L'Officina" di Roma, che ha curato il restauro, sono più che giustificate e valide per un'ottimale conservazione dei mosaici, dal punto di vista dello scavo e della lettura delle evidenze questa scelta, seppure rispettosa del primo restauro effettuato, può essere discutibile, poiché stravolge completamente la sequenza stratigrafica e cronologica, rendendo completamente distorta la visione dell'ambiente. D'altra parte si è trattato di una scelta obbligata per mostrare e rendere fruibile, secondo l'ottica di studio del XX secolo, i resti del mosaico del *frigidarium* che per policromia e disegno, pur nella sua frammentarietà, risulta essere uno dei più interessanti della città, opera di un'officina raffinata, individuabile forse nella stessa Nora (Ghedini 2003: 5–6).

Diversamente è stato possibile procedere con il mosaico dell'*apodyterium*, che, insieme al corridoio, appartiene alla seconda fase di ampliamento e monumentalizzazione dell'edificio con accesso direttamente dalla via del porto. Anche questo mosaico è già noto ed è stato oggetto di precedenti

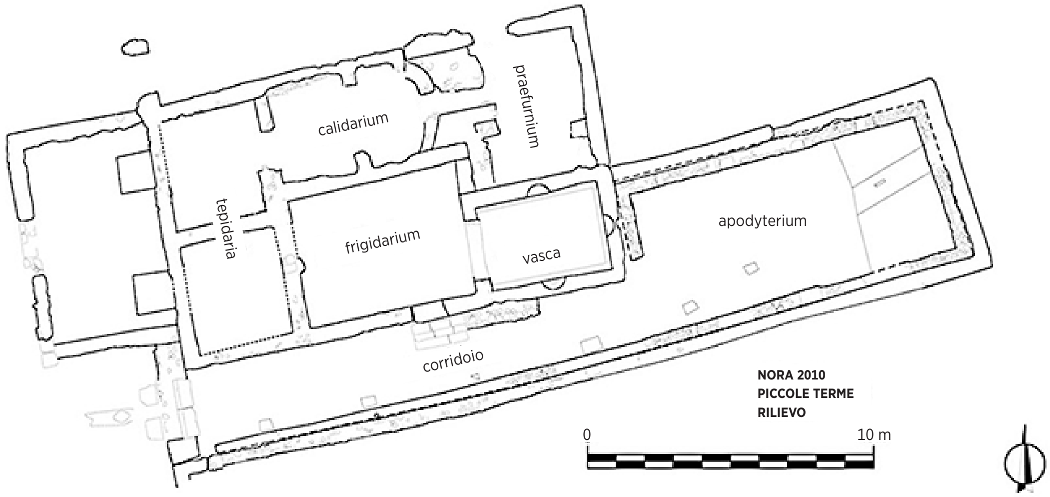

Figura 2 Pianta delle Piccole Terme (I e II fase). Copyright e rielaborazione di B. M.Giannattasio

restauri che, dal punto di vista dell'epoca in cui sono stati effettuati, prevedevano il posizionamento delle tessere musive su un massetto di cemento armato, che è quanto più di deleterio può essere in un ambiente marino, portando alla progressiva distruzione dell'apparato musivo. Qui, di conseguenza, è stato necessario intervenire con un restauro conservativo tra il 2011 e il 2012, che ha consentito, una volta asportato il mosaico, di condurre alcuni saggi di verifica al di sotto del pavimento dell'*apodyterium*, nonché del corridoio (fig. 3). Fortunatamente, però, G. Pesce aveva lasciato nell'angolo nord–ovest dello spogliatoio un testimone di terra, che è stato scavato dall'Università di Genova, grazie alla disponibilità della Soprintendenza Archeologica di Cagliari e Oristano: questo ha permesso di recuperare *in situ*, per quanto frammentario, un lacerto del mosaico originale dell'ambiente (fig. 6). Di conseguenza, quando si è proceduto al restauro, ormai improcrastinabile, la ricostruzione della pavimentazione per il tratto relativo all'*apodyterium* è stata filologicamente corretta, recuperando anche la quota antica. Il problema sorge per la comprensione del rapporto tra questo pavimento e quello del corridoio, che per le murature sembrerebbe in fase, ma che presenta un diverso apparato musivo a decorazione geometrica lineare (fig. 4). In questo caso la lacunosità della decorazione e il precedente intervento di restauro non consentono la comprensione del rapporto, che non è stato possibile recuperare neanche a livello di scavo. Qui, infatti, proprio per cogliere questo problema si è effettuato un saggio di approfondimento, che è servito per definire l'uso dell'area prima della costruzione delle Piccole Terme, ma non ha dato risposta all'interrogativo delle fasi della decorazione musiva, poiché non si è evidenziato nessun elemento di rapporto tra i due apparati. Resta quindi pressante l'interrogativo se il cambio di elementi decorativi – uno strettamente geometrico lineare, quello del corridoio, l'altro più articolato con l'introduzione del nodo di Salomone nell'*apodyterium* – possa comportare a livello strutturale una differenziazione. All'interno di uno stesso even to–fase, che è l'ampliamento dell'edificio termale, si potrebbe assistere ad uno sfalsamento cronologico, relativamente breve, tra la costruzione di un vano rispetto all'altro, oppure semplicemente al volere sottolineare le funzioni diverse dei due ambienti con due tipologie decorative volutamente differenti.

Gli interventi di restauro dei mosaici sono stati per Nora un'occasione di approfondimento di indagine e quindi hanno contribuito a nuove conoscenze o a modificare informazioni già note; riguardo sempre al mosaico dell'*apodyterium* la scelta fatta dalla Soprintendenza Archeologica di Cagliari e Oristano di provvedere a una copertura, seppure parziale, ha obbligato ad un'azione di archeologia preventiva nei punti in cui sono appena state poste (ottobre 2014) le basi dei piloni che devono sorreggere questa copertura, di cui più diffusamente accenna qui di seguito l'arch. E. Romoli.

L'indagine ha permesso così di verificare che sul luogo dove è stato edificato l'edificio termale sorgevano precedentemente, allineate lungo la strada del porto, alcune *domus* di cui al momento si è recuperato un lacerto di vasca di un viridario, e, contemporaneamente, si sono individuati i limiti di questo isolato, separato dall'isolato A–B da una zona aperta, che fungeva da cerniera dell'impianto urbano. E' stato inoltre possibile rintracciare all'interno di un vano dell'*horreum* una fase di incendio tarda (decenni iniziali della seconda metà del IV secolo d.C.), già segnalata da C. Tronchetti (Tronchetti 2010: 264; Giannattasio 2016) nel 1989, che in qualche modo potrebbe ricollegarsi ad un periodo di turbolenza e testimoniare una situazione di difficoltà che si coglie anche in altre aree della stessa Nora, ma che i precedenti scavatori,

Figura 3 Piccole Terme: Mosaico del *frigidarium* (I fase), restaurato e posto in quota con il tardo pavimento in sesquipedali (indicato in rosso). Foto: B. M.Giannattasio

per metodologia di lavoro allora in uso, non hanno ritenuto opportuno considerare.

Quindi volendo fare un bilancio dal punto di vista dello scavo archeologico e di conseguenza dell'accrescersi delle conoscenze in relazione all'esperienza norense, questo non può che essere positivo; d'altra parte l'alternativa era lasciare immutata la situazione con la conseguenza della lenta ma totale distruzione di questi apparati musivi, che testimoniano in maniera chiara ed evidente, anche per un pubblico di non addetti ai lavori, la prosperità e l'importanza di questa città della Provincia Romana in età severiana.

B. M. G.

La conservazione e protezione dei mosaici

Le foto d'archivio documentano quanto l'apparato pavimentale musivo delle Piccole Terme, articolato sui tre ambienti contigui e integralmente decorati del *frigidarium*, corridoio e *apodyterium*, si presentasse notevolmente parzializzato già dal tempo della sua scoperta nel corso della campagna di scavo del Soprintendente Pesce negli anni Sessanta del Novecento. Particolarmente grave risultava tale perdita nel *frigidarium* (pavimento ampio cm 600 × 425), dove l'Angiolillo (Angiolillo 1981: 29) documentava la presenza residua di un mosaico della superficie di cm 460 × cm 300 × cm 195 di larghezza, allora descritto ancora in buone condizioni a una decina d'anni dal restauro. Costituito da tessere bianche, nere, ocra, rosse e verdi delle dimensioni medie di cm 1–1,5 × 1,5–2 viene descritto ricompreso "all'interno di una banda di raccordo bianca, divisa in due da una banda ocra, in campo bianco marginato di ocra e di nero; è scandito dall'alternarsi di cerchi e dei quadrati disposti per la diagonale" riccamente decorati nel centro e sulle cornici.

Subito dopo la messa in luce ne era stato eseguito con particolare perizia il restauro – contestualmente alla maggior parte dei mosaici rinvenuti nell'antica città – ricorrendo a una metodologia, allora considerata d'avanguardia, che ne aveva comportato il distacco e la ricollocazione su una soletta in cemento armato, ma che si rivelò ben più devastante dell'abbandono secolare. L'esposizione all'azione aggressiva dell'aerosol marino e degli agenti atmosferici, non adeguatamente protetto, ha agevolato il manifestarsi di gravi patologie di degrado (sollevamenti, rigonfiamenti, distacchi e fratturazioni) che nell'arco di un ventennio ne hanno scompaginato la struttura (fig. 5). Pertanto la configurazione ornamentale descritta dall'Angiolillo risultava appena leggibile nel lacerto residuo sottoposto a intervento conservativo nel 2011, essendo stato danneggiato gravemente dal distacco del tessellato dalla malta di allettamento, causato da fratture del massetto con l'espansione del ferro per effetto della corrosione e degli apparati radicali di elementi vegetali insediati, fattori che hanno comportato la dispersione di una parte consistente del materiale lapideo.

Anche nel vano allungato del Corridoio, delle dimensioni di ml 17,30 × 2,60, il mosaico si presenta formato da tesserine di cm. 1,5–1,7 × 2, con ampie lacune, prolungato all'interno

Figura 4 Piccole Terme: Mosaici del corridoio e dell'*apodyterium*; indicati in rosso i saggi per la posa dei piloni di copertura. Copyright e rielaborazione di B. M. Giannattasio

dell'*apodyterium* dove raggiunge la lunghezza complessiva di ml 18,15 e disegna un'alternanza di motivi geometrici policromi. L'*apodyterium* misura cm 905 × 405 e il mosaico, realizzato con tessere bianche, nere, rosse, ocra e verdi di cm. 1–1,3 × 1.5–1,7 che formano composizioni geometriche di cerchi e losanghe, viene descritto già negli anni Ottanta fortemente ridotto (Angiolillo 1981: 30–31). Le parti residue di entrambi, anch'esse staccate e riapplicate su cemento armato e ad oggi considerevolmente ridotte, mostravano le medesime patologie descritte per il *frigidarium* con i ferri corrosi del massetto esposti. Tardivi si sono rivelati i tentativi di protezione fatti negli anni Novanta con stesura di strati di sabbia e controproducente l'impiego di teli di plastica, che ha agevolato la crescita di colonie di elementi vegetali superiori e di spesse patine biologiche sul tessellato, oltre al compattarsi di consistenti depositi e tenaci croste.

L'intervento di conservazione, inserito nella più ampia campagna di restauro di tutti i mosaici allettati su soletta in cemento armato, eseguito dalla Soprintendenza tra il 2011 e il 2012 a valere su finanziamento del Comune di Pula di €500.000,00 per il Parco archeologico di Nora Sant'Efisio e dei Quattro Mari. POR Sardegna 2000–2006. Asse II Risorse Culturali, Misura 2.1, ha comportato lo stacco della superficie musiva, la bonifica dal cemento e la demolizione della soletta, il riempimento dell'area scavata dagli archeologi, il ripristino del sottofondo e di una nuova soletta in malta di calce idraulica, oltre al restauro *in situ* della parte di mosaico (fig. 6) rinvenuta nel corso dell'intervento sottostante un "testimone" lasciato dal Pesce, che ci ha restituito le quote originali d'imposta della pavimentazione cui riferirci per il riposizionamento del tessellato restaurato.

Le fasi dell'intervento sui tre mosaici, in sintesi, si sono così articolate: Documentazione, con rilievo 1:1 su foglio di polietilene del disegno e degli elementi caratterizzanti il mosaico (fig. 7); stesura di mappature del degrado e degli interventi da eseguire; realizzazione di dettagliata documentazione fotografica; raccolta delle tessere sporadiche; protezione temporanea dei bordi delle lacune prima della pulitura; pulitura meccanica con acqua e spazzole e con impacchi a base di AB57; micro sabbiatura puntuale di precisione sulle croste persistenti; rimozione dei blocchi mediante velatura delle superfici (fig. 8), taglio e separazione del blocchi da imballare e trasferire in laboratorio; distacco del tessellato dal cemento armato mediante taglio con sega circolare di precisione a controllo numerico; completamento e rifinitura della rimozione fino alla liberazione delle tessere sul retro; imballaggio dei frammenti e trasporto *in situ* su supporto rigido; demolizione della soletta in cemento armato. Tale attività ha consentito l'esecuzione delle verifiche archeologiche al cui compimento è seguito il riempimento dello scavo e la ricostruzione del sottofondo; la predisposizione della nuova soletta in malta di calce idraulica naturale armata con una rete fibro–rinforzata con maglia cm 5 × 5 tipo Fibranet, con la ridefinizione delle pendenze di deflusso delle acque piovane, nello specifico convogliate nei pozzetti antichi liberati e ripristinati all'uso; la riapplicazione del mosaico distaccato *in situ* su un letto di malta idraulica di calce; la svelatura dei frammenti; l'integrazione delle piccole lacune con tessere originali recuperate o con nuove; l'integrazione delle grandi lacune con malta di calce e inerti tonalizzati; il ripristino della malta interstiziale; il trattamento protettivo finale con silossani.

Sulla porzione di mosaico dell'*apodyterium* ritrovato *in situ* (fig. 6), della dimensione di 4,00 mq, successivamente alle procedure di documentazione e di pulitura, sono state eseguite le seguenti operazoni: il consolidamento sul posto e ancoraggio al supporto eseguendo iniezioni di malta di calce idraulica nel sottofondo per riconnettere il piano di posa previo adeguato imbibimento con acqua; ricomposizione della planarità delle zone rigonfiate o depresse; ripristino della malta interstiziale; stuccatura dei bordi perimetrali del mosaico; integrazione delle piccole lacune con tessere di recupero o nuove; integrazione con malta di calce idraulica con finitura scabra delle lacune più ampie; trattamento protettivo finale con silossani.

Figura 5 Piccole Terme: Stato di degrado del mosaico del *frigidarium* ante restauro 2011. Foto: E. Romoli

Figura 6 Piccole Terme: Nuova soletta di malta in calce idraulica e frammento di mosaico originario (testimone Pesce) dell'*apodyterium.* Foto: E. Romoli

Figura 7 Piccole Terme: Rilievo del mosaico dell'*apodyterium* e del corridoio su foglio di polietilene. Foto: E. Romoli

Figura 8 Piccole Terme: Velatura del mosaico del *frigidarium* per la rimozione. Foto: E. Romoli

In considerazione delle condizioni particolarmente precarie dello strato di allettamento di questa porzione originale di mosaico, nonostante il consolidamento eseguito, si è ritenuto necessario proteggerla dalla salsedine, dalle infiltrazioni di acque meteoriche e dall'azione meccanica degli agenti atmosferici mediante la realizzazione di una copertura a contatto eseguita con teli sovrapposti di geotessuto e uno spesso strato di ghiaia. Tale soluzione è provvisoria, ed è in fase di realizzazione una copertura definitiva del solo ambiente dell'*apodyterium* finanziata dal Comune di Pula su progetto dell'architetto. Antonio D'Alessandro di Roma, che poggiando su quattro piloni in acciaio zincato realizzerà una semplice falda inclinata con uno speciale telo tecnico anticondensa, funzionale a proteggere il manto musivo. In considerazione del notevole impatto che strutture in elevazione possono produrre sul paesaggio connotato dai ruderi dell'antica città fenicio–punico–romana affacciata su uno splendido tratto di mare, si è scelto di limitare sia la superficie protetta allo stretto necessario, sia il numero di appoggi della struttura, scelta che però ha richiesto l'esecuzione di micropali sotto ai plinti di fondazione, per assicurare la tenuta al terreno del sistema costruttivo e un'adeguata resistenza ai valori calcolati della forza del vento. La cantierizzazione di tale lavorazione ha evidenziato diversi aspetti di criticità determinati dall'invasività dei macchinari da impiegare per la realizzazione dei micropali e dalle relative movimentazioni, superati esclusivamente per la particolare ubicazione delle Piccole Terme, poste al margine nord della città antica attualmente scavata, e pertanto agevolmente raggiungibile, ma non proponibili in altre aree del sito. Tale esperienza ci ha indotto a ricercare soluzioni alternative, di minore impatto, per proteggere altri mosaici recentemente restaurati, ma molto esposti al degrado ambientale, quali quelli della Casa dell'Atrio Tetrastilo, ancora in fase di definizione.

Contestualmente al restauro dei pavimenti musivi sono state consolidate le murature perimetrali dell'edificio termale, che presentavano punti di erosione talmente profonda da farne rischiare il collasso. Pertanto si è proceduto con il reintegro di sezioni di muro con tozzetti in arenaria alternati a file di laterizi, che sono stati allettati con malta di calce caratterizzata e distinguibile dall'originale per l'aggiunta di graniglia lavata di cocciopesto, e posizionati in sottosquadro rispetto al filo murario per rendere l'intervento riconoscibile, ma non discordante con la percezione dell'antica struttura.

E. R.

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La conservazione dei mosaici inseriti a pavimento nei Musei Vaticani soggetti a calpestio

Roberto Cassio

Abstract: *Poco meno di mille metri quadrati di mosaici di altissima qualità, provenienti da ville sub urbane di epoca imperiale, sono stati per un secolo e mezzo esposti al calpestio quotidiano dei visitatori del Museo, stimati negli ultimi anni in 20.000 unità giornaliere, riportando danni progressivi alle malte e al tessellato. Al fine di affrontare la salvaguardia di questa eredità di opere entro un quadro di spesa contenuto, il Laboratorio per il restauro del mosaico vaticano ha elaborato e messo a punto una metodologia specifica applicabile all'intera collezione e ripetibile in futuro secondo un piano di manutenzione ordinaria.*

Abstract: *Nearly a thousand square meters of the highest-quality mosaics, originating from suburban villas of the Roman Empire, were exposed for a century and a half to the daily footsteps of museum visitors, estimated at 20,000 per day in recent years, causing increasing damage to the mortar and tessellatum. In order to protect this legacy of artwork while limiting costs, the Laboratorio per il restauro del mosaico vaticano (Vatican Mosaic Laboratory) has developed and refined a specific methodology that can be applied to the entire collection and repeated in the future as part of an ordinary maintenance plan.*

Introduzione storica

All'inizio del XVIII secolo fu acquisito nelle raccolte vaticane il primo gruppo di mosaici provenienti da Santa Sabina all'Aventino. Si trattava di frammenti di un pavimento romano rinvenuto presso gli orti dei frati riadattati a pannelli parietali, così com'era stato in uso fino ad allora; il pannello di piccole dimensioni, infatti, meglio si adattava a essere inserito come elemento di arredo nelle residenze nobiliari e del clero.

Il Papa Pio VI, alla fine del XVIII secolo, volle costruire nuove sale espositive utilizzando architetture che rievocassero ambientazioni romane, dedicate a contenere anche pavimentazioni con antichi mosaici (fig. 1). La Sala Rotonda, perciò, fu costruita ad imitazione del Pantheon, la Sala delle Muse e la Sala a Croce Greca riproponevano le grandi aule termali e così per tutto il Museo Pio Clementino.

"I mosaici, dunque, vengono utilizzati con il compito di suggerire la giusta prospettiva al visitatore e di dare le chiavi di lettura del museo, da un lato finalizzata alla tutela e alla valorizzazione di un patrimonio comune, dall'altro come fonte di ispirazione per gli artisti" (Liverani 2002: 11–20, 103–17).

Nella Sala a Croce Greca fu inserito nel 1794 il mosaico del I sec. d.C. con emblema centrale raffigurante il busto di Athena proveniente dagli scavi avviati nel 1741 presso la Villa della Rufinella e quello con Bacci, del III sec. d.C. proveniente dagli scavi fuori porta San Paolo del 1778.

Nella Sala delle Muse, ora non più esposti, furono collocati i mosaici a soggetto teatrale del II sec d.C., provenienti dagli scavi della porcareccia a Castel di Guido del 1779, e quello con l'emblema di Medusa della prima metà del III sec d. C. proveniente dagli scavi di Palazzo Caetani del 1775.

Al centro della Sala degli Animali venne inserito quello con avvoltoio del II sec d. C. proveniente dagli scavi di Palestrina avviati nel 1779, nonché i due con riquadri geometrici e nature morte dagli scavi del 1775 nella tenuta di Toragnola su via Prenestina.

Molti anni furono necessari per rivestire i 250 mq. di pavimentazione della Sala Rotonda con i mosaici del II sec d.C. rinvenuti nelle Terme di Otricoli e Sacrofano e per quelli minuti provenienti da Villa Adriana, collocati nel pavimento del Gabinetto delle Maschere.

Questi mosaici rappresentano una delle più antiche raccolte di questo genere, arricchitasi poi per tutto il XIX secolo con l'inserimento a pavimento di altre opere musive di epoca romana, come i mosaici al Braccio Nuovo e quelli nelle stanze di Raffaello, senza tralasciare i due mosaici che maggiormente

Figura 1 Veduta del Museo Pio Clementino dalla Sala degli Animali.
Photo: Roberto Cassio

si trovano in tutti i manuali di arte antica, ovvero quelli degli atleti raffigurati nelle esedre delle palestre di Caracalla e l'asàratos òikos, il pavimento non spazzato, copia del II sec. d.C. da un originale ellenistico descritto da Plinio il Vecchio, rinvenuto nel 1833 a Vigna Lupi presso Porta Ardeatina e inserito nel Museo Gregoriano Profano secondo più moderni criteri di conservazione.

Sotto il pontificato di Papa Pio VI, per allestire le grandiose sale del museo l'amministrazione pontificia si adoperò quindi a condurre scavi mirati alla ricerca di mosaici e si arricchì la collezione anche con acquisti da privati. Si trattava spesso di mosaici di grandi dimensioni che venivano poi "adattati" a ricoprire le nuove sedi espositive mediante taglio a pannelli. Trattandosi di pavimentazioni di grandi dimensioni lo stacco dal sito e il successivo trasferimento in museo comportavano una complessità tecnica accompagnata dall'alto rischio di danno per le superfici originali.

A mettere in atto i delicati distacchi dal sito originario e successivamente alla ricollocazione in sede espositiva erano i mosaicisti di quel periodo.

A Roma, infatti, a partire dalla fine del Cinquecento, era nato un laboratorio di mosaicisti reclutati da ogni parte d'Italia per la decorazione della nuova Basilica di San Pietro, che erano al tempo stesso artisti e restauratori, e ai quali furono affidati gli interventi sui mosaici del Museo Vaticano.

Per quanto riguarda il distacco e la ricollocazione in museo dei pavimenti a mosaico antichi, non sono stati trovati grafici o descrizioni dettagliate in merito ai sistemi utilizzati, ma è possibile formulare ugualmente ipotesi inerenti alle varie fasi di lavorazione, basandosi su documenti d'archivio che testimoniano pagamenti per lavori svolti e materiali utilizzati. Le osservazioni condotte durante gli attuali restauri hanno poi permesso di arricchire le conoscenze sui materiali utilizzati e ipotizzare applicazioni pratiche delle metodologie adottate in quel periodo dai restauratori.

Un esempio può essere rappresentato nel distacco della sola figura centrale in uno dei tre mosaici figurati inseriti nella galleria del Braccio Nuovo.

Sulla base del disegno realizzato dal Camilli prima del distacco nel 1817, in cui si vede il mosaico allo stato del ritrovamento (fig. 2), è ipotizzabile che l'area presa in esame come esempio sia stata suddivisa in piccole porzioni, intorno alle quali venivano rimosse alcune file di tessere (fig. 3) allo scopo di creare delle aperture fin sotto il massetto, necessarie per inserire gli attrezzi occorrenti al loro sollevamento. Prima di effettuare il distacco, la superficie del mosaico veniva ricoperta da uno spesso strato di gesso che lo racchiudeva insieme al massetto in una specie di sandwich (fig. 4).

Siamo ai primordi del famigerato distacco a blocchi, un metodo che comportava senz'altro una notevole perdita di

Figura 2 Disegno del mosaico prima del distacco. Copyright © Musei Vaticani.

Figura 3 Ipotesi di distacco a blocchi. Credit: Roberto Cassio

Figura 4 Vista in sezione del distacco a blocchi. Credit: Roberto Cassio

materiale musivo, non soltanto per le tessere rimosse prima di effettuare il distacco, ma soprattutto durante il sollevamento delle porzioni di pavimento.

Dopo il trasferimento al Museo, i blocchi distaccati venivano ripuliti dagli strati di malta originaria e preparati per la riapplicazione nella nuova sede. Le sezioni di mosaico erano quindi applicate su un nuovo supporto in lastre di peperino spesse circa 8–9 cm, di forma regolare e con dimensioni adatte a contenere anche più sezioni (fig. 5). A conclusione della riapplicazione si integravano le zone mancanti di tessere sia per ricucire tra di loro le sezioni di mosaico sia per realizzare nuove campiture.

Ogni nuovo pannello veniva così inserito nella zona di pertinenza per la composizione del nuovo pavimento (fig. 6), a cui seguiva l'integrazione sul posto delle cuciture fra i singoli pannelli, integrazioni che tendevano ad essere di tipo

Figura 5 Montaggio su pannelli in pietra peperino dei blocchi distaccati. Credit: Roberto Cassio

Figura 6 Composizione dei pannelli per il mosaico attualmente esposto presso la galleria del Braccio Nuovo. Credit: Roberto Cassio

mimetico, per non alterare le caratteristiche iconografiche e stilistiche originali.

Il Braccio Nuovo fu inaugurato nel 1822: ideato con gli stessi criteri del museo Pio Clementino, accoglie mosaici in bianco e nero del II sec. d.C. provenienti dagli scavi di Tor Marancia. Anche questi mosaici, sia quelli figurati con scene a soggetto marino e mitologico, sia quelli con decorazione geometrica, così come appena mostrato nel precedente esempio, furono modificati profondamente per essere adattati alla nuova esposizione.

Metodologie per la conservazione

La conservazione del patrimonio musivo dei Musei Vaticani è stata da sempre vincolata, da un lato a fattori estetici e di presentazione museale, dall'altro alla finalità di utilizzo. Sono mosaici che devono sostenere ogni anno il passaggio di milioni di visitatori e che hanno una collocazione e una funzione storicizzata all'interno del percorso di visita.

Il calpestio dei visitatori contribuisce in modo decisivo al deterioramento superficiale del tessuto musivo e al distacco delle tessere, ma costituisce solo il fattore aggravante di una situazione conservativa compromessa da altri tre principali fattori:

I) la malta idraulica utilizzata nell'applicazione a pavimento su lastre di peperino ha progressivamente perso le sue proprietà leganti e la sua solidità, a causa della lenta ma costante, perdita dell'elemento carbonatico (Ca^{++});

II) i movimenti di assestamento dell'antica architettura del Museo hanno provocato in molti casi piccoli spostamenti delle lastre in peperino, sufficienti a causare fratture e dissesti della malta lungo le fasce di giuntura;

III) il lento disgregamento della malta di commessura fra le tessere, favorito anche da sistemi errati di pulitura ordinaria dei pavimenti, ha causato la perdita di tensione superficiale e in molti casi, il distacco di tessere con conseguente effetto domino.

Nel corso degli anni le sole misure di conservazione adottate dai mosaicisti per ripristinare le condizioni necessarie a sostenere il calpestio delle superfici danneggiate dal transito dei visitatori, sono state quelle di intervenire a danno avvenuto, integrando le lacune con tessere di materiale simile a quelle andate perdute, causando in questo modo una ulteriore alterazione della già compromessa autenticità. In alternativa sono state adottate misure drastiche, che hanno comportato la rimozione dei pavimenti dalla loro collocazione nel museo. A essere preservati dall'usura della macchina museale tramite questa soluzione sono stati fino ad ora due mosaici, staccati dalla loro collocazione storica e posti in esposizione verticalmente su pannelli. Il primo, il mosaico dei Navalia, distaccato nel 1964 dalla Sala di Eliodoro nelle stanze di Raffaello, si trova attualmente a parete all'ingresso dei Musei. Il secondo proveniente dalla sala delle Muse fu staccato nei primi anni Settanta e smembrato: il complesso decorativo esterno alla raffigurazione centrale è stato suddiviso in pannelli attualmente esposti a parete nell'ambulacro superiore dell'uscita ai musei, mentre il mosaico centrale alla sala, con emblema raffigurante una Medusa, ha subìto un primo montaggio su blocchi cementizi e successivamente, con un restauro da poco ultimato, applicato su pannelli in aerolam che saranno a breve esposti in verticale.

Entrambe le tecniche d'intervento messe in atto nel passato presentano gravi svantaggi: l'intervento a danno avvenuto, ha comportato una continua manomissione delle opere, già ampiamente rimaneggiate, senza affrontare le cause del deterioramento. La rimozione dei pavimenti dalle sale ha provocato la cancellazione del progetto espositivo originario, alti costi per la realizzazione dell'intervento e l'esposizione in verticale in nuovi ambienti espositivi.

La prima soluzione presa in esame, di fronte a una così preoccupante situazione, è stata quella del distacco dei mosaici, con la rimozione delle lastre di peperino di supporto al mosaico e la successiva applicazione in loco su un nuovo piano di sottofondo. Questo sistema avrebbe garantito l'adesione del tessuto musivo a una nuova malta di allettamento e la rimozione del problema dei movimenti statici, salvaguardando in questo modo ciò che di originario era rimasto delle opere. Tuttavia, oltre ad essere un intervento traumatico e maggiormente costoso, avrebbe comportato una lenta progressione dei cantieri di lavoro, influenzando in modo negativo la vita del Museo stesso, poiché, la posizione dei mosaici nella maggior parte dei casi, non permetteva alternative al flusso dei visitatori e avrebbe imposto la chiusura temporanea di parti del Museo. Questa soluzione è stata dunque esclusa, in quanto per esso, tra i più noti e visitati al mondo da persone provenienti da ogni parte del pianeta, avrebbe comportato ricadute negative sotto i punti di vista d'immagine e quello economico.

Si è dunque scelto di indirizzare la strategia d'intervento verso soluzioni di minor impatto applicabili all'intera collezione e ripetibili in futuro secondo un piano di manutenzione ordinaria che permettesse contestualmente l'allestimento dei cantieri su porzioni delle superfici, mantenendo aperti i percorsi di visita.

I primi interventi realizzati risalgono al 1997, per il pavimento cosmatesco delle Stanze di Raffaello, dove sono state sperimentate per la prima volta le procedure di conservazione che sono poi state standardizzate.

Il Laboratorio per il Restauro dei Mosaici, con la collaborazione del Laboratorio di Ricerche Scientifiche, ha voluto affrontare il tema della conservazione dei mosaici vaticani in modo globale vagliando le soluzioni possibili a disposizione e mettendo in pratica i criteri, le metodologie e i materiali della moderna disciplina della conservazione.

Da allora è stata messa a punto una metodologia specifica mirata al consolidamento delle malte, al ripristino della solidità del tessellato, alla stuccatura degli spazi fra le tessere e al reintegro di quelle mancanti. Questo metodo è stato esteso a tutti i mosaici esposti lungo il percorso dei musei e soggetti a calpestio. Per illustrare la metodologia porterò come esempio l'intervento eseguito sul mosaico della Sala Rotonda iniziato nel 1998.

In considerazione dell'enorme affluenza e permanenza dei visitatori, la sala Rotonda è stata ripartita in cinque cantieri, eseguiti in successione in modo da permettere una costante visione delle opere che vi si trovano; quattro cantieri sono stati creati per l'anello di mosaico in bianco e nero che è quello normalmente adibito a percorso museale e di conseguenza anche il più deteriorato; e l'ultimo, per il restauro del grande mosaico policromo delle terme di Otricoli, posto al centro della sala e protetto dal passaggio dei visitatori (fig. 5).

La procedura applicata è quella che segue:

a. Pulitura del mosaico: finalizzata non soltanto alla rimozione dei depositi superficiali ma, in particolar modo, all'estrazione dalle commessure delle tessere di materiale incoerente che con il passare del tempo ha sostituito la malta di allettamento, costituendo, come già visto, uno dei fattori del suo degrado. Come detergente si è utilizzato un tensioattivo non ionico diluito in acqua al 5%, unito all'azione di un macchinario a mono spazzola che ha garantito, per questo tipo di lavorazione, un efficace aiuto, senza causare ulteriore perdita di materiale musivo.
b. Apertura delle sedi. Per l'inserimento di nuovo tessellato, è stata rimossa la malta residua nelle zone mancanti di tessere fino al supporto di sottofondo, costituito dalle lastre in pietra peperino. Tale

intervento è stato eseguito sia per la singola tessera, sia per le lacune più ampie, situate sia sul fondo bianco sia sul figurato. Nella fig. 8 possiamo individuare all'interno della lacuna: la lastra in peperino, la malta di cucitura fra una lastra e l'altra, e la malta di stucco ad olio, conosciuta per il suo utilizzo a partire dalla fine del XVII secolo, nella realizzazione dei mosaici della Basilica Vaticana e per i micro mosaici romani ottocenteschi. Per documentare esattamente tutti gli inserimenti di nuovo materiale prima dell'integrazione, le lacune, anche quelle di minore entità, sono state evidenziate con pigmento giallo sciolto in acqua e poi fotografate e registrate su una specifica mappatura.

c. Consolidamento della malta idraulica. Realizzato mediante penetrazione dalla superficie del mosaico di silicato di etile, applicato a pennello o con altri mezzi adatti a stendere uniformemente il prodotto. L'applicazione del consolidante è stata ripetuta più volte a distanza di alcune ore una dall'altra, fino al completo assorbimento e rifiuto da parte della malta di allettamento. A causa dei vapori tossici si è reso necessario preparare una camera di aspirazione sulla zona trattata per l'evacuazione dei vapori di etile emanati durante l'asciugatura del prodotto. Il prodotto consolidante è stato lasciato agire per circa venti giorni fino a completa asciugatura.

Figura 7 Sala Rotonda, alternanza dei cantieri di restauro. Credit: Roberto Cassio

d. Integrazione del tessuto musivo mancante. Il materiale utilizzato per questo intervento è stato reperito dal magazzino del laboratorio, che attualmente conserva scorte di materiale specialmente di bianco e nero, risultato dai cosiddetti restauri ottocenteschi. L'integrazione attuale, inserendosi su pavimentazioni già ampiamente alterate nel passato riconoscibili anche dall'uso di malte cementizie che ne evidenziano la differenza dall'originale, è stata realizzata in modo mimetico allo scopo di ricucire la lettura dell'insieme decorativo, già compromesso dal punto di vista ottico dai precedenti interventi, affidando alle fotografie e alle mappature grafiche il compito di documentarne la presenza.

   La malta utilizzata per l'allettamento delle tessere è stata formulata per permettere una buona aderenza su tutti i tipi di supporto o intonaci che si trovano nello strato di sottofondo, ovvero la pietra di peperino, la malta idraulica a base di calce e pozzolana, lo stucco a olio e le malte cementizie inserite nei più recenti restauri. La malta è stata realizzata unendo calce idraulica (Lafarge), con polvere di marmo e caolino, nelle proporzioni 2–1–0.5.

e. Stuccatura interstiziale. Il ripristino della malta fra le tessere è stato realizzato con la stessa composizione di malta utilizzata per il fissaggio delle stesse. La sua applicazione è stata preceduta da un'abbondante imbibizione del piano musivo con resina acrilica diluita in acqua con un duplice scopo: quello di fissare le microlesioni della vecchia malta già consolidata con il silicato e quella di migliorare l'adesione e la penetrazione della malta di riempimento.

A completamento di tutta la procedura è stata eseguita una pulitura finale della superficie del mosaico con la rimozione dei residui delle lavorazioni. Per velocizzare e migliorare tale lavorazione, si è utilizzato lo stesso macchinario usato in precedenza per la pulitura iniziale, sostituendo in questo caso la spazzola con un disco in feltro, azionato senza l'ausilio di detergenti, ma con sola acqua. Sempre con lo stesso macchinario, ma con un feltro più morbido, si è infine applicata una cera nutriente e protettiva per i marmi.

Ad oggi, la campagna di salvaguardia dei mosaici è stata estesa a circa 900 metri quadrati di superfici e si è conclusa proprio da pochi mesi.

Costi e valutazioni generali

Dal 2002 è in atto un sistema di stima preventiva dei costi dei singoli interventi di restauro e conservazione, curato

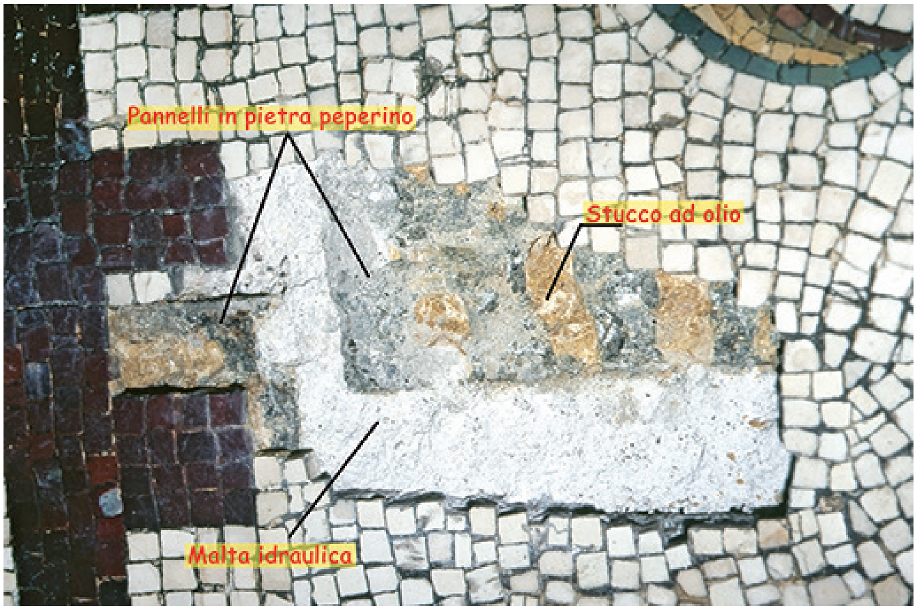

Figura 8 Sala Rotonda, particolare dei supporti del pavimento musivo. Photo: Roberto Cassio

dall'Amministrazione dei Musei Vaticani. Ogni laboratorio di restauro del Museo trasmette un programma dei lavori da svolgere con i relativi costi per l'anno successivo, nel quale vengono quantificati, per ogni intervento, il numero di ore necessarie per il restauratore, per il fotografo, per la diagnostica e la stima dei costi del materiale di consumo.

Con questo metodo è possibile verificare e confrontare i costi preventivati con quelli disponibili a fine lavoro. Nel caso di questo intervento non emergono rilevanti differenze, poiché l'applicazione di questa semplice e schematica procedura non ha mai incontrato imprevisti tali da dover alterare sostanzialmente il calcolo preventivo, già di per sé precedentemente maggiorato circa il 15%. A conclusione di tutta la campagna di restauro dei pavimenti, è quindi possibile calcolare i costi consuntivi al metro quadro.

Per la traduzione in moneta delle ore lavorate per ogni tipo di intervento, mi sono avvalso di una paga oraria fornita dall'amministrazione vaticana, comprensiva di contribuzioni, tramite la quale è stato calcolato il costo al metro quadro per il restauratore che è risultato pari a 320 €, 8,50 € per il fotografo e 13,50 € per la diagnostica.

Di minore entità rispetto alle risorse umane sono i costi dei materiali utilizzati, che ammontano a circa 20 € per metro quadrato. In questo calcolo non sono stati considerati i costi dei macchinari utilizzati e i loro utensili di consumo. Il costo totale al metro quadrato risulta pertanto di 362 €.

Con questa spesa è stato quindi possibile interrompere la giornaliera perdita di tessere musive che avveniva soprattutto per i pavimenti maggiormente esposti al passaggio dei visitatori e introdurre una metodologia di intervento che permetterà di eseguire manutenzioni periodiche a basso costo.

L'aspettativa è che i risultati di questo intervento possano durare ancora per molto tempo, almeno fino ad un lungo periodo successivo al mio pensionamento.

Questo pensiero porta alla tematica della formazione. Attualmente il Vaticano consente di accedere a chi lo richiede, soltanto a brevi periodi di stage presso i laboratori di restauro, per un massimo di sei mesi. Il mio auspicio è che questa possibilità venga trasformata in un progetto formativo, magari una scuola, nella quale preparare giovani direttamente sul campo, vista anche la possibilità di operare su un'enorme vastità di tipologie di mosaico, dall'antico a quello medioevale fino al moderno.

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A New Mosaic from Ain El-Helwe in Latakia, Syria

Maher Jbaee

Abstract: *The mosaic of Ain El-Helwe is considered one of the most important mosaics that has been found recently in Syria. The mosaic depicts a rich variety of marine animals, considered one of the rarest scenes in Syria, and is significant not only for this reason, but because of the building in which it was discovered. The mosaic is now under study, and the excavation work is being completed. It was not possible to keep the mosaic in situ; it has been removed and restored and is now accessible to the public.*

The mosaic of Ain El-Helwe, in Latakia province on the coast (fig. 1), was discovered in 2004 in an archaeological context that appears to be a public building or villa. The excavation of this site is continuing to uncover the building and to determine its function. This extremely significant mosaic depicts a rich variety of marine animals, an exceptional and rare example of the art of ancient mosaics known in Syria.

Scenes of marine life have been discovered previously, for example, in a mosaic now held at the British Museum, in a mosaic in the House of the Faun at Pompeii (fig. 2), in one found near the House of the Boat of Psyche at Antioch, and in one in the House of Oceanus and Thetis also at Antioch (fig. 3). All of these mosaics depict a group of marine animals that appear to be swimming.

Examination of the mosaic found at Ain El-Helwe and studies of the site that can be conducted once excavation is completed should help us understand the nature of the building and confirm the function of the room in which the mosaic was found, as well as its date. The scene in the mosaic and comparisons of similar ones indicate that the mosaic may date to the second century CE.

The mosaic was discovered in an area that left it vulnerable to vandalism. In 2008 we decided to move it from the site to the mosaic conservation laboratory in Damascus, where restoration work could be carried out. Because of its importance and our inability to see the entire scene, we decided to cut the mosaic into only two large pieces, in spite of the difficulty this presented for lifting and transferring it (fig. 4).

The work was limited during the 2009 season to removing the original mortar from the back of the mosaic. During the 2012 and 2013 seasons, we completed the restoration work. We placed the mosaic on a new support that consists of honeycomb panels (Aerolam), using traditional mortar similar in nature to the original mortar (fig. 5).

The new mortar was composed of 3 parts limestone powder + 0.5 part volcanic stone powder + 0.5 part brick powder + 1 part imported hydraulic lime (Lafarge – 4MPa in 7 days) + 1 part slaked lime + 7% acrylic resin AC33 to give the mortar more elasticity.

Condition Assessment

After fixing the mosaic to the new support we were able to determine its condition, as follows:

- Lacunae in places where the artist used glass tesserae, especially in the shaded areas of the marine animals;
- Detachment of some tesserae previous to and during the process of removing the mosaic;
- Deterioration and erosion of some glass tesserae;
- Depressions in some places;
- Salt encrustation on the surface of the mosaic.

Figure 1 Map of Syria showing the location of Ain El-Helwe. By permission of DGAM in Syria

Figure 2 Mosaic of the House of the Faun, Pompeii. Photo: © Vanni Archive / Art Resource, NY

Figure 3 Mosaic of the calendar with Oceanus and Tethys, Antioch. Photo: GM Photo Images / Alamy Stock Photo

Figure 4 Mosaic of Ain El-Helwe being lifted from the site. Photo: Maher Jbaee, by permission of DGAM in Syria, 2008

Figure 5 The mosaic on the new support. Photo: Ousama Nofal, by permission of DGAM in Syria, 2012

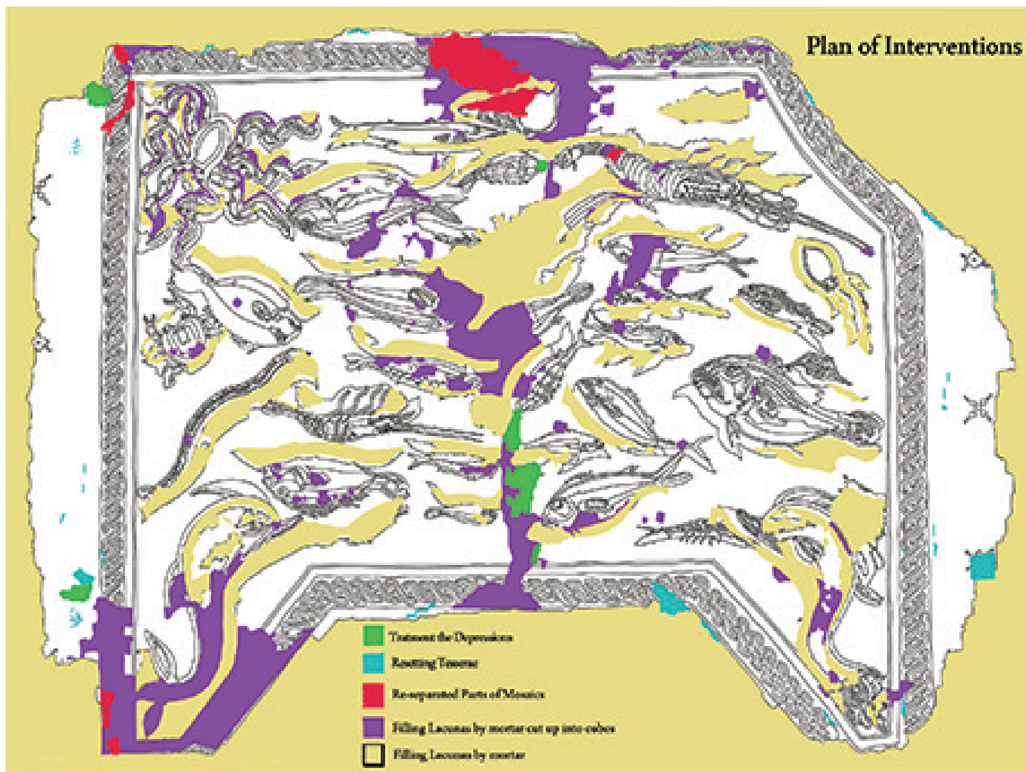

Figure 6 Graphic documentation of the interventions. Photo: Maher Jbaee, by permission of DGAM in Syria, 2013

Interventions

On completion of the condition assessment, interventions were started. The most challenging and difficult stage was the work on the surface of the mosaic as it had many problems, especially the hard crust of salts that caused lack of clarity of the scene and the large percentage of glass tesserae.

Investigations conducted in the Scientific and Conservation Laboratories of the Directorate General of Antiquities and Museums (DGAM), revealed that the salt layer is very hard and could not be removed except by mechanical methods and with the aid of chemical compresses.

Interventions were performed as follows:

- Filling of lacunae using different methods: original tesserae were used where we were certain of their original placement; and mortar cut in the shape of tesserae was used in places that were considered important areas to complete, using mortar in colors similar to those of the mosaic.

The mortar was composed of 2 parts limestone powder + 0.25 part volcanic stone powder + 0.25 part brick powder + 0.5 part imported hydraulic lime (Lafarge – 4MPa in 7 days) + 1 part slaked lime + 7% acrylic resin AC33 to give the mortar more elasticity.

- Documentation by photographs, graphic plans, and plans in Photoshop and AutoCAD and reports (fig. 6).
- Display of the mosaic in the mosaic gallery at the Damascus Citadel on a simple stand (figs. 7, 8).

Table 1 presents the materials used in the restoration and their cost. We want to point out that the hydraulic lime (Lafarge), the acrylic resin (Primal AC33), and the honeycomb panels (Aerolam) are all imported materials and are well known in the mosaic restoration field. The second section of the table, materials used for the support and frame, shows that iron was used for the support; this was necessary given the large size of the two pieces. For framing, aluminum was used.

Figure 7 Final restoration work. Photo: Eman Bouaini, by permission of DGAM in Syria, 2013

Figure 8 The final display of the mosaic in the Gallery. Photo: Maher Jbaee, by permission of DGAM in Syria, 2013

Table 1 Restoration materials used and costs

Materials	**Costs**	
	SYP	**US$**
1- Honeycomb panels (Aerolam) (sold in 1 panel)	75,000 (1 panel)	500 (1 panel)
2- Hydraulic lime (sold in bags of 35 kg)	450 (1 kg)	3 (1 kg)
3- Quicklime (sold in bulk)	50 (1 kg)	0.3 (1 kg)
4- Powder of volcanic stone (sold in 1 kg)	50 (1 kg)	0.3 (1 kg)
5- Powder of brick (sold in 1 kg)	50 (1 kg)	0.3 (1 kg)
6- Powder of limestone (sold in 1 kg)	25 (1 kg)	0.15 (1 kg)
7- Gravel (sold in 1 kg)	50 (1 kg)	0.3 (1 kg)
8- Resin epoxy (sold in 1 kg)	600 (1 kg)	4 (1 kg)
9- Acrylic resin Primal AC33 (sold in 1 kg)	750 (1 kg)	5 (1 kg)
10- Adesilex P10 (sold in bags 25 kg)	600 (1 kg)	4 (1 kg)
Support and Framing Material	**Costs**	
	SYP	**US$**
1- Processed iron (sold in 1 kg)	150 (1 kg)	1 (1 kg)
2- Processed aluminum (sold in 1 m)	225 (1 m)	1.5 (1 m)
3- Screws for fixing (sold in box)	600 (1 box)	4 (1 box)
Display Stand Material	**Costs**	
	SYP	**US$**
1- Processed iron (sold in 1 kg)	150 (1 kg)	1 (1 kg)

Source: Maher Jbaee, by permission of DGAM in Syria

This project was carried out by the mosaic conservation laboratory of the Syrian Directorate General of Antiquities and Museums. As employees our salaries are paid by the government. Student participants who are trained and work with the laboratory team are part of a cooperation agreement between the Directorate General of Antiquities and Museums and the University of Damascus Department of Archaeology. The final cost of the project does not include labor.

The materials used, their costs, and the cost per square meter are as follows:

Cost of restoration materials = SYP 271,875 = US$1,812.50

Cost of support and frame materials = SYP 10,650 = US$71.00

Total cost of the restoration = SYP 282,525 = US$1,883.50

Total area = 9 m^2

Cost per 1 m^2 of the restoration = SYP 31,391.66 = US$209.27

Cost of the display stand = SYP 37,500 = US$250.00

Total cost of the restoration and display stand = SYP 320,025 = US$2,133.50

Total area = 9 m^2

Cost per 1 m^2 of the restoration and display stand = SYP 35,558.3 = US$237.05

This work was performed by the laboratory team of DGAM in Syria: Maher Jbaee, Mohammad Kaeed, and Borhan Al zarraa; and University of Damascus students under the supervision of Komait Abdallah. Our colleagues in the chemical laboratory in DGAM in Syria also contributed.

The Lod Mosaic: Discovery and History of the Intervention

Jacques Neguer

Abstract: *The Roman mosaic from Lod, Israel, was discovered in 1996 during a rescue excavation because of road reconstruction. The mosaic was conserved and reburied due to lack of funds for exhibition to the public. Only after the necessary budget for the reexcavation, conservation, and building of a museum at the site was found (in 2009) was the mosaic lifted, restored, and exhibited in several museums throughout the world. The museum is under construction, and the exhibition of the mosaic will include the discoveries made during the lifting of the mosaic as well as the footprints of the mosaic masters, the synopia painting, and so on. In Israel rescue excavations do not have budgets to deal with important discoveries, and many mosaics uncovered in the past ten years were reburied without proper documentation, conservation, and research. This problem should be approached and funded on a national and an institutional level. The case of the Lod mosaic is only the beginning of a long and painful process.*

Discovery

The Lod mosaic was first excavated in 1996 by Miriam Avissar (1998: 72–169) of the Israel Antiquities Authority (fig. 1). The mosaic, representing both real and mythological animals, consists of three very well preserved floors for a total of 150 square meters (fig. 2). It is dated to about 300 CE (based on the excavated pottery) and probably belongs to a large and important Roman villa. This is the biggest and most well preserved mosaic from the period. The excavation and conservation of the mosaic led to a number of important discoveries about the mosaic-making process in antiquity.

Decision-Making Process

Immediately after the discovery of the mosaic, a conservation team from the Conservation Department of the Israel Antiquities Authority (IAA) monitored the progress of the excavations and provided expertise and in situ conservation treatment of the mosaic. At the same time, the IAA began a very wise decision-making process with the aim of presenting the mosaic and the site in the original context:

- 1996: The first variant of the in situ museum was planned and the search for funding began. Because of lack of funding to conserve and expose the mosaic at the original location in Lod, the IAA decided to backfill the site and wait for better times.
- 2006: IAA inspectors learned that local contractors had begun to use the soil from the protective covering, thus endangering the site and the mosaic. This triggered the reassessment of the conditions of the covered site and the decision to make an effort to find the necessary resources to reexcavate and conserve the mosaics and build a visitors center at the site.
- 2008: The IAA began actively to search for sponsorship; the Shelby White and Leon Levy Foundation expressed an interest in funding the project, including a museum at the site.
- 2009: With clear goals and budget in hand, the IAA proceeded with the reexcavation of the site. The uncovering of the mosaic was carried out in June and July 2009 by staff from the Central Archaeological District of the IAA. The soil layers were removed by mechanical means, and the last layer of protective material was cleaned by hand. Additional excavations were performed as well.

Figure 1 The Lod mosaic.
Photo: Nicky Davidov, IAA

- 2009: The potential of damaging the mosaic during future construction of the museum caused us to consider solutions other than conserving the mosaic in situ on the original lime bed. The risk of further deterioration of the mosaic was increased by the fact that the mosaic is below street level and leakage of sewage and water was to be expected. Another reason to consider lifting and re-laying the mosaic on new supports was the complete lack of archaeological context; other than the mosaics, no other remains such as walls or architectural elements were found. In the end, it would have been very expensive and difficult to

Figure 2 Central panel of the Lod mosaic.
Photo: Nicky Davidov, IAA

Figure 3 Bird's-eye view of the excavation, 2014.
Photo: Nicky Davidov, IAA

maintain the in situ mosaic in the proposed museum. After assessing all the possibilities and estimating costs, we decided to lift the mosaic and re-lay it on new supports in the same location when the museum was ready. In the meantime, it was possible to present part of the mosaic in other locations and, in this way, publicize the future exhibition in Lod.

- 2009: More mosaics were discovered during the excavation, and it was decided to include them in the plan for exhibitions at the future Shelby White and Leon Levy Lod Mosaic Center (fig. 3).
- 2009: The central panel of the Lod mosaic began its journey all over the world.
- 2014: After a long and painful process, the plan for the Center was approved, and a new excavation was performed in order to clear the location of the foundations. During the last campaign, additional discoveries led to the redesign of the original plan.
- 2015: Construction of the Shelby White and Leon Levy Lod Mosaic Center began.

Costs

1996

Rescue excavation – €300,000
Mosaics conservation – €60,000
Cost of reburial – €5,000

2009

Reexcavation – €120,000
Conservation, including lifting and re-laying on new supports – €300,000
Planning – €60,000
Reburial of the site – €3,000

2014

Reexcavation and additional research before building – €300,000
Conservation of additional finds (mosaics) – €50,000
Building the Shelby White and Leon Levy Lod Mosaic Center – €4,000,000
Installation and presentation of the mosaics – €120,000

Summary

Conservation – €518,000
Planning – €60,000
Excavation – €720,000 €
Reburial – €8,000 €
Estimated cost of the future building – €4,000,000
Total cost unknown at present

History of the Intervention

During the excavation in 1996, the mosaic was carefully documented (including 1:1 drawings of the important elements), cleaned (fig. 4), and conserved with lime-based mortars. The reburial was executed using our knowledge of past interventions, and the uncovering of the mosaic in 2009 proved that our approach was very successful. Layers of basalt powder in contact with the mosaic, plastic mesh, geotextile, and local soil (2 m deep) protected the mosaic very well and permitted easy and relatively rapid reexcavation. The mosaic was cleaned again and documented using digital rectified photography. The base map created was used to document the ancient mosaic technique and all the discoveries along with the conservation process. Special care was applied to the glass tesserae, including salt extraction and consolidation of each tessera.

After the decision to lift the mosaic was made, the lifting was carefully planned and the documentation completed with digitally rectified photography, taking into consideration all the risks and the vulnerability of the materials.

The mosaic was divided into thirty sections in order to minimize losses during lifting and conservation. This also provided a relatively easy way of reassembling the fragments on the new supports. Lifting of a mosaic is a very difficult and delicate operation, and the risk of doing irreversible

Figure 4 Cleaning of the mosaic, 1996. Photo: Nicky Davidov, IAA

Figure 5 Lifting of the mosaic.
Photo: Nicky Davidov, IAA

damage exists and should be taken seriously into consideration. The risk increases enormously in the case of a unique, 150-square-meter mosaic. A roller was used for the detachment and immediate transfer to wooden platforms (fig.5). Only in one case (the long panel with vine leaves) was the "sandwich" method used to flip the panel. Wooden planks were inserted under the mosaic, connected with clamps to a wooden support lying on the mosaic surface. The mosaic was turned by a team of twelve persons. The operation was extremely difficult to accomplish because of the quality of the Roman mortar, which was hard to cut through, and the dimensions and weight of the sections (maximum surface 16 square meters; weight approximately 1,000 kg). The tesserae that became detached during the lifting (a very limited number) were glued back in their original places with PVA glue on the canvas before the end of each day's work. The panels were transported to the IAA laboratory and given new supports based on Aerolam (honeycomb aluminum) panels and aluminum bars for reinforcement. The central part of the mosaic, about 35 square meters was prepared in the laboratories for traveling abroad. Up to the present, it has been exhibited with great success at the Metropolitan Museum, New York; the Legion of Honor Museum, San Francisco; the Field Museum, Chicago; the Museum of Art, Columbus, Ohio; the Penn Archaeological Museum, Philadelphia; the Louvre Museum, Paris; the Altes Museum, Berlin; Waddesdon Manor, United Kingdom; and the Hermitage Museum, St. Petersburg, Russia. The mosaic has been seen by more than a million visitors and has the honor of being the most visited traveling exhibition from Israel.

During the conservation process, we made a large number of extraordinary discoveries. The discovery of the footprints of the people who produced the mosaic was a very emotional moment for us (fig. 6). The traces of the trowel and the imprint of the fist of one of the ancient masters were documented and conserved as well. But the highlight was the discovery of an extraordinary polychrome sinopia under the evocative marine scene, representing fishes and vessels (Piovesan, Maritan, and Neguer 2012: 203–9). During the conservation both the sinopia and the mosaic needed to be preserved. To this end, the extremely complicated operation of detaching the nucleus from the lime bed without damaging the paint layer was accomplished in the laboratory, and the painted plaster was conserved using techniques for fresco conservation and consolidation. It is worth noting that this finding, the adoption of a sinopia for a mosaic, is unique in the history of art and typical of the Greek world rather than the Roman period (fig. 7). However, Greek artisans used only one pigment (red ocher or carbon black) to draw the sketch on which to apply the tesserae; polychrome synopias have never been seen before. All the finds were conserved properly and will be a part of the future exhibition.

Ancient Technology and Craftsmanship

The careful study of the mosaic stratigraphy and materials, together with the observation and documentation of the

Figure 6 Footprints on the rudus layer. Photo: Nicky Davidov, IAA

Figure 7 The sinopia under the "marine scene" panel. Photo: Nicky Davidov, IAA

Figure 8 Preparation design (*paradeigma*) under the panel with krater and vine leaves. Photo: Nicky Davidov, IAA

layout of the mosaic, provided us with important information about the working methods of the ancient craftsmen. The foundation of the mosaic was laid on a well-leveled platform composed of two layers of stones (round riverbed stones and cut limestone) covered with a strong and high-quality lime mortar, forming in this way the classical *statumen* and *rudus* layers. The joints between the mortar surface of the rudus laid down each day were very carefully worked (irregular edge with an angle of 45 degrees) in order to provide the best possible adhesion of the mortars applied the following day. The outlines of the mosaic composition were marked on the rudus using a sharp tool or string with red pigment.

The layer of the nucleus was applied according to the composition of the mosaic, and on it was designed the outline of the mosaic composition and the layout of the tessellatum. Two methods were used in different locations: on the long panel with krater and wine leaves, the composition was traced using a sharp tool in the fresh mortar—a method called *graphia* or *paradeigma* in Greek (fig. 8). The second method employed preparatory fresco painting under the "Fish Panel" using five different pigments. This method was unknown until the discovery and scientific study of the paint. We suppose the same method was used under the whole northern section of the composition, but we were not able to conserve enough representative fragments to be certain. The painting was covered with a very thin layer of lime mortar (lime bed) and the tesserae were embedded in it.

Every mortar layer was made with the same raw materials (probably a pure lime, a silicate sand, a carbonate sand, and burnt wood and straw as additives) mixed in different percentages and aggregate sizes to obtain the desired characteristics of the mortar.

According to our observation, at least three mosaic masters worked together and separately on different fragments of the mosaic composition.

Conclusion

This multimillion-dollar project is unique, and it will be very difficult to use this model to resolve similar problems in the future. During rescue excavations and mainly during road construction and reconstruction, a very large number of significant sites with mosaics were discovered recently. The problem of moving entire sites with mosaics with hundreds of square meters of surface area is not only financially and technologically prohibitive, but the available space for exhibition is extremely difficult to find. In the past three years alone, we needed to move several sites to new locations with the imminent loss of their context and of their historical and archaeological values.

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Conservation et présentation des mosaïques du site de Plassac (Gironde)

Évelyne Chantriaux, Marion Hayes, Christophe Laporte et Maurice Simon

Résumé : *Cette opération concerne les six pavements du site de Plassac (Gironde), découverts en 1962 dans les vestiges d'une* villa *gallo-romaine. L'ensemble fit l'objet en 1991 d'une étude diagnostique réalisée par l'atelier de Saint-Romain-en-Gal pour définir les mesures nécessaires à leur conservation et à leur présentation ; les interventions programmées s'échelonnèrent ensuite sur plus de vingt ans. Leur achèvement en 2014, après la construction d'un abri permanent, permet de relater l'ensemble de l'opération, depuis l'élaboration du projet de valorisation initié en 1984 par le Département de la Gironde jusqu'à l'achèvement des travaux d'aménagement du site, menés avec la Conservation régionale des monuments historiques.*

Abstract: *This project involves the six mosaic pavements discovered in 1962 in the remains of a Gallo-Roman villa at the site of Plassac (in Gironde, France). In 1991, a diagnostic survey was conducted on these mosaics by the Saint-Romain-en-Gal workshop in order to identify the measures necessary for their conservation and display. The scheduled interventions were carried out over a period of more than twenty years and completed in 2014 after the construction of a permanent shelter. The history of this project can now be related in full, from development of the enhanced project initiated in 1984 by the Department of Gironde to completion of the site, managed in conjunction with the regional state body for the conservation of historical monuments (Conservation régionale des monuments historiques).*

Le site archéologique de Plassac a été repéré dès le XIXe siècle, lors de travaux de confortement effectués en 1867 et 1883 dans l'église qui constitue sa limite orientale. Situé sur la rive droite de l'estuaire de la Gironde, à une cinquantaine de kilomètres au nord de Bordeaux et au cœur des vignes du Blayais-Bourgeais, ce site présente, sur une superficie de plus de 5 000 m², les vestiges de trois *villae* antiques qui se sont succédé, au même emplacement, du début du Ier siècle aux Ve et VIe siècles apr. J.-C. Ces riches demeures, installées face au fleuve au prix de terrassements considérables, présentent des plans inspirés de modèles architecturaux italiens, depuis la première *villa* maritime au vaste hémicycle centré sur une salle à manger-belvédère, à laquelle succède la fastueuse résidence à péristyle des IIe et IIIe siècles dont subsistent des restes d'enduits peints et de marbres rares, jusqu'à la *villa* du Bas-Empire. C'est à cet état tardif, reconstruit suivant le même plan général que la *villa* précédente, qu'appartiennent les six mosaïques mises au jour en 1962[1] (fig. 1). Celles-ci, localisées dans l'aile orientale du péristyle, totalisent une surface de 150 m² en incluant les parties récemment dégagées le long de l'église ; elles présentent des décors polychromes à composition géométrique (écailles, osselets, croix de fuseaux) et motifs végétaux (fleurons variés et guirlandes de lauriers) caractéristiques des productions de l'école d'Aquitaine.

Dès la mise au jour des vestiges, les habitants de la commune, soucieux du devenir des structures dégagées et des mosaïques, créent – avec l'appui de la municipalité – une association culturelle, Les Amis du Vieux Plassac[2], dont la finalité est d'œuvrer pour la sauvegarde et la promotion du patrimoine de la commune. Consciente des problèmes de dégradation auxquels sont exposés les pavements, l'association effectue la consolidation des bordures de tesselles instables et fait installer un auvent au-dessus des mosaïques situées contre l'église ; les autres pavements sont recouverts de graviers. En 1984, l'acquisition par le conseil général de Gironde du site – alors classé monument historique – permet l'engagement d'une réflexion en vue de la valorisation du site, en concertation avec la Direction régionale des affaires culturelles d'Aquitaine (Conservation des monuments historiques et Service de l'archéologie), la municipalité de Plassac, l'association des Amis du Vieux Plassac et les responsables

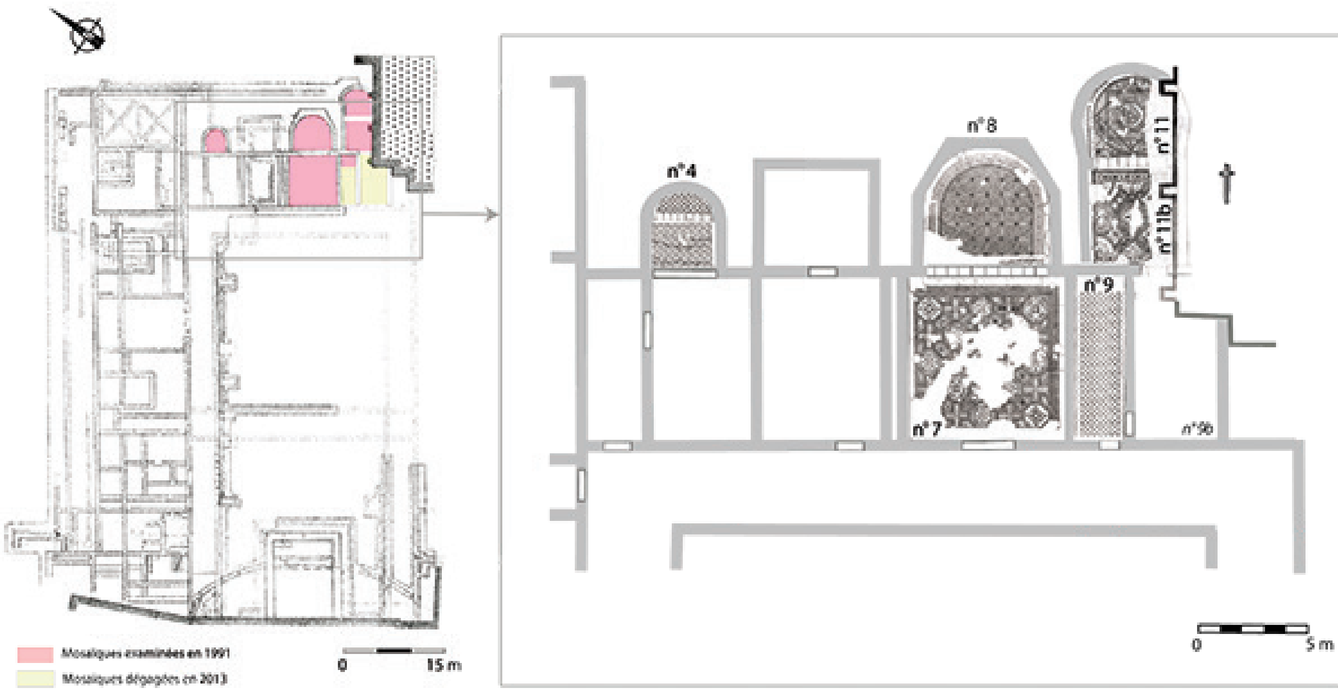

Figure 1 Plan de la *villa* de Plassac avec repérage des mosaïques et détail de l'état tardif (IVe–VIe siècle). © ARM (Atelier de restauration de mosaïques de Saint-Romain-en-Gal)

scientifiques impliqués dans le projet[3]. Des travaux de consolidation des murs dégradés sont entrepris dès 1985.

1991 : L'étude diagnostique

En 1991, le conseil général de Gironde[4] commande une étude diagnostique confiée à l'atelier de restauration de Saint-Romain-en-Gal. L'objectif est de dresser le constat de l'état des pavements puis de proposer des solutions pour leur conservation, leur restauration et leur présentation.

L'atelier intervient après le dégagement des mosaïques recouvertes de graviers. Les pavements font l'objet d'un examen attentif, accompagné par l'enregistrement des dégradations constatées sur les relevés fournis par le Service archéologique[5]. Parmi les six mosaïques, deux groupes se distinguent rapidement : d'une part les trois mosaïques qui n'ont pas été protégées par un abri, mais simplement recouvertes par une couche de graviers (nos 4, 7, 8), et d'autre part les trois autres, situées contre l'église et protégées par un auvent après leur découverte (nos 9, 11, 11b). Le premier groupe présente des dégradations apparentes sous la forme de lacunes, parfois très étendues (nº 7), de lignes de fracture et de zones fissurées avec dissociation des tesselles (nº 4), de pertes de liaison avec les murs et d'une érosion parfois très prononcée des tesselles (nº 7). La mosaïque de la salle à abside (nº 8), traversée de racines qui ont soulevé le *tessellatum* et dont une bande est disloquée sur toute la largeur de la pièce, constitue le cas le plus alarmant (fig. 2). Les mosaïques du second groupe paraissent moins altérées ; leur cohésion est mieux préservée malgré quelques lacunes, des fissures et le développement de mousses le long du mur de l'église.

L'auscultation systématique des surfaces révèle un degré d'adhérence très variable entre le *tessellatum* et l'assise, d'une mosaïque à l'autre mais aussi à différents endroits d'une même

Figure 2 Bordure disloquée de la mosaïque nº 8 en 1991. © ARM (Atelier de restauration de mosaïques de Saint-Romain-en-Gal)

mosaïque : les déposes indispensables et celles pouvant être évitées ou du moins différées sont ainsi définies, en fonction de l'étendue et de la gravité des pertes d'adhérence.

Les déposes jugées prioritaires et nécessaires à la sauvegarde des mosaïques concernent celles qui sont entièrement désolidarisées de leur support : pour les trois pavements qui n'ont pas été protégés par un abri, le transfert sur un nouveau support est la seule solution rationnelle pour éviter la poursuite du processus de dégradation qui les endommage déjà gravement et menace de conduire à leur entière dislocation. Les causes de cet état d'altération sont directement liées à la protection insuffisante procurée par la couche de graviers étendue sur leur surface, mais également aux problèmes d'humidité transmise par l'infrastructure. C'est ce qui explique l'état extrême de dégradation de la mosaïque n° 8 : le vide que ménageait la *suspensura* sur laquelle elle a été installée s'est en effet progressivement comblé de terre, et avec la proximité de la nappe phréatique, très haute généralement sauf pendant une courte période estivale, son soubassement baigne quasiment constamment dans l'eau. Dans ces conditions, son prélèvement, en vue d'une repose sur un nouveau support, constitue une mesure conservatoire indispensable.

L'état de conservation inégal des pavements aboutit à la planification suivante de mesures qui tiennent compte des différences constatées :

- mise en œuvre de mesures de conservation préventive pour l'ensemble des pavements et dépose des trois mosaïques présentant un état de dégradation extrême (nos 4, 7, 8) ;
- prise de décision par les responsables concernant l'édification d'abris permanents, condition nécessaire à la repose des mosaïques déposées ; puis élaboration du cahier des charges, étude et réalisation du projet architectural ;
- pendant cette phase, restauration des mosaïques déposées (remontage sur un nouveau support et traitements de surface). Parallèlement, sur le site, fouille des salles correspondant aux mosaïques déposées et entretien des mosaïques conservées *in situ* ;
- repose des mosaïques déposées après édification des abris ;
- programmation des mesures de maintenance.

Mesures de conservation préventive

Dès l'examen des pavements, des interventions de conservation préventive sont effectuées afin d'assurer la sauvegarde des mosaïques pendant la période nécessaire aux prises de décision. Ces mesures consistent à :

- stabiliser les parties vulnérables par des solins de bordure en mortier de chaux chargé de sable et par des pansements de gaze collés sur les zones boursouflées ou en voie de dislocation (figs. 3 et 4) ;
- recouvrir les mosaïques nos 9, 11 et 11b, maintenues *in situ*, par des géotextiles et une couche de sable ;
- protéger à titre temporaire, avant leur dépose, les mosaïques des salles nos 4, 7 et 8. L'état de dégradation extrême de ces trois pavements ne permettant pas de les recouvrir de sable, des abris temporaires sont installés par le Service archéologique de Gironde ; il s'agit de serres-tonneaux à structure tubulaire métallique, bâchées avec des matériaux présentant une isolation thermique, en l'occurrence un film multicouche anticondensation utilisé dans le secteur agricole. Des protections complémentaires pour protéger les pavements

Figure 3 Mosaïques nos 11 et 11b après les consolidations effectuées en 1991.

Figure 4 Mosaïques n[os] 7 et 8 en cours de consolidation en 1991. © ARM (Atelier de restauration de mosaïques de Saint-Romain-en-Gal)

du gel pendant la période hivernale sont par ailleurs mises en place, sous la forme de housses contenant des billes d'argile expansée, matériaux légers thermiquement isolants ; cependant, un développement de mousses dû aux remontées d'eau et à l'accumulation d'humidité entre le *tessellatum* et les housses, puis à la combinaison chaleur-humidité-lumière, a été constaté après le premier hiver et l'enlèvement des housses isolantes ; celles-ci n'ont donc pas été replacées, et les mousses ont été traitées avec un agent bactéricide et algicide appartenant à la classe des ammoniums quaternaires.

1994 : La dépose[6] des trois mosaïques n[os] 4, 7, 8

Malgré les trois années écoulées depuis l'étude préliminaire de 1991, l'état des mosaïques, consolidées et efficacement protégées par les abris temporaires, s'est maintenu sans aggravation. Après le nettoyage et l'entoilage de leur surface (gaze chirurgicale et toile de jute collées avec un adhésif vinylique en solution dans de l'alcool), les mosaïques sont déposées. L'état des tapis de tesselles, entièrement désolidarisés de leur support, permet d'utiliser deux modes opératoires : le système habituel du prélèvement en plaques de 1 à 2 m^2 environ, complété par la dépose au rouleau de certaines parties des tapis – la composition de croix de fuseaux notamment – qui ne se prêtent pas à un découpage en plaques.

La mosaïque de la salle n° 4 est prélevée en 5 plaques, la mosaïque n° 7 en 13 plaques, et l'abside n° 8 en 7 éléments. L'ensemble des parties déposées est immédiatement transporté à Saint-Romain-en-Gal en vue de la restauration des mosaïques. L'opération est filmée et intégrée à la réalisation d'un film présentant le site de Plassac et les actions du Département de la Gironde pour sa conservation et sa mise en valeur[7].

1995–2005 : Le remontage des mosaïques déposées

Dès 1995, la restauration de la mosaïque n° 4, représentant une surface de 8,7 m^2, est engagée. Les restes de mortier antique sont enlevés au ciseau de marbrier, et le *tessellatum* est remonté sur un support de nid d'abeille en alliage d'aluminium de 50 mm d'épaisseur dont chaque face est revêtue d'un stratifié de toile de verre et de résine époxyde. Puis le désentoilage est effectué – avec le solvant de l'adhésif utilisé pour les entoilages appliqués *in situ* –, et les tesselles prélevées lors de la dépose sont remises en place entre les différentes plaques. Les concrétions calcaires sont désépaissies au scalpel sous microjet de vapeur d'eau déminéralisée, et les bordures des panneaux sont consolidées. Après l'achèvement du traitement, en 1996, la mosaïque reste entreposée en réserves jusqu'à son rapatriement en 2004 à Plassac ; elle rejoint alors le mobilier issu des fouilles du site, présenté dans le musée associatif installé depuis 1985 dans une dépendance de l'ancien presbytère jouxtant le site. Pour cette mosaïque en effet, sa situation isolée par rapport aux autres pavements a conduit à la décision de ne pas la reposer *in situ*, afin d'éviter la construction d'une structure ponctuelle qui aurait perturbé la lecture des vestiges.

Le traitement des mosaïques n^os^ 7 et 8 est effectué de 2000 à 2005, suivant le même mode opératoire. Ces pavements, dont les surfaces respectives – avec les lacunes – représentent 54 m^2 et 30,5 m^2, sont remontés en 15 panneaux pour la pièce carrée et 10 panneaux pour l'abside. Le traitement des zones disloquées nécessite une durée de travail particulièrement longue : dans une partie des vides, les tesselles d'origine sont reposées ; le reste des microlacunes est comblé par des enduits de chaux. L'ensemble restauré rejoint les réserves en attendant que l'abri destiné à l'accueillir soit édifié.

2009–2014 : Édification de l'abri[8]

Envisagée par les responsables de l'opération dès les années 1980, la construction d'un abri permanent pour la protection des mosaïques s'est concrétisée de 2009 à 2014. Outre les raisons d'ordre financier inhérentes à ce type d'opération, qui engage des crédits conséquents, les délais ici particulièrement longs traduisent la difficulté d'implanter une structure moderne dans un environnement archéologique, avec, à Plassac, la contrainte supplémentaire de la présence de l'église bordant les vestiges à protéger.

Sur ce site aquitain au climat tempéré par la proximité de l'océan, la solution retenue par l'architecte est une structure semi-ouverte. L'abri édifié, en ossature métallique avec couverture de tuiles et habillages en bois et verre, couvre les mosaïques n^os^ 7 et 8 et protège également les mosaïques n^os^ 9, 10 et 11, restées en place le long de l'église. Il présente en toiture une bonne isolation thermique, qui réduit l'échauffement dû au rayonnement solaire et évite les problèmes de condensation ; une ventilation modulable, pouvant être augmentée par fort ensoleillement grâce à des panneaux orientables disposés suivant le contour des salles à absides ; et un système de passerelles permettant de voir les mosaïques au niveau du sol et en surplomb. La lisibilité de la *villa* antique est favorisée par l'aménagement de l'accès et des circulations, et par l'orientation de l'abri, ouvert comme dans l'organisation originelle, vers le péristyle et l'estuaire (fig. 5).

Ces points positifs, à considérer avant tout, ont cependant été tempérés lors de la repose ultérieure des mosaïques par les problèmes liés aux pénétrations d'eau et aux nombreux oiseaux se partageant l'abri. Le débordement insuffisant de la toiture du côté des pluies dominantes venant de l'ouest a occasionné des flaques assez importantes qui, bien que s'écoulant le long de la pente jusqu'aux exutoires

Figure 5 Vue depuis l'entrée du site de l'abri édifié en 2013. © ARM (Atelier de restauration de mosaïques de Saint-Romain-en-Gal)

pratiqués pour leur évacuation, ont eu le temps de détremper les mosaïques. Certaines de ces zones reçoivent aussi le soleil à différentes heures du jour. Ces cycles humides et chauds risquent d'être dommageables à la conservation des pavements, pouvant notamment entraîner l'altération rapide du film de protection appliqué en surface, une cire minérale réversible, qui peut se dégrader, voire disparaître assez vite dans ces conditions. Cette protection de l'épiderme des matériaux constitutifs des mosaïques est d'autant plus indispensable que les oiseaux qui nichent sous l'abri laissent quotidiennement de nombreuses traces de leur séjour sur les pavements.

2014 : La repose *in situ* des mosaïques déposées[9]

Le support

Vingt ans après leur dépose, les mosaïques des salles n^os^ 7 et 8 sont reposées à leur emplacement d'origine (fig. 6). Dans la salle n^o^ 8, les niveaux de pose antique du pavement sont conservés pour une bonne part ; mais leur fouille partielle les a fortement bouleversés dans la partie nord de la pièce, avec des effondrements qui transpercent par endroits la *suspensura* du système d'hypocauste. Dans la salle n^o^ 7, seule une bande médiane de ce support antique a été conservée. Les tranchées qui perforent les niveaux antiques atteignent 0,6 m de profondeur, ce qui représente au total un volume de 20 m^3 à compenser.

De ce fait, il est choisi de reposer les mosaïques sur une structure métallique calée sur des plots de ciment pour les parties les moins profondes, et sur des piles de parpaings dans les fosses (fig. 7). Au préalable, un géotextile a été étendu sur l'emprise des deux pièces. Constituée de tubes métalliques carrés de 50 mm de section, espacés de 0,6 m à 0,8 m en moyenne, la structure présente une pente de 3 mm/m pour l'évacuation des eaux, et elle ne vient pas en contact avec les murs périphériques ; elle est interrompue entre les deux pièces pour laisser place à une semelle maçonnée, sur géotextile elle aussi, destinée à recevoir l'emmarchement en briques qui séparait les deux tapis.

L'installation des mosaïques

Les mosaïques sont posées sur ces châssis sans y être fixées afin que la structure métallique du support puisse réagir aux variations de température et aux mouvements de l'édifice sans affecter l'assemblage des panneaux constitutifs des pavements. Les panneaux eux-mêmes sont fixés entre eux, afin que chaque mosaïque conserve son unité et puisse supporter sans se désassembler le passage des personnes chargées de l'entretien. Deux types de fixation sont mis en œuvre pour assurer cette cohésion tout en permettant une réversibilité en

Figure 6 Transport des panneaux des mosaïques n^os^ 7 et 8 pour leur repose *in situ*. © ARM (Atelier de restauration de mosaïques de Saint-Romain-en-Gal)

Figure 7 Assemblage des panneaux constitutifs des mosaïques n^{os} 7 et 8 lors de leur repose *in situ* en 2014. © ARM (Atelier de restauration de mosaïques de Saint-Romain-en-Gal)

Figure 8 Vue des mosaïques n^{os} 7 et 8 après le traitement des lacunes. © ARM (Atelier de restauration de mosaïques de Saint-Romain-en-Gal)

cas de nécessité de démontage : des agrafes en acier inoxydable insérées, par l'endroit, transversalement aux raccords des plaques ; et des platines de contreplaqué collées au revers des panneaux le long de ces raccords. En périphérie de chaque pavement, un joint en polyuréthane expansé assure la liaison des mosaïques avec les murs. La base de ces derniers est protégée par un film polyéthylène pour éviter l'adhérence de l'enduit lors de sa mise en place dans les lacunes.

Le traitement des lacunes

Les lacunes des mosaïques sont ensuite comblées avec un mortier de chaux dont la couleur et le grain ont été choisis après une série d'essais réalisés en atelier. Il a été décidé de réaliser un traitement bicolore afin d'évoquer, en plus sombre sur une base claire, la trame géométrique des décors dans les parties disparues, tant pour faciliter la lecture des motifs que pour animer les grandes plages inertes qu'auraient constituées les lacunes sans ce traitement complémentaire. Composé du mélange de chaux hydraulique de Saint-Astier et de sables colorés, ce mortier vient combler les lacunes à environ 1 mm en retrait de la surface de la mosaïque afin que celle-ci se détache du fond.

Après séchage pendant trois semaines, l'enduit est renforcé par un traitement hydrofuge de surface, afin de le protéger des projections d'eau et permettre son nettoyage. Dans la partie basse du pavement, trois saignées de 1 cm de large par 30 cm de long sont laissées ouvertes afin de permettre l'évacuation des eaux de ruissellement, dans cette zone exposée aux pluies, avant qu'elle n'en soit protégée par un aménagement ultérieur de l'abri. L'emmarchement de terre cuite qui assurait la liaison des deux tapis dans le dispositif antique ayant disparu, il est décidé de le remplacer par un fac-similé ; celui-ci est constitué d'un béton de chaux, coloré et découpé selon le module des carreaux antiques. Redonnant au décor sa continuité dans la pièce, il consolide aussi la stabilité du support des mosaïques tout en offrant une bande de cheminement qui pourra faciliter la circulation sous l'abri et constituer un appui pour d'éventuelles protections hivernales.

À l'issue de l'opération réalisée en mai 2014, les deux mosaïques de retour dans leurs murs retrouvent ainsi toute leur qualité d'ornements d'une grande salle d'apparat antique (fig. 8).

Mesures de maintenance

2014 : mesures effectuées sur les mosaïques conservées *in situ*

Les mosaïques restées en place font l'objet du contrôle de leur état après l'enlèvement de la couche de sable et des géotextiles qui les recouvraient. Les solins de consolidation mis en place en 1994 sont sains et renforcent efficacement les parties traitées. Certains solins, plus anciens, se sont dégradés et sont remplacés. Par ailleurs, les travaux de renforcement du mur de soutènement de l'église ayant fragilisé certaines bordures, de nouveaux solins – en chaux chargée de sable de couleur claire pour les distinguer des précédents – sont mis en place. Les parties nouvellement dégagées de la mosaïque du couloir n° 9 font également l'objet de consolidations appliquées en bordure des lacunes et dans quelques petites zones disloquées.

À l'auscultation, les trois mosaïques présentent un état de cohésion inégal. Des pertes d'adhérence ponctuelles sont ainsi repérées dans les mosaïques n^os^ 9 et 11b. Le constat est plus alarmant pour la mosaïque de la pièce n° 11, dont le tapis de tesselles est totalement décollé de son support et par endroits boursouflé. Quant à la mosaïque n° 9b, découverte plus récemment, elle reste inaccessible, recouverte de géotextile sous une couche de sable lavé.

Programmation des interventions de protection et d'entretien

À l'issue des constats établis en 2014, l'atelier rédige un cahier des charges listant les mesures à programmer pour la protection et l'entretien des mosaïques du site.

Une partie concerne les aménagements de l'abri à prévoir pour une meilleure protection des pavements : la mise en place d'un système de rideaux ou d'auvents est ainsi préconisée pour mettre les mosaïques hors d'eau ; par ailleurs, la nécessité de rechercher les moyens de chasser les oiseaux de l'abri est soulignée.

Les autres points concernent les mosaïques :

- leur nettoyage régulier est à effectuer à cause des apports éoliens, sous la forme de balayages doux. Il est conseillé que les opérateurs se munissent de surchaussures jetables et qu'ils évitent toute circulation sur les pavements si leurs surfaces sont mouillées. Les préconisations ajoutent des conseils pour le nettoyage des fientes en cas de persistance des problèmes liés aux oiseaux. Il est souhaité qu'au terme de la première saison d'exposition l'atelier soit mandaté pour en faire le bilan : contrôler l'état de surface des mosaïques n^os^ 7 et 8, juger de la nécessité du renouvellement du film protecteur puis élaborer et mettre en place un système de couverture hivernale ;
- les mosaïques conservées sur leur support originel doivent faire l'objet d'un contrôle de leur état de surface et de leur degré d'adhérence à leur support avant de les protéger pour l'hiver. On pourra juger alors de la possibilité de les exposer à nouveau l'année suivante, de la nécessité de les conserver recouvertes et d'entreprendre, le cas échéant, des opérations conservatoires plus lourdes : injection de consolidants dans les mortiers de support, dépose partielle et repose sur une nouvelle chape, dépose totale de la mosaïque n° 11b.

Coût de l'opération

Suivant la thématique de cette conférence, la question du coût est abordée. Le montant total des interventions effectuées de 1991 à 2014 pour le diagnostic, la dépose, le remontage et les traitements de surface puis la repose des mosaïques *in situ* et les opérations de maintenance s'élève à 340 000 euros (valeur 2014). Ramené aux 137 m^2 traités, il atteint 2 482 euros/m^2. Sur les vingt-trois ans de l'opération, échelonnée de 1991 à 2014, il aboutit à 14 783 euros/an.

Le montant indiqué concerne les interventions sur les mosaïques mais n'inclut pas le coût de l'abri. Les chiffres donnés comprennent les matériaux, les transports et les frais de déplacement. L'essentiel du montant correspond aux dépenses de personnel, proportionnelles à l'effectif chargé de l'opération, soit trois à cinq restaurateurs habilités à travailler sur les collections publiques et dont les salaires correspondent au statut d'attaché de conservation du patrimoine, dans la filière culturelle de la fonction publique territoriale.

Conclusion

Le bilan de l'opération permet de mettre en évidence l'importance du diagnostic, qui s'est avéré déterminant dans la définition des mesures planifiées en 1991. Le constat de l'état de conservation inégal des pavements a ainsi abouti à des solutions adaptées aux différents cas et à la décision de procéder à des consolidations *in situ*, mais aussi à des déposes suivies de transferts sur un nouveau support pour les mosaïques dont l'état de dégradation ne permettait pas de les conserver sur leur support originel.

Les interventions réalisées ont finalement suivi les préconisations formulées dans l'étude effectuée par l'atelier en 1991, bien qu'à cette date il n'ait pas été prévu que leur déroulement s'échelonne sur plus de vingt ans. Les raisons d'une gestation aussi longue sont multiples ; elles s'expliquent par les difficultés d'ordre financier inhérentes à toute opération lourde de ce type et à la complexité des arbitrages entre les différentes instances décisionnelles impliquées, scientifiques et administratives.

Il faut ici saluer la volonté de la maîtrise d'ouvrage, qui a permis de mener à bien la valorisation du site de Plassac. Cette initiative, qui s'inscrit dans la politique départementale de développement culturel et touristique en Haute-Gironde, a été relayée par l'action associative des Amis du Vieux Plassac, dont le rôle stimulant a été déterminant. Cette présence attentive reste essentielle pour le devenir des mosaïques et du site dont ils sont les fidèles gardiens.

Notes

1 Le site a été exploré par Gabrielle Emard de 1962 à 1974 ; Jean-Pierre Bost, professeur à l'université de Bordeaux III, prit la direction des fouilles jusqu'en 1978.

2 Association présidée par Jacques Dubourg.

3 Jean-Pierre Bost et Raymond Monturet, chercheur au CNRS – Institut de recherche sur l'architecture antique.

4 Étude menée avec Marie-Christine Leurat-Hardy, alors responsable du Service départemental d'archéologie.

5 Relevés effectués en 1976–77 par C. Ney, Bureau d'architecture antique du Sud-Ouest.

6 Intervention effectuée avec la contribution d'Andréas Phoungas, alors restaurateur à l'atelier de Saint-Romain-en-Gal.

7 Film de dix minutes coproduit par le conseil général de Gironde et la société Hareng Rouge *Les Villae gallo-romaines de Plassac*, primé au Festival de l'audiovisuel à Biarritz, 1995.

8 Responsables de l'opération :

– Drac d'Aquitaine : M. Rieu, conservateur régional des Monuments historiques ; M. Regaldo, Service régional de l'archéologie ; maîtrise d'œuvre : M. Goutal ; et architecte : M. Leulier ;

– conseil général de Gironde, Direction de la culture et de la citoyenneté : Sylvain Gautier ; Salima Hout-Zaffran, responsable du Pôle de coopération départementale ; Patricia Parisi, responsable de la Mission Programmes départementaux ; Laurent Thomas, architecte du patrimoine.

9 Intervention effectuée avec la contribution d'Alain Wagner, restaurateur.

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I mosaici Ellenistici nel *balineon* dell'antica Kaulonia (Monasterace M. – Calabria) dallo scavo al restauro: Modalità di documentazione e schedatura dei materiali, delle decorazioni e delle tecniche esecutive

Francesco Antonio Cuteri, Alessandra De Natale, Maria Teresa Iannelli, Flavia Gazineo e Giuseppe Mantella

Abstract: *Lo studio del pavimento musivo del grande* balineon *ellenistico di Kaulonia (Monasterace M., RC – Italia), effettuato in occasione del suo restauro attraverso una sistematica e approfondita metodologia di indagine scientifica, ha messo in luce importanti e inediti dati sulla tecnica esecutiva. In particolare, la complessa soluzione preparatoria, caratterizzata da una scomposizione in più blocchi funzionali a differente stratigrafia, che si associa alla gerarchia dell'impianto decorativo, ha consentito di formulare diverse ipotesi di studio sulle modalità operative e di cantiere e, più ampiamente, sull'esperienza musiva di età ellenistica in quest'area della Magna Grecia.*

Abstract: *Studies of the mosaic floor in the great Hellenistic* balineum *(baths) of Caulonia (Monasterace Marina, Reggio Calabria, Italy), conducted during its restoration using a systematic, in-depth scientific research methodology, have brought to light new and important information on execution techniques. In particular, the complex preparation process involving breaking down the work into functional blocks of different stratigraphy, which is associated with the hierarchy of decorative installation, has led to the formulation of many hypotheses on methods of execution and, more broadly, on mosaic expertise of the Hellenistic period in this area of Magna Graecia.*

Le ricerche condotte a partire dal 1998 nel tratto a mare dell'abitato dell'antica Kaulonia hanno permesso di identificare un monumentale e articolato complesso termale (*balineon*) di età ellenistica (Iannelli, Cuteri 2013, fig. 1). All'interno dell'amb. H, una sala con lunga vasca destinata al bagno collettivo, è stato rinvenuto un grande mosaico figurato (fig. 2) la cui cronologia viene preliminarmente fissata tra gli ultimi anni del IV e la prima metà del III sec. a.C.

Lo schema compositivo del pavimento prevede una doppia partizione con tappeto musivo posto al centro dell'ambiente, racchiuso entro una cornice in *cementizio a base fittile* con inserti di tessere lapidee e in cotto (fig. 2). Lo spazio musivo è organizzato in un tappeto centrale che riproduce un soffitto a cassettoni, con sei lacunari resi in prospettiva, perimetrato da una cornice a pannelli (tre per lato) a imitazione di lastre marmoree; una sequenza, su due lati, di pannelli a figure di animali marini (draghi, delfini e ippocampo) affrontati per coppie, di cui quattro posti sul lato lungo occidentale e due su quello corto meridionale. Isolato all'interno del cementizio, in prossimità dell'accesso alla sala, è un piccolo mosaico circolare che ospita una rosetta a dodici petali. Il tessellato è realizzato con tessere di taglio e forma irregolare, posate con orditura incoerente e non omogenea, e si ricorre tavolta all'uso di sottili lamine in piombo per ottenere diversi effetti disegnativi. La gamma dei colori utilizzati è abbastanza variegata nelle parti figurate, ma più rigorosa nei sei lacunari, dove si limita a un'equilibrata tetracromia. Le tessere lapidee sono costituite in prevalenza da calcari, scisti e altri litotipi reperiti localmente. Caratteristico è invece l'uso di tessere in terracotta, ricavate da frammenti di forme ceramiche (pareti e anse) per ottenere il vivace colore rosso e da laterizi per un tono più rosato e delicato. Sono assenti tessere in vetro e *faïence*. Si segnala infine la particolare ed estensiva presenza di tessere appositamente sagomate, utilizzate per la resa sintetica e immediata di alcuni particolari del disegno.

La scoperta di questo nuovo mosaico (Iannelli, Cuteri 2014), in concomitanza con i lavori di restauro del già noto "mosaico del drago" (Mantella et al. 2014), ha consentito di avviare un percorso di studio rivolto all'approfondimento delle conoscenze sull'esperienza musiva di età ellenistica

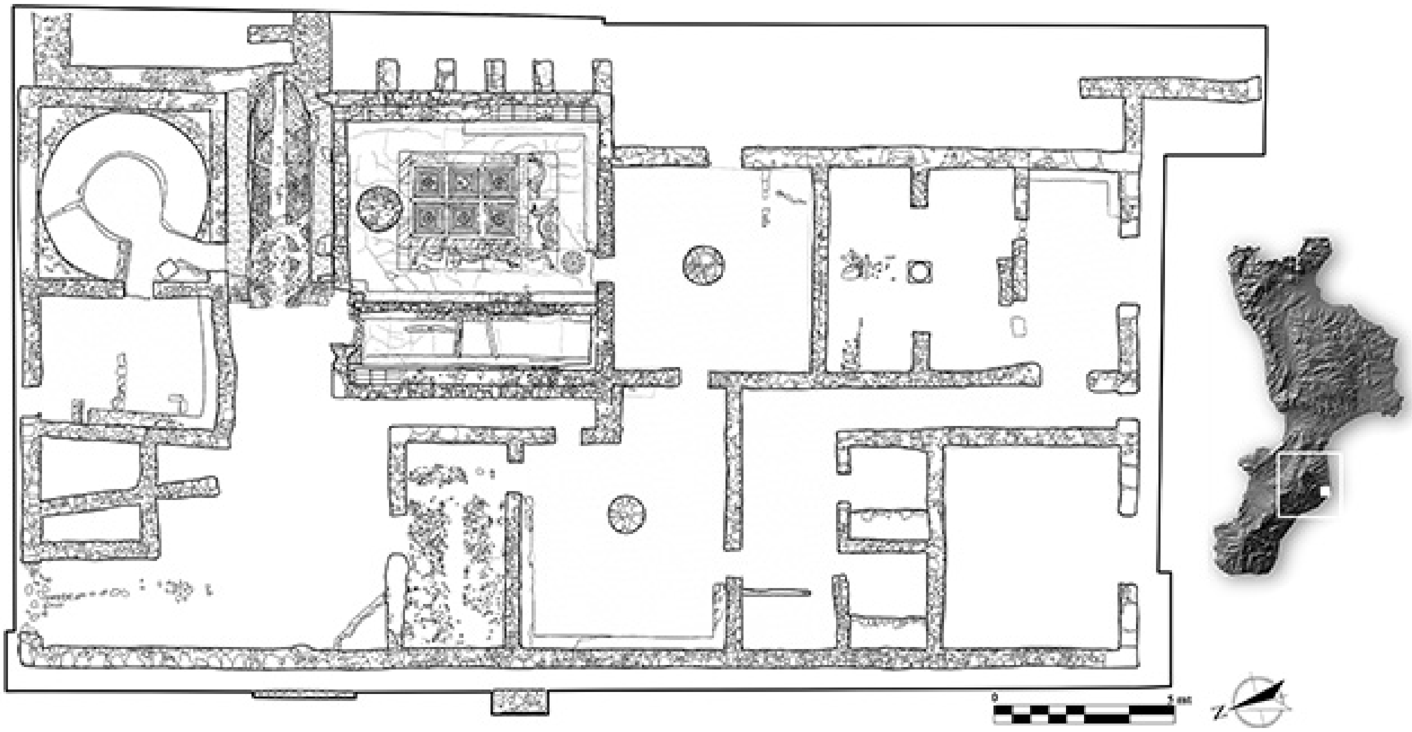

Figura 1 Localizzazione geografica del sito di Kaulonia e planimetria delle Terme Ellenistiche.
Dessino: F. A. Cuteri, A. De Natale, 2014

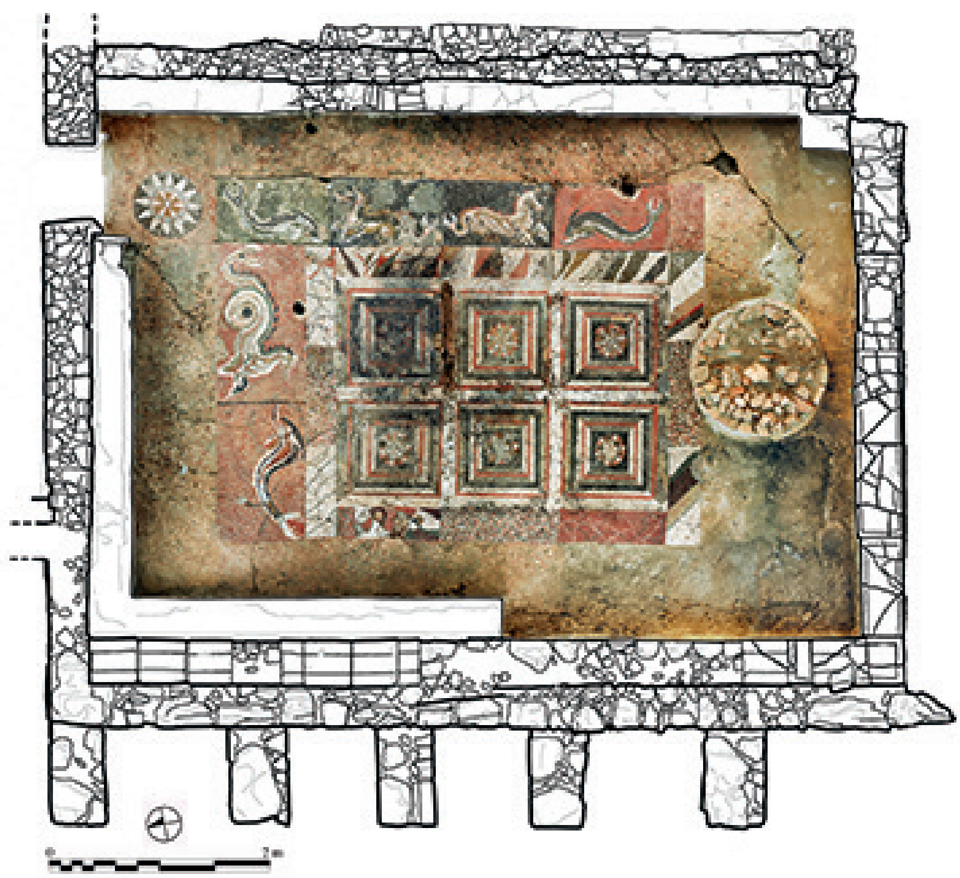

Figura 2 Ortofotopiano del pavimento musivo della "Sala dei draghi e dei delfini". Foto: A. De Natale, 2014

maturata in quest'area della Magna Grecia. Le indagini si sono concentrate specialmente sullo studio delle tecniche di realizzazione dei pavimenti, partendo da un'analisi approfondita della stratigrafia e dei materiali impiegati nel blocco preparatorio, per giungere alla superficie musiva ed esaminarne particolari aspetti esecutivi e di finitura.

Durante l'attività di restauro, che costituisce il punto di partenza di questa ricerca[1], è stato possibile eseguire un'approfondita ricognizione dell'opera, finalizzata alla comprensione delle problematiche di conservazione e alla pianificazione di adeguate strategie di intervento, ma anche allo studio di tutti gli aspetti materici più strettamente tecnici. La rilevanza e la complessità dei dati che man mano emergevano, hanno richiesto la messa a punto di una metodologia di indagine sistematica e la creazione di un team specialistico, formato da archeologi, restauratori, archeometri e geologi, la cui stretta collaborazione ha consentito di spaziare in diversi ambiti di indagine.

L'analisi sul campo è stata condotta principalmente a livello autoptico e con l'ausilio di tecniche quali la microscopia digitale e la macrofotografia, affiancate alla realizzazione di accurati rilievi grafici e alla redazione di accurate schede tecniche per ogni settore. Una campagna mirata di campionamento dei materiali per le indagini diagnostiche (malte di preparazione, tessere, finiture cromatiche) è stata funzionale all'ottenimento di dati di natura scientifica utili alla caratterizzazione chimica, qualitativa e quantitativa, dei materiali costitutivi; l'esecuzione di un rilievo geofisico con metodo Georadar, in affiancamento al rilievo tridimensionale dell'ambiente mediante laser scanner 3D, ha consentito di sondare gli strati più profondi e mettere in relazione le anomalie risultanti dal Georadar con i dati morfologici del pavimento, interessato da forti deformazioni e cedimenti (fig. 3).

Se nel caso del Mosaico del Drago parte dell'opera è risultata direttamente analizzabile sul retro, poiché posta su supporto mobile (Mantella et al. 2014), in questo caso, trattandosi di un pavimento *in situ*, tutti i dati raccolti sono il risultato dell'indagine capillare condotta sia in superficie sia al di sotto di essa, dove le numerose lacune e mancanze (del tessellato o degli strati preparatori) e la presenza di buche di palo, praticate nel pavimento durante la fase di abbandono dell'ambiente (fine III secolo a.C.) ne permettevano l'ispezione (fig. 3). Per questo motivo, i dati e le conclusioni che di seguito presentiamo sono il frutto di ipotesi formulate preliminarmente sulla base dei dati disponibili, puntuali ma pur sempre parziali, e finalizzate a ricostruire il quadro della vicenda costruttiva di questa particolare opera.

Il dato più peculiare riguarda l'organizzazione stratigrafica verticale e orizzontale del blocco preparatorio del pavimento, che non risulta eseguito in un'unica soluzione, bensì suddiviso dal punto di vista fisico e strutturale in cinque settori o "blocchi" funzionalmente distinti, la cui configurazione sembra mostrare un forte legame con l'impianto compositivo e iconografico del mosaico (fig. 4). Tale scansione emerge, in particolare, a livello del massetto, e si associa spesso a una differente composizione degli strati preparatori che di seguito analizzeremo. La frequente individuazione dei giunti tra i diversi blocchi, osservabile attraverso le lacune o spesso rivelata da alcune importanti fessurazioni, ha consentito, dove possibile, di ricostruirne i profili e, in via alternativa, di ipotizzarne la configurazione. Lo stesso schema sembra essere rispettato anche nel sottostante strato di vespaio che mostra, a seconda delle zone, una differente orditura o tipologia degli elementi che lo compongono. La dinamica dei rapporti fisici tra le diverse parti, purtroppo, non è sempre individuabile o comprensibile, ed è importante ribadire la parzialità dei dati in ragione della limitatezza dei punti di accesso agli strati più profondi.

Il Blocco A è costituito da sei pannelli quadrati (fig. 4 – rosso), autonomi ma non contigui tra loro, ognuno dei quali coincide in superficie a un lacunare prospettico con rosone centrale. Il blocco non è fisicamente unico ma, per assimilazione, si è preferito raggruppare i sei elementi che lo compongono, omogenei per composizione e posizione, all'interno di un unico insieme. La stratigrafia del blocco è del tipo 1 (fig. 5a), che prevede un vespaio in frammenti di laterizi posti apparentemente di piatto o in maniera caotica, un sovrastante massetto in ciottoli granitici di piccola e media pezzatura, legati da abbondante malta a base di calce e sabbia; un ultimo strato di malta, ugualmente a matrice sabbiosa, impiegata direttamente per l'allettamento delle tessere. Tale sequenza stratigrafica è attestata solo in questo blocco.

Nella griglia ottenuta a risparmio tra i sei elementi del blocco A, si inserisce il Blocco B (fig. 4 – giallo), strutturalmente autonomo e dall'articolata configurazione. La stratigrafia qui è di tipo 2 (fig. 5b), con vespaio di laterizi posti di taglio, massetto costituito da un impasto magro di malta mista a cocciopesto grossolano, strato di livellamento a base di malta ad aggregato fittile più fine, sottile livello di malta ben depurata per l'allettamento delle tessere. Il suo rapporto rispetto al primo blocco appare di posteriorità (fig. 6). I primi due blocchi formano e chiudono la parte centrale del pavimento, il cuore del sistema decorativo e iconografico.

L'analisi visiva delle evidenze documentabili mette in luce la presenza di un ulteriore elemento, il Blocco C (fig. 4 – viola), apparentemente limitato al lato della cornice a finti marmi chiusa tra la zona centrale e i quattro pannelli figurati. La sua autonomia, verificata con certezza sui lati lunghi, resta tuttavia ancora incerta su quelli corti e non si esclude la sua pertinenza al blocco 5. La stratigrafia e la qualità dei materiali utilizzati coincidono con il tipo 2.

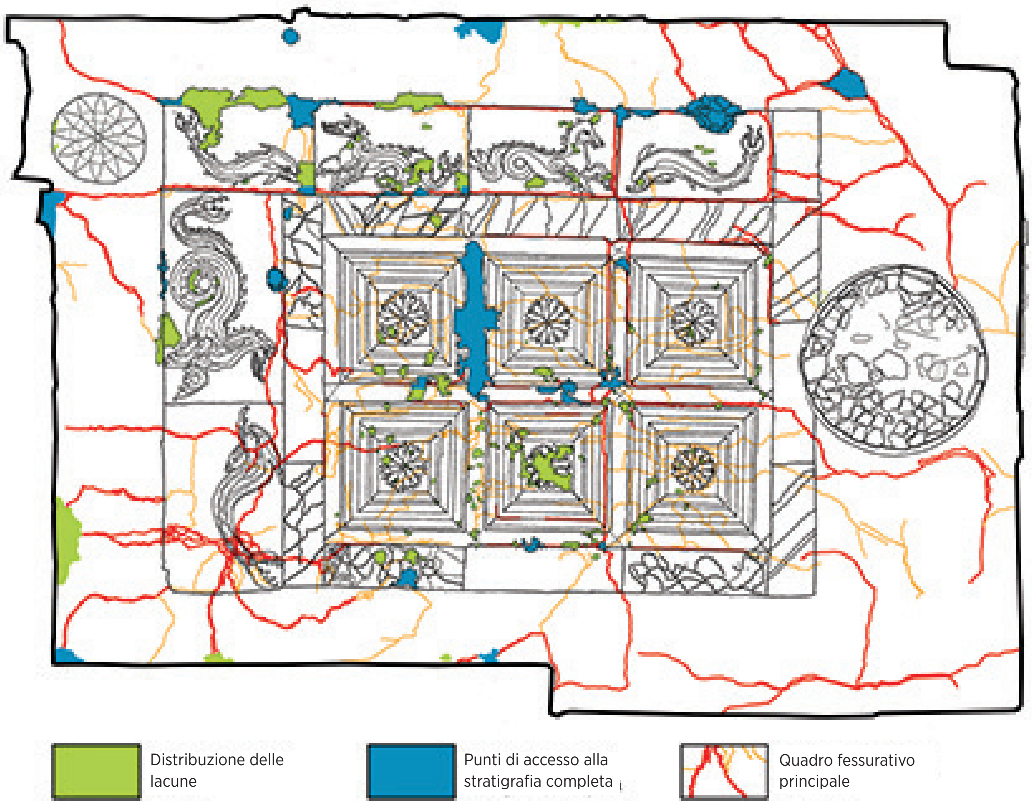

Figura 3 Mappatura grafica dello stato di conservazione del pavimento musivo. Foto: A. De Natale, 2015

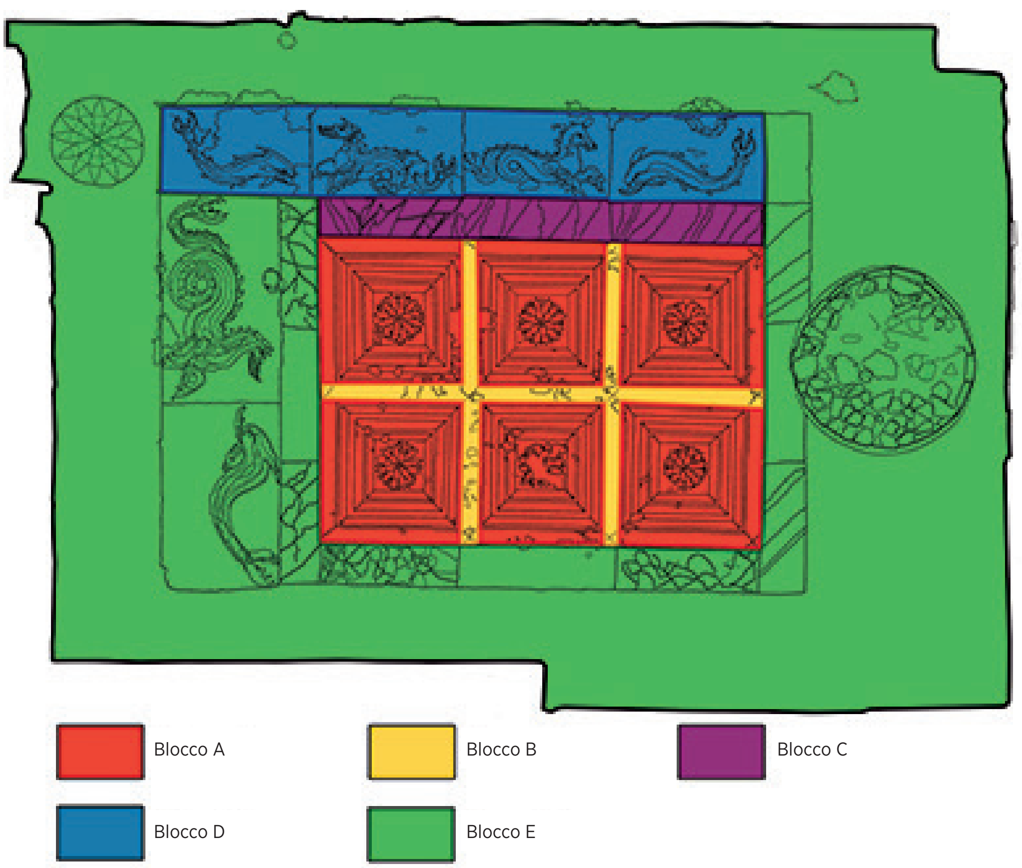

Figura 4 Mappatura grafica dell'organizzazione in "blocchi funzionali" del pavimento musivo. Foto: A. De Natale, 2015

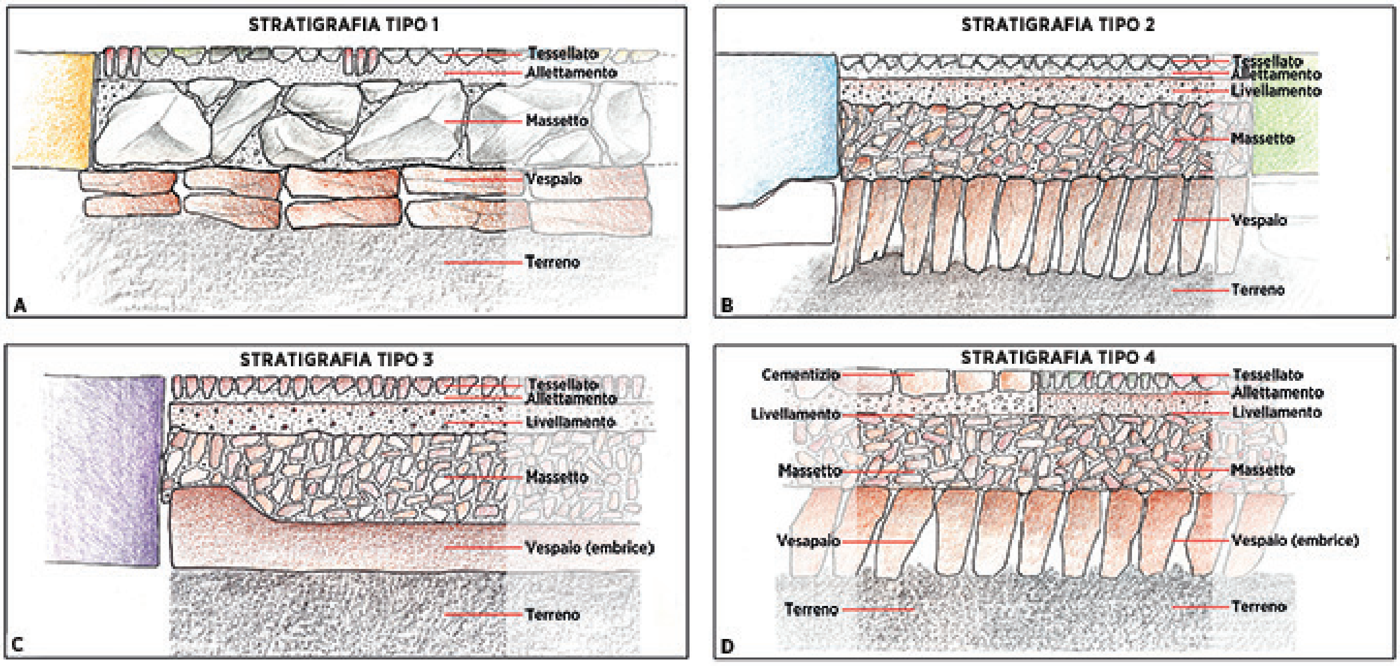

Figura 5 Rappresentazione grafica delle tipologie stratigrafiche dei diversi blocchi funzionali.
Foto: A. De Natale, 2014

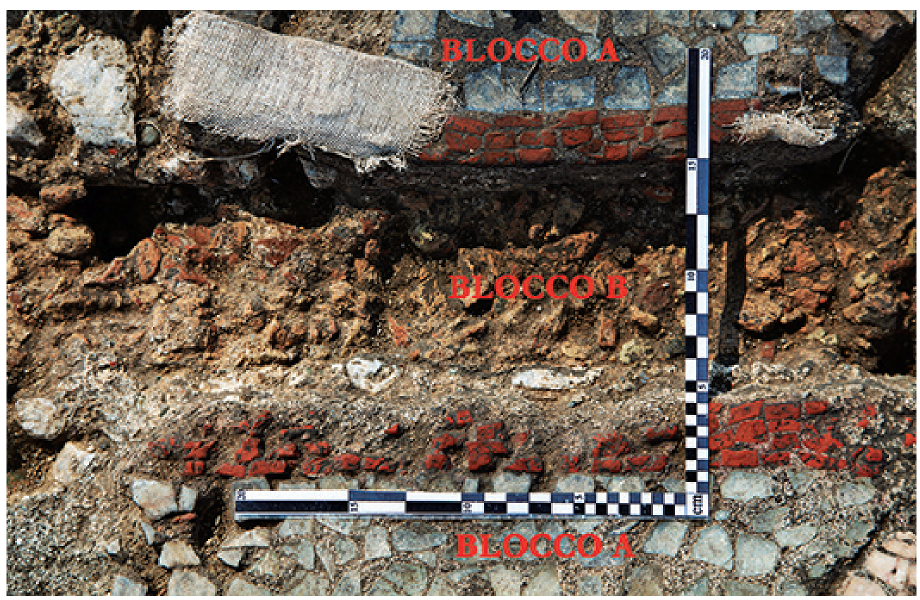

Figura 6 Particolare fotografico della giustapposizione dei Blocchi A e B: in evidenza la differente composizione stratigrafica e materica.
Foto: A. De Natale, 2013

Il Blocco D (fig. 4 – blu) sembra limitarsi esclusivamente allo spazio occupato dalla sequenza dei quattro pannelli musivi con animali del lato ovest. La sua autonomia è certa sui lati lunghi, dove si giustappone ai Blocchi C ed E, e su almeno uno di quelli corti. L'organizzazione della stratigrafia è del tipo 3 (fig. 5c), simile al tipo 2 ma con una sostanziale differenza a livello del vespaio: in sostituzione dei frammenti laterizi si posano quattro grandi embrici (60 × 90 cm circa), posti in piano con le alette verso l'alto, sistemati a intervalli regolari tra loro come a individuare, in profondità, lo spazio di un pannello figurato (fig. 7). Per quanto riguarda il massetto a base di cocciopesto, non è ancora chiaro se questo si sviluppi in maniera continua, al di sopra delle grandi tegole, e sia quindi frutto di un'unica gettata di malta, o se invece sia ulteriormente scomponibile per ogni singolo pannello. I punti osservati non permettono di chiarire appieno questo aspetto e in seguito proporremo le ipotesi formulate a riguardo.

Il Blocco E (fig. 4 – verde), il più grande per estensione, occupa tutta la parte periferica in cementizio a base fittile, e include anche i due grandi pannelli musivi figurati posti a sud, i restanti tre lati della cornice a finti marmi e il mosaico di soglia. Tuttavia la limitatezza dei punti di accesso alla preparazione non ci permette di stabilire con certezza se questa sia la sua reale configurazione o se risulta invece scomponibile ulteriormente. È comunque utile sottolineare la differenza della sequenza stratigrafica tra la parte periferica di cementizio, dove è del tipo 4 (fig. 5d), composizionalmente simile alla 2, ma ridotta per mancanza del livellamento, contrariamente alla porzione che accoglie il mosaico che presenta il tipo 2 completo. Le diverse ispezioni dei punti di contatto tra queste due parti a differente stratigrafia (mosaico e cementizio) non hanno evidenziato segni di discontinuità, ragione per la quale si è ipotizzata la pertinenza a un unico blocco funzionale.

Il quadro appena esposto mostra certamente una complessa organizzazione, nonché inedite, articolate e non sempre giustificabili o comprensibili soluzioni tecniche.

Il dato che emerge con più forza e su cui è utile dedicare un'ulteriore riflessione, per comprenderne il significato e la funzione, è sicuramente la necessità o la volontà di individuare e distinguere, sia dal punto di vista strutturale sia da quello strettamente materiale, le diverse porzioni del pavimento.

Partendo dal tappeto centrale a lacunari, vero fulcro compositivo e iconografico del mosaico, la soluzione preparatoria adottata, costituita da due blocchi distinti e intersecati tra loro e realizzati con materiali e tecniche completamente differenti sia nella preparazione sia nel tessellato, lascia affiorare diversi dubbi e formulare alcune riflessioni. Una prima ipotesi potrebbe riguardare la prefabbricazione dei sei pannelli su supporto mobile e la successiva posa in opera all'interno del pavimento durante la realizzazione del blocco B, o addirittura la loro appartenenza a un pavimento preesistente, da cui sarebbero stati staccati e prelevati per essere collocati nel nuovo, con intento "antiquario" o semplicemente come pratica di recupero e riuso. In entrambi i casi, si giustificherebbe la diversità dei materiali della preparazione tra i due blocchi contigui, nonché le notevoli ed evidenti differenze tecniche, materiche ed estetiche, del tessellato. Tuttavia, non sembra possibile trovare immediato e diretto riscontro sul campo in queste due direzioni, poiché le analisi finora eseguite e la mancanza di una visione completa del substrato non permettono di affermare con certezza tali ipotesi. Semmai, i profili netti e precisi dei sei riquadri smentirebbero eventuali operazioni di strappo o stacco da altri pavimenti, e l'assenza di segni o resti di un supporto unitario al di sotto degli stessi, come una lastra di terracotta, di pietra o anche lignea poi deperita, sembrerebbero contraddire l'ipotesi della prefabbricazione. Si segnala infine come in molti casi, nei punti di contatto tra i blocchi A e B, gli ultimi filari più esterni di tessere della cornice rossa del lacunare siano allettati sulla preparazione del contiguo blocco B e con la stessa malta impiegata per la posa delle tessere bianche. Questo dato non solo potrebbe indicare un'eventuale contestualità di esecuzione del tessellato tra le due parti, ma, di fatto, concorrerebbe a escludere la prefabbricazione dei sei lacunari.

Anche per quanto riguarda il blocco D, occorrerebbe spiegare la presenza del grande embrice al di sotto di ogni riquadro, poiché potrebbe essere effettivamente interpretata come supporto per un pannello prefabbricato a parte. Tali elementi risultano di dimensioni leggermente inferiori, sul lato lungo, rispetto a quelle del sovrastante riquadro musivo, generando uno spazio di risulta tra un elemento e l'altro compreso tra i 5 e i 10 cm. Il sovrastante strato di massetto, indagato nei punti accessibili, sembrerebbe mostrare continuità fisica per tutta la superficie pertinente al blocco D, fino a penetrare in profondità negli spazi vuoti tra le tegole. Inoltre, il suo perimetro si attesta perfettamente a quello del Blocco E corrispondente al cementizio. Questi dati aiuterebbero a smentire l'ipotesi dei pannelli mobili, confermando il ruolo degli embrici come semplice strato di vespaio. Tuttavia, in altre zone lacunose si osservano delle evidenze di non facile interpretazione, che solo ulteriori analisi potranno specificare. Per esempio, si nota che spesso i perimetri dei quadri mostrano un'orditura del tessellato in filari più regolari e, in alcuni casi, una diversa sfumatura del colore delle tessere rispetto al resto del fondo; appaiono inoltre evidenti e profonde fratture proprio in corrispondenza degli spazi di risulta tra una tegola e l'altra, che mettono in evidenza bordi molto netti e regolari, sia nel mosaico sia negli strati sottostanti del *nucleus* e dell'allettamento; infine si verifica, almeno in un caso, il collasso della parte a cavallo tra due pannelli contigui. In conclusione, se da un lato sembra possibile accertare che i quattro pannelli figurati insistono al di sopra di un unico massetto posato sui quattro embrici, che svolgono essenzialmente la funzione di vespaio, dall'altra bisognerebbe ricostruire attentamente la scansione delle fasi di realizzazione per escludere l'eventuale prefabbricazione dei pannelli musivi, realizzati in dimensioni lievemente inferiori e su supporti mobili rimossi in fase di posa, e completati *in situ* in accordo al resto della pavimentazione.

In ogni caso, al di là dei dati di natura strettamente tecnica, emerge con sempre maggior forza la frammentarietà di questo pavimento concepito, nonostante la forte coerenza iconografica, non come un'unità strutturale, ma come l'insieme di più elementi, sia a livello materico sia decorativo. In particolare, le peculiarità dei quattro pannelli con animali del Blocco D, e soprattutto quelle dello spazio centrale (Blocco A), con la sua articolata scomposizione fisica associata a una sostanziale differenza materica ed estetica, sia nella preparazione sia nel tessuto musivo, restituiscono l'immagine di un cantiere molto complesso che sarebbe interessante ricostruire nelle sue fasi, fino a rintracciare le personalità che l'hanno concepito e realizzato. In questa direzione, una corretta interpretazione della forte anomalia costituita dai sei lacunari risulterebbe fondamentale. La loro diversità emerge, infatti, anche a livello della tecnica musiva e della forza decorativa: un tessellato irregolare molto ben gestito e raffinato, con tessere di differente taglio, costituite da materiali spesso selezionati qualitativamente; una diversa scelta cromatica, con una rigorosa ed equilibrata tetracromia a un solo tono intermedio che, associata anche in termini luministici con alternanza di luci e ombre alla prospettiva centrale, contribuisce ad accentuare il distacco dalle zone musive limitrofe, cromaticamente meno organiche, più vivaci e variegate e dall'incerto sviluppo plastico e tridimensionale. Infine, sembra essere riservato solo a questo spazio un esclusivo trattamento di finitura con maltine interstiziali colorate, volto ad annullare la discontinuità propria del tessellato e a rinforzare la già forte vocazione pittorica e illusionistica. Tutti questi elementi, se associati all'effettiva differenza di preparazione, potrebbero trovare spiegazione ipotizzando la prefabbricazione dei riquadri, oppure, riferendo la loro realizzazione a maestranze distinte, forse esterne e itineranti, chiamate a operare autonomamente con cartoni, materiali e tecniche differenti, frutto della propria esperienza e del proprio bagaglio tecnico e culturale, per la sola realizzazione del cuore del mosaico.

Al di là di queste suggestioni, una simile organizzazione del cantiere presuppone non solo una notevole padronanza della tecnica, ma anche un'articolata e precisa concezione e pianificazione di tutto il processo esecutivo. Le ragioni che hanno determinato l'adozione di simili scelte tecniche, al momento senza confronti e di difficile comprensione, potrebbero essere legate in prima istanza a esigenze economiche, di pratica effettiva di cantiere e di suddivisione del lavoro, delle squadre e delle maestranze. Spingendosi oltre, si potrebbe pensare alla traduzione tecnica e operativa di quel principio di gerarchia centripeta tra spazi, tecniche e materiali, che qui non governa esclusivamente l'impianto decorativo, ma viene, di fatto, completamente assorbito dalla superficie musiva stessa agli strati più profondi del pavimento (Dunbabin 1979).

La mescolanza tra questi fattori e i saperi tecnici ha generato tale esperienza costruttiva, donando a questa straordinaria opera un respiro così ampio, innovativo e inedito, sintesi perfetta di un gusto ellenistico e tutto mediterraneo.

La complessità del quadro appena esposto ha reso necessaria una classificazione dei materiali costitutivi delle varie parti funzionali per individuarne la natura e, quando possibile, la provenienza. I micro–prelievi hanno interessato soprattutto le malte degli strati preparatori e quelle di finitura. Si discutono qui i dati preliminari ottenuti dallo studio di una stratigrafia verticale relativa alla preparazione del pavimento appartenente al blocco D, e i primi risultati dello studio dei pigmenti minerali utilizzati per le malte di finitura cromatica[2].

La stratigrafia analizzata è localizzata nella buca di palo che attraversa completamente il pavimento tra uno dei pannelli del Blocco D e la fascia perimetrale in cementizio a base fittile (Blocco E, figg. 7; 5c), selezionata per completezza e rappresentatività dei campioni. Sono stati effettuati tre prelievi di malte appartenenti a massetto (M05), livellamento (M06) e allettamento (M07). Dall'analisi minero–petrografica in sezione sottile e microanalisi SEM–EDS, effettuata al microscopio elettronico a scansione, è stato confermato che le malte relative al massetto e livellamento sono costituite da un legante a base di calce e da un aggregato composto prevalentemente da frammenti ceramici frantumati, frammenti di rocce metamorfiche e granitiche e, in misura minore, da frammenti carbonatici. Lo strato di allettamento è invece costituito prevalentemente da un legante a base di calce, quindi da una percentuale nettamente inferiore di aggregato rispetto agli strati sottostanti. L'analisi petrografica ha confermato le differenze già emerse autopticamente, riscontrando infatti, dallo strato più profondo a quello più superficiale, una diminuzione della dimensione media dell'aggregato e un aumento della classazione. Allo stesso modo, il rapporto legante/aggregato aumenta, evidenziando quindi una progressiva raffinazione degli impasti e una maggiore selezione dei clasti in funzione dei diversi strati. Le analisi chimiche condotte sul legante e sui grumi presenti hanno inoltre sottolineato un sostanziale aumento dell'idraulicità delle malte del massetto e del livellamento, ossia in quegli strati con maggiore presenza di materiale pozzolanico artificiale (frammenti ceramici).

I campioni di malte di finitura cromatica sottoposti a indagine sono 3: la malta di colore rosso (MC01), quella di colore nero–bluastro (MC02), e quella di colore bianco (MC03). I risultati discussi sono relativi all'indagine tramite microscopia ottica a luce polarizzata trasmessa su sezione sottile, microanalisi SEM–EDS, e laddove è stato possibile è si effettuata l'analisi mineralogica in diffrattometria a raggi X.

L'impasto delle malte è costituito da un legante a base di calce e, nel caso delle due malte pigmentate, da un aggregato di natura carbonatica. L'impasto di colore bianco è invece costituito esclusivamente da calce aerea, che risulta quindi

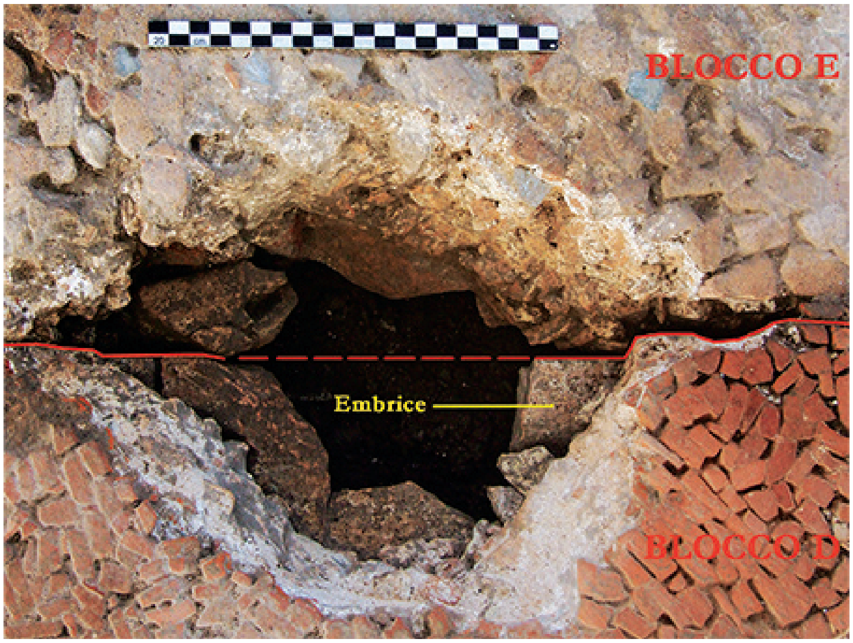

Figura 7 Buca di palo praticata nel punto di giunzione tra i blocchi D ed E: in evidenza la presenza del grande embrice al di sotto di uno dei pannelli del Blocco D.
Foto: A. De Natale, 2013

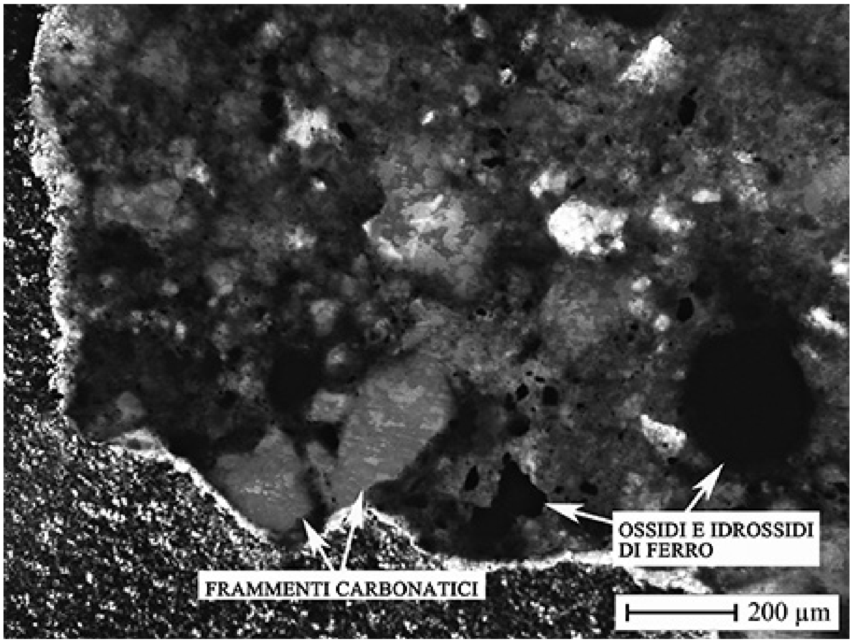

Figura 8 Malta rossa, campione MC01, immagine a nicols incrociati (M.O. a luce polarizzata trasmessa).
Foto: F. Gazineo, 2014

essere responsabile della colorazione bianca. Per quanto riguarda gli altri materiali pigmentanti, i dati più certi riguardano la pigmentazione della malta rossa, che in prima analisi sembra essere ottenuta dall'uso di un'ocra rossa. Infatti, dall'analisi chimica SEM–EDS si evidenziano ossidi e idrossidi di ferro finemente polverizzati dispersi nella fase legante (fig. 8). Si tratta di ossidi non puri per la presenza di altri elementi quali Ca, Si, Al, S. La particolare natura geochimica del pigmentante consentirebbe di associarlo, in via ancora preliminare, ai noduli rossastri di idrossidi di ferro che sono presenti nelle argille plioceniche attestate localmente (Miriello et al. 2010). Questo studio ha infatti evidenziato che sottoponendo questi noduli a cotture con temperature diverse si ottengono polveri utilizzabili come pigmenti minerali con tonalità cromatiche variabili dal marrone al rosso. Un'ulteriore fonte di approvvigionamento del pigmentante rosso potrebbe essere rintracciato nelle miniere di ferro del distretto minerario del Monte Consolino, appena alle spalle del sito archeologico.

Dall'analisi chimica SEM–EDS sulle aree di legante dell'impasto di colorazione nero–bluastra è emersa la presenza di contenuti significativi di carbonio, che suggerisce in prima analisi l'uso di un pigmento nero a base di carbonio come materiale pigmentante. Analisi di spettrofotometria IR e Raman di approfondimento sono in corso per definirne la natura. Le analisi finora condotte, seppure parziali, permettono dunque di classificare gli impasti colorati come vere e proprie malte, composte da legante e da una propria struttura interna, cui si aggiunge, dove necessario, un pigmentante per conferirgli la colorazione desiderata. L'impasto viene steso sulla superficie musiva limitatamente agli spazi interstiziali tra le tessere, coprendo le malte di allettamento e uniformando del tutto la campitura. Questo tipo di accorgimento tecnico ed estetico era stato precedentemente segnalato e indagato sul Mosaico del Drago (Mantella et al. 2014). In questo caso, però, il trattamento si limitava al fondo bianco del pannello, e ricopriva in buona parte il tessellato stesso. Inoltre, la recente apertura dell'ambiente originario ha consentito di visionare il resto della pavimentazione. Si è quindi verificata l'assenza di simili trattamenti sul resto del tappeto musivo, e confermata, invece, la già nota colorazione rossa del bordo in cementizio a base fittile già parzialmente studiata[3] (Mantella et al. 2014). Si tratta di un sottile livello pittorico dello spessore dell'ordine di 100 micron sovrammesso alla superficie del pavimento, costituito in prima analisi da un legante di calce in cui è disperso un pigmento rosso a base di ematite, come confermato anche dall'analisi XRD. Ulteriori approfondimenti sono in corso per verificarne la probabile affinità con il pigmento rosso impiegato nel pavimento musivo delle terme e riscontrare la presenza di eventuali composti organici aggiunti all'impasto.

Note

1 L'intervento di restauro, commissionato nel 2013 dalla Soprintendenza Archeologica della Calabria subito dopo la completa messa in luce del vasto pavimento a cura di F. A. Cuteri, è stato eseguito da G. Mantella, A. De Natale, F. Gazineo, M. C. Ranieri. I rilievi fotografici e fotogrammetrici 2D sono stati eseguiti da A. De Natale, che ha curato anche la restituzione grafica in ambiente CAD e l'esecuzione del presente apparato illustrativo; le indagini geofisiche e il rilievo tridimensionale con Laser Scanner 3D dal dott. G. Ferraro e dal dott. G. Mainieri; le indagini diagnostiche da D. Miriello, R. De Luca, F. Gazineo, G. M. Crisci, presso il Dip. di Biologia, Ecologia e Scienze della Terra (DiBEST) dell'Università della Calabria.

2 L'iter diagnostico programmato è attualmente in corso presso il Dipartimento DIBEST dell'Università della Calabria, a cura dell'équipe del prof. G. M. Crisci e coordinate dal dott. D. Miriello. I dati discussi e le informazioni fornite sono del tutto preliminari.

3 Le indagini sono state eseguite dal dott. M. Positano di Emmebi Diagnostica Artistica s.r.l., Roma.

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PART FIVE

Education and Training

Conservation and Management of Archaeological Sites with Mosaics: A Training Program of the MOSAIKON Initiative

Leslie Friedman, Jeanne Marie Teutonico, Thomas Roby, Martha Demas, and Demetrios Michaelides

Abstract: *Growing out of past Getty Conservation Institute (GCI) capacity-building activities in Tunisia for site managers responsible for archaeological sites, the MOSAIKON Initiative is implementing a number of regional training courses for mid-career site directors primarily from the southern and eastern Mediterranean region. Based on needs identified by heritage leaders from the region, this training program aims to enhance the knowledge and skills of site managers and others who are charged with the daily care of archaeological sites with in situ mosaics. The first course was held at the sites of Tyre, Lebanon, and Herculaneum from spring 2010 to fall 2012. The second course was held at Paphos, Cyprus, and Herculaneum from spring 2014 to fall 2015. The third course is scheduled to begin at Volubilis, Morocco, in spring 2017.*

The Mediterranean region possesses an enormously rich heritage of archaeological mosaics from the Hellenistic, Roman, and Byzantine eras (fig. 1). Unfortunately, this heritage is at risk from development, neglect, lack of resources, and lack of trained personnel. Yet despite increased national and international efforts to conserve these significant remains from the ancient world, mosaics and other archaeological heritage continue to be lost at a rapid rate. In 2008, in order to address this situation, the Getty Conservation Institute (GCI), the Getty Foundation, the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM), and the International Committee for the Conservation of Mosaics (ICCM) created MOSAIKON, a strategic, regional initiative that aims to improve the conservation and management of archaeological mosaics throughout the southeastern Mediterranean (Teutonico, Bouchenaki, and Michaelides 2014; Teutonico and Friedman forthcoming). MOSAIKON identified twelve countries on which to focus its efforts, where the needs were deemed the greatest: Algeria, Cyprus, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Palestine, Syria, Tunisia, and Turkey.

Since 2008, we have witnessed an ever increasing number of threats to archaeological heritage from human conflict, intentional destruction, looting, and climate change; in some cases, this has resulted in the total loss of some of the world's irreplaceable cultural treasures, making the work of MOSAIKON ever more critical (fig. 2). These threats, combined with a rapidly changing political situation in the region, have also brought an unexpected set of challenges. The MOSAIKON Initiative has continually strived to adapt and to respond with creative solutions to these unforeseen difficulties.

During a 2008 Regional Advisory and Needs Assessment Meeting, which gathered heritage leaders from the various MOSAIKON countries, training in the conservation and management of archaeological sites with in situ mosaics was identified as a critical need. In response to this identified need, MOSAIKON developed a series of regional courses in an effort to increase capacity on local and regional levels. Based in part on past GCI training activities in Tunisia (Dardes 2009), these courses, for participants from the southern and eastern Mediterranean regions, provide training for mid-career archaeological site managers and others responsible for the stewardship of these sites.

Maintaining mosaics in situ requires integrating conservation with site management, allowing for the study and visitation of a site while preserving the integrity of the archaeological fabric. These courses aim to teach effective management approaches that place the conservation of in situ mosaics within the context of broader site management issues such as visitation, urban encroachment, development pressures, and presentation and interpretation.

By working primarily with archaeologists, conservators, and architects who are affiliated with national authorities

Figure 1 Detail of a mosaic pavement at the archaeological site of Volubilis, Morocco. Photo: Livia Alberti. © J. Paul Getty Trust

Figure 2 Heavily deteriorated mosaic, near-risk of total loss. Photo: Ermanno Carbonara. © J. Paul Getty Trust

and governments, efforts are focused on professionals who are in a position to safeguard their sites. In a separate, yet complementary, component of the MOSAIKON initiative, training courses have been developed for mosaic conservation technicians who are largely responsible for the daily care and maintenance of in situ mosaics (Roby, Alberti, and Ben Abed 2005; Roby et al. 2008). The ultimate objective of these two programs is to produce national teams of trained site managers and technicians who can effectively safeguard their archaeological heritage. Furthermore, the regional nature of these courses, which brings together site managers and directors from different countries, helps to create and strengthen professional networks in the region and beyond.

Course Format

The MOSAIKON courses for site managers cover all aspects of the conservation and management of archaeological sites with in situ mosaics, from documentation and recording to visitor management and site presentation and interpretation. The courses stress decision making and the importance of prioritization in the face of limited resources. Preventive conservation measures, including reburial and other sustainable approaches to conserving archaeological sites, are also emphasized.

These are extended courses, one to two years in duration, which comprise three components: an intensive workshop, an extended long-distance mentoring period, and a follow-up review workshop. These components complement and reinforce the knowledge learned through different pedagogical approaches. Each course begins with an intensive workshop of approximately three weeks in length at a mosaic site in the region. Through a mixture of classroom lectures, group work, and on-site activities, the workshop is designed to provide theoretical and practical learning in all aspects of the conservation and management of archaeological sites with mosaics (fig. 3). Topics include mosaic history and typology; documentation and recording; condition assessments; material deterioration; remedial and preventive conservation interventions, including reburial and sheltering; structural and sitewide issues; values-based management planning; and presentation and interpretation.

Directly following this initial instruction period, a program of extended long-distance mentoring has been developed to reinforce the skills and knowledge acquired during the initial workshop. During the mentoring program, which lasts eight to twelve months, participants develop and implement practical projects at their home sites. These projects have included surveys, inventories, documentation, condition assessment, conservation implementation, and conservation and management planning. The projects are followed remotely by multiple course instructors who oversee the progress of the work and provide guidance. The participants submit regular reports and updates on their projects, in written and photographic forms, to which the instructors respond with feedback and comments.

Figure 3 Course participant giving a presentation after a group exercise, Paphos, Cyprus, 2014. Photo: Scott Warren. © J. Paul Getty Trust

The third and final course component is the review workshop, which brings the participants and instructors together once more. This workshop takes place at a mosaic site in the region, ideally at a different site from the original location in order to provide opportunity for comparison and reflection. This concluding workshop provides the time to revisit important subjects or to introduce new topics that could not be covered previously. It also gives the participants the opportunity to present and discuss their own projects, and to share experiences with one another. At the end of this third component, the participants receive certificates of completion (Dardes et al. forthcoming; Friedman et al. 2014).

Tyre, Lebanon, 2010–2011

Led by the GCI and ICCROM's ATHAR program, and in partnership with the Directorate of Antiquities of Lebanon, the first regional training course in the Conservation and Management of Archaeological Sites was held from May 2010 to September 2011 (fig. 4). Intended for site managers from the Arabic-speaking countries of the region, the course was attended by fifteen participants from Egypt, Algeria, Tunisia, Morocco, Lebanon, and Syria and was taught in Arabic and English.[1] The first component of the course was held at the World Heritage Site of Tyre, Lebanon. The site, with remains ranging from the Bronze Age through the Ottoman period, features over one hundred mosaics in varying states of preservation that are at risk from exposure, lack of maintenance, and development pressures. The final exercise, which focused on the need for decision-based management planning, required the group to develop a conservation and presentation plan for the site of Tyre, which was presented to local officials, the Department of Antiquities, and other stakeholders.

The second component, the long-distance mentoring phase, required participants to develop and implement a practical project at their home site or institution. Projects included site conservation and management plans, inventories, and public outreach initiatives such as youth education programs. Participants submitted project updates every two months, which were reviewed by the instructors, who then provided comments and guidance on each project. The opportunity to adapt and apply what they had learned during the workshop to their own projects in their own contexts allowed the participants to reinforce their new knowledge and skills, and to turn theory into practice. The third and last component of the course was a one-week review workshop, which was held at ICCROM headquarters in Rome and the site of Herculaneum.[2] During this period, the participants presented and discussed their own projects and were able to see other conservation and management approaches outside

Figure 4 Participants conducting a condition assessment exercise, Tyre, Lebanon, 2010. Photo: Leslie Friedman.

Figure 5 Presentation of a site planning exercise during the follow-up workshop at Herculaneum, Italy, 2011. Photo: Leslie Friedman. © J. Paul Getty Trust

of their home countries. Site visits and exercises reemphasized key concepts and skills, such as documentation and planning (fig. 5).

Through a Getty Foundation grant, the participants were subsequently brought together at the 2011 ICCM conference in Morocco, where a number of them presented the projects they had developed during the course, thus continuing the training process, as well as strengthening their professional network. The Getty Foundation also provided grants, awarded through a competitive application process, to continue the implementation of a few select projects. In many cases, the grantees were able to secure matching (or more than matching) funds from their respective government institutions for the implementation of their projects.

Among the selected projects, one was the development and partial implementation of a conservation plan for the archaeological site of Chella in Morocco. Another focused on the conservation and presentation of the mosaics at the site of Echmoun, Lebanon. A third grant was awarded to the participants from Syria who developed a database and countrywide inventory that helped them to record the majority of the country's in situ mosaics. Although the current conflict has made it difficult to carry out further practical work, the existence of an inventory and trained personnel is of critical importance at this time.

Paphos, Cyprus, 2014–2015

The second course, led by the GCI in partnership with the Department of Antiquities of Cyprus and the Archaeological Research Unit of the University of Cyprus, was held from April 2014 to September 2015.[3] The first component took place at the World Heritage Site of Paphos, Cyprus, a site containing mosaics of the Hellenistic, Roman, and Early Christian periods. This course was offered in English to facilitate inclusion of the non-Arabic-speaking countries of the eastern Mediterranean and was opened as well to participants from southeastern Europe. Twenty professionals were trained from twelve countries: Albania, Bulgaria, Cyprus, Egypt, Greece, Israel, Jordan, Lebanon, Libya, Palestine, Serbia, and Tunisia.

Based on evaluations of the first course, the second course was revised, including changes to the curriculum, content, and course structure, in order to better meet the needs of the participants. For example, during the Cyprus course, more time was allocated to documentation methods and techniques, monitoring, sheltering for archaeological sites, and

Figure 6 Condition recording exercise, Paphos, Cyprus, 2014. Photo: Scott Warren. © J. Paul Getty Trust

Figure 7 Working on the final site planning exercise, Paphos, Cyprus, 2014. Photo: Scott Warren. © J. Paul Getty Trust

preventive measures (figs. 6, 7). This course placed more emphasis on decision making and the importance of prioritization in the face of limited resources, both financial and human. Economically sustainable approaches to conserving archaeological sites, such as reburial, were also more heavily emphasized.

To enhance its effectiveness, the mentoring phase was reconfigured by making adjustments to the organization, type of assignments, and methods of communication between instructors and participants. A more structured decision-based management planning process led the participants through the development of their own projects. Last, the follow-up workshop was increased in length in order to review a number of selected topics in more depth.

The participants and instructors were brought back together in September 2015 at the site of Herculaneum for

Figure 8 Group of Paphos course participants at the site of Herculaneum, Italy. Photo: © J. Paul Getty Trust

the final course component. As before, lectures, practical exercises, and visits to sites such as Pompeii and Stabiae were intermixed with participant presentations of their own mentoring projects. This structure provided opportunities to share projects and experiences, meet heritage professionals from other countries, and understand other approaches to the conservation and management of archaeological sites, such as the unusual private–public partnership established at Herculaneum by the Herculaneum Conservation Project (see note 2) (fig. 8).

As previously, the Getty Foundation provided a grant to bring the Cyprus course participants and selected Tyre course participants to the 2014 ICCM conference, where they also took part in a specialized one-day workshop on grant writing and fund-raising for heritage projects. Another new addition to this course was the development of an online webinar that followed up on the grant writing workshop to provide additional expertise on the topic. It is hoped that building capacity in the areas of grant writing and securing external funds for conservation will help ensure the long-term sustainability of the initiative.

Volubilis, Morocco, 2017–2018

Led by the GCI, the third regional training course is being planned and is scheduled to begin in spring 2017 at the World Heritage Site of Volubilis, Morocco, which represents Roman urban history, as well as all phases of its ten centuries of occupation, from prehistory to the Islamic period. Intended for French speakers, the course will involve approximately twenty site managers primarily from the French-speaking Maghreb. Though the format of this course will be similar, modifications will be made based on evaluations of the previous two courses. Aspects of the curriculum and certain teaching methodologies will be adjusted. For example, more emphasis will be placed on practical site work, particularly documentation and planning exercises. Further, the site exercises will be developed so that they can contribute directly to the daily conservation and management of the site of Volubilis.

In addition, part of the site management course will be held in conjunction with the GCI-led training course for mosaic conservation technicians. The next course for mosaic conservation technicians will begin in spring 2017 at the site of Volubilis as well, creating an exciting opportunity to have the two teams work together. As site managers typically oversee the work of the conservation technicians, it is important that the two groups possess an understanding of the other's work, priorities, and needs. This will help facilitate the development of trained professional teams who are able to collaborate and work together effectively.

Finally, as before, the course participants will be invited to attend the next ICCM conference, in October 2017. A specialized workshop will be organized that brings current and previous course participants together, forging stronger ties between the groups and reinforcing the professional network in the region.

Challenges, Opportunities, and Outcomes

Since the start of the MOSAIKON initiative in 2008, we have witnessed an enormous and rapid change in the political situation in many of the MOSAIKON countries, and it has been a challenge to respond to these changes in ways that advance the objectives and activities of the initiative. By working with local partners and the other MOSAIKON partner organizations, the GCI has been able to adapt planned activities to the political climate, for example, by changing the locations and host countries for the course workshops and follow-up meetings, obtaining visas for participants to travel from certain countries, and remaining flexible regarding participation in planned activities. Such adaptations have enabled us to continue implementing courses and to successfully train site managers from the region during these very difficult times.

One important advantage of this program is the opportunity to create national teams of trained personnel, composed of both site managers and conservation technicians. By targeting both professions and providing the opportunities for the two groups to work together, MOSAIKON is helping to create trained multidisciplinary teams, which are critical to the long-term sustainability of the program's outcomes. Particularly where there is a dearth of trained conservators, site managers must understand the work of the conservation technicians, develop and manage prioritized work programs and conservation budgets, and obtain the correct conservation materials and supplies for their work.

We have also found that it is vital to provide opportunities for course participants to come together in different contexts over a more extended period. One of the original concepts behind the three-part course structure was to bring the participants together again at the end of a course to strengthen the regional network. However, it is clear that bringing current and previous participants together at other key times is essential to sustaining a dynamic professional network. For example, securing funding for course participants to attend ICCM conferences allows them to interact with each other and the wider international professional community, present papers and posters on their own work, and take part in specialized workshops. This approach both strengthens and expands existing networks and reinforces professional standards of practice.

At the conclusion of these three courses, almost sixty site managers will have been trained in archaeological site conservation and management, with an impact on many of the important mosaic sites in the southeastern Mediterranean. With the help of organizations like the ICCM, all sixty site managers will be connected to each other and to the wider mosaic heritage professional network. In addition, didactic materials produced for these courses will be available in English, French, and Arabic at no cost on the GCI website.

Through training programs like this one and other activities, MOSAIKON seeks to create a critical mass of trained mosaic heritage personnel in the region, as well as replicable models of best practice that are locally sustainable. Ultimately it is hoped that such efforts will improve the conservation, maintenance, and presentation of archaeological sites with mosaics and ensure a better future for the extraordinary cultural heritage of the Mediterranean region.

Notes

1 Instructors and team members on the Tyre course: Zaki Aslan, Aïcha Ben Abed, Kathy Dardes, Gaël De Guichen, Martha Demas, Leslie Friedman, Alaa Habashi, Yasmin Hashem, Yasmin Makaroun, Gionata Rizzi, Thomas Roby, Isabelle Skaf, John Stewart.

2 At the Herculaneum workshops following the Tyre and Paphos courses, various members of the Herculaneum Conservation Project team, led by Jane Thompson, provided facilitation and instruction.

3 Instructors and team members on the Paphos course: Aïcha Ben Abed, Ascanio D'andrea, Martha Demas, Eleftherios Charalambos, Maria Dikomitou-Eliadou, John Fidler, Leslie Friedman, Marina Solomidou-Ieronymidou, Demetrios Michaelides, Gionata Rizzi, Thomas Roby, Niki Savvides, John Stewart, Jeanne Marie Teutonico.

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A Multilevel Preservation Directory for Archaeologists: How to Think Like a Conservator When Excavating Mosaics

Hande Kökten

Abstract: *The major question of what to do with mosaics discovered at archaeological excavations is always followed by many others. Answers to these questions can be confusing as the decision makers (excavation directors, archaeologists, and government representatives) do not have adequate information about preservation and options for carrying it out. This uncertainty often causes serious problems and confusion to occur. This paper discusses these questions in the context of in situ mosaics in Turkey and attempts to develop a multilevel preservation directory to help excavators find an ethical, reliable, and sufficient solution for the preservation of archaeological sites with mosaics.*

Why does a multilevel mosaic preservation directory need to be designed and introduced to archaeological excavations? The most illuminating answer to this question is given by intervention cases at various archaeological sites in Turkey, which can be described as insufficient, inaccurate, irreversible, unnecessary, of poor quality, unstable, and tentative. This is a long list of unfortunate adjectives, but it is a fact that most archaeologists (who are either field directors or excavators) do not know how to handle mosaics properly, and thus from the moment of discovery preservation of mosaic floors becomes a growing problem for the expedition.

Although the problems described here may be observed at most archaeological sites with mosaic floors anywhere, all the circumstances and issues discussed are restricted to the conservation approaches at archaeological sites in Turkey. This is an attempt to narrow the distance between the viewpoints of the archaeologist and the mosaic conservator, which we hope will help the excavator foresee the problems that can result from the absence of proper conservation treatments.

To be able to draw the outlines of such a directory, one must classify and define the issues that arise upon the discovery of a mosaic floor, a topic discussed in detail at the 11th ICCM Conference in Meknes (Kökten forthcoming). However, before presenting the reasons for promoting a more effective role in conservation for field directors and excavators, let us recall the chart created by Gaël de Guichen (2003, 14), as it is the main source of inspiration for designing a multilevel mosaic preservation directory for archaeologists. This paper concentrates on the issues concerning systematic excavations in Turkey, and Turkish legislation strongly advises archaeologists to preserve the mosaics in situ.

The issues concerning the responsibility of the excavator and field director, which I have observed during the past thirty years at various archaeological sites in Turkey (Kökten 2012), are described below.

1. Lack of preventive conservation during and after the excavation of a mosaic floor

- Use of incorrect tools and techniques for the excavation of mosaics
- Heavy human traffic in the excavation area
- Wetting of the mosaic surface for photography and documentation
- Lack of protection against rapid drying or rain.

2. Lack of detailed documentation and condition assessment of the mosaic floor

Although assessing and recording damage to a mosaic is as important as archaeological documentation, in the absence of condition assessment standards and regulations that oblige the archaeologist to prepare a condition report, this vital phase is often ignored. In addition, for mosaics that are discovered near the end of the excavation season, shortage of time results in mosaic floor reburial without proper documentation and condition assessment.

3. Issues concerning first-aid treatments

- Lack of first-aid treatments:
  - Absence of experienced field conservators or conservation technicians
  - Insufficient time for first-aid interventions
  - Insufficient equipment and/or supplies
  - Lack of resources to provide conservation supplies
- Faulty or unnecessary first-aid interventions

In Turkey, very few excavation projects include experienced field conservators; the common practice is to employ an objects conservator and expect him or her to take care of all the material discovered during excavation. Under the supervision of a nonspecialist conservator, first-aid interventions may turn into disasters if unnecessary steps are taken and treatment goes too far, or if improper materials are used so that the first aid process itself causes damage. On the other hand, the field director may be responsible for determining the materials to be used in treatment and wish to avoid spending his resources on conservation. Impetuous and clumsy workmanship is also very common, especially when the size of the mosaic requires the excavators to increase the number of unqualified operators in order to speed up the process.

4. Absence of conservation planning for mosaics to be preserved in situ

When the condition assessment and first-aid treatments are completed, it is necessary to make plans for the short- and long-term preservation of the mosaic. This requires an extensive discussion and exchange of ideas among the excavator (field director), conservator, architect, and site manager; however, in most cases, this crucial step is ignored. In addition, the final authority to approve this decision is in the hands of the government representative, who may not have the background to evaluate the chosen approach and its grounds.

In more complicated cases, for instance, when a mosaic is recovered in a standing structure or when it requires long-term in situ conservation, planning is even more vital. However, if the field director does not have enough knowledge about different conservation approaches and the conditions that require them, he cannot evaluate the proposals made by the conservators and therefore may skip or postpone the planning stage until severe conservation problems arise.

5. Issues concerning the reburial of the mosaic floor

As prescribed by national regulations, the common practice for in situ preserved mosaics in Turkey is reburial. However, recommended methods, standards, or rules for backfilling process have not been approved; therefore, confusion and lack of knowledge may result in partial damage or total destruction of the mosaic floor in the short or long term.

6. Erroneous judgments about lifting the mosaic floor

The national legislation for the Protection of the Cultural and Natural Heritage, Article 9, states that “if there is a necessity to remove an immovable cultural property to a different location, or if its condition makes this removal unavoidable, such an action will be taken by the Ministry of Culture and Tourism with the approval of the District Board of Preservation and only after the necessary security measures are taken.” However, the legislation does not specify what constitutes a “necessity,” leading in some cases to misjudgments. Therefore, the field director plays two different roles during the decision-making process for lifting: he may be the one who proposes to lift the mosaic for archaeological or security reasons, or he may be the authority who evaluates the lifting option proposed by the conservator. In the first case, the field director’s proposal will be evaluated either by the government representative or by the District Board of Preservation. In the second case, however, the necessity of lifting needs to be discussed in detail with the conservator who has proposed the process, and the argument should be based on clear and valid evidence. If the conservator is not a specialist this rarely happens. In addition, the field director must be knowledgeable about the conditions and rationale for lifting to be able to evaluate the conservator’s proposal.

7. Damage caused by the lifting process due to the method and its application

Although it is not typical to lift mosaics in systematic excavations, this method is often used in the form of local lifting during stabilization treatments. However, as discussed above, unnecessary interventions carried out by a nonspecialist conservator combined with improper lifting causes damage to the mosaic floor.

8. Improper storage of lifted mosaics in excavation depots

In most cases, lifted mosaic sections are stacked in layers and placed in remote parts of the excavation depot. Re-laying on a new support is a very rare practice at excavations; thus lifted mosaic sections are stored while attached only to layers of facing, thereby increasing the risk of water damage and biodeterioration, particularly in uncontrolled and unmonitored storage conditions between excavation seasons. Unfortunately, field directors tend to believe that lifted mosaics do not need any further treatment after removal and thus even if there is an experienced specialist conservator on the team are reluctant to pay for rebacking treatment.

9. Display of mosaics in shelters

Roofs and shelters for the protection of mosaics at archaeological sites may turn into a major problem due to the lack of regular inspection and maintenance. This is partly related to the deficiency of site management activities and the funds allocated to maintenance. Excavators do not pay attention to mosaics displayed under shelters unless they are unique and highly decorated, which causes severe damage especially at archaeological sites where excavations are completed.

All these issues lead us to conclude that it is the *human factor* that is of great significance in the successful preservation of in situ mosaics. In our context, the human factor is represented by the field director/excavator and conservator, who are responsible for the safety, preservation, and well-being of the archaeological finds, and the government representative, whose duty is to observe the excavation and ensure that it is undertaken in accordance with the legislation.

There is no doubt that conservation professionals are primarily responsible for all stages of mosaic conservation; however, the qualifications and experience of the conservator plays a major role in the decision-making process and during the application of treatments. Therefore, these qualifications should be clearly defined, so that the field director will employ conservators accordingly.

For all these reasons, it is so important to minimize problems that arise at excavations where in situ mosaics are discovered by educating archaeologists in the basics of mosaic conservation. Archaeologists need to know about different conservation approaches, as well as the successive stages of mosaic conservation so as to be able to

- understand and evaluate the advantages and disadvantages of major treatment approaches, such as in situ preservation, lifting, and re-laying.
- realize the importance of their own active role in the preventive conservation of mosaics.
- make better decisions about the long-term preservation of mosaics.
- understand the treatment priorities of the mosaic conservator during intervention.
- follow the different stages of conservation treatment and make their excavation plans accordingly.
- be aware of the need for preventive conservation and maintenance of displayed mosaics and the maintenance of shelters.
- optimize excavation funds in relation to seasonal and long-term conservation work on mosaics.
- make site management plans more effective, especially at sites with a large number of mosaics preserved in situ.
- contribute to discussions on mosaic conservation during the decision-making process.

The directory for archaeologists aims to unite the field director/excavator and conservator around a single and common concern, the well-being of mosaics, and eventually to help the archaeologist think like a conservator.

The structure of the multilevel directory had to be simple and clear, as the users are not professionals in conservation. Too many details, too much technical information, and long descriptions will make it difficult to use. At the same time, the directory should not offer "recipes" that are too easily adopted in the wrong circumstance; instead, it should clearly describe the outlines and aim of each successive treatment. Also, it should cover as many problematic situations as possible to help both the excavator and the field director understand the complexity of the solutions and eliminate confusion during the decision-making process. However, as certain stages of mosaic conservation require the active involvement of the excavator (especially preventive conservation measures, documentation, condition assessment, and maintenance of the excavated mosaics), we included appendixes, described below.

The directory has five successive levels and six appendixes.

- Level I: Determination of the appropriate conservation approach (in situ preservation or lifting)
- Level II: Condition assessment of the mosaics and evaluation of the conservation facilities (documentation, condition assessment, conservation team and materials)
- Level III: Reburial of the mosaic
- Level IV: Planning for in situ conservation and display of the mosaics (conservation team, conservation interventions, shelters, preventive conservation of in situ displayed mosaics)

- Level V: Planning for lifting and storage of lifted mosaic panels (conservation team, lifting and reback-ing treatments, storage, maintenance of the mosaics in storage)
- Appendix A: Preventive conservation during and after the excavation of mosaics + list of materials
- Appendix B: Documentation and condition assess-ment of the mosaics + condition assessment form with illustrated glossary of mosaic deterioration
- Appendix C: First-aid treatments (to be applied by a conservator) + list of materials
- Appendix D: Reburial + list of materials
- Appendix E: Maintenance of lifted mosaics stored in excavation depots
- Appendix F: Preventive conservation of displayed mosaics under shelters

Each appendix of the directory contains a short description and a statement about the aim of the application or treatment and provides basic instructions supported by illustrations and photographs. Included are lists of supplies needed during preventive conservation, reburial, and first-aid treatments of the mosaics. A list of suppliers will be also included for easy and quick access to the materials.

The multilevel mosaic preservation directory for archaeologists is presented in Turkish; however since it aims to help all the excavators who undertake archaeological digs in Turkey, there will be an English version too. This project is a part of the publication series that Ankara University is preparing for the twenty-fifth anniversary of the foundation of Başkent Vocational School, and it will also be accessible on the Web.

I believe that when archaeologists realize that preservation is a valuable key that opens the door to the well-being of their discoveries, they will begin to think and act like conservators. Equally important, one of the major missions of a conservator should be to share his or her knowledge, experience, and observations with the excavator instead of criticizing without offering help. This directory is an attempt to create a new and closer connection between the professionals of two complementary disciplines and to contribute to the preservation of mosaics by raising awareness in the decision-making process among field directors and excavators.

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Mosaic Conservation Course (MCC) 2011–2016, a Program of the MOSAIKON Initiative: Mid-Program Review

Roberto Nardi

Abstract: *This paper describes and comments on the Mosaic Conservation Course (MCC) 2010–2016, an initiative designed in response to the growing need to develop increased capacities for the conservation and management of mosaic heritage, whether in situ or in museums. This program, organized by CCA-Rome is part of MOSAIKON, a collaborative initiative of the Getty Conservation Institute (GCI), the Getty Foundation, the International Centre for the Study of the Preservation and Restoration of Cultural Property in Rome (ICCROM), and the International Committee for the Conservation of Mosaics (ICCM).*

The Mediterranean region, in particular, countries like Syria, Jordan, Tunisia and Libya, contains the most important concentration of mosaics in the world, in terms of both quantity and quality. This precious heritage represents the material memory of the history of humankind and is a potentially enormous economic resource for the sustainable future of the local populations.

Despite their importance, mosaics are neglected, vandalized, looted, or lost in museum and site deposits. Every day important evidence of this heritage is lost forever. The reason for this scenario is that mosaics are naturally fragile and exposed to and affected by numerous risk factors, both natural and human. Therefore, their preservation calls for constant and qualified care.

Among the most active agents of deterioration are the inadequate qualifications of professionals and/or decision makers for what they do or for what they do not do. Equally inadequate are the technical facilities available in the countries in this region and access to training opportunities in conservation. For years, these countries have been a preferential target of the national and international archaeological research community. As a result, a large number of mosaics have been exposed, and some of them have been removed from the sites, as the only option in conservation practice. Some of these were relaid on reinforced cement or plaster panels and put on display in museums or placed in storage.

The current political instability in the region has produced an increasing number of mosaics damaged, looted, and lost; the risk of isolation of the conservator/restorers acting in the frame of local institutions; general impoverishment, with special reference to the field of cultural heritage (cultural tourism); and limited access to projects, resources, and international collaborations.

In 1977, in Rome, at the founding meeting of the International Committee for the Conservation of Mosaics (ICCM), the recommendation was made "to organize training courses in mosaic conservation to reply to the problem of mosaic conservation." Since that time, many training initiatives have been organized in the field of mosaic restoration and conservation. Rather than focus on an analysis of the effectiveness of these programs, it is sufficient to highlight one common characteristic: they were never part of a long-term strategy capable of generating deep and long-lasting changes.

Today, thirty-five years later, we are finally seeing the opportunity that the mosaic conservation profession has being awaiting for decades: a multiyear, wide-ranging program, at a regional scale, designed to approach the topic of mosaic conservation with various lines of action, all coordinated and finalized toward a common objective. This is MOSAIKON, created by the Getty Conservation Institute (GCI), supported by the Getty Foundation, managed in collaboration with the International Centre for the Study of the

Preservation and Restoration of Cultural Property in Rome (ICCROM) and ICCM. The initiative was designed in 2008 in response to the growing need to develop increased capacities for the conservation and management of mosaic heritage, whether in situ or in museums. The ultimate goal of MOSAIKON is to safeguard this important cultural heritage and to improve public access and appreciation.

In the frame of MOSAIKON, in 2010 the Centro di Conservazione Archeologica di Roma (CCA) received a grant from the Getty Foundation to design a multiyear training program focused on the conservation and restoration of mosaics removed from sites in Syria, Jordan, Tunisia, and Libya. In 2011, the CCA launched the Mosaic Conservation Course (MCC), a six-year program aimed at reinforcing institutional capacities in these countries in order to manage the mosaic heritage and prepare a group of twelve to sixteen mosaic conservation technicians selected from an initial pool of twenty-eight course participants. At the time of this writing, the end 2014, the program has reached its middle term; phase 1 is concluded and phase 2 is about to begin. In this second phase, a select group of fifteen participants will have access to a series of courses offering a higher level of training.

Objectives

The goal of MCC 2011–2016 is to reinforce institutional capacities in managing the legacy of mosaics in Syria, Jordan, Tunisia, and Libya, and to prepare a well-equipped group of fifteen mosaic conservation technicians, supported by local authorities, capable of dealing autonomously with the care and conservation of mosaics and linked to an international professional network. Members of this group will themselves be ready to train new generations of technicians.

The mosaic conservation technicians will be capable of treating detached mosaics displayed in museums or held in storage, and of documenting and communicating their work. They also will receive basic training in the treatment of mosaics in situ, according to the essential principles of preventive conservation.

The definitive goal of this program is to support Syria, Jordan, Tunisia, and Libya in the process of designing and implementing effective and sustainable strategies for the conservation of mosaics in the framework of an international professional network.

Project Description

The Mosaic Conservation Course developed by the CCA, is supported by two grants from the Getty Foundation, one for the period 2011–2013 and one for the period 2014–2016. The 2014–2016 program is a natural continuation of the training process started in 2011 with MCC Syria, Libya, Jordan, and Tunisia, when twenty-eight mosaic conservation technicians received general education/training in the conservation of lifted mosaics. This program was completed in October 2014, when a new two-year program started.

The 2011–2016 program is based on three lines of action: Education and Training, Networking, and Regional Assistance (technical and institutional) (fig. 1).

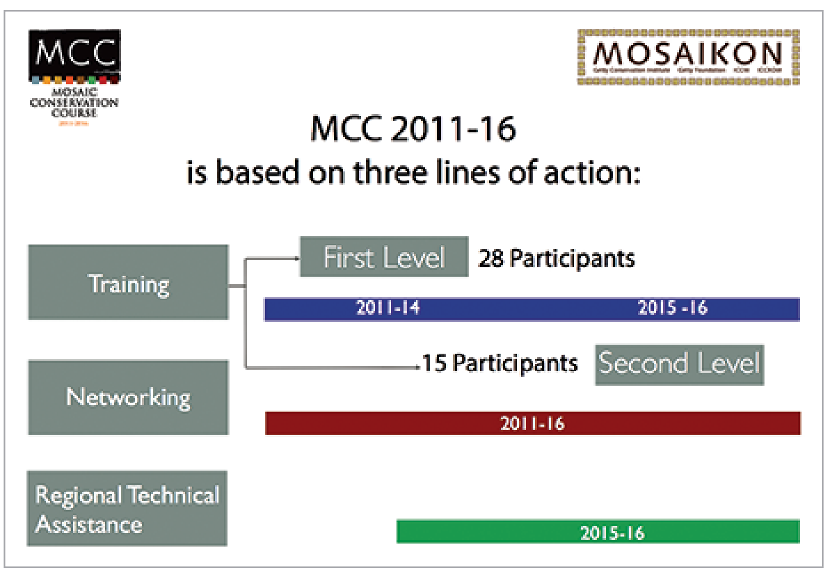


Figure 1 Mosaic Conservation Course 2011–2016 activities

Education and Training

The MCC 2011–2016 training program is divided into two parts: a general education phase (2011–2014), followed by a more advanced phase (2015–2016). Courses were based on a four-week module, with a full workday divided into theoretical lessons and laboratory practice. Two weekends were dedicated to study trips. Courses were held at CCA's headquarters located in Belmonte in Sabina, Rieti, Italy.

The course comprises theoretical lessons, laboratory practice, case studies, seminars, and study visits. It places strong emphasis on the link between theory and practice, providing participants with practical training in the application of conservation treatments to mosaics. The didactic activity involves morning study sessions with theoretical lessons and afternoon practical working sessions on actual mosaics.

The course is taught in English, Arabic, and Italian. Theoretical lectures have an English-Arabic-Italian interpreter. An English-Arabic translator has been employed for producing didactic material.

General education (phase 1): In the first part of the program, trainees received general education and training in the conservation of lifted mosaics. One group of participants from the General Directorate of Antiquities and Museums of Syria (DGAM), one from the Institut du Patrimoine de la Tunisie (INP), one from the Department of Antiquities of Jordan (DOA) and the Madaba School for Mosaics, and one group from the Department of Antiquities of Libya received training based on the following subjects (fig. 2):

- History of mosaic technology: historical approaches to the restoration and conservation of mosaics (Demetrios Michaelides);
- Mosaics significance (Gaël de Guichen);
- Aggressors, deterioration processes, and risk assessment (Gaël de Guichen and Roberto Nardi);

Figure 2 List of subjects covered in phase 1 of the course

- General principles of conservation (Roberto Nardi);
- Technology of ancient materials, and techniques of mosaic making (Andreina Costanzi Cobau and Roberto Cassio);
- Lime-based mortar technology (Andreina Costanzi Cobau);
- Visual documentation: photographic, video, and graphic recording (the use of Photoshop software, glossary/standardized graphic patterns in mosaic conservation) (Andreina Costanzi Cobau and Gian Mario Porcheddu);
- Techniques and materials for lifting mosaics and restoring detached mosaics (cleaning, consolidation, reapplication on Aerolam, treatment of lacunae) (Roberto Cassio and Roberto Nardi);
- Chemistry of organic and inorganic solvents used in conservation and basic laboratory analysis (Maurizio Coladonato);
- Safety procedures and correct use of individual protection equipment in conservation (Chiara Zizola and Francesca Guiducci);
- Case studies (Kristian Schneider, Flavia Ravaioli, Roberto Nardi, Roberto Cassio, and Andreina Costanzi Cobau);
- Study visits (Giovanni Freni, Francesca Guiducci, Gian Mario Porcheddu, and Flavia Ravaioli).

Fifty percent of the course was devoted to laboratory practice, where actual conservation projects were implemented. Thanks to an agreement with the Soprintendenza Archeologica di Roma, Museo delle Terme, and Museo Civico di Alghero, which provided three second-century Roman mosaics and an opus sectile, course participants were able to apply the techniques learned during theoretical classes. Roberto Cassio and the staff of CCA assisted and directed the participants during the practical work in the laboratory (fig. 3).

Today the trainees are able to

- understand the meaning of a mosaic;
- identify original manufacturing techniques and materials;
- understand old and current materials and techniques for conservation/restoration;
- identify problems that may put the mosaic's condition at risk;
- implement basic chemical identification of soluble salts and deterioration products, and judge the efficiency of cleaning procedures;
- recognize health risks during conservation procedures;

Figure 3 The participants in one of the MCC courses at work in the laboratory

- carry out proper photographic and graphic digital documentation;
- treat detached mosaics with lime-based mortars, including re-laying on new supports;
- work within a professional group at a national level.

During the course, participants prepared presentations based on their professional experience. These documents were helpful for evaluating their understanding of conservation problems, their skills at planning solutions, and their communication capabilities.

Final exams concluded the evaluation process. As for the proficiency levels attained by the trainees, personal profiles of each participant were compiled during the course, based on the following criteria: motivation, manual skills, technical skills, and theoretical knowledge; management and organizational capacity; computer skills.

The results of MCC Syria, Libya, Jordan, and Tunisia were positively received by the authorities of the respective countries. The countries' Directorate Generals of the Departments of Antiquities stressed the dramatic need in the region for similar initiatives. It also communicated its satisfaction with the results achieved by MOSAIKON MCC so far and a clear desire for the continuation of the initiative, with new participants.

In 2013, the participants from Syria, Jordan, and Tunisia were joined by participants from Libya after the director general of Libya's Department of Antiquities called for "strengthen[ing] our collaboration with MOSAIKON especially after having seen the results of the first Mosaic Conservation Course organized in Italy for Syria, Tunisia, and Jordan." In Syria, despite the difficult political situation, course participants, based in the central laboratory for mosaic conservation of DGAM in Damascus, are currently exporting the format of the course to young Syrian mosaic conservation technicians, in addition to launching two Facebook pages.

The second phase of the course, to be implemented in 2015–16, represents a more advanced level of education for mosaic conservation technicians and trainers. Fifteen participants, selected during the previous courses in 2011–2013, will be divided into two groups (fig. 4). The selection of participants is based on their current position in the administration, critical capacity, motivation, learning skills, ability to work in a team, managerial capacity, and manual skills. Each group will attend two four-week courses.

The topics covered during phase 1 will be reviewed in detail in phase 2, and new topics will be introduced. The new topics are planning, budgeting, logistics, teamwork, safe storage, chemistry applied to materials for restoration, preparation

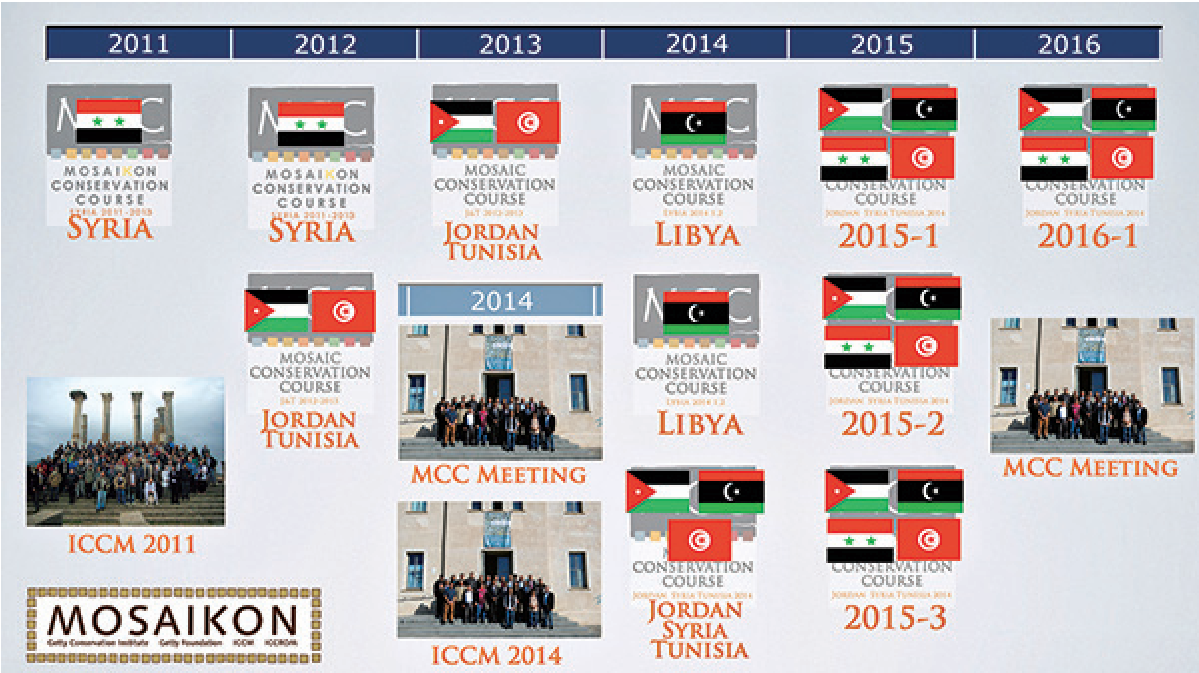


Figure 4 Map of all activities implemented (2011–14) and to be implemented (2015–16) in the MCC 2011–2016 program

of supports, handling and packing, teaching skills, communication, presentation, and reporting.

Networking

Networking is an essential component in ensuring the sustainability of professional activities in the region. We believe that the best way to achieve positive results is to work together, sharing problems and solutions and developing common frameworks that can be adapted to specific local needs.

Part of the success of the training initiative in the Middle East and North Africa is linked to the capacity of the program to keep the participants connected through an international professional network, both via actual meetings and via a digital platform.

Participants received funding to attend the 11th International ICCM Conference, held in Morocco in 2011, and the 12th ICCM Conference, held in Sardinia in 2014. On both occasions, some of the participants presented posters reporting on their activities in their own countries. In Alghero, Italy, preceding the 12th ICCM Conference, a general meeting of the participants was held, completing the initiatives organized with the aim of network building. The participants, divided into groups, presented reports on the activities they had implemented in the past year, following their attendance at the Mosaic Conservation Course.

Scholarships, job opportunities, conferences and meetings, publications, new projects, and field experiences specifically related to mosaic conservation are diffused via the Web network that has been created. It also serves as a place were MCC participants can post their own experiences, in order to share questions and solutions with colleagues. The network is public, and other professionals are constantly invited to be part of it. The aims of this line of action are the following:

1. To create online platforms to facilitate the professional networking of MCC participants, in order for them to have visibility, receive feedback, and share resources and information
2. To provide remote learning for MCC participants and anyone interested in mosaic conservation (especially in the Arabic world)
3. To provide a public account of MCC activities for those interested in learning more about our training courses

The MCC Network system is based on dedicated webpages on the CCA website (www.cca-roma.org/mcc-mosaic-conservation-course-2014-2016), which offers information on the curriculum, the teachers and staff, and the participants; YouTube (www.youtube.com/user/CCARoma), a blog (www.cca-roma.org/en/blog), on Facebook (www.facebook.com/CCARoma), and Twitter (twitter.com/CCA_Roma) (fig. 5).

Figure 5 Networking program on the Web

Regional Technical Assistance

In order to support the participants in implementing in their own countries the principles and methodologies of mosaic conservation learned during MCC 2011–2016, it is crucial to create logistical and organizational conditions at a regional level. This is true both at the material level (laboratories, storage, equipment, materials) and the institutional one (relationships with the management).

A Regional Assistance Program is included in the MCC project. It is dedicated to improving, in collaboration with the participants, already existing regional mosaic conservation laboratories, reorganizing mosaic storage rooms to make them safe, and providing expertise focused on specific mosaic conservation cases, which may be representative of the daily working life of mosaic conservation technicians. The main activities of the Regional Assistance Program will include improving the direct link with the hierarchical levels of the institutions to which participants belong, in order to sustain them in their work; refurbishing laboratories with tools, materials, and equipment and reorganizing working spaces efficiently; investigating and identifying local suppliers of materials and tools, with special reference to lime and aggregate producers; reorganizing storage rooms according to principles of safety and efficiency; guaranteeing assistance for technical surveys in museums and sites, in order to support the participants in implementing conservation in their field of action.

Conclusion

Mosaic Conservation Courses brought together mosaic conservation technicians from a number of countries to create, on a regional level, trained teams capable of dealing with mosaic conservation in a wide range of site, administrative, and logistical conditions. These groups are expected to be involved in the management and implementation of conservation projects on their own national mosaic heritage and will become trainers of the next generation of mosaic conservation technicians at the local level. On the one hand, such an

Figure 6 The “world” of the MOSAIKON Mosaic Conservation Course

achievement will be very positive, allowing the building on a national scale of solid knowledge and confidence in relation to problems and solutions. On the other hand, it highlights the limitations of the national scale itself. For these reasons it will be of great importance to make efforts to strengthen and sustain the position of these new professionals in their own countries and at the same time guarantee them a relationship with other colleagues from the Mosaic Conservation Course and MOSAIKON network, with the objective of sustaining a new generation of mosaic conservation technicians who share common principles and methodologies, capable of "making the difference" at a regional level (fig. 6).

2011–2014 Course Participants

Directorate General of Antiquities and Museums of Syria (DGAM)
- Ali Al Ahmad
- Ayham Alfakhri
- Firas Alhahj Ali
- Mouhamad Al Sbeeh
- Borhan Alzaraa
- Maher Jbaee
- Mohammad Kaeed
- Taghrid Mouhamad
- Mohamad Moutaz Alshaieb
- Jihan Sulaiman

Institut National du Patrimoine de la Tunisie (INP)
- Taieb Belgacem
- Ferhani Chihaoui
- Jamel Lazid
- Samira Arous Ouslati
- Anis Ouslati
- Hamadi Sillini

Jordan Museum, Amman
- Nihad Ziad Hendawi

Department of Antiquities of Jordan
- Ziyad Aziz Othman
- Mohammad A. Y. Sh'Yyab
- Firas M. M. Tbaysha

Institute for Mosaic Art and Restoration of Madaba, Jordan
- Mashhour A. A. Altfiehat
- Nemer I. H. Alzouby
- Samaher Khames

Department of Antiquities of Libya
- Essam Mustafa Ali Baridan
- Badr al-Beraiki
- Mahmoud Milad
- Ashraf Mohammed
- Abdalsalam Sadoun

PART SIX

Backing Material and Techniques

Alternative Backing Methods for Lifted Mosaics: A Project of the MOSAIKON Initiative

Beril Biçer-Şimşir and Ertugrul Taciroglu

Abstract: *One of the greatest challenges in the conservation of lifted mosaics in museums and storage is the need for backing methods that use locally available and inexpensive materials rather than methods based on the use of costly materials like aluminum honeycomb panels that are unavailable or unaffordable in many countries. The Getty Conservation Institute, as part of the MOSAIKON Initiative, has been conducting research to develop sustainable and cost-effective backing methods. This paper presents an overview of the experimental program, preliminary results, and the development of the finite-element (FE) computer model of the studied alternative backing.*

A large number of mosaics in the Mediterranean region were lifted from archaeological sites from their original supports and currently reside in museum collections, either on display or in storage. The conservation of these lifted mosaics requires installing them on new backings that can support their weight with minimum deformation while holding the tesserae in place. Unfortunately, existing low-cost backing methods, such as supports that are mortar based (lime or cement) (Bassier 1978; Selvig n.d.; Papageorghiou 1985; Montanaro 1997; Uprichard, Thickett, and Lee 2000) or made of reinforced concrete (Bassier 1978; Selvig n.d.; Severson and Fullick 2005; Mei-An Tsu et al. 2005), are heavy and experience several durability problems (rebar corrosion, soluble salts, distortion during curing, etc.). The lightweight and more durable backing methods, such as stratified and reinforced resins (Bassier 1978; Blackshaw and Cheetham 1982; Bradley, Boff, and Shorer 1983; Selvig n.d.; Báthy 1984; Szalay 1984; Bassier 1985; Silvestrini 1985; Zadravko 1985; Munday 1986; Soultanian and Strohschnieder 2000; Mei-An Tsu et al. 2005) or aluminum honeycomb panels (Lodge and Mckay 1982; Chantriaux 1985; Kosinka 1991; Uprichard, Thickett, and Lee 2000; Sweek et al. 2000; Mei-An Tsu et al. 2005; Barnes 2006), are expensive and require special technical skills.

In recent years, the backing or rebacking of the thousands of lifted mosaics has become a major conservation challenge in the Mediterranean region, where resources are scarce and costly conservation treatments are reserved for only the most exceptional ones. As a result, lifted mosaics, especially those in storage (fig. 1), continue to deteriorate at a rapid rate.

Since 2010, the Getty Conservation Institute (GCI), as part of the MOSAIKON Initiative, has been addressing this situation by investigating alternative backing methods that can be prepared with locally available materials that are also cost-effective, durable, compatible, reversible (i.e., with an intervention layer), adequately rigid, and lightweight. Given these needs, a two-layer system was developed: a thin, low-strength mortar with high lime content that is used to produce an intervention layer (reversible, compatible with mosaic tesserae); and a thicker, stronger supporting layer made from mortar with plastic panel reinforcement (fig. 2).

An international survey of the local availability of the materials in the countries of interest to the MOSAIKON Initiative (Biçer-Şimşir, Weichbrodt, and Roby 2011) led to the selection of lime-based mortars to be tested for the intervention layer (IL) and supporting layer (SL); and a range of cost-effective plastic panels to be evaluated as possible reinforcement material within the supporting layer. An experimental program was designed to address the following questions:

1. Which lime-based mortars are most appropriate (in terms of flexural-tensile strength and drying shrinkage characteristics) for the IL and SL? *(Mortar tests)*

Figure 1 Lifted mosaics without backing placed on stacked wooden planks in temporary storage, Dara, Syria

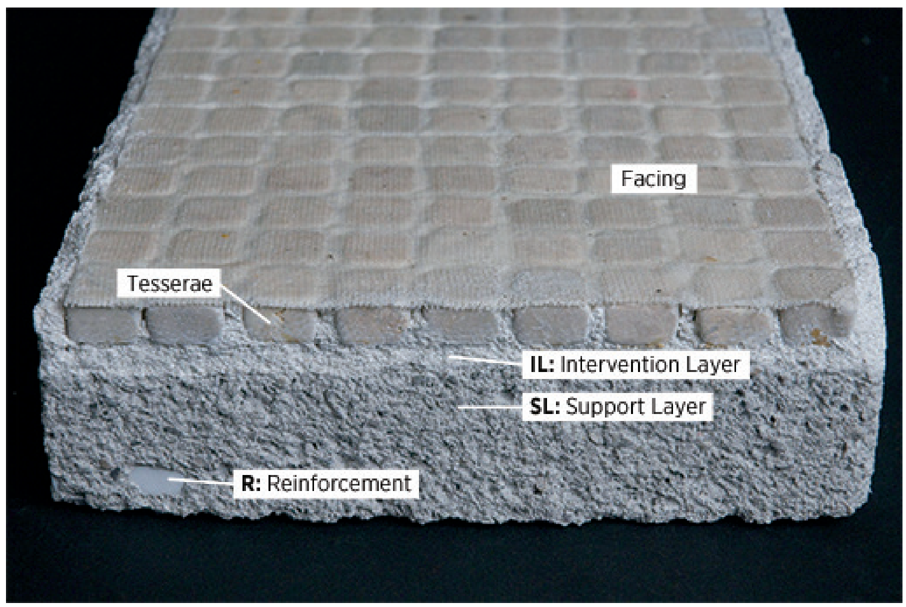


Figure 2 A mid-scale mockup prepared by following the proposed backing

2. How important are curing conditions to the resultant flexural-tensile strength and drying shrinkage of the lime-based mortars tested? *(Mortar tests)*
3. How do the two mortar layers of the proposed mosaic backing system function together in terms of bonding? *(Mock-up tests)*
4, How do reinforcements and meshes affect the load-bearing capacity, toughness, and deflection of the SL mortar and two-layer mosaic backing? *(Mock-up tests)*
5. Are plastic reinforcements durable in lime-based mortars? *(Mock-up tests)*
6. Is the backing reversible? *(Mock-up tests)*
7. Are the selected design criteria for flexural-tensile strength and drying shrinkage acceptable? *(Mock-up tests)*

A principal challenge in this research is the adaptation of the developed backing method by using locally available materials. Consequently, it is very important to develop the tool(s) that will assist this adaptation and make sure that the final design criteria are fulfilled. In order to accomplish this, in parallel with experimental work, finite-element (FE) computer models of the lime-based mortar specimens and of the plastic reinforcements were prepared and the simulated and experimental mechanical responses of these materials were compared. FE is a common numerical method used to solve complex engineering and mathematical physics problems (i.e., complicated geometries, loadings, and materials) by dividing the solids or bodies into smaller and simpler, easier to solve parts called finite elements. In this case, once satisfactory FE models for individual materials were developed, an FE model of the two-layer backing system mimicking the mock-ups was prepared and the evaluation of the model conducted by again comparing the simulated results and the experimental mechanical response of the mock-ups. Since currently existing material models and computation simulation methodologies such as FE have never been used for the combinations of materials of interest to this study, it was an important step to build the FE models step-by-step and confirm the capabilities of existing material models to mimic the mechanical responses of the IL and SL mortar specimens, reinforcements, and two-layer mortar backing system. When a reliable FE model of a proposed backing is produced, it will be used to implement material changes with minimal material testing. The results obtained will help to create user-friendly design guidelines to assist professionals in designing appropriate backings using local materials based on the specific size and weight of the mosaic under consideration.

Experimental Program

Materials

Four types of lime-based mortars were tested for the intervention layer (IL) and supporting layer (SL): slaked lime (L), natural hydraulic lime (NHL), lime-metakaolin (LM), and lime-white Portland cement (LC). A range of cost-effective, plastic panels, including light diffusers, geonets, and thin-wall sheets, were evaluated for inclusion in the SL. LC mortars were not considered for the IL due to compatibility concerns, as the alkalis and gypsum in Portland cement are known to damage the tesserae due to salt formations. Therefore, the mock-ups using LC mortars as the SL were combined with L mortars as the IL.

Lime mortars included slaked lime putty (from US Heritage Group) and were assigned as the Control Lime group (CL) for identifying the effects of metakaolin and Portland cement additions on the studied mortar properties. NHL mortars included St Astier NHL 2, NHL 3.5, and NHL 5 (from TransMineral USA, Inc.). LM and LC mortars included varying amounts (5–30% by volume) of metakaolin (from BASF Metamax® PA) and white Portland cement (from Lehigh White Cement Company), respectively. The test mortars were prepared with different binder-to-aggregate volume ratios, including 1:1.75, 1:2, 1:2.5, and 1:3. The mortars were prepared using an aggregate mixture of equal volumes of ASTM C778 graded sand and 20/30 sand (from U.S Silica, Ottawa, IL). In order to study the effect of aggregate gradation on the relevant mortar properties, mortars were also prepared using a commercial washed plaster sand and several lightweight aggregates. The water-to-NHL weight ratio was kept at 1.0 for all NHL mortars, except for the 1:1.75 NHL 5 mortar. In this case, the water-to-binder ratio (w/b) was reduced to 0.7, as 1.0 was too liquid to obtain a stable mortar mix. The w/b ratios of all the LM and LC mortars were kept constant for each binder-to-aggregate ratio by adding extra water when lime putty was replaced by metakaolin or Portland cement (see table 1 for the water content).

All of the mortars were mixed by a Hobart N50 mixer satisfying ASTM C305. Different mixing procedures (mixing sequence, time, resting period, etc.) were carried out depending on the mortar type in order to provide thoroughly mixed mortars. While the initial proportioning was done based on volume, weight proportions were used to provide consistent mixtures during the study. The volume and weight proportions and ingredients of selected NHL, CL, LM, and LC mortars including ASTM standard sand mixture are given in table 1.

Panel reinforcements and meshes used in this study are shown in table 2. Panel reinforcements included polystyrene grids (egg crate), light diffusers with two thicknesses (12.5 mm and 8 mm), PMMA hexagonal light diffusers, polypropylene geonets, and polycarbonate thin-wall sheets. Four types of meshes were used to improve the load distribution between the mortar and the reinforcement and to reduce the weight of the mock-up. These meshes were polypropylene plaster mesh (4 × 4 mesh), high-density polyethylene extruded diamond geonet (0.3 in. × 0.3 in. opening size), fiberglass insect screening (0.011 in. wire), and chemical-resistant polypropylene mesh (6 × 6 mesh). The costs of the studied panels were in the range of US\$20 to US\$140 per m^2 (table 2), while the cost of the honeycomb aluminum panels in the region was estimated to be around US\$450 to US\$550 per m^2. Therefore, the use of plastic panels is expected to reduce the cost of the backing significantly.

Test Methods

The experimental program began with testing the mortar formulations and determining the mortar combinations (i.e. one IL and one SL) that met the desired mechanical (flexural-tensile strength, compressive strength, and dynamic modulus of elasticity) and physical (drying shrinkage) properties. The tested properties were determined based on the identified challenges of using a two-layer mortar backing design. The flexural-tensile strength of mortars determines the total load-carrying capacity of the backing, while the compressive strength of the mortars controls the ease of reversibility.

Table 1 Mortar mix designs

Mortar Name	Graded Sand (g)	20/30 Sand (g)	NHL (g)	Metakaolin (g)	Portland Cement (g)	Lime Putty (g)	Water (g)
CLM (1:0:3)[1]	769	768	—	—	—	437	0.0
CLM (1:0:2.5)	769	768	—	—	—	525	0.0
CLM (1:0:2)	769	768	—	—	—	656	0.0
NHL 2 (1:3)[2]	769	768	196	—	—	—	196
NHL 2 (1:2.5)	769	768	235	—	—	—	235
NHL 3.5 (1:3)	769	768	197	—	—	—	197
NHL 3.5 (1:2.5)	769	768	236	—	—	—	236
NHL 3.5 (1:2)	769	768	295	—	—	—	295
NHL 5 (1:3)	769	768	238	—	—	—	238
NHL 5 (1:2.5)	769	768	286	—	—	—	286
NHL 5 (1:2)	769	768	358	—	—	—	358
NHL 5 (1:1.75)	769	768	431	—	—	—	302
LM (0.95:0.05:3)[3]	769	768	—	5.9	—	415	3.5
LM (0.95:0.05:2.5)	769	768	—	7.0	—	498	4.2
LM (0.95:0.05:2)	769	768	—	8.8	—	623	5.3
LM (0.9:0.1:3)	769	768	—	11.7	—	393	7.0
LM (0.9:0.1:2.5)	769	768	—	14.1	—	472	8.5
LM (0.9:0.1:2)	769	768	—	17.6	—	590	10.6
LM (0.8:0.2:3)	769	768	—	23.5	—	350	14.1
LM (0.8:0.2:2.5)	769	768	—	28.2	—	420	16.9
LM (0.8:0.2:2)	769	768	—	35.2	—	525	21.1
LM (0.75:0.25:2.5)	769	768	—	35.2	—	393	21.1
LM (0.75:0.25:2)	769	768	—	44.0	—	492	26.4
LM (0.70:0.3:2.5)	769	768	—	42.3	—	367	25.4
LM (0.70:0.3:2)	769	768	—	52.8	—	459	31.7
LC (0.95:0.05:3)[4]	769	768	—	—	19.1	415	11.5
LC (0.95:0.05:2.5)	769	768	—	—	22.9	498	13.8
LC (0.95:0.05:2)	769	768	—	—	28.7	623	17.2
LC (0.75:0.25:3)	769	768	—	—	95.6	328	57.4
LC (0.75:0.25:2.5)	769	768	—	—	114.7	393	68.8
LC (0.75:0.25:2)	769	768	—	—	143.4	492	86.0

Notes:
1 Lime (lime : metakaolin : sand) vol. ratio.
2 NHL type (binder : sand) vol. ratio.
3 Lime-metakaolin (lime : metakaolin : sand) vol. ratio.
4 Lime-cement (lime : Portland cement : sand) vol. ratio.

The difference of modulus of elasticity or drying shrinkage between the two mortar layers will indicate the potential bonding problems between them.

The three-point flexural-tensile strength test (table 3) was performed using an Instron 5885H universal mechanical testing machine. Prismatic specimens 40 mm × 40 mm × 160 mm were loaded at a rate of 1.27 mm/min. The compressive strength test (table 3) was carried out on two fragments of each mortar specimen and they were also loaded at a rate of 1.27 mm/min. Dynamic elastic moduli of the mortars were obtained by pulse velocity method using a TICO Ultrasonic Instrument (table 3). Direct transmission technique, in which

Table 2 Plastic panel reinforcements and meshes

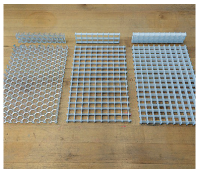
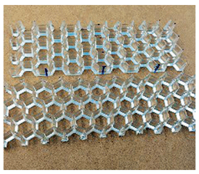
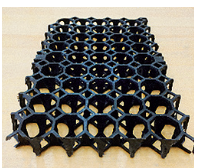
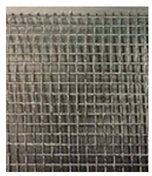
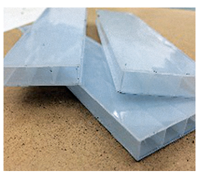
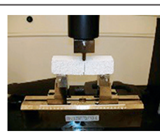
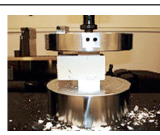
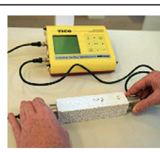
Panels		**Meshes**	
	Grid light diffusers Polystyrene 25–30 US$/m^2		Plaster mesh Polypropylene 1 US$/m^2
	Hexagonal light diffuser PMMA 140 US$/m^2		Diamond geonet High density polyethylene 9 US$/m^2
	Geonet for drainage Polypropylene 20 US$/m^2		Insect screening Fiberglass 3 US$/m^2
	Twin wall sheet Polycarbonate 30 US$/m^2		Chemical-resistant mesh Polypropylene 90 US$/m^2

Table 3 Test methods

Measured Property	**Test Method**	**Standards**	**Specimen Type**	**Specimen Quantity**
Flexural-tensile strength		EN1015-11 EN 196-1 ASTM C348	Beam (40 × 40 × 160 mm)	3
Compressive strength		EN1015-11 EN 196-1 ASTM C348	Fragments from flexural-tensile strength test (40 × 40 × 80 mm)	6
Dynamic elastic modulus		EN 12504-4 ASTM C597	Beam (40 × 40 × 160 mm)	3
Drying shrinkage		ASTM C490	Beam (25 × 25 × 285 mm)	2

the transducers face each other, was implemented using two 82 kHz transducers, pressed on each end of the beam.

All the specimens used for mechanical testing were demolded after 3 days, except for the control lime (CL) group mortar specimens, which needed a longer period to cure since their strength development is slower than that of hydraulic mortars; these were demolded after 5 days. Applied curing conditions included

- 28 days at a relative humidity (RH) of 90 ±5 % and zero days at a RH of 70 ±5 % (abbreviated as 28/0, corresponding to 28 days at 90 ±5 % RH/zero days at 70 ±5 % RH);
- 21 days at a RH of 90 ±5 % and 7 days at a RH of 70 ±5 % (21/7);
- 14 days at a RH of 90 ±5 % and 14 days at a RH of 70 ±5 % (14/14);
- 7 days at a RH of 90 ±5 % and 21 days at a RH of 70 ±5 % (7/21);
- and 28 days at a RH of 70 ±5 % (0/28).

Specimens tested at longer curing times (up to 2 years) were stored at a RH of 70 ±5 % after 28 days of curing. All specimens cured under 28/0 condition were dried out in a chamber filled with nitrogen gas during their last 48 hours of curing before testing. Drying was necessary since a higher moisture content of the specimen would lead to obtaining lower strength and higher dynamic elastic modulus values. Nitrogen gas environment was chosen to avoid carbonation during drying.

The changes in the length of drying shrinkage specimens were measured as the difference between the specimen and an Invar reference bar, which is a low coefficient of expansion alloy bar with a defined length. The comparison is obtained using a length comparator with a digital indicator having a precision of 0.002 mm (table 3). Drying shrinkage (S) results are presented in millimeter/meter (mm/m). These specimens were kept inside the molds under wet burlap and plastic sheets for 7 days until demolding. A longer period than the mortar specimens prepared for mechanical testing was necessary, since they needed to be stronger before demolding due to their particular shape (i.e., being longer and having a smaller cross section than the other mortar specimens). All of the specimens were kept in 90 ±5 % RH until the first measurement, which was taken 14 days after the preparation (i.e., 7 days after demolding). The measurements were repeated every 7 days and continued for 112 days.

The three-point flexural-tensile testing of the reinforcement panels (40 mm × 160 mm) were carried out using the same loading fixture and following the testing procedure used for mortar specimens.

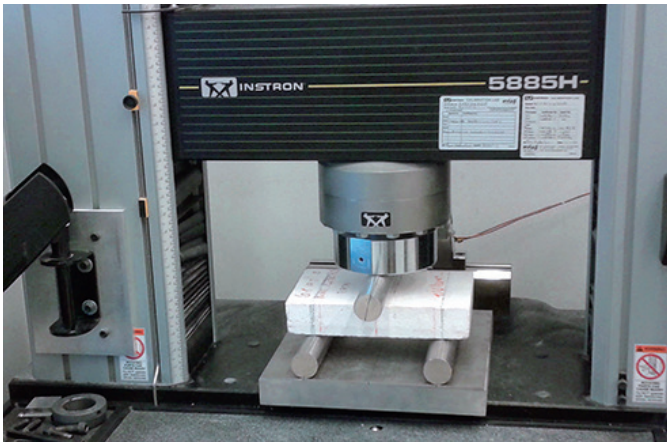


Figure 3 Flexural-tensile strength testing on a mid-scale mockup placed into an in-house built testing fixture loaded by the Instron Universal Testing Machine.

Mid-scale mock-ups (255 mm × 165 mm × 50 mm) (fig. 2) were prepared using commercially available travertine tesserae, selected IL and SL mortar combinations, and with either varying reinforcements and meshes embedded in the SL or without reinforcements. At least two mock-ups were prepared for each mortar and reinforcement configuration. All of the mid-scale mock-ups were observed for a long duration (i.e., up to 3 years) and any physical changes (i.e., detachments within a layer or at the interfaces, or cracking of the mortar layers) were recorded periodically. Once visual evaluation was completed, the three-point flexural-tensile test was carried out using an in-house-built loading fixture that accommodated the nonstandard dimensions of the mid-scale mock-ups (fig. 3). The load was applied at a rate of 1.27 mm/min. During the flexural-tensile strength test, a mid-scale mock-up was broken in half. These two fragments were then used to test the ease of reversibility. A MultiMaster FMM250Q oscillating cutter with a rigid scraper blade was used to cut through the IL and separate the tesserae from the backing. The level of difficulty of removing the backing was determined as the cutting time (i.e., the longer it took to cut, the more difficult it was to remove the backing). If the blade could not cut or was damaged or broken during cutting, it was concluded that the backing was not reversible. A total of four time measurements was obtained for each set of mid-scale mock-ups and the average time was used for comparison.

Results

The flexural-tensile results of the NHL and CL mortars cured under five conditions are shown in figure 4(A). Long-term flexural-strength results of selected NHL mortars are given in figure 4(B). Due to space limitations, the results of the other

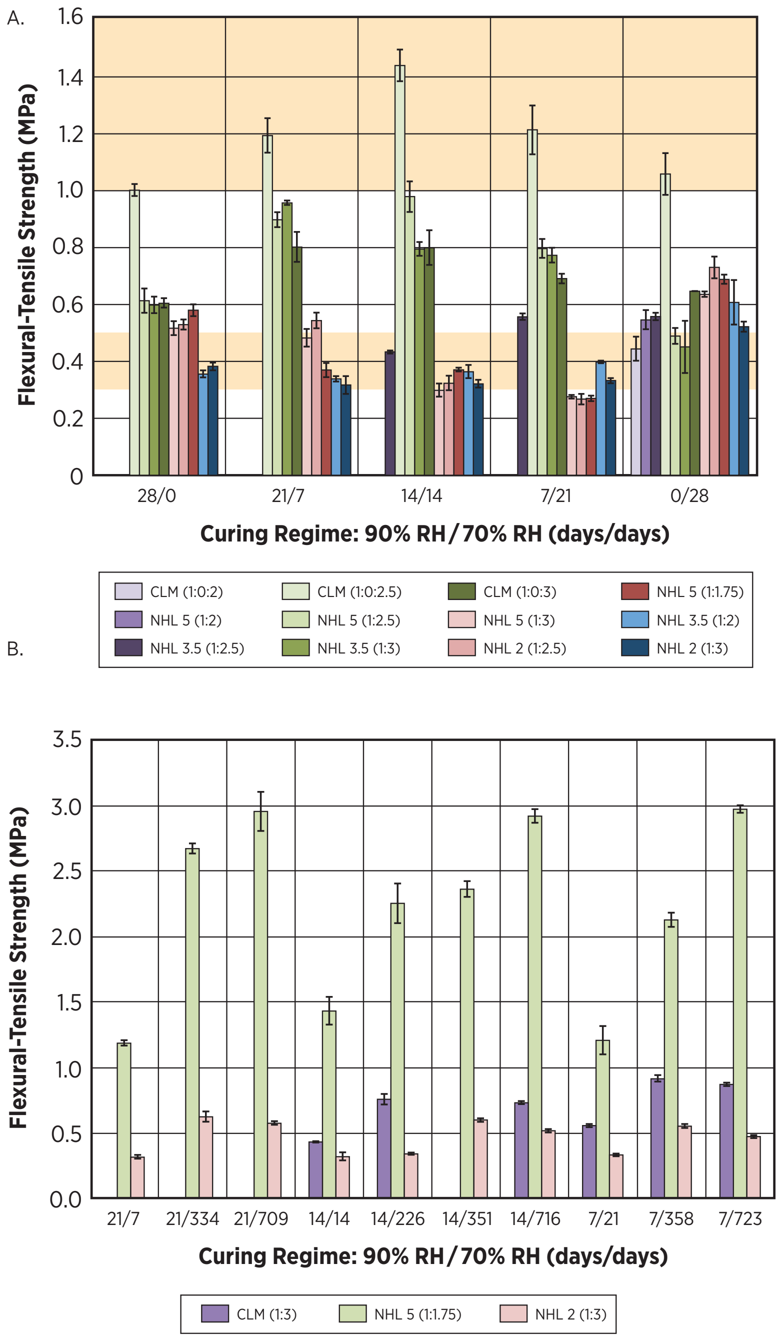


Figure 4 Flexural-tensile strength results of NHL and CLM mortars under (A) five curing conditions at 28 days old (shaded area above 1 MPa indicates SL mortar candidates and shaded area between 0.3-0.5 MPa indicates IL mortar candidates); and (B) three curing conditions up to 2 years old

mortars and the dynamic modulus of elasticity results are not discussed in this paper.

The design criteria for the two mortar layers were decided based on literature reviews and expert opinions, and all the candidate mortars were evaluated against these criteria. Acceptable flexural-tensile strength values for the IL after 28 days of curing was defined as 0.30–0.50 megapascal (MPa), which is the upper limit of the range of the flexural-tensile strength of lime mortars, and higher than 1 MPa for the SL, also after 28 days of curing. The design strength range of the IL mortar, as defined by the design criteria, aims for making the backing easily reversible (the higher limit) while still providing some flexural-tensile strength (the lower limit). The design strength for the SL took into account the effect of flexural-tensile strength on the thickness of the backing and, therefore, on the overall weight of the backed mosaic (the weaker the mortar, the thicker the SL needs to be to support the mosaic). The linear drying shrinkage criterion for the

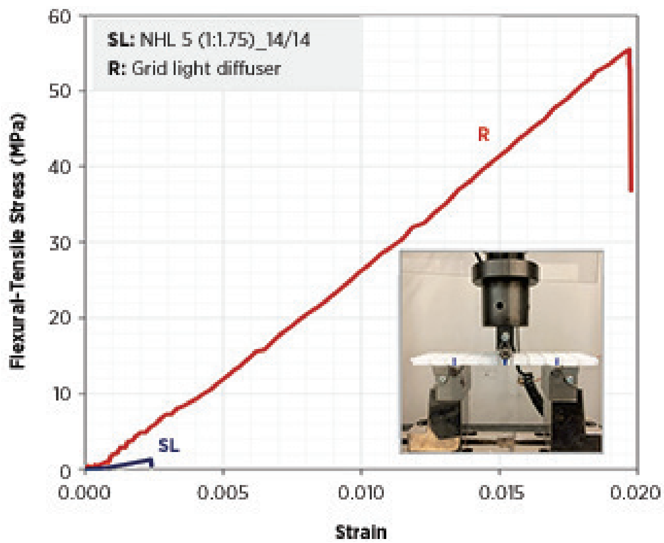


Figure 5 Flexural-tensile strength comparison of NHL 5 (1:1.75) mortar cured under 14/14 and grid light diffuser

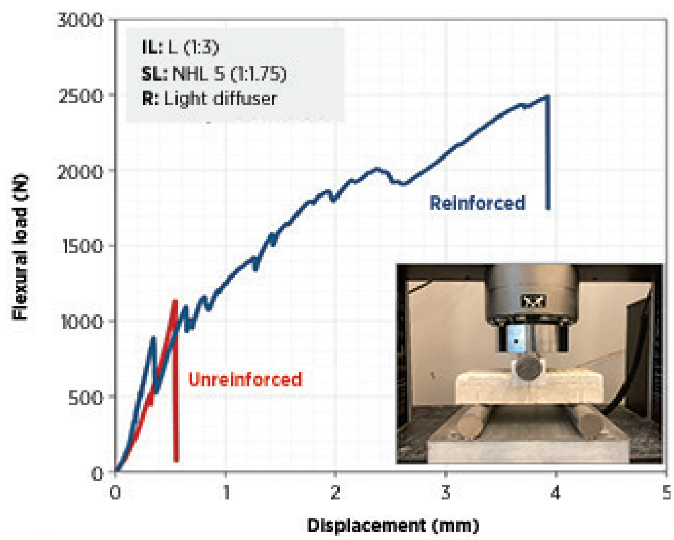


Figure 6 Flexural-tensile strength comparison of unreinforced mid-scale mockup, CLM (1:3) as IL and NHL 5 (1:1.75) as SL; and reinforced mid-scale mockup (same IL and SL) with grid light diffuser

SL and IL mortars was determined as the percent difference between the drying shrinkages of two mortars (i.e., drying shrinkage of IL (S_{IL}) and drying shrinkage of SL (S_{SL})) being less than 50%; the equation provided is in table 4.The relative drying shrinkage results of the IL and SL combinations that fulfilled the strength criteria are also given in table 4.

The flexural-tensile strength comparison of mortar and grid light diffuser is given in figure 5. The load carrying capacity of a plain mid-scale mock-up is compared to a reinforced (using a grid light diffuser) mock-up in figure 6. Finally, the reversibility of the mock-ups is discussed in figure 7.

Discussion

Mortar and Reinforcement Tests

Flexural-Tensile Strength

As expected, flexural-tensile strengths of the NHL 5 mortars (fig. 4A) were higher than the defined IL flexural-tensile strength limit. Only the NHL 5 (1:1.75) mortar satisfied the strength limit. Only the NHL 5 (1:1.75) mortar satisfied the flexural-tensile strength criterion of the SL mortar (which should be > 1 MPa) under all curing conditions. While the strength of the NHL 5 (1:2) sample cured under 14/14 was also very close to 1 MPa, the NHL 5 (1:1.75) mortar performed best under all curing conditions and was selected as the SL mortar.

Apart from metal reinforcements, which are ductile (i.e., undergo a substantial deformation before failure), flexural-tensile strength test results of the grid light diffuser (fig. 5) showed a brittle failure indicated by a sudden drop of stress after maximum stress is reached. The strength of the diffuser was considerably higher than the mortar; therefore, it was expected to improve the load bearing capacity of the mortar when embedded. However, due to the brittle failure of both the reinforcement and mortar, the backing also demonstrated brittle failure (i.e., sudden failure without any visual signs such as deformation or cracking).

Curing Conditions

All of the NHL 2 mortars and NHL 3.5 mortars cured under 28/0, 21/7, and 14/14 were considered IL mortar candidates since their strength values were between 0.3 and 0.5 MPa (fig. 4(A)). Following the same criterion, the CL (1:3) and CL (1:2.5) mortars in the control group were also considered IL mortar candidates.

Table 4 Selected IL and SL combination and their differential drying shrinkage results

Mortar Combinations		Days in 90% RH	Differential Drying Shrinkage[1] (%)
IL	SL		
NHL 2 (1:3)	NHL 5 (1:1.75)	7	77
NHL 3.5 (1:3)	NHL 5 (1:1.75)	14	45
NHL 3.5 (1:2.5)	NHL 5 (1:1.75)	14	10
CLM (1:3)	NHL 5 (1:1.75)	7	38

[1] Differential drying shrinkage $= \frac{S_{IL} - S_{SL}}{S_{IL}} \times 100$

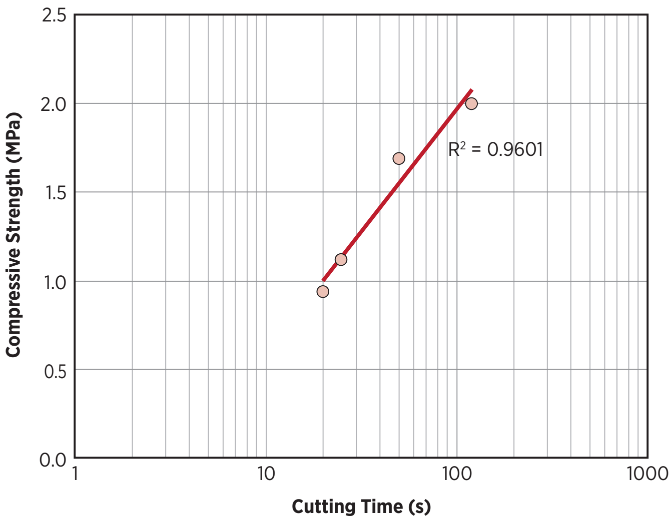


Figure 7 Relation between the compressive strength of IL mortars and the cutting time needed to separate mosaic from the backing

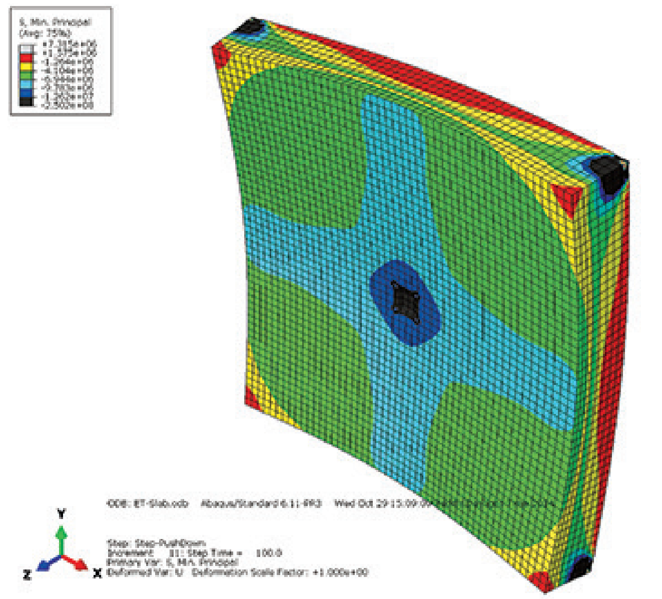


Figure 8 Computer model of a mortar beam and grid light diffusers is used to design the model of the mortar slab (minimum principle stress results of a center-loaded and corner-supported backing are shown).

Different curing conditions resulted in up to a 60% increase in flexural-tensile strength of the NHL mortars. For example, the flexural-tensile strength of the NHL 5 (1:1.75) mortar was 1.0 MPa under 28/0 and more than 1.4 MPa under 14/14 (fig. 4(A)). The initial effects of the curing conditions on the flexural-tensile strength of the NHL 2(1:3) and CLM (1:3) mortars were diminished after one year of curing (Fig. 4(B)) and there was no impact on the strength of the NHL 5 (1:1.75) mortar after two years. These results demonstrated that curing could be used to speed up the strength development of mortars at early ages without adverse effects on the long-term strength development. Unfortunately, most of the time there was no single curing condition that provided optimum mechanical properties for both the IL and SL mortars. It should be also considered that the curing conditions of the IL could not be directly controlled since the IL was covered with the SL when it was still fresh to improve bonding and avoid cold-joint formation and, therefore, delaying the drying of the IL. Our tests indicated that it took approximately two weeks for the RH in the IL to reduce to 70% RH when the mock-ups are exposed to 70% RH. Therefore the most likely curing condition of the IL would be 28/0 or 21/7 or 14/14 during the first 28 days, depending on the applied overall curing condition. As a result, the curing condition including the longest 70% RH exposure, which also led to acceptable mechanical properties of the SL, was selected as the overall curing conditions for the backing.

Mock-up Tests

Among all of the NHL mid-scale mock-ups, only the ones prepared with NHL 2 (1:3) as the IL and NHL 5 (1:1.75) as the SL and cured under 7 days in 90% RH demonstrated detachment, between the tesserae and the IL, and was noted after 18 months of observation. The lack of delamination between the IL and SL of the mid-scale mock-ups showed that the differential shrinkage between the mortar layers (table 4) could be as high as 77%, much higher than the initially considered limit (50%). This criterion will be revised once large-scale tests are completed.

The comparison of the flexural-tensile test of unreinforced and reinforced mid-scale mock-ups in figure 6 showed that the use of reinforcement noticeably increased the load bearing capacity (more than a 100% increase), as well as enhanced the toughness (i.e., the ability of the material to deform and absorb energy before failure), which is calculated as the area under the curve in figure 6. The latter demonstrated that the amount of energy that could be absorbed by the support had also increased. Observations and strength test results did not indicate any problems regarding the durability of reinforcements in the mortars.

Reversibility tests that included cutting through IL mortar from the side of mid-scale mock-ups (165 mm long) showed that it took an average of 120 seconds (s) to remove the NHL 5 (1:3) mortar, 50 s to remove the NHL 3.5 (1:3) mortar, 25 s to remove the NHL 2 (1:3) mortar, and 20 s to remove the CLM

(1:3) sample. All of the IL mortars were cut with a straight line without damaging the tesserae. The average compressive strength of these IL mortars after 28 days of curing had a linear correlation with the log of their cutting time (fig. 7). This relationship will be further investigated, and it will be used to determine a critical compressive strength for the IL mortars while ensuring reversibility.

Computer Model Development

Simulation studies showed that the overall response of flexural-tensile strength tests of a prismatic mortar specimen and polystyrene light diffusers could be simulated with reasonable accuracy using the Concrete Damage Plasticity model (CDP) in ABAQUS. This model assumes that the main two failure mechanisms are tensile cracking and compressive crushing of the material. During flexural-tensile strength tests, the top of the mortar specimen is crushed under compression and the bottom of the specimen is cracked due to tension. Both simulations matched the experimentally obtained maximum stress level and the transverse strain at maximum stress level (see fig. 5). At present, the development of finite element models of a mid-scale mock-up continues. Figure 8 shows the computer model results for a center-loaded and corner-supported mock-up. Further analyses for various possible storage conditions (stacked or side by side) resulting in varying loading and support conditions including two side-supported or four side-supported that can be encountered in the field will be also carried out.

Conclusions

Preliminary results showed that two-layer lime-based mortar backing systems with plastic reinforcements could be a viable cost-effective option for backing lifted mosaics. Selected IL and SL mortars (CLM and NHL mortars) stayed bonded to each other, to the mosaic, and to the plastic reinforcement until the end of testing (up to 3 years). Curing conditions could be used to speed up the strength development of mortars at early stages without any adverse effect on the long-term strength development. However, there was not a single curing condition that provided optimum mechanical properties for both the IL and SL mortars. Grid light diffusers were found to be durable in NHL mortars. Based on the strong correlation between the compressive strength of the IL mortar and the cutting time needed for reversibility, a maximum compressive strength would be determined for IL mortars based on the selected reversibility method (i.e., cutting with a oscillating cutter). Mortar candidates having compressive strength values higher than the limit will be avoided. It was also shown that the existing state-of-the-art material models and computation simulation methodologies (i.e., FE) were able to mimic the mechanical response of IL and SL mortar specimens, plastic grid reinforcements, and mock-ups prepared with NHL mortars.

A limited number of large-scale mock-ups will be tested to study the possible implementation issues related to installing the reinforcements, curing, possible strength development issues (i.e., carbonation), and assessing the final design criteria. Finally, large-scale mock-ups will support the computer model development by demonstrating how well the model can predict the mechanical response (deflection and strength) of backed mosaics.

Acknowledgments

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Innovative Materials for Restoring Mosaic Pavements of the Roman Villa of Silin (Lepcis Magna, Libya)

Barbara Davidde Petriaggi, Carla D'Angelo, Daniela Gennari, Vincenzo Angeletti Latini, Adel El-Turki, Maria Laura Santarelli, Franco Bontempi, Stefania Arangio, Gaia Quattrociocchi, and Martina Zuena

Abstract: *This paper presents the results of a study conducted by the Istituto Superiore per la Conservazione ed il Restauro and by the Sapienza University of Rome to restore a mosaic of the Roman Villa of Silin. Detached after the discovery and relayed on reinforced concrete panels with iron net, it presented complex conservation conditions because of its proximity to the sea. The restoration interventions included lifting and disassembling of the mosaic panels, removal of the metal, and partial removal of the concrete. An extensive study was carried out in order to select the best support for the panels and the in situ replacement.*

Villa of Silin is one of the most important Roman maritime villas on the Libyan coast (Al Mahjub 1980, 1987; Musso 1995) (fig. 1). The ancient landscape of Lepcis Magna was characterized at the turn of the second century CE by the presence of luxury coastal residences, often located on promontories (Salza Prina Ricotti 1970–71; Musso 1995; Petriaggi, Calì, and Davidde 2010; Davidde et al. 2011) or slightly inland (Musso 1996: 152–168). More modest homesteads and farms were also present farther inland. The gradual abandonment of these villas started around the middle of the third century as a result of a deteriorating economic situation. The farming network went into decline in the middle of the fifth century, after the Vandal conquest (Munzi 2010: 52).

Discovered in 1974 at the mouth of the Wadi Yala about 15 kilometers west of Lepcis Magna, the villa was in good condition, though all the original roofs no longer existed. Thanks to the protective covers deployed during excavation work, the rich decorative features of the mosaics and the walls, in some cases exquisite in nature, were preserved. The mosaic floors have been dated by Luisa Musso to between 140 and 160 CE. The villa was abandoned in the middle of the third century (Munzi 2010: 52).

The rich decorative elements of the villa consist of *sectilia* and polychromatic mosaics of stone and glass tesserae (Musso 1994, 1995; Papini 1984; Picard 1985; Dolciotti 2010). The main causes of deterioration are the exposed maritime location and the conservation measures undertaken in the late 1970s when the site was first discovered. Inappropriate techniques and materials were used, including failure to ensure constant maintenance of protective coverings or to replace severely damaged sections.

For these reasons, after a joint inspection of the site in December 2011, a convention was signed in 2012 by the Department of Antiquities (DoA) of Libya, Istituto Superiore per la Conservazione ed il Restauro (ISCR), and the Roma Tre University to establish an operational framework for the study and restoration of the villa.[1] The work started in September 2012 and is still under way. It is coordinated by ISCR[2] and funded by the Italian Ministero dei Beni, delle Attività Culturali e del Turismo. Results to date include a conservation plan for the whole site, emergency conservation work on the mosaic floors and the murals, experiments with new conservation materials, and training of the Libyan technical personnel.

The team also includes an architect, Riccardo Dalla Negra, and an engineer from the University of Ferrara, Andrea Giannantoni, who are conducting research on the deterioration of the structures and working on the design of new protective coverings; and a research team from CISTeC (Sapienza University Rome), led by Maria Laura Santarelli, which is investigating new materials for the restoration of the mosaic floors.[3]

The development of a conservation plan has led to the following activities: laser scanning of the whole complex, high-resolution photographic documentation using both natural and oblique lighting, analysis of the constituent materials of

Figure 1 Villa of Silin: laser scan showing the view from the north; on the right, mosaic A1 of the peristyle. Image: ISCR Archive

the villa, analysis of the factors contributing to environmental and structural deterioration of the site, cataloging of the deterioration in each room and each decorative element (mosaics, *sectilia*, and murals), mapping the methods and techniques of earlier conservation measures and the current situation, and urgent conservation measures undertaken to ensure the safety of the artifacts at highest risk.[4] The walls have been studied, and preliminary work on designing new protective coverings has been undertaken.[5]

We present here the research, analyses, and experiments undertaken to restore mosaic A1 of the peristyle. The mosaic flooring, *sectilia*, murals, and architectural structures of the villa will be discussed in forthcoming publications.

The Condition of the Mosaic Flooring

Most of the flooring was lifted and reassembled on layers of concrete reinforced with iron rods during 1977–1979. Detaching the tesserae led to severe damage even shortly after the work was done, as noted in the reports produced by the Roma Tre University and the ICR following several site visits and regular restoration work between the 1990s and 2011.

Deterioration has intensified over time as a result of the harsh environmental conditions of the location of the villa and inadequate maintenance of protective coverings and structures. The close proximity of the sea has exposed the mosaics to deposits of soluble salts, in particular chlorides. Moreover, the abrasive effects of airborne sand, exposure to intense solar radiation, and wide day/night temperature variations subject both the original materials and the exposed restoration materials to mechanical stress. Further deterioration has been caused by the vascular and ornamental flora that colonize the archaeological remains and by photosynthetic microflora.

Initial work consisted of studying the condition of the flooring in order to determine appropriate conservation measures. To elaborate the conservation plan, it was first necessary to gather data on the condition of the surfaces, the nature of the deterioration agents, and the principal constituents of the original and the early restoration materials. This phase revealed that the mosaics that were exposed completely or partially to environmental forces showed the severest damage, especially in the mosaic layer and the supporting layers, where still extant.

The principal forms of deterioration noted include widespread erosion of the tesserae (in particular, black leucitite tesserae), cracking, flaking, crumbling, and detachment from the bedding layer, leading to lacunae and microlacunae. Mosaics still on their original bedding layers show deformation and detachment from these layers. There are also widespread areas exhibiting biological patina, especially where deformation has allowed stagnant water to accumulate and where conservation materials have been applied in the past using cotton gauze and organic glue. The roots of the invading vegetation have also contributed to the detachment of the tesserae in several areas and to the disintegration of the original grouting.

Mosaics reassembled on concrete panels were obviously in a more critical condition. The oxidation of the metal reinforcement rods, often placed in direct contact with the tesserae, has caused widespread deformation and detachment. In some cases the damage was severe enough to cause cracking and crumbling in the concrete itself.

The floors of the interior of the villa exhibited different characteristics. Although most of these had also been detached and then reassembled on reinforced concrete, they were found to be in a less serious and generally more stable condition (Davidde Petriaggi et al. forthcoming).

Stabilizing of the Mosaic Floors and Dismantling of the A1 Mosaic Panels

A number of measures were undertaken during the first phase of work in September and October 2012 to stabilize the condition of the most severely damaged areas (Davidde Petriaggi et al. forthcoming). More complex measures addressing the mosaics of the northwest arm of the peristyle were initiated in April and May 2013, and a series of experiments were conducted in Rome in collaboration with CiSTEC. The oxidation of the iron rods in the concrete has produced severe deformation, as well as cracking and stratified exfoliation. This has also caused crumbling of the mortar and some missing sections in the concrete support, and the consequent detachment of large areas of tesserae. Urgent action to arrest this deterioration was required.

We decided to start with floor A1 of the peristyle, given the seriousness of its condition and the severe deformation of the mosaic surface caused by the oxidized iron rods (figs. 2, 3). It was clear that the best approach would be to dismantle the panels, partially remove the reinforced concrete,[6] and create new supporting structures (possibly freestanding) to replace the floor in situ.

Once the methodology had been defined and agreed on in May 2013 and the preliminary emergency work had been completed, the dismantling of the mosaic panels of floor A1 of the peristyle was initiated. This work focused on ten mosaic panels, some 4 cm thick and varying in surface area from 120 × 170 cm to 170 × 283 cm.[7]

Before dismantling the panels, the entire mosaic was documented in detail and the surfaces were carefully prepared to ensure the stability of the tesserae on the concrete substrate and good adhesion of the protective binding. The mosaic

Figure 2 The original state of preservation of the mosaic. Photo: ISCR Archive

Figure 3 Removal of materials used during earlier work; iron rods in the concrete that have caused severe deformation and cracks are visible. Photo: ISCR Archive

was cleaned, the tesserae were consolidated with mortar, and the lacunae, microlacunae, and surface discontinuities were filled using Saint-Astier NHL 3.5 hydraulic lime and local sand (1:3). Then the mosaic surface was treated with a double layer of protective coating using cotton gauze and sealed with a 20% solvent solution (acetone) of Paraloid B72. Reference points were inserted for subsequent repositioning.

The complexity of the operation called for a series of preliminary tests and checks to ensure the safe dismantling of the panels, refining all the procedures required to maintain the integrity of the mosaic during the phases of dismantling, handling, and transportation from the site, as well as during the later work to remove the reinforced concrete.

Preliminary investigations and examination of images held at the Lepcis Magna Department of Antiquities revealed that the mosaic panels had been laid on the concrete base and fixed with a coarse paste only in a few small areas, mainly near the edges. Moreover, a number of stone fragments were found that had been used as spacers to level the panels. This had created 1 cm to 2 cm gaps between the panels and the screed below. These points of adhesion were removed using diamond-tipped saws, hand chisels, and serrated metal strips, taking care to avoid damage to the tesserae.

Bespoke (made-to-measure) supports were used to lift each of the panels. These supports were designed not only to facilitate the dismantling, lifting, and transportation of the panels to the Lepcis laboratory during this phase of the work but also to allow the sections to be rotated when work was required on the back. The supports were made of varnished galvanized iron strips to hold the sections rigid and to provide lifting points.

The structures were inserted between each panel and the screed, then hooked to similar structures above to create a rigid cage suitable for transporting the individual panels from the site. Deformed sections and those rendered extremely thin as a result of cracking, detachment, or loss of substantial amounts of concrete were supported by expanded polyurethane cushioning or Stratocell foam. The mosaics and their metal cages were then wrapped in elastic cushioning material and moved to the Lepcis Magna DoA warehouse, where work to replace the concrete will be undertaken (figs. 4, 5).

Figure 4 Dismantling phase of the panels: insertion of galvanized iron strips to facilitate the dismantling, lifting, and transport of the mosaic. Photo: ISCR Archive

Figure 5 Lifting phase of one of the mosaic panels, showing the crane lifting the made-to-measure metal box. Photo: ISCR Archive

Scientific Tests and Laboratory Analyses

The CISTeC research focused on defining a solution that was noninvasive, innovative, and reversible if required. The aim of this investigation is the identification and validation of a solution for the replacement of the screed that supports the mosaic. The existing screed is composed of concrete with embedded steel reinforcing bars. Due to the aggressive environment this screed was severely damaged. Influencing the degradation was the choice of materials (concrete and steel), which are not suitable for the environmental conditions; moreover, the thickness of the support was not adequate, and the lack of isolation and dilation joints could have led to the occurrence of cracks.

In order to design the new support, some specific requirements were taken into account:

- The intervention should be as noninvasive as possible and reversible, even over time.
- The intervention should make use of natural sustainable materials but at the same time guarantee adequate structural performance.
- The compatibility of the new materials with the residual concrete, which is in direct contact with the mosaic tiles, has to be assured.

Starting from these requirements, chemical and structural analyses were carried out in order to choose the materials and define an optimized design for the panels. The cross section and the aerial view of the chosen solution are shown in figure 6. There is a new foundation, and above this there are various rows of small Roman bricks that support the new panels.

It was decided to demolish the existing concrete foundation under the panels and rebuild a new thinner one in order to keep the mosaic at the same height but allow the use of thicker support panels. In the new foundation, instead of the common metallic reinforcing bars, a basalt grid will be embedded.

The layer of Roman bricks (standard dimensions: 27.5 × 13 × 2.8 cm) has been inserted because the bricks provide good structural support for the panels and good insulation against humidity; furthermore, they are made of a natural material, compatible with the ancient construction techniques. As it is possible to see in figure 6B, the rows of bricks have been placed in the longitudinal direction, allowing access from the right-hand side for placement of the panels.

The new support panels for the mosaic will be cast before their placement on the rear part of the mosaic; then the panels will be rotated and placed in the upright position. The new support, measuring 5 cm, is composed of natural hydraulic lime, local sand, water, chopped basalt fibers, and basalt MiniBars. These materials were selected after extensive testing. The testing was carried out in two phases: first, for the selection of the binder and the type of fibers; second, to determine the optimal mix and select the reinforcements.

Selection of Binder and Fibers

The binders were chosen among those that do not contain gypsum and that have low salt content.

The binders that were tested are the following:

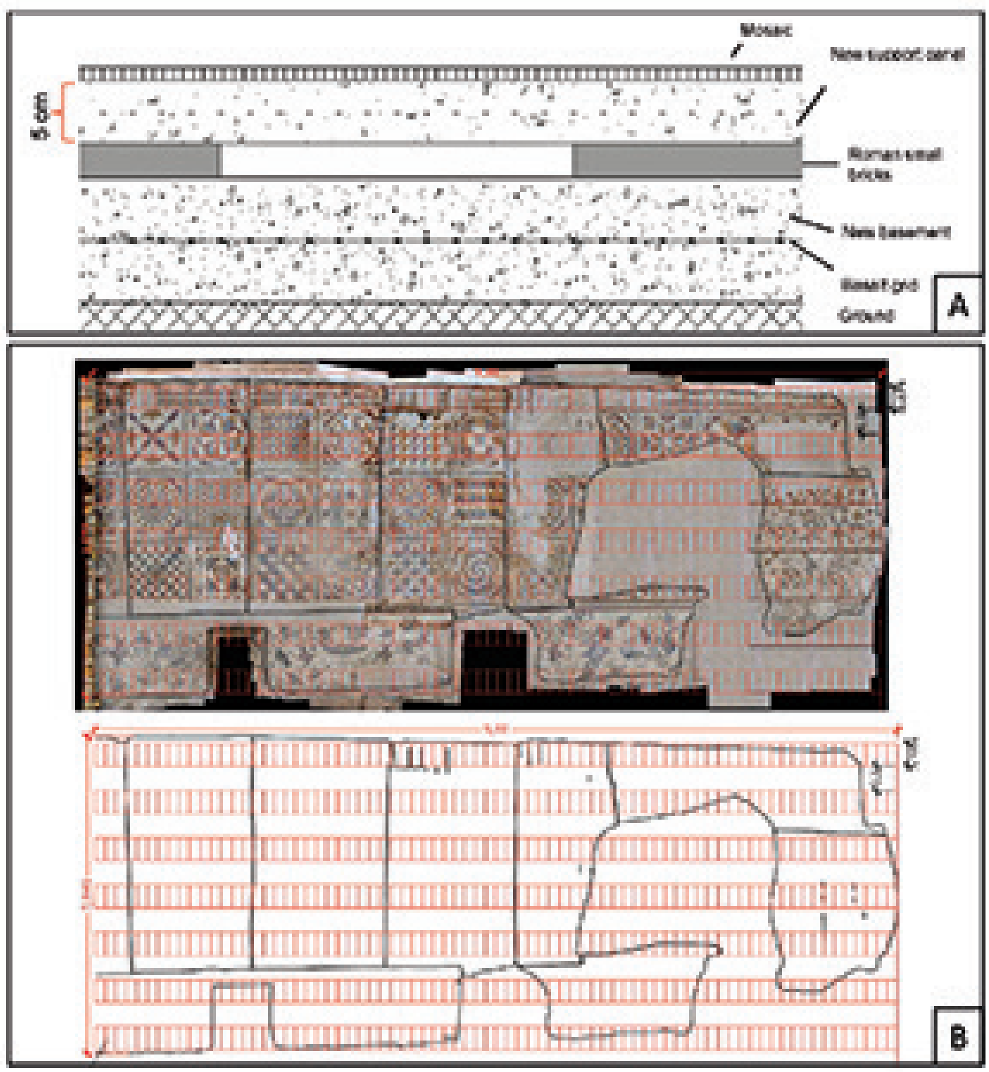

Figure 6 (A) Cross section of the chosen solution. (B) Scheme of the design of the new support for the panels.
Image: ISCR Archive

- Natural hydraulic lime Saint-Astier types NHL 3.5 and 5;
- Natural hydraulic limes premixed with sand aggregates having a defined granulometry: CIMAX MAS ES hydraulic lime and CIMAX MAS ES cocciopesto.

The various binders were tested with different percentages of basalt fibers of various types and lengths (chopped and milled) in order to identify the best type and the right percentage. Basalt was chosen because it is natural and sustainable and has good structural properties: high tensile strength, which can lead to a 95% reduction in shrinkage cracks; not prone to corrosion; and very durable, providing a longer life and lower life cycle costs. Moreover, the basalt fibers do not float or sink, providing for fast and effective mixing, and they are highly compatible with concrete.

The different mortars were studied to verify their compatibility with the substrate of residual concrete and to evaluate their mechanical properties. Their compositions were investigated using thermogravimetric analysis (TGA) and X-ray diffraction (XRD). These tests showed that the addition of fibers significantly improves the strength and ductility of the binders. The best behavior, in terms of both strength and deformability, was given by the Saint Astier NHL 5 mixed with chopped fibers, and this was chosen for the new panels.

Structural Performance of Basalt Grids and MiniBars

In order to give adequate structural strength to the panel it was necessary to add to the mixture basalt grids or MiniBars as reinforcements. Different mixtures were considered and their mechanical properties evaluated and compared by means of flexural tests carried out on full-scale specimens. The tests were conducted on eight simply supported plates 100 × 50 × 5 cm, with an increasing load at the midspan. The tested materials are shown in figure 6:

B) Mortar made with hydraulic lime of the type Saint Astier NHL 5 and a feldspatic silica sand (ratio 1:2);
C) Chopped basalt fibers in different percentages (length ½ in.);
D) Basalt MiniBars (length 43 mm; diameter 0.65 mm);
E) Reinforced basalt grid 25 × 25 mm.

The different mixtures are schematized in table 1.

Figure 7 shows the load-displacement curves obtained for the various plates. Some mixtures were tested also under cyclic loads (mixtures B1 and B4). It is possible to observe that the mortars without chopped fibers (green curves) are less ductile than the others. The light blue curve and the deep blue one represent the behavior given by different percentages of fibers (6% and 3% in weight respectively). The brown and red curves refer to the mixture with basalt MiniBars (and without basalt geogrid). They have a high load capacity and good ductile behavior. It was an innovative application to use MiniBars with this lower-strength binder since they are most commonly used with high-strength concrete.

Table 1 Different mixtures of the tested materials

No.	NHL 5	Chopped Fibers	Basalt Geogrid (H = 2.5 cm)	MiniBars
B1	X	No	X	No
B2	X	X 6%W	X	No
B3	X	X 3%W	X	No
B4	X	X 2%W	No	X

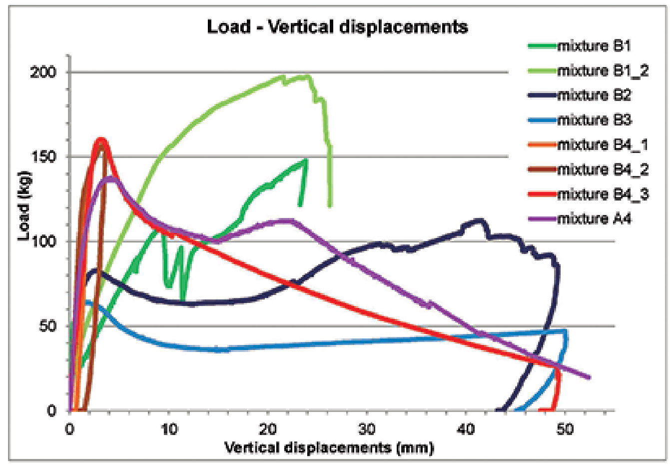

Figure 7 Comparison of the results in the working range of the considered situation. Graph: ISCRA Archive

The supports are supposed to work under load for very small displacements, so it is important to analyze and compare the behavior of the different mixtures within a range of displacements. The plot in figure 7 shows the curves for displacements under 1 mm. All the mixtures with chopped fibers in this range have a more or less linear behavior. In the end, mixture B4 (chopped fibers + MiniBars) was chosen because it exhibits a higher load capacity and good behavior when subjected to cyclical loads.

Numerical Analysis for Validation of the Design

All the investigations were supported by accurate finite element analyses. Linear and nonlinear analyses able to consider the behavior of the plate in operational condition and during the transitory phase (movement of the panels) were carried out. For example, figure 8 shows the vertical displacements obtained by a nonlinear analysis under the live load of 2.5 kN/m^2. All the analyses showed that for the considered load combination the behavior of the plate is linear.

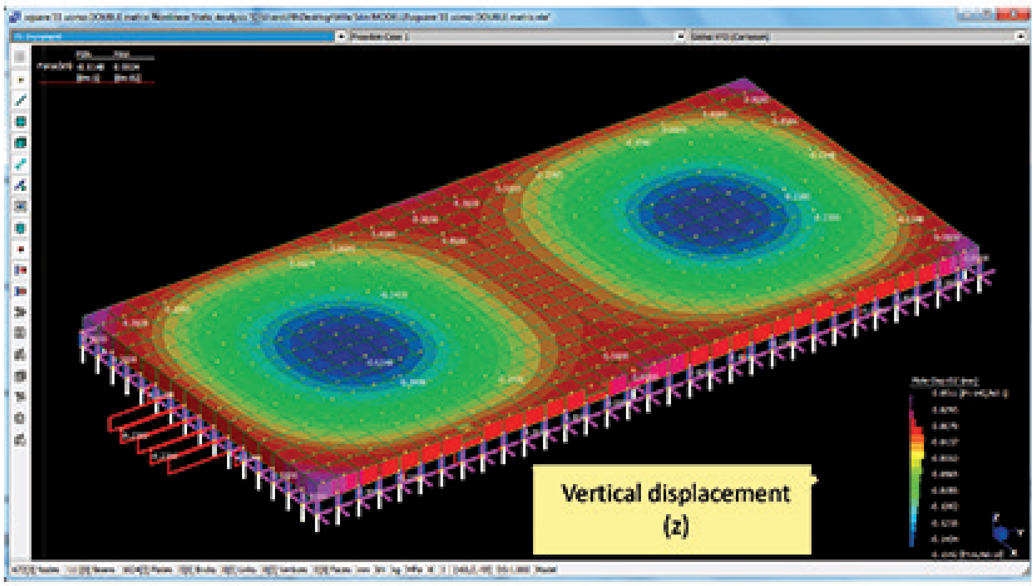

Figure 8 Finite element analysis: Vertical displacements (nonlinear analysis). Image: ISCRA Archive

The Project to Reposition Mosaic A1

Unfortunately, the volatile political situation in Libya has meant that this work, planned for May and June 2014, had to be postponed.

The planned project to reposition the A1 floor in situ is as follows. First, the thickness of the concrete layer of each single panel will be reduced by creating a series of close incisions using diamond-tipped saws, allowing access to and removal of the metal rods, leaving a thin layer of concrete in contact with the tesserae. The new support panels will be made of biocompatible cement-free mortar, mixed on-site and applied directly to the remaining layer of concrete. The new mortar will consist of Saint-Astier NHL 5 (natural hydraulic lime), local aggregate, and mixture B4 containing chopped fibers and MiniBars to give a final thickness of 5 cm, following the specifications of the protocol elaborated by CISTeC. These panels will be freestanding and, once finished, will be returned to Silin for in situ repositioning on a new screed foundation and the final restoration of the surfaces.

Conclusion

Preliminary work in the Roman Villa of Silin included emergency conservation, professional training, scientific research, and the production of a structured conservation plan for the site. The project funded by the Italian Ministry of Cultural Heritage and Activities and Tourism envisaged not only the repositioning of mosaic A1 but also the restoration of the master *cubiculum*, which has a geometric mosaic and emblema depicting *Damnatio ad Bestias*.

We hope that the political situation will stabilize, and we will be able to return to complete this work. The restoration and enhancement of the Villa of Silin could contribute to the improvement of local socioeconomic conditions by becoming a focus for tourism and cultural activities and provide new opportunities for cultural exchange between Italy and Libya.

Notes

1 Roma Tre University, as part of its Archaeological Mission led by Luisa Musso, has for years been involved in the study of the site, with regular conservation measures applied to some of the mosaics and wall paintings. We thank her for her scientific expertise but also for the energy and enthusiasm with which she has worked over all these years on the conservation of this monument. Much of the work done so far would not have been possible without her dedication. We would also like to thank the various directors of the Department of Antiquities of Libya, Tripoli, since 2012 and the Superintendency of Antiquities of Lepcis Magna, as well as Jabar Majub and our colleagues at the Superintendency for their help and support during this work. We also offer our deepest thanks to Gisella Capponi, director of ISCR, and the contribution that her valuable advice has made to this work, and to the Italian embassy in Tripoli, in particular Ambassador Giuseppe Buccino Grimaldi, for the support given to the ISCR.

2 B. Davidde Petriaggi is the scientific and administrative coordinator. C. D'Angelo and D. Gennari took part in the planning of the restoration of the mosaics flooring, and M. J. Manò took part in the planning of the restoration of the wall paintings. Vincenzo Angeletti Latini took part in the planning of the assessment of the condition of the buildings and of the transportation of the mosaic panels. Adel El-Turki provided technical advice concerning the restoration work.

3 The team is composed of the authors of this paper.

4 The conservation data were gathered by the restorers F. Moro and A. Pujia, coordinated by D. Gennari and C. D'Angelo. Diagnostic investigation was performed by Lucia Conti and Giancarlo Sidoti of ISCR's chemical and materials testing laboratory, and by Anna Maria Pietrini and Antonella Altieri of ISCR's biology laboratory. Photographic documentation was produced by Angelo Rubino and graphic documentation by the architect Sergio Tagliacozzi of ISCR's documentation service. Laser scanning was executed by Pietro Gasparri (CPT Studio srl). The following equipment was used: FARO Focus 3D 120 laser scanner with integrated digital camera, Canon EOS 5D MarkII 21MP with lens calibrated for relief photogrammetry, Leica Geosystems TS02 workstation for 3D model creation.

5 The Department of Antiquities of Libya, Tripoli, pending funding to allow new protective structures to be built, has for years been using the limited funds at its disposal to at least minimize rainwater damage.

6 The complete removal of the reinforced concrete would not only have taken too much time, but would have risked damage to the tesserae.

7 The work was executed by R.O.M.A.Consorzio under the direction of ISCR.

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Conservation and Restoration of Mosaics from the Roman Towns of Emona and Celeia (Slovenia)

Martina Lesar-Kikelj, Katarina Žagar, Sabina Kramar, Lina Završnik, Matjaž Bizjak, Maja Gutman, Katarina Toman Kracina, and Bernarda Županek

Abstract: *This paper presents the conservation and restoration of two Roman mosaics from Slovenia. The two cases discussed differ fundamentally, in both the lifting and preservation circumstances and in the presentation demands. In the first case, a mosaic from Roman Emona (Ljubljana, Slovenia) that had been lifted decades ago was conserved for museum presentation, which required a new lightweight and movable support. In the second case, the conservation-restoration was carried out in order to preserve a mosaic in situ at the site of Roman Celeia that will likely be presented in an airtight display case with a controlled microclimate.*

The Large Mosaic XIII.8 from Roman Emona

Our first case study is a large mosaic from the Roman town Emona. Colonia Iulia Emona was built in the area of modern Ljubljana (Slovenia) at the beginning of the first century CE and flourished up to the mid-fifth century, slowly declining thereafter. The remains of the Roman town were archaeologically researched from the end of the nineteenth century on, and the topography of Emona is consequently quite well known. Several mosaics were discovered in public and private buildings, predominantly of a geometric and black-and-white design.

The remains of the mosaic XIII.8 (found in insula XIII, room 8) were discovered during large-scale archaeological excavations in the eastern part of the Roman town in 1996–1997 (fig. 1). The same mosaic was first discovered in 1909–1912, during the large excavation campaign led by W. Schmid. The results of this excavation were published (Schmid 1913), and the mosaic was reburied, as were several of the other mosaics found by Schmid (Djurić 1976).

In 1996–1997 the mosaic was rediscovered during a large excavation campaign aimed at exploring and clearing the site for construction of the new National and University Library of Slovenia. The mosaic was first documented with photographs and drawings and an exact colored copy on PVC film was made. Then the mosaic was cut into fourteen rectangular pieces. On the facing of the mosaic fragments a solution of Paraloid B72 and Mowilith in toluene was applied, and the fourteen pieces were lifted separately onto temporary wooden supports. The edges of the fragments were temporarily protected with a facing and cement mortar and the pieces were lifted onto wooden supports of approximately 170 × 80 cm. During the lifting procedure, the original mortar was unfortunately almost completely removed. Today we aim to preserve the original mortar layers when lifting mosaics, as they represent valuable information about their technology and materials used.

Originally, the mosaic measured roughly 960 × 560 cm, that is, almost 54 m^2. It was already heavily damaged when first discovered, and on its rediscovery only about a third of the original was found. The tesserae are made of stone (white and black limestone) and red brick.

The mosaic's pattern represents a carpet with a central panel bordered by a white and black band. The pattern of the central panel shows a diagonal grid of serrated black-red-white filets (69 cm square) with geometric red-black rosettes in the squares (Djurić 2012).

The Mosaic GT I/D from Roman Celeia

The exceptionality of the late Roman archaeological remains at the site of Roman Celeia, including three large Roman mosaics from the second half of the fourth century (all of

Figure 1 Emona mosaic after excavation in 1997. Photo: Aleš Ogorelec, MGML (Museum and Galleries of Ljubljana)

Figure 2 Mosaic after excavation in April 2014. Photo: Documentation RC ZVKDS (Restoration Centre Institut for the Protection of Cultural Heritage of Slovenia)

which were recently discovered on the main square in Celje, Slovenia) lies not only in the fact that they are well preserved, but that they were preserved in their original position. The clearly legible phases of activity and stratigraphy point to the presence of apartment houses with mosaic floors, hypocausts, ovens, and halls. The finds are remarkable both for Slovenia and for Europe more broadly, since they alter the image of the Roman Celeia period to a great extent. What is more, they redraw the map of the late Roman and medieval period.

The largest mosaic (25 m^2) from room GT II/A represents a motif of a carpet, whose main geometrically patterned surface is surrounded by a black-and-white border. The mosaic (32 m^2) from the room next door, GT II/, is totally black. They are both provisionally protected and will be conserved and presented in situ. The third and smallest mosaic, from room GT I/D (8 m^2), with colorful (white, black, red, yellow, and green tesserae) floral ornaments, was heavily damaged and deformed (fig. 2). Because of the unstable backing it has subsided in some places along the columns of the previously damaged hypocaust. The unstable condition demanded that the mosaic be lifted along with its original Roman mortar. After its conservation and restoration this third mosaic will also be presented back in place, probably in an airtight display case with a controlled microclimate to stop the growth of mold, which appeared soon after the excavation. Alternatively, this mosaic will be presented in the museum, near the original location, in a building next to the excavation site that the municipalilty now owns.

All three mosaics were carefully documented: measurements and orthophotographs were taken and the fragments of the lifted mosaic were drawn on plastic film, marking individual tessarae with the corresponding color. Individual fragments of the damaged mosaic, which was lifted, measure 10 to 150 cm in length. In view of the size of the preserved fragments, the original size of the whole mosaic is estimated at 8 m^2.

Conservation and Restoration of the XIII.8 Mosaic from Emona

After its rediscovery in 1996, the XIII.8 mosaic was again documented. In addition to recording the contextual archaeological data, measurements were taken and photographic documentation was done, which included a drawing of the whole mosaic on PVC foil. The foil was then cut into fourteen sections matching the pieces into which the mosaic itself had been cut. This served as an important basis for reassembling the mosaic and for filling in the missing parts.

Detailed documentation of the conservation and restoration was performed, including vectorization of photographs of the mosaic (fig. 3). Using a computer program, the exact position, color, and shape of each tessera was documented. In addition, all the missing, loose, and broken or damaged tesserae were marked. Thus we obtained an accurate drawing of the mosaic surface.

The conservation and restoration procedures in 2013 began with the mechanical removal of dirt and dust from the mosaic backing and the remaining original deteriorated bedding mortar of the mosaics. The tesserae and the spaces between them were then thoroughly cleaned with scalpels, chisels, and a vacuum cleaner. Where the original mortar was stuck to soil and other impurities and could not be removed this way, the surface was wetted for an hour with cotton swabs. After the impurities and the backing mortar had been removed, the mosaic pieces were completely cleaned with water and brushes.

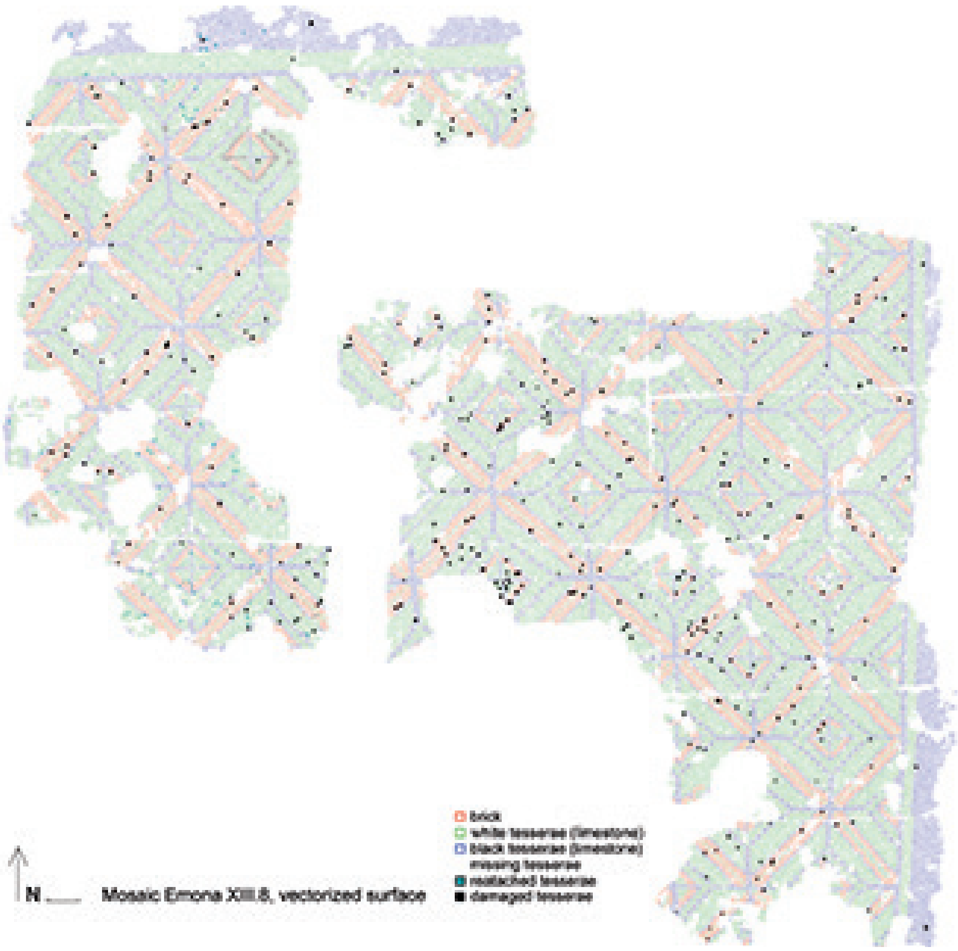

Figure 3 Vectorization of photographs of the mosaic. By Matjaz Bizjak, MGML

To develop a lightweight and easily removable support the mechanical properties of lightweight mortars based on natural hydraulic lime were investigated (Županek et al. 2016). A low density mortar was developed by using lightweight aggregate made of recycled glass beads.

Before application of a lightweight mortar, the edges of the mosaic fragments were hemmed with plasticine to prevent the mortar from reaching beyond the mosaic's edge. In the next phase the mosaic was set in mortar in three consecutive layers, each about 1 cm thick. The back surfaces of the mosaic fragments were first covered with calcite sand, which filled the spaces between the tesserae, enabling the top of the tesserae to be 1 mm above the bedding mortar. This sand was later removed when cleaning the facing.

The mosaic back, which was wetted, was then covered with the first layer of bedding mortar, composed of calcite sand, natural hydraulic lime 3.5, and Microsil microspheres (hollow glass particles) in a 1:1:1 ratio. The four sides of each mosaic tessera were enclosed by mortar reaching up to three quarters of their height (fig. 4). Then the mosaic was shaken so that the mortar could settle and reach its temporary support.

Figure 4 Application of the bedding mortar to the Emona mosaic. Photo: Documentation RC ZVKDS

After ten minutes, when the mortar had partially dried, a first layer of the lightweight mortar composed of natural hydraulic lime 3.5, Microsil, three different size fractions of Rondofil (recycled glass beads), and polypropylene fibers was applied in a thickness of about 1 cm to achieve a flat and smooth surface. This mortar was applied with trowels and pressed hard onto the layer beneath to prevent air pockets between the layers. The second layer was reinforced with glass fiber mesh tape. After the mortar dried, the second layer of lightweight mortar was applied in a thickness of approximately 1 cm. This made the back surfaces of the fragments even, thus leveling the height of all the tesserae. This layer was applied in the same manner as the previous one. We took extra care that the mortar stuck to the layer beneath completely. The resulting composite is now 2.5 cm high.

Before the next step of the conservation-restoration procedure, the mosaic fragments treated this way were left to dry for three weeks for binder setting and hardening. During the first two weeks the mosaic surface was wetted daily so as to prevent crack formation in case the mortar dried too fast.

Further work included mechanical removing of the plasticine. Three weeks after the mortar application, the mosaic fragments were thoroughly vacuum-cleaned, pressed between two boards, fastened with clamps, and turned around using the sandwich method.

Next the facing of mosaic, applied between 1996 and 1998, was removed using cotton swabs soaked in acetone that was left at the surface for 15 minutes until the glue layer (Paraloid B72 and Mowilith in toluene) under the film absorbed it completely. The gauze softened this way could be easily removed. It was carefully rolled, using only very little force. On top there was still the solution of vinyl acetate glue Mowilith and Paraloid B72, which remained there as part of the provisional protection provided between 1996 and 1998. Tesserae were cleaned with cotton swabs soaked in a solution of acetone, ethanol, and ammonium, in the same proportions. The dirt and dust stains that were too ingrained to be removed this way were removed using laser cleaning with Smart Clean II laser, Nd:Yag 1064 nm.

With the provisional facing removed, the mosaic fragments were prepared for gluing onto new supports (Aerolam panels). First, accurate measurements of the fragments were done and their original positions clearly marked. Then the panels were cut to appropriate sizes. To the panels we fastened aluminum brackets 4.5 cm high. These new supports were then degreased with alcohol, and the exact position of each separate mosaic fragment was drawn on them. Then the mosaic fragments were turned over, again using the sandwich method with the mosaic facedown. Parts of transportable panels of light Aerolam, marked with the future mosaic positions, were then covered in polyurethane glue. After the glue was applied we had a 30-minute time frame to position the fragments in the correct places. After that time this would not be possible because the glue would dry out completely. Together with the Aerolam panels the mosaic was turned over again faceup. For the parts of the mosaic with lacunae, mortar fill was planned. The lacunae were covered using beads of recycled glass of three different sizes so that mortar would later easily stick to the surface. The mosaics were then fastened with clamps for 24 hours so that the glue could dry completely.

The area between the edge of the mosaic and the edge of the aluminum honeycomb panel was covered with decorative plaster mortar fill in two layers. For the first layer, lightweight mortar was used, reaching up to 0.5 cm below the mosaic surface. The top of this layer was then abraded and left for 24 hours to dry only partially. Then the second layer of mortar was applied. This time we did not use lightweight aggregate but quartz and calcite sand and natural hydraulic lime in a ratio of 2:1, which gave us the desired texture.

For the purpose of testing the most appropriate retouching technique for the lacunae, a sample mosaic of 30 × 30 cm was prepared. On it four different filling techniques were tested: engraving tesserae; impressing tesserae in lime mortar; painting with different colored mortars; and potato impressions. In the end we opted for potato impressions since this technique enabled us to use *fresco buono* painting technique which is reversible and easy to accomplish. Today conservation guidelines permit only limited retouching, but the chosen method to imitate the tesserae and their colors enabled us to connect the fourteen pieces into one legible whole.

First, lime mortar was applied to the lacunae to 1 mm below the mosaic surface. Then potato stamps of various sizes and shapes were set in lime water with selected pigments: cinnabar, titanium white, yellow ocher, carbon black, and burnt umber.

At present, the mosaic is part of the exhibition *Emona: City of the Empire* in the Ljubljana City Museum. The mosaic panels rest on additional supports, 30 cm above floor level, to enable better visibility (fig. 5). On the floor there is a graphic reconstruction of the mosaic in its original size, in black and white. Thus the visitor can envision the size of the original mosaic and the hall in which it stood.

Conservation and Restoration of the Mosaic GT I/D from Celeia

Petrographic-mineralogical analyses of the original mortars of the three Celeia mosaics were performed to determine the composition of the preparatory layers and the presence of soluble salts. Results showed that preparatory layers consist of three mortar layers and do not contain salts.

As discussed, it was decided to lift mosaic GT I/D. The mosaic was plastered with three layers of gauze attached with

Figure 5 Presentation of the restored mosaic at the exhibition *Emona: A City of the Empire*. Photo: Andrej Peunik, MGML

vinyl acetate glue Mowilith dissolved in acetone. The mosaic was then lifted in pieces along with its original Roman mortar on temporary wooden supports.

The conservation and restoration of the lifted mosaic began with mechanical removal of dirt and deteriorated original mortar from the back of the mosaic since the initial Roman mortar was partially brittle and had lost its binder. Between the mosaic tesserae the mortar was preserved; elsewhere it was removed using scalpels, chisels, and a vacuum cleaner.

Afterward, we leveled the deformed fragments by applying acetone to the mosaic surface and covering it with PVC foil. The solvent softened the vinyl acetate glue Mowilith, with which the facing of the mosaic was covered before being lifted. When all the fragments were leveled, we assembled them together and then divided the fragments, due to their size, into three sections.

The previously tested lightweight mortar was applied in three layers (mortar with silica fume additives of recycled glass, such as Rondofil and Microsil). The mosaic back, which was wetted, was then covered with the first layer of bedding mortar, composed also of calcite sand, Microsil, and natural hydraulic lime in a ratio of 1:1:1. The mortar thoroughly enveloped all four sides of each tessera up to three quarters. After ten minutes, when the mortar had partially dried, a first layer of the lightweight mortar was applied to level the surface and then covered with a reinforced mesh (fig. 6). After 20 minutes or more, depending on how fast the mortar dried, we applied the second layer of the lightweight mortar, which leveled the entire back of the individual fragments and resulted in their equal height. To make it still more solid we put additional reinforced mesh into the last layer. The resulting composite is now 2 cm high.

After three weeks, when the binder had set and hardened, further work involved removing the facing with acetone. We used cotton swabs soaked in acetone and left them on the surface for 15 minutes until the glue layer under the film

Figure 6 Application of the first layer of lightweight mortar with mineral additives. Photo: Documentation RC ZVDKS

Figure 7 Decorative render. Photo: Documentation RC ZVDKS

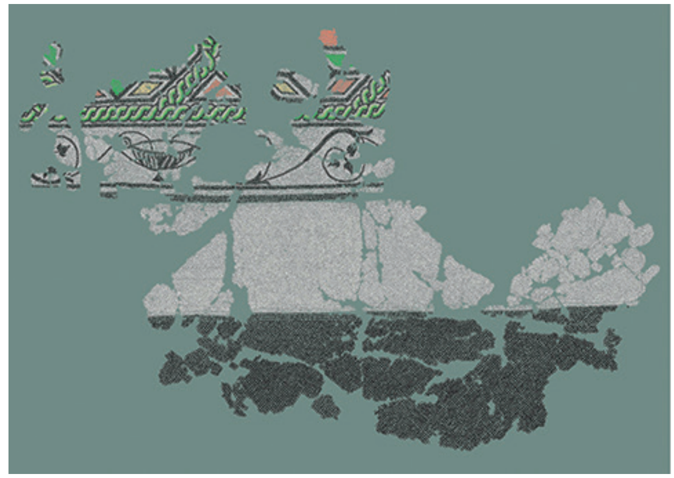

Figure 8 Vectorization of photographs of the Celeia mosaic. By Anja Novak, Katarina Žagar

absorbed it completely. The gauze softened this way could be easily removed. On the top there was still the solution of vinyl acetate glue Mowilith, which remained there as part of the facing. The tesserae were cleaned using cotton swabs wetted in a mixture of acetone, ethanol, and ammoniac in equal proportions.

The mosaic fragments were then ready for gluing onto new supports (Aerolam). Fragment sizes were accurately measured and their original positions clearly marked. Along the edges where the fragments were to be attached together, we sawed the supports with a jigsaw to achieve precise assemblage between the two fragments. Fragments were then, together with a light honeycomb panel, moved to the floor and raised to 90^0. The face of the mosaic was then leaned against a board of suitable size as support, and the Aerolam panel was moved back to the ground. On the surface of the panel a two-component polyurethane glue was applied, mixed according to the manufacturer's instructions. The Aerolam panel was again raised to 90^0, pressed to the mosaic, and the entire construct gently moved back to the floor. Having applied the glue, the mosaic fragments had to be positioned onto the panels within a 30-minute interval. The mosaic fragments were then fastened with clamps for 24 hours so that the glue could dry completely.

For those parts of the mosaic containing lacunae, the application of mortar fill was planned. These lacunae were covered using beads of recycled glass of three different sizes glued with a two-component polyurethane glue so that the mortar would later easily stick to the surface.

The spaces between the edge of the mosaic and the edge of aluminum honeycomb panel were filled with a decorative render in two layers. For the first layer the same new lightweight mortar with mineral additives was used, to a depth of 0.5 cm below the mosaic surface. The top of this layer was abraded and left for 24 hours to dry only partially. The second layer of mortar was then applied: a mixture of two types of quartz sand and natural hydraulic lime 3.5 in a 2:1 ratio, in order to obtain the desired mortar texture.

Lime mortar was applied to the areas of lacunae of the tesserae to a depth of 1 mm below the mosaic surface. We used the same mixture as that for the decorative render, only a shade lighter. For the parts with missing black tesserae we used lime mortar with carbon black and natural umbra pigments added (fig. 7).

Alongside the conservation work the mosaic had also been undergoing thorough documentation and vectorization of the documented photos. With the help of a computer program we have documented the position, color, and outline of the individual tesserae and marked all the missing, loose, and broken tesserae and fractures that appear locally on the surface of the mosaic (fig. 8).

Conclusion

In this paper we present two conservation-restoration approaches with different aims: first, a late Roman floor mosaic from Emona (Ljubljana, Slovenia) for museum presentation; second, a Roman mosaic from Celeia (Celje, Slovenia) for presentation back on site.

For both cases, we developed a lightweight support composed of lightweight mortars and aluminum honeycomb panels. This is an important innovation, as the supports we used are completely reversible, compatible with the original materials, and, of course, quite light, thus enabling a wide variety of presentation choices. Mosaics with lightweight backing can be used for frequently changing museum presentations, and moreover, can be exhibited in different ways, even mounted on walls. The light weight of the backing does not compromise its strength and support. In addition, the chosen materials are not costly, thus descreasing the costs of conservation, are widely available commercially, and are easy to use. In order to ensure long-term conservation of the mosaics to be replaced on site, the mortar mixtures were studied for their durability properties: accelerated laboratory tests of weathering were done, and some samples were exposed on site.

In the future, testing of the reinforced meshes and different types of fibers to improve strength and flexibility is planned.

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Gerasa Mosaic Treatments at Yale University: An Examination of Materials Used in Structural Backing Systems

Elena Torok, Catherine Stephens, Robin Hodgson, and Carol Snow

Abstract: *The recent conservation treatment of a ca. 526 CE mosaic floor from Gerasa, Jordan, involved replacement of an old reinforced concrete backing with a new composite system designed to meet four major objectives: provide adequate structural support, enable both horizontal and vertical display, be cost-effective, and allow for future reversibility. A review of the Gerasa mosaic treatments at Yale University led to the development of research to investigate new foaming epoxy formulations. The performance of a variety of epoxy resins, foaming agents, and bulking materials was tested. The results led to further examination of conservation materials and guided treatment decisions.*

Whenever a mosaic is taken from an archaeological context to a museum, its stewardship becomes a shared responsibility among curators, conservators, scientists, engineers, and collection managers. With the intent of correcting past mistakes through cost-effective solutions, collaborative teams at the Yale University Art Gallery (YUAG) replaced old concrete backing systems with new composite materials, thereby redefining reversibility and stabilization. In an ongoing effort to improve on these techniques, new formulations of foamed epoxies were tested for potential applications, and although not used, this research yielded new information and promising results that could be beneficial for future conservation use.

Review of Gerasa Mosaic Treatments at YUAG

Limestone floor mosaics representing some of the best examples of early Byzantine church mosaic production in Jordan were excavated from 1928 to 1934 by archaeologists from Yale University, the British School of Archaeology at Jerusalem, and the American Schools of Oriental Research (Crowfoot 1931; Kraeling 1938). Following partage agreements and laws established with the local government at that time, portions of five floor mosaics were stabilized for travel and shipped to YUAG. These mosaics, which date to the sixth century CE, are now important objects in YUAG's collection of ancient art.

At the time of excavation, each mosaic was given a backing for structural support. Further work was undertaken when the mosaics arrived at Yale University. YUAG records indicate that Robert Georges Eberhard, Yale sculpture professor and YUAG sculpture curator, supervised the structural backing of four mosaics: 1929.419, 1932.1735, and 1932.1736 were given steel reinforced concrete backings and 1938.6000.1401 was backed with steel reinforced plaster. A geometric floor mosaic, 1929.418, received a concrete backing reinforced with chicken wire, with further backing and fills made with concrete containing large rubble aggregate. YUAG records indicate that it was treated by the commercial firm Ravenna Mosaic Works. More information and images of these mosaics can be found on the YUAG website (http://artgallery.yale.edu/).

Each backing treatment has aged differently with the passage of time. A 2009 condition assessment showed that two mosaics, 1929.419 and 1932.1736, remained stable on their reinforced concrete backings and required minimal conservation. The largest mosaics, 1932.1735 and 1929.418, suffered major structural damage related to failure of the reinforced concrete and required major conservation interventions. The fifth mosaic, 1938.6000.1401, was badly damaged in a 1969 fire at the Yale School of Architecture and awaits treatment.

Between 2009 and 2011, conservation treatment of the city mosaic (1932.1735), which shows isometric views of Alexandria and Memphis, involved the development of novel methods for concrete backing removal and replacement (Snow et al. forthcoming). Research and development during its conservation led to the use of a computer numeric controlled (CNC) milling machine retrofitted to safely remove the concrete backing. A new, lightweight composite backing, fabricated from polyester foam core with fiberglass surfaces and stainless steel hardware inserts, was adhered with epoxy to an isolating plaster interlayer discovered below the concrete. After treatment, the city mosaic was displayed in the Metropolitan Museum exhibition, *From Byzantium to Islam: Art in Transition* (Brody and Snow 2015), and then permanently mounted on a masonry wall in the Isabel B. and Wallace S. Wilson Art of the Ancient Mediterranean Gallery at the Yale University Art Gallery (Snow 2015). This approach, which allowed easy transport and vertical or horizontal display, served as an inspiration for treatment of the Gerasa geometric floor mosaic.

Geometric Floor Mosaic Cleaning and Backing Removal

Following the city mosaic's successful conservation, the geometric floor mosaic (1929.418) was conserved between 2013 and 2014 for the YUAG exhibition, *Roman in the Provinces: Art on the Periphery of Empire* (Brody and Hoffman 2014). This show included a second venue at the McMullen Museum of Art, Boston College. Because the geometric floor mosaic's structural issues and old backing composition were different from those of the city mosaic, the treatment provided the opportunity to research new backing materials and techniques. First, though, a complete analysis of the mosaic in its current state was required.

At the time of excavation, field photographs show that the elaborately patterned geometric floor mosaic (measuring approximately 3.7 × 6.3 m) was over 75 percent complete (fig. 1). It is believed the sections were divided following the geometric patterns and backed using concrete reinforced with steel chicken wire. Soon after arriving in the United States, the floor fragments were joined and backed with additional concrete, then cut into ten rectangular sections, ignoring the geometric patterning. The ten sections were stored in flimsy wood crates stacked on top of one another, thereby causing significant damage and loss over time. By 2013 multiple long cracks and areas of missing or loose tesserae were present in all sections and layers of oil and glue that had been applied post-excavation were discolored (fig. 2). These condition issues were thoroughly documented before actual treatment began.

Due to time, space, and budgetary constraints, only six of the ten sections in the best condition and with the largest part of undisrupted design were chosen for exhibition; the others were cleaned, stabilized, and rehoused for proper storage. The six selected sections received a more thorough surface cleaning with 5% benzyl alcohol in deionized water (v/v) that was gelled using methyl cellulose and cleared using deionized water and a steamer. The clean surfaces were then protected using a 5% solution of Paraloid® B-72 in acetone (w/v). Cracks and losses were stabilized and filled as necessary using a 20% solution of Paraloid® B-72 in acetone (w/v) bulked with glass microballoons. Each section was then faced with cotton muslin fabric and animal glue and flipped over onto a cushioned support in preparation for removal of the old backing system.

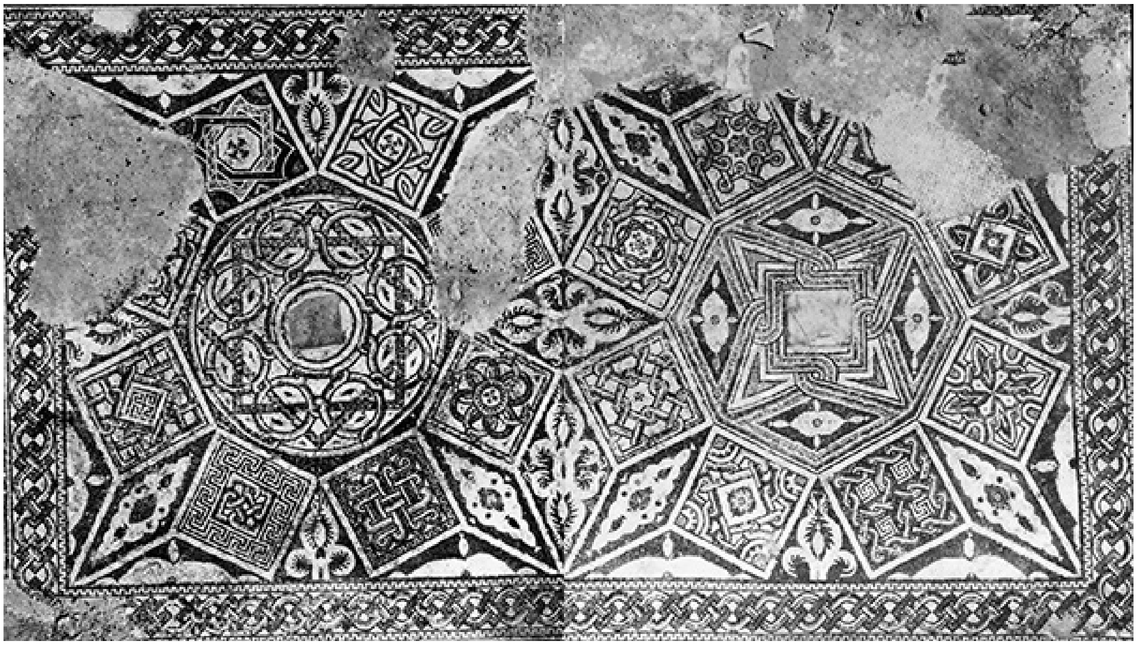

Figure 1 Archival photograph of the geometric floor mosaic (526 CE) from the south aisle of the Church of Bishop Paul (Procopius Church), during excavation in the late 1920s.
Credit: Yale University Art Gallery, The Yale–British School Excavations at Gerasa

Figure 2 The geometric floor mosaic from the south aisle of the Church of Bishop Paul (Procopius Church) (1929.418), before conservation treatment in 2013. Only six of the ten fragments were treated for exhibition. Dimensions of the object overall: 406.4 × 792.5 cm (160 × 312 in.).
Credit: Yale University Art Gallery, The Yale–British School Excavations at Gerasa

The retrofitted CNC milling machine was again used to mill off each section's concrete and chicken wire backing. Because the concrete was of inferior quality, a sintered coarse diamond cutting disk (10 cm diameter) was chosen for milling; it was far less expensive than the braze-bonded diamond router bits used for concrete removal in the city mosaic treatment. A large magnet was added to the dust extractor to enable easy collection of the chicken wire fragments. Major concrete removal using this machine took approximately 8 to 10 hours with final concrete removal completed by hand. This was not difficult, as the modern concrete layer was not well adhered and multiple air pockets were present. A few traces of concrete that could not be easily removed were left in place.

Unlike the city mosaic, the geometric mosaic had no plaster interlayer. Also, the exposed versos of the ancient limestone tesserae were very uneven, with limited amounts of original mortar. This provided the chance to see the back of the mosaic and enabled new opportunities for examination; for example, samples of the original mortar were taken and sent for analysis to Jordanian colleagues conducting research on ancient Gerasa mortars (Hamarneh 2010).

At this stage of the treatment, an engineer was consulted for recommendations on various backing materials to use on the geometric floor mosaic. A wide range of lime mortars and synthetic resins was considered. Lime mortar was not recommended due to concerns about the bond strength for vertical hanging given that the pores of the limestone were already filled with ancient mortar, so application of a new lime mortar would not achieve a bond as strong as the original mortar to stone bond. Furthermore, the uneven distribution of extant ancient mortar would further compromise the bond strength of a new mortar. Because the geometric mosaic will remain in a controlled museum environment and never be returned to the field, the engineer recommended the use of a two-part epoxy as the adhesive to attach the mosaic to a new backing (Daniel Morrissey pers. comm.).

Though widely used, two-part epoxy systems have drawbacks such as toxicity of the hardener and irreversibility of the cured resin. However, two factors at YUAG made epoxy a suitable material for mosaic backings: the conservation work spaces are outfitted with necessary safety and fume extraction equipment, and CNC technology will be capable of milling through epoxy if removal is ever necessary in the future. Even so, epoxy should never be applied directly to the back of a mosaic; the verso must (and did) have an isolating interlayer applied first.

Epoxy adhesives were therefore investigated, and as a way to make the entire system more reversible and more lightweight and to meet the needs of adhering a nonplanar, slightly three-dimensional mosaic to a planar backing material, the use of a foamed epoxy was explored. The multiple advantages of a foamed epoxy would be good gap filling properties, improved reversibility due to its lower density, lighter weight per unit volume than a continuous layer of epoxy, ready adhesion to multiple materials, and better affordability than a nonfoamed epoxy.

A review of conservation literature showed this material had been used in similar mosaic treatments (Blackshaw and Cheetham 1982; Bradley, Boff, and Shorer 1983; Stewart 2014). However, little information has been published in several decades regarding use with currently available foaming epoxy systems. A collaboration was therefore formed with RH Conservation Engineering, as this firm has successfully used foamed epoxy systems for fills and as an adhesive for a variety of three-dimensional objects since the 1980s. While the goal was to find an epoxy system commercially available for purchase in most regions of the world, novel mixtures were also considered.

Foamed Epoxy Experiments

A foamed epoxy system consists of four major components: resin, hardener, foaming agent, and filling agent. A change in the amount or composition of any one of these components can cause significant physical and/or chemical modifications to the system. Therefore, experimental testing was necessary to determine if alterations to commercially available materials made suitable adhesives for use in the treatment of the geometric mosaic. For this treatment, an adhesive was needed that was strong enough to support the weight of the mosaic in a vertical position, would not flow to the front of the object during application, cured over a long enough time period that enabled it to be applied and adhered to a backing board, and did not expand or release heat in a way that would damage the mosaic.

Two sets of experiments were designed to explore foaming epoxies and their properties: one set using a commercially packaged system (used both as-directed and modified) and a second set using an innovative system designed by RH Conservation Engineering.

Experimental Set 1

Only one commercially marketed foamed epoxy system was found for sale to consumers in the United States, Rencast 1774 (Rencast, Huntsman Corporation). This three-component product consisted of a resin (R), hardener (H), and foaming agent (A) and was designed for mixing by weight (wt. %), 100R:25H:1.2A. In experiments, resin was always measured out to 10 g, while the hardener, foaming agent, or filler content was adjusted.

Components of this formulation were modified to see whether alterations would improve the properties of the epoxy used in this treatment. To examine foaming, the system was foamed using different amounts of foaming agent (0–4 wt. % resin plus hardener) as well as with a different foaming agent, poly (methylhydrosiloxane) (PMHS). To modify the flow of the uncured epoxy, Cabosil M5, Cabosil TS720, or glass microspheres were added in varying quantities (0–4 wt. % resin). Finally, to modify the hardness, the resin was cured using different hardeners (2–3 wt. % resin), the Rencast 1774 hardener and West Slow Hardener 206. Hand-mixed formulations were poured onto a sample limestone tile matrix measuring 3 × 3 (fig. 3a) and allowed to cure at ambient conditions.

Experimental Set 2

The second series of foamed epoxy samples were made by RH Conservation Engineering and devised based on the treatment of a wooden Napoleonic warship (Hodgson, Kosinova, and Thorn 1987). That treatment used Huntsman Chemical LC177 resin (mineral filled), HY 956 hardener, and Ciba Geigy DY 050 foaming agent, as first proposed by Blackshaw and Cheetham (1982) and modified by Hodgson et al. to meet the needs of the warship project.

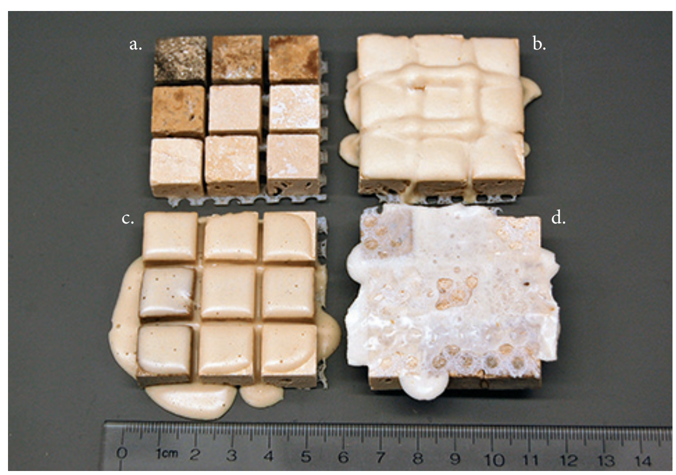

Figure 3 Properties of the Rencast 1774 (Rencast) epoxy system mixed and poured according to the manufacturer's guidelines. (a) Uncoated 3 × 3 tiles, adhered on the bottom with a mesh, used as a mock-up. (b) 10g Rencast resin (R):2.5 g Rencast hardener (H):0.125g Rencast foaming agent (A). (c) 10g R:2.5 g H:no foaming agent. (d) Back side of the 3 × 3 tiles showing how the 10g R:2.5g H:0.125g A mixture flowed through the gaps between tiles and covered the back. Credit: Institute for the Preservation of Cultural Heritage, Yale University

Because some components of that system were not available for sale in the United States, an alternative was developed. Epon 828 was selected as the resin, with English whiting and a Huntsman Chemical proprietary diluent added as filler and diluent, respectively, to closely mimic the components of LC177. The Huntsman Chemical proprietary diluent, a difunctional diluent, was used to both modify the viscosity and act as a plasticizer; English whiting (calcium carbonate) was added as a mineral filler; and Epidene 6140 was added as an equivalent. Formulations were mixed by volume (vol. %). Epon 828 resin (10 or 20 vol. %) was hardened with Polymid 75 (1:3 vol. % resin plus diluent plus filler). PMHS (1–3 vol. % resin plus diluent plus hardener) was used as the foaming agent.

Figure 4 The effect of increasing the amount of Rencast 1774 foaming agent on the foaming of the Rencast 1774 epoxy system (all formulations include 10 g Rencast 1774 resin, 2.5 g Rencast 1774 hardener, and 0.3 g Cabosil TS720 as well). (a) 0.12 g foaming agent; (b) 0.38 g foaming agent; (c) 0.50 g foaming agent. Credit: Institute for the Preservation of Cultural Heritage, Yale University

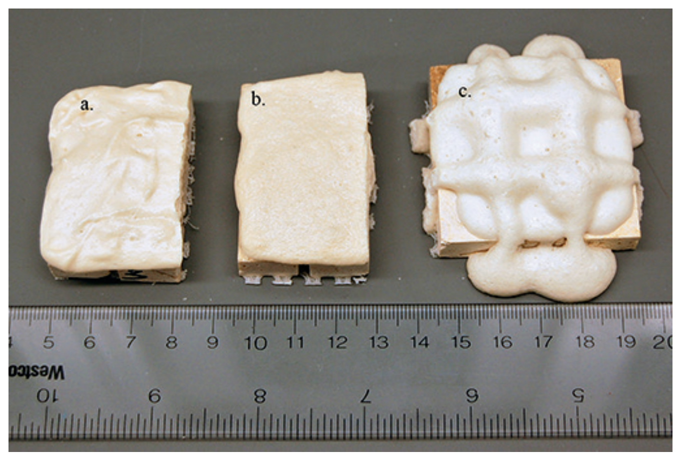

Figure 5 Effect of the use of three different fillers added at 3 wt. % on the properties of the Rencast 1774 Epoxy system. (a) Cabosil M5 fumed silica; (b) Cabosil TS720 fumed silica; (c) glass microballoons. Credit: Institute for the Preservation of Cultural Heritage, Yale University

Results and Discussion

Mixing the three-component Rencast foamed epoxy system following manufacturer's guidelines resulted in an epoxy that was unsatisfactory for treatment of the mosaic. It foamed heterogeneously, to a greater extent in gaps between tiles than on the tiles themselves (fig. 3b). The foaming was negligible and generated a coating with almost the same thickness (on the tiles) as a sample blended without foaming agent (fig. 3c). When applied, the uncured epoxy flowed through the gaps and covered the back side of the tiles (which represent the recto of the mosaic) (fig. 3d). Finally, the cured epoxy flaked when handled. Based on these results, it was concluded that the Rencast 1774 system would need to be altered if it were to be used for this conservation treatment.

It was decided that the ideal foamed epoxy should not flake as that should lead to weakening of the adhesion between the backing system and mosaic over the long term. In addition, the uncured formulation should not flow. It should foam homogeneously and not shrink during cure. With this in mind, twenty-seven unique mixtures using the Rencast resin were made, with the hope that the traits of the ideal foamed epoxy would be found. A summary of the samples made is shown in table 1. Unfortunately, the series of formulations made to see if the Rencast epoxy system could be modified to meet desired treatment criteria were largely unsuccessful. Despite this, several interesting outcomes were observed. First, a more space-filling epoxy was made by changing the amount of foaming agent. Adding more foaming agent, regardless of type, resulted in an increase in the final volume of the cured epoxy (fig. 4), with the Rencast foaming agent foaming slightly more than the PMHS.

Figure 5 shows three samples mixed with 3 wt. % Cabosil M5, Cabosil TS720, or glass microballoons, respectively. These materials were added to increase the thickness of the uncured epoxy. Microballoon inclusion (fig. 5c) did not modify the viscosity at all. The mixture flowed everywhere and foamed heterogeneously. Microballoons were therefore deemed inappropriate here for use as a thickener. Both fumed silica fillers appeared to behave the same, increasing the thickness of the uncured mixture and foaming more or less homogeneously. Depending on the formulation, at least 2 wt. %, and in some cases 3 wt. %, fumed silica addition was required to prevent flow through the gaps. Inclusions of larger amounts of fumed silica resulted in an epoxy that foamed less and flaked more easily.

Table 1 Summary of the foamed epoxy formulations mixed at IPCH and resulting observations

Epoxy	Weight epoxy (gm)	Hardener	Weight hardener (gm)	Foaming agent (FA)	Weight FA (gm)	Filler	Weight filler (gm)	Does cured epoxy flake?	Did it flow through cracks?	Did it foam uniformly?	Did it shrink during cure?
Rencast	10	Rencast	2.5	Rencast	0.12	—	—	yes	yes	no	no
Rencast	10	Rencast	2.5	Rencast	0.12	M5	0.1	yes	yes	no	no
Rencast	10	Rencast	2.5	Rencast	0.12	M5	0.2	yes	yes	yes	no
Rencast	10	Rencast	2.5	Rencast	0.12	M5	0.3	yes	no	yes	no
Rencast	10	Rencast	2.5	Rencast	0.12	TS720	0.1	yes	yes	no	no
Rencast	10	Rencast	2.5	Rencast	0.12	TS720	0.2	yes	no	yes	no
Rencast	10	Rencast	2.5	Rencast	0.12	TS720	0.3	yes	no	yes	no
Rencast	10	Rencast	2.5	Rencast	0.25	TS720	0.1	yes	yes	no	no
Rencast	10	Rencast	2.5	Rencast	0.36	TS720	0.1	yes	yes	yes	no
Rencast	10	Rencast	2.5	Rencast	0.48	TS720	0.1	yes	yes	no	no
Rencast	10	Rencast	2.5	Rencast	0.38	TS720	0.2	yes	yes	no	no
Rencast	10	Rencast	2.5	Rencast	0.50	TS720	0.2	yes	yes	no	no
Rencast	10	Rencast	2.5	Rencast	0.38	TS720	0.3	yes	no	yes	no
Rencast	10	Rencast	2.5	Rencast	0.50	TS720	0.3	yes	yes	yes	no
Rencast	10	Rencast	2.5	Rencast	0.38	TS720	0.4	yes	no	yes	no
Rencast	10	Rencast	2.5	Rencast	0.50	TS720	0.4	yes	no	yes	no
Rencast	10	Rencast	2.5	Rencast	0.50	TS720	0.4	yes	no	yes	no
Rencast	10	Rencast	2.5	PMHS	0.38	TS720	0.2	yes	yes	no	no
Rencast	10	Rencast	2.5	PMHS	0.50	TS720	0.2	yes	yes	no	no
Rencast	10	Rencast	2.5	PMHS	0.38	TS720	0.3	yes	yes	yes	no
Rencast	10	Rencast	2.5	PMHS	0.50	TS720	0.3	yes	no	yes	no
Rencast	10	West 206	2.0	Rencast	0.12	TS720	0.2	yes	yes	yes	yes
Rencast	10	West 206	2.5	Rencast	0.12	TS720	0.2	yes	yes	no	yes
Rencast	10	West 206	3.0	Rencast	0.12	TS720	0.2	yes	yes	yes	yes
Rencast	10	Rencast	2.5	—	—	TS720	0.2	no	no	—	no
Rencast	10	Rencast	2.5	—	—	MB	0.2	no	yes	—	no
Rencast	10	Rencast	2.5	Rencast	0.12	MB	0.3	yes	yes	no	no
Rencast	10	West 206	2.5	Rencast	0.12	MB	0.3	yes	yes	no	no

Rencast: Rencast 1774; PMHS: poly(methylhydrosiloxane); M5: Cabosil M5; TS720: Cabosil TS720; MB: microballoons

Table 2 Summary of the foamed epoxy formulations mixed by RH Conservation Engineering and resulting observations

Epoxy	Volume epoxy (%)	Diluent	Volume Diluent (%)	Filler	Volume filler (%)	Hardener	Volume hardener (%) hardener: epoxy+ diluent+filler	FA	Volume FA (%) FA:epoxy+ diluent+ hardener	Does cured epoxy flake?	Did it foam uniformly?
Epon 828	20	HPD	10	EW	70	Polymid 75	1:3	PMHS	1	no	yes
Epon 828	20	HPD	10	EW	70	Polymid 75	1:3	PMHS	2	no	yes
Epon 828	10	HPD	20	EW	70	Polymid 75	1:3	PMHS	1	no	yes
Epon 828	10	HPD	20	EW	70	Polymid 75	1:3	PMHS	2	no	yes
Epon 828	10	HPD	20	EW	70	Polymid 75	1:3	PMHS	3	no	yes

HPD: Huntsman propriety diluent; EW: English Whiting; FA: Foaming Agent; PMHS: polyhydrosiloxane

Since all of the Rencast samples flaked, it was thought that perhaps by changing the hardener the foamed epoxy could be made more resilient. When West Slow Hardener 206 was tried, the amine hydrogen equivalent weight was unknown (this number determines the resin-to-hardener ratio), so three samples were made with 2.0, 2.5, and 3.0 g of West 206 hardener, respectively. While the final foamed epoxies made using this hardener were more resilient, the samples still flaked, albeit less readily than the Rencast samples. More problematic, however, after initially foaming outward, they shrank noticeably while curing.

Overall, the Rencast foamed epoxy system disappointed. There was not one formulation that generated a foamed epoxy that met all desired criteria, that is, did not flake, did not flow through to the back of the tile, foamed uniformly, and did not shrink. The best samples were made using a different hardener and large amounts of foaming agent and fumed silica. Since these formulations were quite unusual, further testing would be necessary, including physical testing and artificial aging, to verify their appropriateness for use in a conservation application. A second set of materials was looked at to see if a better material could be found.

A summary of the samples mixed for the second set of experiments is shown in table 2. Important observations regarding those samples were the following: the amount of foaming and pore size distribution of these samples was larger than that of the Rencast samples, and the samples did not flake when handled. Samples made with 10% Epon 828 were tougher and less prone to shattering. They also were capable of being carved, a useful property when trimming excess material at the edges of an adhered sample.

Figure 6 shows the samples made with 10% Epon 828, with increasing poly(methylhydrosiloxane) content. The sample with 2% foaming agent seemed ideal for application with the mosaic treatment; however, the foaming this sample exhibited would need to be monitored as it bubbled quite a bit. It was worried the foam would push on, and possibly disrupt, the mosaic surface. Testing of this hypothesis was not possible, so this epoxy was not chosen for treatment of the mosaic.

Figure 6 Effect of foaming agent on the Hodgson foams made with 10% Epon 828, 20% diluent, and 70% English whiting. (a) 1 vol. % foaming agent (FA); (b) 2 vol. % FA; (c) 3 vol.% FA. Credit: RH Conservation Engineering

Backing Materials for the Geometric Floor Mosaic

Although foamed epoxies were thought to be ideal, the foaming experiments conducted showed more work would be necessary to prove them adequate for this application. An epoxy system applied in layers was therefore decided on; it was similar to that used in the city mosaic treatment and could be applied within a reasonable time frame (fig. 7). With the mosaic still facedown, the back of each ancient fragment was consolidated using sequential applications of 5%, 10%, and 20% solutions

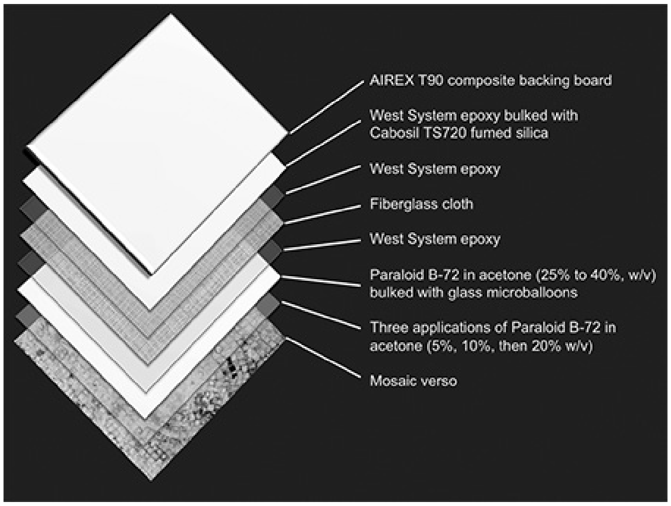

Figure 7 Layering stratigraphy of the new composite backing system applied to the geometric mosaic (1929.418). Copyright © Yale University Art Gallery

of Paraloid B-72 in acetone (w/v). To protect the mosaic from contact with the epoxy, an isolating layer of a 25% to 40% Paraloid B-72 in acetone (w/v), bulked with lightweight glass microballoons, was applied to increase future reversibility and prevent the next series of layers from penetrating through to the ancient mortar and limestone tesserae. Next, the isolating layer was wet up with a thin layer of West System 105 Epoxy Resin and 206 Slow Hardener, followed by a layer of fiberglass cloth for structural reinforcement, followed by another thin layer of epoxy. West epoxy was chosen for both the city mosaic and this mosaic due to its bond strength, compatibility with other layers, slow cure time, durability, relatively high UV resistance, cost, and availability (Snow et al. forthcoming).

Because surface topography on the reverse of the fragments was highly variable, additional layers of epoxy bulked with Cabosil TS720 fumed silica were applied to the back in order to level and add further reinforcement. While the epoxy gelled, the composite backing board was applied. This composite panel, consisting of an Airex T90 polyester foam core with polyester/fiberglass surfaces and stainless steel hardware inserts, was the same one chosen to back the Gerasa city mosaic for its stiffness, coefficient of thermal expansion, light weight, and international availability (Snow et al. forthcoming). Before use, the backing board was degreased with acetone, wet up with a thin layer of epoxy, and applied to the fiberglass cloth layer of the mosaic. It was secured and weighted while the epoxy cured.

When the application of the backing was complete, the object was flipped over, facings were removed, and the surfaces were cleaned to remove the hide glue. Composite backing boards were trimmed so that the pieces could fit together, and appropriate aesthetic treatment work on the front was conducted in consultation with YUAG Ancient Art curators. Leveling feet were screwed into the stainless steel inserts to allow good alignment of the six sections during horizontal display. After treatment (fig. 8), each fragment weighed only 36 to 54 kg. The removal of old concrete backings and application of a new lightweight composite support resulted in approximately an 80% reduction in the object's weight. The final cost of all materials required for the treatment was just under US$8,000.

Conclusions

Upon completion of the treatment of the geometric floor mosaic, the initial project goals were revisited. Although a foamed epoxy was not used, the layering system that was applied was strong, relatively lightweight, reversible (as it could be removed using CNC technology), and cost-effective. This system worked well for this particular treatment; however, the treatment team remains interested in exploring other ways to manipulate the system in the future so it could offer just as much structural support, be more reversible, and, if possible, also be less expensive.

Despite the fact that none of the foamed epoxy formulations were used during the treatment of the geometric floor mosaic, new epoxy formulations should continue to be explored. Further experiments, namely, artificial aging coupled with strength measurements, are recommended to determine the viability of foamed epoxies as adhesives. When considering foaming agents, equal consideration should be given to the hardener and diluents to optimize foaming in a particular epoxy. The right combination of components, coupled with a study of the strength and aging properties, needs to be thoroughly assessed before practical use can be safely recommended.

Acknowledgments

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Figure 8 The geometric floor mosaic from the south aisle of the Church of Bishop Paul, i.e., Procopius Church (1929.418), after conservation treatment. Dimensions of treated fragments: 364.5 × 284.5 cm (143.5 × 112 in).
Credit: Yale University Art Gallery, The Yale–British School Excavations at Gerasa

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Materials

Airex T90 structural foam
Manufactured by Airex AG, Sins, Switzerland

Cabosil M5 and Cabosil TS-720
Manufactured by Cabot Corporation, Boston, MA, USA

Custom-built composite backing board
Manufactured by Composite Panel Solutions, Cattaraugus, NY, USA

Fiberglass cloth
Manufactured by Hexcel Corporation, Stamford, CT, USA

Glass Bubbles J05-1457
Manufactured by 3M, St. Paul, MN, USA

Paraloid B-72
Manufactured by Dow Chemical Company, Midland, MI, USA

Poly(methylhydrosiloxane)
Manufactured by Sigma-Aldrich Chemical, St. Louis, MO, USA

Rencast 1774, Epon 828, proprietary diluent (discontinued)
Manufactured by Huntsman Corporation, The Woodlands, TX, USA

Stainless steel inserts
Manufactured by Rotaloc International, Littleton, CO, USA

West System 105 epoxy resin and 206 hardener
Manufactured by West System, Inc., Bay City, MI, USA

PART SEVEN

Presentation and Display

Il mosaico di una casa romana a *Hispellum* (Spello) – Umbria

Dorica Manconi

Abstract: *Negli anni 2003–2004 è stato messo in luce a Spello, in Umbria, presso il foro del municipio romano, un ambiente di rappresentanza di una* domus *romana con un mosaico che contiene la rappresentazione di uno pseudo emblema policromo con volatili, circondato da decorazioni floreali. Dopo il restauro l'ambiente con il mosaico è stato valorizzato e reso fruibile al pubblico. Il contesto cronologico della* domus *è quello di epoca adrianeo–antonina, ma l'abitazione sopravvisse fino a epoca tardo antica.*

Abstract: *From 2003 to 2004, near the Roman municipal forum in Spello, Umbria, the receiving room of a Roman* domus *was unearthed, along with a mosaic that contained a polychromatic* pseudo-emblema *of birds surrounded by floral decorations. After the restoration, the room and its mosaic were made accessible to the public. The* domus *dates to the time of Hadrian and Antoninus, but the dwelling survived into late antiquity.*

Il mosaico in esame ha avuto varie vicissitudini e la conservazione *in situ* ha creato complicazioni per renderlo adeguato alla visita del pubblico[1]. È stato in parte rinvenuto più di sessant'anni fa dall'allora soprintendente Umberto Ciotti, in occasione di lavori presso l'edificio dell'Ex Ospedale di Spello (Ciotti 1952: 247 n. 3114), un piccolo municipio romano alla sinistra del Tevere, inserito in epoca augustea nella VI *regio*, l'Umbria, situata tra Adriatico e Tirreno. Il mosaico si trova, in particolare, nel pieno centro (fig. 1), accanto al foro romano della città, di conseguenza in posizione di rilievo al suo interno. Conservato *in situ* era rimasto sepolto, dal momento della scoperta, in un piccolo ambiente, adibito a caldaia, al di sotto di un solaio di mattoni.

Nel momento in cui l'edificio nel quale si trova il mosaico, una palazzina con cortile interno, viene ristrutturato dall'Azienda Territoriale per l'Edilizia Residenziale[2] per essere adibito a Case Popolari, la Soprintendenza per i Beni Archeologici dell'Umbria[3] ha seguito con particolare interesse il progetto, rintracciato il mosaico, realizzato un saggio nella via laterale e, dopo averlo recuperato e restaurato, ha provveduto a darne una fruibilità al pubblico, rendendolo indipendente dal resto del contesto abitativo, nello scantinato del palazzo[4], con la

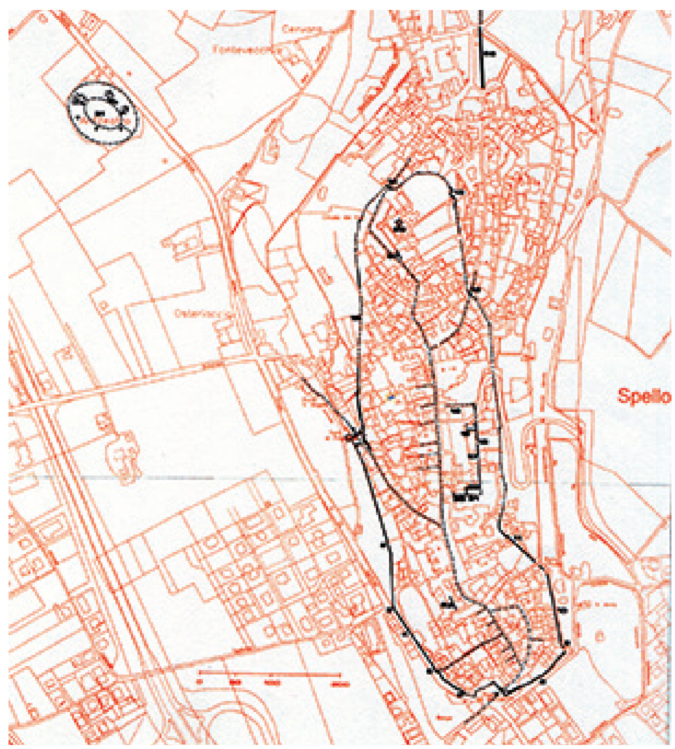

Figura 1 Spello, planimetria della città e localizzazione del mosaico. Foto: Francesco Giorgi. Riprodotto con il permesso della Soprintendenza per i Beni Archeologici dell'Umbria

creazione di un ambiente con ingresso appositamente realizzato, in sicurezza e con idonea illuminazione.

Fin qui le premesse.

L'indagine è stata condotta nel corso degli anni 2003–4.

Rimosso il laterizio che copriva il pavimento antico, il mosaico appariva in discreto stato di conservazione e si sviluppava anche oltre la parete settentrionale del piccolo ambiente, proseguendo fuori dal complesso architettonico (fig. 2).

La decorazione musiva, sviluppata su un tappeto monocromo bianco, intercalato a intervalli irregolari da tessere rosse, è composta da una doppia cornice con ordito diritto (fig. 3), realizzata con tessere di calcare rosso bruno, la pietra del vicino monte Subasio[5]. La duplice fascia inquadra, sul lato occidentale dell'ambiente, un rettangolo a tessere nere – quasi uno pseudo emblema – con la raffigurazione di volatili policromi, circondato tutt'attorno da una raffinata fascia con ramificazioni a motivi floreali (fig. 4). Quest'ultima, eseguita con tessere nere e rosse, presenta girali a volute, caratterizzati

Figura 2 Spello, Ex Ospedale, locale adibito a caldaia e rimessa in luce del mosaico. Foto: Valentino Pescari. Riprodotta con il permesso della Soprintendenza per i Beni Archeologici dell'Umbria

Figura 3 Spello, Ex Ospedale, mosaico. Foto: Valentino Pescari. Riprodotta con il permesso della Soprintendenza per i Beni Archeologici dell'Umbria

Figura 4 Spello, Ex Ospedale, pseudo emblema e fascia a decorazione floreale. Foto: Valentino Pescari. Riprodotta con il permesso della Soprintendenza per i Beni Archeologici dell'Umbria

Figura 5 Spello, Ex Ospedale, pseudo emblema policromo. Foto: Valentino Pescari. Riprodotta con il permesso della Soprintendenza per i Beni Archeologici dell'Umbria

da un'elegante armonia compositiva, che si dipartono da un unico cespo d'acanto – posto a metà del lato breve della stanza – su cui si sviluppa un'infiorescenza su alto stelo composta da un calice con pistilli terminanti in foglie lanceolate e in steli conclusi da corolle stilizzate.

Nello spazio centrale (fig. 5) sono raffigurate simmetricamente su due registri due coppie di volatili affrontati: in basso sono due uccelli (della specie "anatidi") che si accingono a beccare un granchio, in alto sono altri due volatili (della specie *columbus*) accanto a un ramoscello d'olivo. La restituzione degli effetti cromatici nel piumaggio degli uccelli è realizzata con l'inserzione di paste vitree policrome e *faïence*.

Simultaneamente, per poter verificare l'estensione del mosaico e la presenza di stratigrafie utili a un inquadramento cronologico della situazione, sono stati realizzati due saggi nella contigua via Due Ponti, la strada direttamente addossata a nord dell'ambiente appena descritto.

I saggi hanno interessato in questo caso la parte di carreggiata proprio in prossimità del muro perimetrale dell'ex Ospedale e sono risultati fortemente condizionati dall'ampiezza della carreggiata stradale e dai conseguenti problemi statici. Gli strati più superficiali del terreno mostravano rinvenimenti ceramici con indicazioni cronologiche valutabili tra l'età altomedievale e quella rinascimentale. Uno strato di limo argilloso giallastro distribuito lungo le pareti segnalava la fase finale di frequentazione, dopo l'abbandono della struttura e prima della definitiva obliterazione. L'origine della sua formazione potrebbe essere dovuta al dilavamento del legante dei muri, conseguente al crollo della copertura del tetto della primitiva struttura, in un momento in cui l'ambiente era ancora oggetto di attività legate presumibilmente a una riutilizzazione di materiale edilizio. Tra gli elementi più significativi di questa sequenza stratigrafica sono da ricordare frammenti di terra sigillata italica e africana e una moneta bronzea (fig. 6, con la scritta nel D/ IMP MAXIMIANVS AVG) con il busto di Massimiliano Erculeo radiato e drappeggiato a ds. con corazza (mentre nel R/ è presente la sigla VOT/XX/E entro corona d'alloro) databile tra il 297/298 d.C.[6], con una circolazione che ci permette di fissare il *terminus post quem* per la formazione dello strato corrispondente nell'ambito del IV sec. d.C.

La situazione dello scavo, con intonaco ed elementi rimescolati, sembrerebbe accreditare l'ipotesi che l'abbandono dell'ambiente sia stato non improvviso, ma il risultato di una serie ripetuta di crolli. Il *terminus post quem* della fase d'interramento dell'ambiente può essere fissato tra il IV e il VI sec. d.C.

Completata la fase di rimozione degli strati che obliteravano il proseguimento del mosaico già rinvenuto, è stato possibile riportare alla luce sia la parte del pavimento mancante (fig. 7), sia ciò che rimaneva dell'elevato delle pareti settentrionale e orientale dell'ambiente, ancora in parte intonacate di bianco con una fascia rossa orizzontale alta circa 4 cm, a una certa distanza dal suolo (fig. 8). Immediatamente a contatto con il pavimento era presente lo strato di frequentazione finale dell'ambiente con un residuo di bruciato. La ceramica comune presente in esso non sembra allontanarsi da quella cronologia di fine III–inizi IV secolo d.C., già presente nello strato sovrastante.

Con questa nuova indagine l'apparato decorativo del mosaico si completa con l'incrocio ad angolo della doppia cornice di colore rosso bruno e con il proseguimento dell'intreccio semplificato di girali floreali attorno allo pseudo emblema centrale con uccelli policromi (fig. 7).

Due ingressi (fig. 7) da nord e da ovest consentivano l'accesso al vano, attraverso un'area purtroppo non esaminata, pavimentata con un grossolano cocciopesto. Il primo (fig. 8) era stato successivamente obliterato da una tamponatura – presumibilmente in una fase di ristrutturazione della *domus* – ed era composto dalla soglia in pietra allo stesso livello del mosaico e dal ripiano più basso in pietra, con i segni dei cardini della porta. L'apertura di quest'ultima era inquadrata da due basi modanate.

Figura 6 Spello, Ex Ospedale, moneta di Massimiliano Erculeo. Foto: Francesco Giorgi. Riprodotta con il permesso della Soprintendenza per i Beni Archeologici dell'Umbria

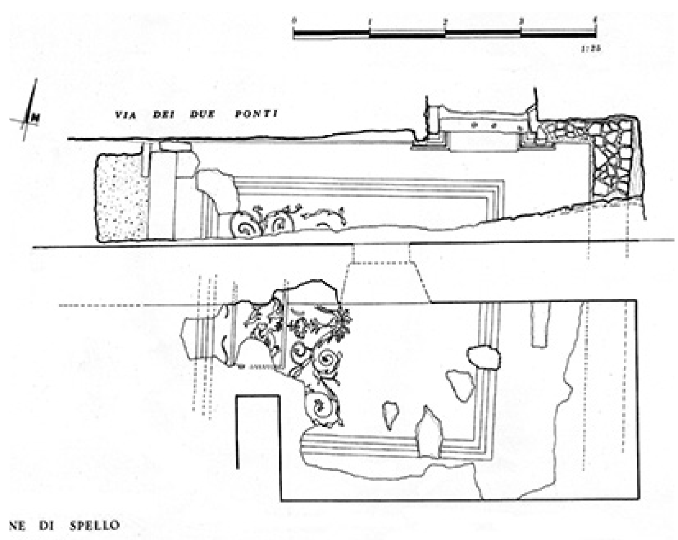

Figura 7 Spello, Ex Ospedale – Via Due Ponti, planimetria dell'ambiente della *domus* e della decorazione del mosaico. Rilievo: Francesco Giorgi. Riprodotto con il permesso della Soprintendenza per i Beni Archeologici dell'Umbria

Figura 8 Spello, via Due Ponti, ingresso settentrionale e pareti nord ed est dell'ambiente della *domus*. Foto: Valentino Pescari. Riprodotta con il permesso della Soprintendenza per i Beni Archeologici dell'Umbria

Il secondo ingresso (fig. 7) era in prossimità dell'angolo nordovest dell'ambiente. Aveva ancora la soglia in pietra calcarea e il blocco contiguo, sistemato in verticale, costituiva l'elemento di base di uno degli stipiti della porta.

I due saggi riuniti hanno permesso di completare la ricostruzione della decorazione dell'ambiente, a eccezione della zona occupata dal muro perimetrale dell'ex Ospedale, che ne nasconde una parte. L'intero pavimento ha una dimensione di m 5,80 × 4,60. Il mosaico, dopo il restauro, è oggi visitabile all'interno dell'edificio delle Case Popolari. È costituito, come si è detto, da un pavimento monocromo bianco, punteggiato a intervalli irregolari, da tessere rosse, riquadrato da una duplice fascia di colore rosso bruno, che delimita sul lato occidentale un riquadro con rappresentazione di volatili, circondato a sua volta da una fascia con motivi vegetali.

Benché non sia possibile trovare confronti puntuali per la decorazione fitomorfa, poiché ogni esempio per questo genere di repertori ornamentali costituisce notoriamente un *unicum*, si può notare una disposizione ancora naturalistica degli elementi floreali e confermare che la stessa rientra nella tipologia di ornati dello stile fiorito che ebbe particolare fortuna nella produzione italica di età adrianea. Questi motivi ornamentali, di gusto ellenistico[7], divengono una delle espressioni più peculiari e autentiche dei mosaici di età adrianea–antonina: si confrontino i casi ostiensi (relativi al Caseggiato di Bacco e Arianna, quelli dell'Insula delle Pareti Gialle e del Palazzo Imperiale) (Becatti 1961: 153ss., n. 292, tavv. LXXV–LXXVIII; 124: n. 226, tav. LXXIV; 287: n. 296, tav. LXIX) e gli eleganti esempi degli *Hospitalia* di villa Adriana a Tivoli (datati tra il 118 e il 125 d.C.)[8]. A essi si possono associare i mosaici di Castra Praetoria (Vincenti 2004: 253–70, fig. 4), datati al primo quarto del II sec. d.C.

Dal punto di vista esecutivo, l'esemplare in questione è reso con uno stile semplificato e leggermente schematico, pur nell'uso della policromia che distingue foglie, nervature, inserimento dei tralci, con qualche disinvoltura nell'esecuzione, già visibile nell'utilizzo di tessere abbastanza grandi (fino a 2 cm di lato). In ogni caso, proprio per il carattere schematico, essenziale, di racemi e di boccioli, l'apparato floreale del mosaico può rientrare concretamente nell'età adrianea–antonina.

Nella rappresentazione del riquadro o pseudo emblema centrale è d'altra parte riscontrabile un accentuato uso pittorico delle sfumature cromatiche, rafforzato dall'inserzione di paste vitree colorate e *faïence* nel piumaggio dei volatili e degli elementi floreali e naturali che compongono la rappresentazione.

Considerata la porzione ridotta dell'indagine di scavo, non è possibile individuare la funzionalità dell'ambiente in esame, anche se la leggera inclinazione del locale verso est, così come la ricchezza e la tipologia della composizione decorativa, possono far supporre che si tratti di uno dei vani più rappresentativi della *domus*, quale si può attribuire solitamente a un *triclinium*. Proprio il fatto che l'apparato decorativo fosse collocato su un margine dell'ambiente può far pensare alla sala dove si svolgevano i banchetti, con la sistemazione sui tre lati della stanza dei *lecti tricliniares*, sui quali erano sdraiati i commensali in ordine di importanza per tutta la durata del pranzo. Non sembra accidentale la centralità della composizione floreale che con il suo calice si trova esattamente in asse con la composizione del riquadro centrale.

Quest'ultimo doveva, a sua volta, avere un collegamento simbolico, legato agli interessi e alle attività del padrone di casa e alla qualità delle proposte nel suo convivio[9].

L'insieme degli elementi creati dalla posizione della *domus* all'interno del municipio romano e il tipo di composizione musiva, che si rifà a un sapere tecnico realizzato da maestranze qualificate, ci fanno comprendere in ogni caso la disponibilità economica di una committenza che aveva a sua disposizione possibilità non trascurabili.

I lavori di ristrutturazione nell'edificio dell'Ex Ospedale hanno, inoltre, riportato alla luce un altro ambiente – a una certa distanza e a una quota inferiore rispetto al mosaico – che ha restituito una successione pluristratificata, che rivela una frequentazione dall'epoca preromana (VII–VI secolo a.C.) fino a un'epoca post medievale non meglio definibile.

Note

1 Ringrazio vivamente i membri dell'ICCM per avermi dato la possibilità di presentare il caso che mi accingo a esporre.

2 Fino a qualche anno fa "INA casa", attuale "ATER (Azienda Territoriale per l'Edilizia Residenziale)".

3 Il lavoro è stato controllato dalla Soprintendenza per i Beni Archeologici dell'Umbria, in particolare: da chi scrive nella veste di Direttore Scientifico, con l'assistenza del geom. Luca Bartolini e la collaborazione tecnica del geom. Sergio Vergoni. Sul campo il controllo e la documentazione tecnico-scientifica sono stati affidati al collaboratore esterno archeologo dott. Francesco Giorgi della ditta Themys. Nel testo le fotografie sono di Valentino Pescari, i disegni di Francesco Giorgi. I restauri son stati eseguiti a spese della Soprintendenza dal restauratore esterno dott. Adamo Scaleggi. Un contributo notevole è stato dato, sul piano della collaborazione economica e concretamente nel progetto di sistemazione, dalla direzione dell'ATER, in particolare nella persona dell'ing. Luca Federici. Un sincero ringraziamento va a tutti loro singolarmente, e ancora alla Soprintendenza per i Beni Archeologici dell'Umbria per la possibilità di utilizzare la documentazione grafica e fotografica di scavo, così come a Massimo Paolucci per l'aiuto tecnico offertomi in questa come in altre occasioni. Inoltre la mia gratitudine va all'amico Roberto Berretta per l'identificazione della denominazione scientifica dei volatili.

4 L'accesso all'ambiente è attualmente possibile dal cortile interno del palazzo, attraverso la scala che conduce agli scantinati.

5 La pietra viene definita in un'iscrizione (CIL XI) come *lapis hispellatis*.

6 Cfr. un esemplare simile in Bergamini e Catalli 1991: 262.

7 Si veda in particolare Balmelle e Prudhomme 2002: tav. 55 b, d.

8 In particolare negli *Hospitalia*: si veda a questo proposito l'esempio di decorazione floreale presente in HS 17, De Franceschini 1991: 46–47.

9 Si veda a questo proposito quanto propone Kondoleon 1991: 105.

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Changing Approaches to the Design of Shelters over Mosaics: The Zippori Case Study

Yael Alef

Abstract: *Three permanent shelters were built at the archaeological site of Zippori during the 1990s. A massive concrete enclosure was built over the Dionysos mosaic and building; an open shelter, made of metal and wood, was built over the Nile Festival mosaics and building; and a "glass box" enclosure was built over the synagogue and its mosaic. Each shelter presents a different approach to the design of protective shelters over mosaics. This study analyzes the effect of the different shelters on the interpretation and presentation of the site and assesses the "costs," with the aim of revealing criteria for evaluating shelter designs.*

The large-scale archaeological excavation of Zippori that took place as part of the development of the national park unearthed over forty mosaics.[1] The mosaics, depicting a wide range of scenes, figures, and geometric designs, some of which are of the highest quality, place the city among the more important mosaic centers of the Roman and Byzantine East. During the 1990s, three shelters were built over the Zippori mosaics: the first enclosure was built over the Dionysos villa in the early 1990s; the second was an open shelter built over the Nile Festival building in the mid-1990s; and the last enclosure, over the synagogue, opened in 2000. Each presents a different approach to the design of protective shelters over mosaics.

The particular characteristics and value of mosaics lie in their equal importance as historical evidence of works of art and of architectural elements. This poses an intrinsic conflict in their presentation. Mosaics, for example, are usually presented as "objects," while their architectural setting forms the context. These distinctions are amplified in the presentation of mosaics under shelters and become even more profound when comparing the presentation of mosaics in closed museums, isolated from the context in which they were found, with open site museums.

Shelters over mosaics have been an ongoing challenge for over a decade (Teutonico 2001; Roby and Demas 2012). This is not surprising, as shelters seem to encompass all the complexities of modern interventions in archaeological sites: conservation, interpretation, and presentation. The protective performance of shelters over mosaics has been investigated in collaborative research by the Getty Conservation Institute, Historic England (formerly English Heritage), and the Israel Antiquities Authority (Stewart, Neguer, and Demas 2006; Neguer and Alef 2014). This research served as the basis for development of protective criteria and guidelines for the modification of existing shelters and the planning of new shelters (Alef and Neguer 2012). The study of the shelters at Zippori will focus on the effect of the shelters on the interpretation and presentation and its costs, with the aim of establishing criteria for evaluating shelter designs.

The Zippori National Park

In the mid-1980s a joint Israeli-American team from the Hebrew University in Jerusalem and Duke University in North Carolina joined the excavation at Zippori. As a means of funding the excavations, Zippori was promoted as a tourist destination. During the first years, from 1985 to 1987, the excavation was supported by the Jewish National Fund and the Ministry of Economy, which hired workers that were otherwise unemployed. At that time initiatives were taken by the Israel National Parks Authority (INPA) to declare the site a national park. Those efforts, however, were affected by the decline of tourism during the 1987 Intifada, and no funds were allocated to the project. At this same time, the Dionysos mosaic was discovered. The American archaeologists were in favor of lifting and displaying the mosaic in the Israel Museum in Jerusalem. However, Ehud Netzer, the lead archaeologist from Hebrew University, thought that "on-site presentation" of the mosaic was crucial for further development of Zippori for tourism. He raised the funds for a shelter, and the enclosure over the Dionysos mosaic was constructed. This was the trigger for paving a road and building other facilities for visitors such as rest rooms and a shop. The opening of the Dionysos mosaic to the public in 1992 marked the official opening of the Zippori National Park.

The second turning point in the development of the site was in 1992 when it was included in a group of national priority projects, funded by the Ministry of Tourism, which combined development of sites for tourism and employment of recent immigrants from Ethiopia and the former Soviet Union. The number of workers employed daily at Zippori reached approximately 100 to 150, drastically increasing the rate and scope of the excavations. At present (2015), new development plans are under way, among them a new audio-visual presentation of the synagogue mosaic and renovation of the Dionysos mosaic building. The Zippori National Park today encompasses over 16 square kilometers, and it is among the most visited national parks in Israel, with a yearly average of 100,000 to 120,000 visitors.

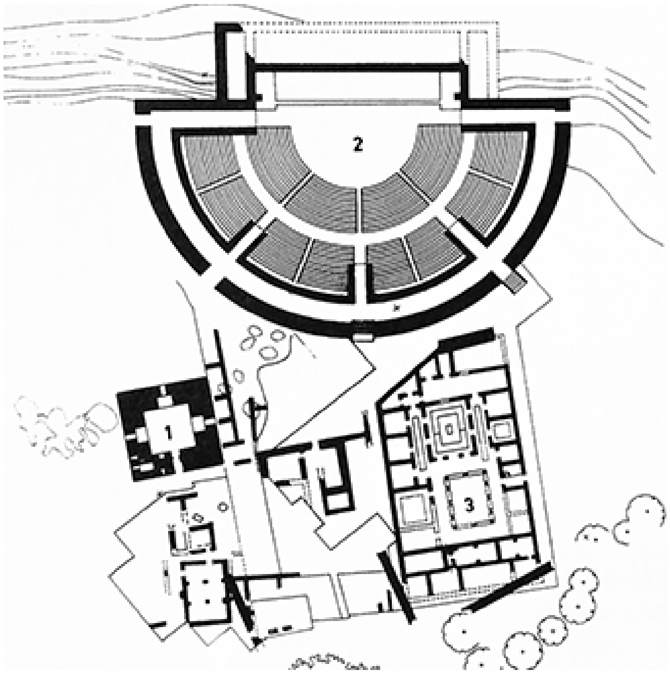

Figure 1 Plan of the Dionysos mosaic building in the acropolis of Zippori. (1) Watchtower, (2) Theater, (3) Dionysos mosaic building. From Martin Nagy et al. 1996. Courtesy of the Sepphoris Expedition, The Hebrew University Expedition

The Dionysos Mosaic Building

Excavations uncovered the Dionysos mosaic building in 1987–1988. Soon after, the Dionysos mosaic was lifted and restored by the Laboratory for Restoration of Antiquities at the Israel Museum, Jerusalem. In 1990 plans were drawn up for the enclosure, which was constructed in 1991. A year later the panel was relaid and the site was officially opened to the public.

The building is located at the summit of the hill next to the Crusader Watchtower, which provides views of the site and of the Beit Netofa valley (fig. 1). This is a large private dwelling from the early third century CE that occupied the entire width of the acropolis. The building is planned around a triclinium, which opened to a peristyle courtyard. Its size and elaborate decorations suggest that it was built by a wealthy aristocrat or perhaps a Roman official. An earthquake destroyed the building in 363. Its northern side was preserved buried under the rubble, and the southern side was altered by later Byzantine construction (Netzer and Weiss 1994).

Figure 2 The triclinium with the mosaic floor made in the emblem tradition, illustrating scenes from the life and cult of Dionysos. Photo: Y. Alef (2006) © IAA

The triclinium is embellished with a well-preserved mosaic floor made in the emblem tradition, illustrating scenes from the life and cult of Dionysos (fig. 2). The richness of detail, and especially the combination of the myth and reality of the Dionysian cult depicted in the same floor, makes this mosaic unique, not only among the mosaics of Zippori, but in Roman art in general. This is particularly interesting for illuminating the Hellenic influence on Jewish cultural life in the Galilee (Talgam and Weiss 2004).

The Enclosed Shelter

The first phase of the planning for the enclosure over the mosaic in the northern area took place while the excavation was still in progress, and little information on the archaeological context to the south was available. The planning for the southern area was to take place in the second phase. In

Figure 3 View of the massive concrete enclosure over the northern part of the Dionysos mosaic building, Zippori. While respecting the views from the watchtower, the enclosure does not evoke the image of the Roman villa, and lack of development of the surroundings impairs the legibility of the urban layout. Photo: Y. Alef (2006) © IAA

the end, the excavations to the south revealed remains that were considered less "interesting." Eventually resources ran out, the northern area was sheltered while the southern area was not developed, and the project as a whole was never fully realized.

The enclosure, designed by L. Belkin,[2] is a reinforced concrete structure built in parts directly on the original walls covering an area of about 400 square meters. Illumination in the building is provided by spotlights concentrated over the Dionysos mosaic. The total shelter planning and construction costs (not including mosaics treatment) was $400,000.

The enclosure is situated in sensitive proximity to the watchtower and therefore presented some difficult challenges. Careful attention was given to the design of the roof so that it respected the setting and made minimal alterations to the landscape (Margalit pers. comm. 2014). The solution was to partially bury the structure into the slope and divide its mass into different planes that follow the topography (fig. 3).

The outstanding artistic value of the Dionysos mosaic directed the interior design of the shelter. The presentation designed by R. Sivan[3] is primarily based on the display of the Dionysos mosaic and secondarily on the architectural space.

Evaluation

While respecting the views from the watchtower, the enclosure enables limited understanding of the architecture of the Roman villa and its urban context. Although it reconstructs the plan of the remains, it does not evoke an image of a Roman villa. In addition, lack of development of the surroundings impairs the legibility of the urban layout (see fig. 3).

The design of the shelter as a "closed museum" highlights the mosaic. This, however, results in experiencing the Dionysos mosaic as a two-dimensional artwork, isolated from its architectural and urban context. Blocking natural light and ventilation, in addition to the darkened rooms around the triclinium, detracts from the legibility of the remains as a whole and prevents the experience of the spatial qualities of the reconstructed building (fig. 4). Relying on artificial lighting also came at the cost of intensive maintenance. The original lighting system consisted of about fifty-five short-life lightbulbs; they were later replaced by nine light fixtures of 2,000 lifetime hours (Sela 2002). The alternative illumination system requires only annual changing, but the amount of lighting is not sufficient and affects the presentation.

The closed interior restricts the understanding of the unique setting of the villa on the top of the hill, between two streets, and obscures the connection of the triclinium to the peristyle courtyard. Ironically, in contrast to the initial desire of the archaeologist to present the mosaic in situ, the result is complete isolation from the site.

Figure 4 Interior view of the Dionysos mosaic building. The closed interior highlights the mosaic's artistic qualities at the cost of understanding the unique setting of the building and the connection of the triclinium to the peristyle courtyard. Photo: Y. Alef (2014) © IAA

Figure 5 View of the open shelter over the Nile Festival building next to the cardo. The modular roof is composed of a complex system of pyramids made of fiberboard covered with copper sheets. Photo: Y. Alef (2014) © IAA

The Nile Festival Building

The site was excavated in 1991 by Ze'ev Weiss and Ehud Netzer from the Hebrew University. In 1994–1995 in situ conservation of the mosaics was undertaken by the Centro di Conservazione Archaeologica of Rome, along with the construction of a permanent shelter.

The Nile Festival building is located to the east of the cardo, at the center of the Byzantine city (fig. 5). It was constructed in the fifth century CE with rooms planned around a basilical hall and a courtyard. The function of the building is not clear; however, its central location, size, and elaborate mosaic floors indicate that it may have been a public building (Netzer and Weiss 1997). The Nile Festival building is the largest and one of the most impressive structures, with its collection of mosaic floors, in Zippori.

The entire building was originally paved with mosaics: twelve mosaic floors decorated with geometric patterns and figurative designs. The Nile Festival mosaic, at 6.7 × 6.2 meters, is the largest and most elaborate mosaic found in the building. Its design, in a rather free composition, displays Nilotic scenes as well as various hunting scenes. Such a rich combination of the two themes and the remarkable artistic quality are exceptional in Byzantine art (Netzer and Weiss 1997).

The Open Shelter

The Nile Festival building presented circumstances different from those of the Dionysos villa in its setting and size, and a very different approach was adopted. Early on, it was agreed that this would be an open shelter due to the large area of the building. The concept of modular "umbrellas" covering the areas that require protection was then developed to enable flexibility and adaptability, if it was decided to expand the shelter or build it over other mosaics (Belkin pers. comm. 2002). The open-sided shelter combines metal and timber framing and measures 670 square meters. The roof is composed of a complex system of pitched roofs made of fiberboard covered with copper sheets (fig. 5).[4] The relatively high cost of the shelter, about $500,000, was partly influenced by the selection of expensive materials.

The rural landscape of Zippori, set on the hills of the Galilee, with its villages, traditional agriculture, and flora, has kept a historic characteristics and aesthetic value. In contrast to the isolation of the Dionysos enclosure, the planners made a point of keeping this shelter open to the scenery and emphasizing the location of the building on the cardo, which is a significant value of the site. The principal concepts drafted by the planning team were modularity and compatibility with the landscape in materials and colors. The mass

Figure 6 Interior view of the open shelter over the Nile Festival building. The elaborate design "competes"with the remains. Photo: Y. Alef (2014) © IAA

of the large roof was broken into smaller modules to avoid a heavy appearance.

The presentation of the site focused on the display of the mosaics as architectural elements. This entailed re-creating the sense of volume by partially reconstructing the walls and defining the perimeters of the room in roof partitions and by integrating new floors in missing places. The path too had a role in enhancing the archaeological context by leading from the cardo to the original entrance and inviting visitors to view the mosaics from the ground level (Sivan 2002).

The in situ treatment of the mosaics aimed at presenting them in their architectural and historical context. Constanzi Cobau and Nardi (1996) described the philosophy underlining the conservation work on the site as preserving the aesthetic image of the floor as it has come down through the centuries. By this they meant preservation of all natural and anthropic traces, which have characterized the mosaic, as we know it, avoiding the trap of presenting a mosaic bright and shiny and instead encouraging a historical interpretation through the marks left by time. The outcome would be presenting a clean work of art, free of disturbing elements but complete in its particular history and in its own context.

Evaluation

The shelter is a contemporary work with its own architectural qualities. Its expressive design stands in contrast to the archaeological environs and is quite dominant in the landscape. The same "busyness" of the exterior design affects the interior of the shelter as well. The roof design comprises an elaborated system of pyramids made of intricate timberwork details and metal joints (fig. 6). This complex construction, with its own architectural qualities, detracts attention from the mosaics.[5]

Open views from the shelter to the surroundings enable comprehension of the archaeological context. The downside is that it does not provide protection from dust accumulation on the mosaics. This, in addition to the use of natural illumination only, affects the artistic quality of the mosaics. Another aspect of the open shelter is the conflict between presentation purpose and conservation. The plan of the roof is exactly in the perimeter of the original walls to re-create the volumes of the rooms. This, however, did not leave enough roof overhang to protect from rain.

The decision to use copper and fiberboard on the roof for their aesthetic appearance had its costs too. The high thermal conductivity of the copper causes condensation on the fiberboard in summer. In winter, leaks from the roof were noticed after rain. It is not surprising, then, to find mosaics that show signs of microbiology and fiberboard that shows signs of rot.

The Synagogue

Excavations led by Ze'ev Weiss and Ehud Netzer from the Hebrew University revealed the synagogue in 1993. The mosaic was lifted a year later and restored at the Laboratory for Restoration of Antiquities, the Israel Museum, Jerusalem. Construction of the enclosure, designed by Lawrence Belkin, took place in 1999, with a total cost of $400,000. In 2000 the mosaic was relaid.

The synagogue is situated on the northern slope of the hill looking over the picturesque views of Beit Netofa Valley. In the ancient urban layout, the synagogue was located not far from the city's center in the north section (figs. 7, 8). The plan consists of a main hall and one aisle. It was built during the first half of the fifth century CE and destroyed at the end of the Byzantine period.

The most significant remnant of the synagogue is its mosaic floor, which contains rich iconography of a zodiac, Jewish symbols such as the Holy Ark with a menorah, and biblical scenes that include the story of the binding of Isaac (see fig. 7). The unique narratives make this mosaic highly significant in Jewish art (Weiss and Netzer 2005).

The Glass Box Shelter

The initial design envisioned a glass box over the remains that would also accommodate special religious occasions such as bar mitzvah celebrations (Belkin pers. comm. 2002). Due to budgetary constraints, two walls on the narrow ends of the enclosure were constructed with prefabricated cement boards.

In the instructions to the architect, Shalev (2002) specifically required keeping open views from the building and integration into the landscape. The design of the enclosure, as opposed to the earlier Dionysos and the Nile Festival shelters, took a more abstract form, and is not built directly on the walls of the synagogue (see fig. 8).

The mosaic is displayed with natural light filtered through the glass curtain walls supplemented with spotlight illumination. It is viewed from the ground level, enabling close examination of the details.

Evaluation

In the interpretation of the values of the synagogue, its social and historical significance was found prominent. These concepts were successfully carried out in the reuse of the site and clear display of the mosaic. This came at the cost of the sense of authenticity of the archaeological material and somewhat sterile appearance of the enclosure. The attempt to clarify the mosaic's narratives removed some of the evidence of damage and sense of age. The contemporary abstract design of the enclosure further contributes to the conflict of the shelter with the genuine archaeological remains. While in the Nile Festival building the path follows the original circulation as an interpretive tool, the path in the synagogue leads the visitor around the building to view the mosaic from the exterior.

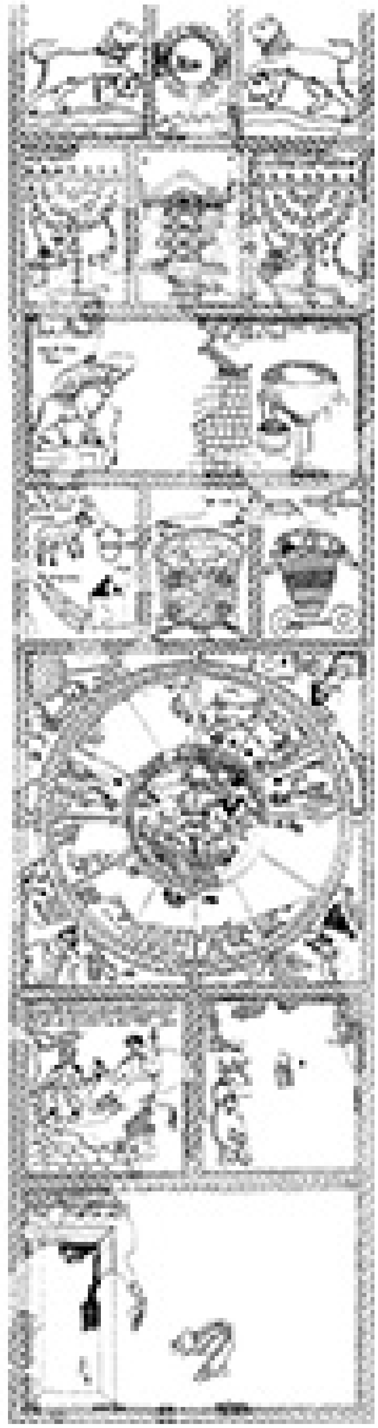

Figure 7 Drawing of the mosaic in the nave of the synagogue (Weiss 2005). Courtesy of the Sepphoris Expedition, The Hebrew University Expedition.
Drawing: Pnina Arad

Figure 8 Interior view of the synagogue with glass curtain walls. Plans for the new presentation will cover the windows in order to better control the lighting of the mosaic. Photo: Y. Alef (2006) © IAA

The synagogue is displayed as an object in a modern "showcase" that stands apart from the remains and does not create a unique sense of place.

Discussion and Conclusions

The shelters at Zippori reflect different approaches for the presentation of mosaics in situ. The Dionysos building is an enclosure, while the Nile Festival building is an open shelter. The synagogue enclosure was designed with wide windows providing views to the surroundings. Those windows are being sealed now to enable better artificial lighting control in the new multimedia presentation of the mosaic.

What has changed? Ranellucci (1996) describes the interpretation and presentation of the site as a critical process of identification and selection of the most valuable objects—the "extraordinary" and the "ordinary"—and the context of the site with its modest but characteristic elements, which allow the understanding of the site as a whole. This explains the shift in the Israel National Parks Authority's approach to the presentation of the mosaics and the site. The presentation of the Dionysos mosaic focused on the "extraordinary" artistic value, which was then a common approach, where in most cases mosaics were lifted and presented in museums. Constanzi Cobau and Nardi (1996) marked a change in the approach for presentation of mosaics in the in situ treatment of the Nile Festival mosaic. It reflected developing practices in the international conservation community at the time, based on conserving the historical value and the architectural context and setting of the mosaic. It seems that in recent years, the INPA is neglecting this approach in favor of a more accessible or, in other words, less elitist, visitor experience. One may relate it to some disappointment regarding the enormous investment in the development of archaeological sites by the Ministry of Tourism during the 1990s that did not result in a significant increase of visitors to the sites. Today, with the idea that "archaeology does not sell," the INPA prefers enclosures such as Hamat Tiberias, Beit Alpha, and the Dionysos mosaic at Zippori, which offer a multimedia experience and other facilities for visitors in order to compete with other tourist attractions (Margalit pers. comm. 2014).

The examples from the Dionysos mosaic building and the synagogue demonstrate cases where the presentation of the mosaics, although in their original settings, came at the cost of an incomprehensible context.

The presentation of the Dionysos mosaic emphasizes its individuality. There are no views to its surroundings and no natural light, instead using artificial illumination in an artistic and dramatic manner. This approach, as noted above, is being adopted today to the synagogue mosaic as well.

The Nile Festival mosaics, unlike the Dionysos mosaic and the synagogue mosaic, are displayed as architectural elements in an urban, archaeological context. This is emphasized by the path, sense of volumes, open views, and the mosaics' in situ conservation.

The particular values of each of the mosaics and its setting, in addition to a changing cultural context, directed their presentation and the design of the shelters, resulting in three different shelters. The decision-making process regarding the shelters design in Zippori was conducted with no written design criteria or design briefs for the shelters (Margalit pers. comm. 2014). The analysis of these case studies has revealed the criteria that were chosen for the design of the shelters, as well as their "costs." From those specific criteria, we can formulate general interpretation and presentation criteria as follows:

- What are the architectural qualities of the shelter in its own right, and how do they affect the experience of the landscape as it is expressed in shape, color, materials, texture, scale, massing, and height? This refers to the setting of the shelter, which in most cases is a single building in a landscape of ruins. What is the relation to other shelters on the site and its effect on the perception of the site as a whole?

- What is the effect of the shelter on the legibility of the archaeological context? This criterion could refer to views from the shelter outward and continuity of the architectural unity of a complex to enhance the presentation of the archaeological context.
- What is the effect of the shelter on the legibility of the remains within the shelter as it refers to the urban and architectural characteristics of the archaeological remains? Some approaches prefer "abstract" design in contrast to the remains. In that case, does the shelter create a sense of place with unique qualities? Other approaches favor analogical relationships. In that case does it convey a sense of volume of exterior and interior spaces; does it promote the understanding of the entrance, circulation, and the meaning of different ground levels, or are the mosaics isolated from the surroundings and presented as "objects"? Visitor circulation as an interpretive tool may utilize the original routes and entrances, enabling the original views of the mosaics and creating hierarchy and differentiation of the various paths.
- In view of the artistic and historical values of the mosaics, does the shelter enhance the mosaics, and does it enable clear views of the entire artwork, from an elevated point of view as well as closer views from the original floor level? How does the illumination affect the mosaic itself and its spatial context? Where artificial lighting is used, the visual impact of the light fixtures should also be considered.
- Does the design of the shelter follow conservation principles, such as distinguishing the new interventions from the original structure, respect for the authenticity of the remains as it is expressed in minimal intervention, compatible materials, and reversibility?

With all the variables that need to be addressed in the process of planning shelters, the result is always a compromise between conflicting requirements. Choosing to express one value comes at the expense of another value, for example, presentation of a mosaic as a work of art where the complete image and vivid colors are most important versus presentation of the setting. A clear evaluation of the various criteria in a critical planning process may assist in arriving at a balanced design.

The lessons from the Zippori case study highlight the importance of defining the criteria for the design of shelters based on the different values of the site, collaboration of a wide range of professionals in the planning team, and awareness and implementation of conservation principles.

Notes

1 This paper is mainly based on the Zippori case study undertaken as part of a master's thesis, "Evaluation of Shelters over Mosaics in Israel," by Y. Alef, Katholieke Universiteit, Leuven, 2002.

2 L. Belkin planned all three shelters at Zippori.

3 R. Sivan was the curator of all three sites under shelters at Zippori.

4 The planned roof details included insulation, but it was not installed.

5 Some visitors have been more impressed with the roof structure than the mosaics themselves (Kuryat-Aharon pers. comm. 2002).

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Shelter: The Point of View of a Practitioner

Gionata Rizzi

Abstract: *This paper describes a few cases where shelters could have been avoided and a few others where they have been designed with a conscious effort to tailor them to the object to be protected. All the types of interventions—from reburial to the construction of an architectural envelope molded on the* forma pristina*—are discussed to show how the effort to write guidelines takes the field nowhere.*

As I have often had the opportunity to say when I am invited to speak about shelters, I have a twisted attitude about them: I profoundly dislike them, yet I keep designing them. More than this: I keep designing them, although I not only dislike them but also believe that they are often unnecessary and sometimes even bad for the conservation of what they are meant to protect.

Let me start from a case in Quirigua, Guatemala, where a decision was made to build little roofs over each stone stela to protect them from the rain. In spite of the choice to construct the roofs with local materials and local techniques (which makes them easy to build and to maintain, avoiding at the same time the effect of "alien structures"), their presence totally upset the visual meaning of these gigantic nails driven into the ground and pointing to the sky (fig. 1). But this aside—I recognize this is a very subjective impression—let's look at what these roofs actually do: like all roofs they concentrate the rain in a few spots, or if they have no gutters, the rain is concentrated along the line of their perimeter. This is enough to create a pond that feeds the rise of capillarity, which in the areas where wet/dry cycles occur started to damage the stone—stone that, judging from the sharpness of the details, did not suffer much from the rain. Why, then, were these shelters built? The answer I eventually heard was, "to keep the top portion of the stelae from turning black from the algae that forms on the surface in the wet season."

To prevent this, however, another option would have been to test the effect of chemicals (biocides in solvent) largely used in conservation or to design a "cap" attached to the top of the stela, which is easy to place and remove and which is to be used only during the wet season.

A totally opposite concept has been used in Pompeii, where a portion of a house has been "protected" by a glass cage in what I would call *high-tech style*. The first thing that struck me was how little this type of shelter blends into the archaeological context and how it makes the house seem like a museum. Again, this is a personal view, and there are people who may enjoy feeling that in Pompeii they are in a museum. However, there are more practical concerns than my negative reaction to glass (which is often used with the justification that it represents a *neutral* solution). The fact is that these high-tech objects need to be unremittingly cleaned by a gang of workers. I am also shocked that architects keep using glass after the well-known failure of Minissi's shelter at Piazza Armerina: the greenhouse effect was so strong that it convinced the Soprintendenza to replace the glass shelter with an opaque one (fig. 2). In Pompeii the glass cage is still there, but the vertical enclosure had to be removed because "it was too hot."

Another case where, to my mind, it would have been a mistake to build a shelter is at the San Bernardo pass between Italy and France. Here I convinced local authorities to tackle the problem in a different way. The remains to be protected are important but not very interesting to look at: they are in fact the traces of Roman mansions in a place that today gets up to five meters of snow. Subjected to that climate, the remains of the walls have been conserved, retouched, and reconstructed so many times that it is difficult to say to what extent they are still Roman. In addition to this, a structure able to take five meters of snow is by necessity so massive that

Figure 1 Shelters "protecting" the stelae in Quirigua, Guatemala. Photo: Gionata Rizzi

Figure 2 Basilica of the Villa del Casale at Piazza Armerina before the recent intervention. Photo: Gionata Rizzi

it would have visually overwhelmed the little traces of time past. Under these circumstances, it seemed preferable to bury what remained of these mansions, creating little embankments above them so as to suggest to visitors the presence of an architectural plan. This project was approved but has not yet been implemented because of the lack of funds.

Now, to address a few cases where shelters were actually unavoidable. The first, another project that has not so far been implemented, is in Guatemala City, in an urban park, at a site called Kaminaljuyu, one of the few Mayan sites with adobe buildings. Here the archaeologists excavated a large rectangular structure and brought to light an amazing imbroglio of

Figure 3 Basilica of the Villa del Casale at Piazza Armerina after the recent intervention. Photo: Gionata Rizzi

Figure 4 Temporary shelter over the atrium of the House of the Gemma at Herculaneum. Photo: Gionata Rizzi

Figure 5 Temporary shelter over the triclinium of the House of Telefus at Herculaneum. Photo: Gionata Rizzi

walls belonging to different periods that make no sense to the average tourist and are even difficult for specialists to understand. It would be good to show visitors that when they walk on the grass of that park they are literally walking on their past. Hence the idea of a "shelter" that would communicate that message.

The second example is a project that has been implemented, although it is still to be completed: the large shelter mentioned above for the Roman Villa at Piazza Armerina and its famous mosaics. In this project we had to deal with two failures of the previous interventions: one due to the unbearable temperature that this transparent shell created inside, and the second due to the shadows that the structure projected on the floor, making it very difficult to appreciate the mosaics (fig. 3).

The third case is at Herculaneum, a fascinating site where it is becoming more and more obvious that finishes conceived for indoor conditions (mural paintings, stuccoes, mosaics, and opus sectile) cannot be preserved without restoring the conditions of an indoor place. In the atrium of the House of the Gemma we reproduced the same structure used by the Romans to support the roof; but instead of using large and heavy beams (which are expensive and difficult to bring to a site that is not reachable by vehicles), we used a series of simple poles tied together (fig. 4).

Figure 6 New cover over the missing vaults in the House of the Hunt (Maison de la Chasse) at the site of Bulla Regia, Tunisia. Photo: Gionata Rizzi

Figure 7 Installing the new cover over the missing vaults in the House of the Hunt (Maison de la Chasse) at the site of Bulla Regia, Tunisia. Photo: Gionata Rizzi

Also at Herculaneum, in the triclinium of the House of Telefus, we set a series of trusses on a longitudinal beam supported by window frames set in their original position but over-dimensioned. With a little creativity we managed to produce reversible roofs for two rooms and without reconstructing the walls (fig. 5).

Finally, I want to discuss two examples from the extraordinary site of Bulla Regia, a cooperative project of the Institut National du Patrimoine (INP), the Getty Conservation Institute, and the World Monument Fund. Bulla Regia is famous for its subterranean houses, which, as long as their vaults are intact and no rain gets inside, provide the ideal conditions for the preservation of their mosaics. In the House of the Hunt, French archaeologists carried out extensive restoration work in the 1930s, but they left two gaps in the vaults of the peristyle that were both dangerous for visitors (who could fall into the lower level of the house) and bad for the preservation of the ancient fabric (because rain fell where it was not supposed to). In this case we solved the problem by finding a simple way to restore the continuity of the ground-floor peristyle: a "metal lid" made of metal slab (made of Corten, an alloy that is protected by its own rust), narrow enough to be handled by two people and joined together by ribs that increase the overall rigidity. The system proved effective: it leaves the section of the vault visible, and it is slowly taking up a patina that makes the metal slab recede visually into its surroundings. Among its good qualities, it is totally reversible (figs. 6, 7).

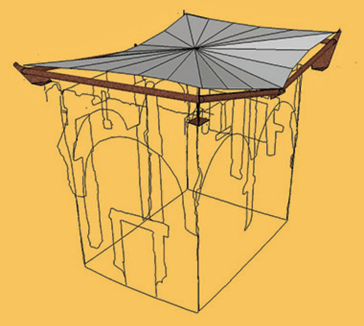

Figure 8 Temporary shelter designed for protecting the House of Amphitrite from rain at the site of Bulla Regia, Tunisia. Drawing: Gionata Rizzi

Also at Bulla Regia, at the House of Amphitrite the vaults have been totally lost above one of the rooms. Here, based on the traces left on the walls, it would be possible to reconstruct the masonry vault (in this case, it would actually be beneficial for the equilibrium of the complex since it would balance the outward thrust of the vaults on the adjacent room); yet, knowing how complicated it is to tackle a project like this, I suggested a temporary solution using a tensile structure stretched among six anchor points resting on the wall-head (fig. 8). This proposal was never implemented because the INP decided to undertake the reconstruction of the masonry vaults.

It should be clear by now that in designing a shelter one cannot follow general guidelines and there are no recipes for this activity. The only suggestion that I feel entitled to give is, try your best to avoid a shelter, and if you reallly have to design one, look more for elegance than neutrality.

Mosaici e *sectilia in situ* e multimedialità: Il caso di Palazzo Valentini (Roma, Italia)

Paola Baldassarri

Abstract: *Le indagini archeologiche della Provincia di Roma nei sotterranei di Palazzo Valentini hanno rivelato emergenze di notevole importanza, esposte permanentemente al pubblico. Si tratta di due lussuose* domus *di età imperiale e degli imponenti resti di un edificio pubblico identificabile con il Tempio dei divi Traiano e Plotina. Nel contributo vengono illustrati in sintesi: risultati della ricerca, interventi di restauro, sistema di musealizzazione multimediale adottato, costi e fonti di finanziamento, impatto socio-economico, gradimento del pubblico e inserimento del sito nei circuiti del turismo internazionale.*

Abstract: *Archaeological excavations by the Province of Rome beneath Palazzo Valentini have unearthed discoveries of considerable importance, now permanently exhibited to the public: two luxurious* domus*, or residences, from the age of the Roman Empire, and the stately remains of a public building identifiable as the Temple of the Divine Trajan and Plotina. This paper describes and summarizes the research results, the restoration measures, the multimedia system adopted for museum display, costs and funding sources, socioeconomic impact, public approval, and the site's introduction into the international tourism circuit.*

Le indagini archeologiche promosse e finanziate dall'Amministrazione Provinciale di Roma, con un contributo anche del Ministero per i Beni Culturali, dei fondi Roma Capitale e della Fondazione Roma, dirette da Eugenio La Rocca e dalla sottoscritta, sono state intraprese a partire dal 2005 nei sotterranei di Palazzo Valentini, sede storica e istituzionale dell'Ente[1], e sono parte di un più ampio progetto di restauro, rifunzionalizzazione e valorizzazione degli interrati del Palazzo, realizzato dal Servizio Manutenzione e Ristrutturazione dei Beni Patrimoniali diretto da Roberto Del Signore (cfr. Del Signore 2008), di cui, come archeologa, faccio parte. Il progetto generale è stato redatto e realizzato da un'équipe di archeologi, architetti, storici dell'arte e amministrativi di ruolo presso l'Amministrazione, coadiuvati dalle Società Parsifal e Archeometra per gli scavi e Capitolium Conservazione e Restauro, Marco Pepoli e Arecon per gli interventi di restauro e conservativi. Le Società Archeometra e Parsifal hanno anche realizzato una serie di rilievi in 3D che, oltre a essere illuminanti per lo studio di alcuni problemi di carattere scientifico, sono stati utilizzati per la realizzazione del percorso multimediale di visita che esamineremo poi in dettaglio.

Le emergenze rinvenute, qui illustrate sinteticamente, sono sostanzialmente riferibili a due contesti (fig. 1): un contesto privato a nord e a est, parte di un quartiere residenziale di alto livello, cui sono riconducibili i resti di due distinte *domus* di media età imperiale, le c.d. *domus* A e B, divenute forse nella tarda età imperiale un unico complesso; un contesto pubblico a sud e a ovest, relativo con ogni probabilità a un edificio di grandi dimensioni dell'inizio dell'età adrianea, che chiude a nord il complesso del Foro Traiano, i cui resti, riferibili alle fondazioni e ad alcuni sporadici elementi dell'alzato, suggeriscono l'identificazione con il *Templum Divi Traiani et Divae Plotinae*[2]. L'edificio, così menzionato nella *Historia Augusta* (cfr. Baldassarri 2008: 40–46; Baldassarri 2008–9: 347–51), sarebbe stato l'unico monumento sul quale Adriano, consacrandolo ai genitori adottivi defunti, avrebbe consentito di apporre il proprio nome[3]. La costruzione di tale edificio avrebbe comportato, come per il resto del Foro, un'integrale sistemazione anche dell'area circostante, con una presumibile sistemazione a piazza lastricata con basolato, sopraelevata rispetto alla viabilità carrozzata circostante, che si riscontrerebbe anche nella prima fase riconoscibile dell'area residenziale[4]. Di questo edificio, il cui scavo è iniziato solo molto recentemente (Baldassarri 2013: 386–403), si comincia ora a delineare una prima definizione come di un monumento

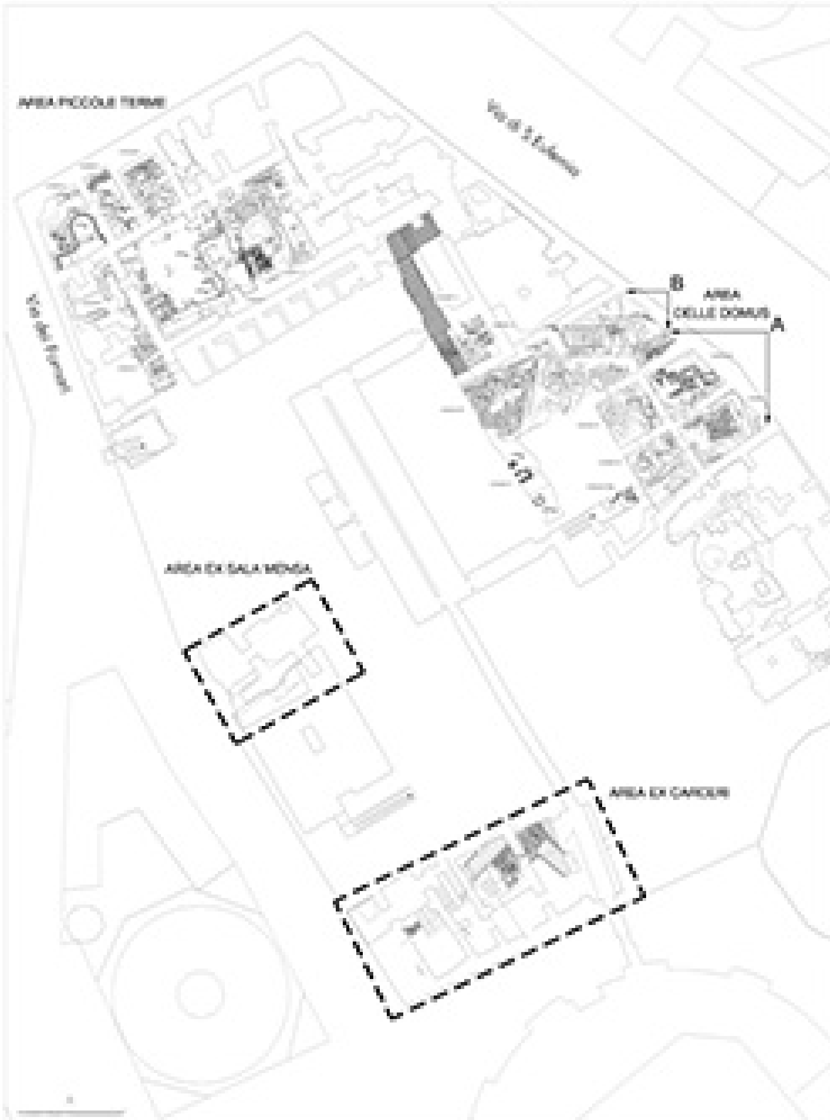

Figura 1 Palazzo Valentini: Planimetria dell'isolato con le emergenze archeologiche rinvenute. Foto: Parsifal Cooperativa di Archeologia

su podio, cui si accedeva tramite una gradinata sulla fronte meridionale, sostenuta da volte gettate contro terra. All'interno del podio sono ricavati ambienti di forma pressoché quadrata, associati ad altri rettangolari allungati, coperti rispettivamente a crociera e a botte, completamente costruiti in opera laterizia su zoccolo di travertino, su fondazioni in opera cementizia di malta grigia di ottima qualità mista a scaglie esclusivamente di travertino allettate a mano, uniti a blocchi di travertino e peperino (Baldassarri 2012b; 2013: 422–44; c.s.) (fig. 2). All'edificio sembrano doversi associare elementi architettonici di grandi dimensioni, come spezzoni di enormi colonne monolitiche in granito grigio egiziano, del diametro minimo di 1,83 m e massimo di 1,90 m e di altezza stimabile pari a circa 15 m, che hanno anche caratterizzato il quadro dei rinvenimenti nell'area a partire dal lontano XVI

Figura 2 Palazzo Valentini, ex carceri: Fondazione in opera cementizia e spezzone di colonna in granito grigio dal *Templum divi Traiani et divae Plotinae*. Foto: ACC Photo Autuori Carletti Callipari

Figura 3 Palazzo Valentini, domus A: Triclinio con mosaico pavimentale policromo. Foto: ACC Photo Autuori Carletti Callipari

secolo (Baldassarri 2008: 42–46; Quattrocchi 2008b: 161–63, 9.8 e 9.9).

Un quadro più esattamente definibile è quello offerto dalle due *domus* che si attestano già nel corso dell'età adrianea: la più antica è la A, di cui due bolli laterizi *in situ* indicherebbero una datazione prossima al 125 d.C.[5] e che peraltro non sembra essere con tutta sicurezza una *domus* nella prima fase. L'esame delle murature, infatti, sembrerebbe spingere a ipotizzare un primitivo progetto di uno degli ambienti, poi divenuto un triclinio, come un vano con portici aperti verso l'esterno, solo successivamente tamponati con muri continui. In ogni caso, la sua configurazione come *domus* sembra sicura a partire dalla seconda fase di vita, di età costantiniana, epoca nella quale si datano i tappeti musivi a tessere lapidee dei due ambienti rinvenuti, un peristilio con mosaico bianco e nero e un piccolo triclinio con mosaico policromo (fig. 3) a disegno geometrico di notevole complessità e varietà di motivi (Quattrocchi 2008b: 160–62, 9.6 e 9.7). Quanto alla *domus* B, la sua destinazione a residenza privata sembra invece risalire già alla fase iniziale, inquadrabile verso la fine del II sec. d.C., epoca alla quale risalgono le strutture murarie perimetrali in opera laterizia, corredate di bolli *in situ*[6], e la sistemazione a giardino dell'area aperta a nord–est, già basolata. Risale peraltro alla prima metà del IV secolo la ristrutturazione dei vani interni, dei quali sono stati messi in luce un'aula absidata (fig. 4) ancora completamente rivestita di *opus sectile* pavimentale e *sectilia* parietali (fig. 5) e una grande scala a tre rampe che conduceva al piano superiore, anch'essa originariamente rivestita di marmi, anche se in buona parte perduti (Baldassarri 2012a: 1641–43; Baldassarri 2012d: 56–58).

Figura 4 Palazzo Valentini, domus B: Aula absidata. Foto: ACC Photo Autuori Carletti Callipari

Figura 5 Palazzo Valentini, domus B: Parete est dell'aula absidata con decorazione a *opus sectile*. Foto: ACC Photo Autuori Carletti Callipari

Di questa seconda *domus* conosciamo anche un settore di servizio, un complesso termale di grandi dimensioni – tradizionalmente chiamato "Piccole Terme" – che si estende a nord–ovest degli ambienti appena esaminati e che ne condivide fasi edilizie e motivi decorativi[7]. Forse dotato di un suo ingresso a ovest, lato sul quale si affacciava il *praefurnium*, che si conserva assieme al *calidarium*, al probabile *laconicum*, al *tepidarium*, al grande *frigidarium* con più vasche e forse all'*apodyterium*, era con ogni probabilità collegato agli ambienti residenziali tramite un grande peristilio, di cui si è potuto esplorare solo un piccolo settore a sud. Anche nelle terme restano *in situ sectilia* pavimentali e parietali, ma i resti forse più spettacolari si riconducono all'elaborato e sontuoso pavimento di un ambiente al secondo piano della casa, attribuibile alla ristrutturazione della prima metà del IV secolo, crollato su quello del pianterreno a causa probabilmente di un terremoto e di un incendio, avvenuti alla fine del V–inizi del VI secolo d.C. Di questo pavimento si sono rinvenuti inizialmente frammenti sparsi in più strati di crollo. Accantonata la prima ipotesi che si trattasse di frammenti di decorazione parietale dell'*apodyterium* al pianterreno, data la tipologia del disegno di cui si intuivano le linee generali, si è compreso che si trattava del pavimento del secondo piano (fig. 6). Quanto al disegno, il rinvenimento di alcuni settori più consistenti di pannelli, che all'origine misuravano 74 cm di lato – l'*opus sectile* di "modulo grande a motivi complessi" della classificazione Guidobaldi (Baldassarri 2012a: 1641; Baldassarri 2012d: 56–58, fig. 34) –, ne ha consentito l'esatta ricostruzione, mentre l'entità dei frammenti ha permesso di ricomporne ben 34, pari a un totale di circa 47 mq, di cui 9, come vedremo, riposizionati nell'area. Proprio i resti del catastrofico crollo, da attribuirsi forse a una scossa tellurica e a un conseguente incendio, ci hanno permesso di ricostruire che l'ambiente corrispondente al pianterreno, di cui si conserva l'*opus sectile* pavimentale, aveva il soffitto a incannucciata decorato da affreschi con motivi vegetali e figurati[8]. I frammenti di intonaco, accanto a settori di travi bruciate e a oggetti rimasti schiacciati sotto il peso delle strutture, sono stati volutamente lasciati *in situ* per esigenze espositive legate alla spettacolarità del crollo.

Figura 6 Palazzo Valentini, area delle Terme, *apodyterium:* Pannelli del pavimento in *opus sectile* del piano superiore riposizionati in stato di crollo.
Foto: ACC Photo Autuori Carletti Callipari

Al termine dello scavo di ciascuna area degli interrati, si è proceduto con interventi di restauro che hanno coinvolto strutture murarie, manufatti e apparati decorativi, e che erano stati preceduti da alcuni, necessari "pronto interventi" durante lo scavo, atti a salvaguardare l'integrità e a scongiurare la compromissione o la perdita totale di materiali e strutture. Sin dall'inizio le operazioni di restauro sono state condotte in concomitanza con la ricerca scientifica, che ha visto coinvolti studenti del Corso di laurea in Diagnostiche applicate ai Beni Culturali dell'Università La Sapienza di Roma, coordinati dalla prof.ssa Maria Pia Sammartino, in merito in particolare allo studio del microclima e dei sistemi di illuminazione, al fine di inibire la crescita e l'attacco di organismi e di un'ottimale conservazione, e all'analisi di materiali quali marmi, malte, intonaci colorati, metalli[9]. Accurati interventi di restauro sono stati condotti in maniera differenziata e operando puntuali scelte metodologiche sulla base delle diverse tipologie dei materiali e del loro differente stato di conservazione. Le condizioni di umidità e di luce artificiale del sito favoriscono la proliferazione di patine e di formazioni biologiche che hanno comportato e comportano, a scadenze periodiche, l'uso di specifici biocidi. Infine, è in buona parte dovuta all'abilità e alla competenza dei restauratori[10] la ricostruzione effettuata del pavimento in *opus sectile* del secondo piano delle terme, che ha comportato la necessità di studiare metodologie di recupero e di ricostruzione ottimali e di individuare soluzioni specifiche per l'allestimento dei materiali, come la ricostruzione degli strati di allettamento delle 33 mattonelle, per i quali si sono utilizzati materiali "leggeri", come pannelli in alluminio a nido d'ape, tela in fibra di vetro e schiuma poliuretanica autoespandente per poterne facilitare l'esposizione.

Si sta ora approntando un progetto pilota di manutenzione – della durata per il momento di un anno solare – e, al tempo stesso, di monitoraggio del sito e dei suoi manufatti, al fine non solo di programmare le operazioni, eseguendo diagnosi precoci e interventi tempestivi a fronte degli imprevisti, ma anche di "prevenire" quanto più possibile l'insorgenza dei problemi conservativi, rallentandone il degrado ed evitando la necessità di restauri radicali. Il sistema di monitoraggio dello stato di conservazione del sito, che si effettuerà con cadenza bimestrale, sarà utile a tenere sotto controllo le criticità dovute alle condizioni espositive e microclimatiche degli ambienti in cui i beni sono conservati. Questo monitoraggio permetterà quindi non solo di quantificare in anticipo e con una certa approssimazione i costi di manutenzione, ma anche e soprattutto di ridurli di consistenza e, via via, anche di frequenza, con un minor dispendio di energie fisiche ed economiche. Ponendosi come strumento di indagine, studio e monitoraggio delle condizioni conservative dei beni stessi, ai fini della loro stabilizzazione, questo sistema permetterà infatti di redigere un Piano di Conservazione programmata dell'area e dei manufatti artistici che fornirà le opportune indicazioni su eventuali problemi espositivi e su esigenze di restauro, e puntuali valutazioni economiche per previsioni di bilancio. I dati confluiranno poi in un database al servizio dell'Ente, che potrà così gestire nelle condizioni migliori tutte le attività lavorative nell'area.

L'allestimento del sito per la sua apertura al pubblico è stato il terzo principale obiettivo del programma di ricerca e valorizzazione del sito archeologico di Palazzo Valentini (cfr. già Angela 2008; Lanciano 2008; Baldassarri, Angela e Lanciano 2012), accanto a quelli della ricerca e della conservazione. Si sono pertanto realizzati interventi volti a rendere accessibili, fruibili e comprensibili tutte le emergenze rinvenute. L'accessibilità è stata garantita a un'utenza allargata, comprendente anche i diversamente abili; la fruibilità e la comprensione, come si vedrà, anche a un pubblico di non specialisti, pur mantenendo il carattere di scientificità con cui si sono condotte le indagini. Le linee guida per l'accessibilità e la fruibilità sono state quindi: il superamento delle barriere architettoniche; l'introduzione di elementi e strutture dal design semplice e lineare che fossero in armonia con l'ambiente circostante, non invasive e sempre rimovibili e, al tempo stesso, immediatamente riconoscibili come contemporanei; l'utilizzo del vetro per pavimenti, passerelle e parapetti (fig. 7) per consentire la massima visibilità dei resti e la lettura della loro volumetria; la creazione, attraverso un apposito impianto di trattamento dell'aria, di un microclima adeguato alla conservazione dei resti e, possibilmente, confortevole per i visitatori.

L'allestimento dei reperti ha previsto l'esposizione secondo criteri tradizionali in vetrine o su supporti in due diverse aree espositive, ubicate tra un settore e l'altro del percorso multimediale, ma anche soluzioni più originali e d'impatto, dettate dal percorso di visita multimediale, come quella del posizionamento *in situ* di nove pannelli del pavimento del secondo piano delle terme (fig. 6), esposti in posizione di crollo, nell'atto di cadere dall'altezza presumibile del pavimento originale, altezza ricavata in base al diametro di una delle colonne del piano di sotto, di cui resta la base, o quella della sospensione di manufatti ceramici di un butto rinascimentale nel sito di rinvenimento.

Per quanto riguarda la comprensione del sito da parte di un pubblico allargato, trattandosi di uno scavo urbano dalla complessa stratificazione, affinché il tutto fosse intelligibile anche ai non addetti ai lavori, si è optato per un percorso museale innovativo, che permettesse di valorizzare le emergenze "raccontandole" e cercando di "farle rivivere". Il compito è stato affidato al team di Piero Angela, Paco Lanciano con la

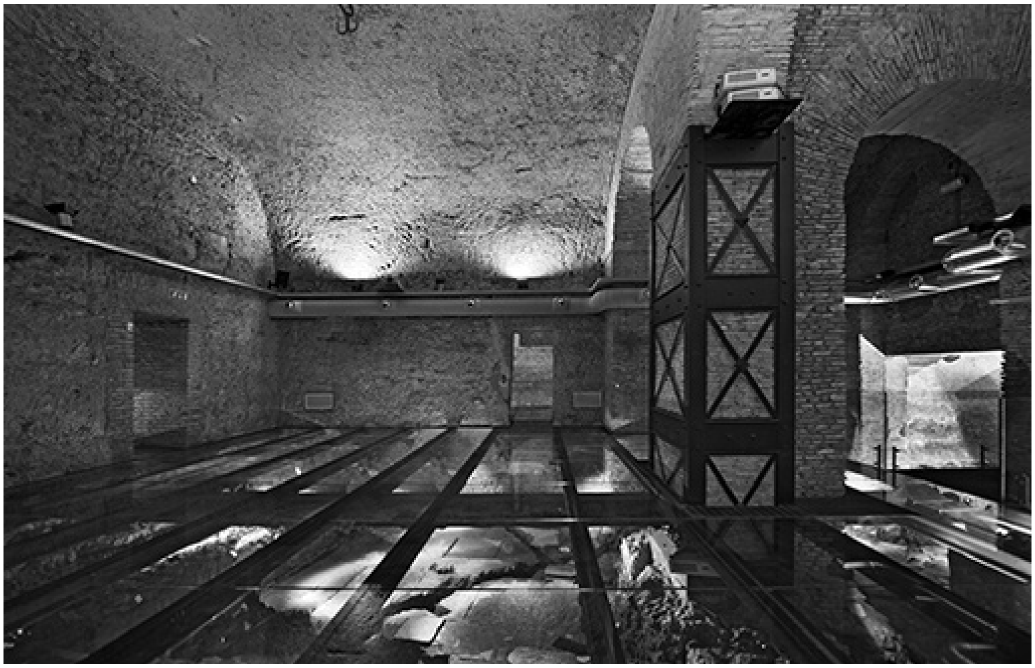

Figura 7 Palazzo Valentini, area delle Terme: Allestimento dell'ambiente 9 con i resti del *frigidarium*. Foto: ACC Photo Autuori Carletti Callipari

società MIZAR Srl e alla società Capware di Gaetano Capasso che, lavorando fianco a fianco con gli archeologi e traducendo via via i risultati degli scavi in un linguaggio divulgativo che però non ne compromettesse la scientificità, ha realizzato un percorso all'interno dell'area volto a esaltare la realtà storica e non a soppiantarla: a luci accese nessun elemento tecnologico interferisce con la visione del sito e delle strutture. La tecnica utilizzata è quella di "raccontare" questa realtà: senza l'utilizzo di audioguide o altri strumenti che si frappongano tra il visitatore e la voce narrante, ma guidando materialmente i visitatori. Raccontarla con l'aiuto di particolari effetti di luce che, proiettati su strutture e reperti mobili, ne esaltino i particolari, attirando su di essi l'attenzione dello spettatore, e suggeriscano l'integrazione delle eventuali lacune per fornirne subito dopo, e sul posto, una possibile ricostruzione virtuale (fig. 8), supportata da un adeguato studio storico–antiquario. Una ricostruzione che contribuisca anche a chiarire singoli aspetti della vita quotidiana del tempo e a calare i resti in una realtà vissuta.

È chiaro che, in tale tipo di progetto, una scelta doveva essere operata: non tutto si può raccontare, pena la difficoltà di comprensione; quindi la scelta è ricaduta sulla fase o sulle fasi di maggiore monumentalità dell'area: la tarda antichità nel settore delle *domus* e la fase tardo traianeo–adrianea nel settore del tempio, con un approfondimento sul grande Foro traianeo e sulla Colonna Traiana. Tuttavia in vari momenti cenni relativi ad altre fasi contribuiscono a mitigare, almeno in parte, quella sensazione di "appiattimento" della realtà storica di cui, almeno noi archeologi, per deformazione professionale, un po' soffriamo di fronte a questo tipo di esperienza.

Da un punto di vista tecnico il risultato ottenuto si basa sull'utilizzo sapiente di software specialistici gestiti da computer, videoproiettori, luci programmate elettronicamente, effetti sonori e ricostruzioni 3D, con attrezzature sapientemente nascoste. Il team impegnato è stato di circa quaranta persone tra esperti, divulgatori e tecnici che si sono costantemente confrontati con i responsabili dello scavo e dell'allestimento, in una continua rivisitazione del progetto, con decisioni prese di volta in volta sulla scorta di quanto andava emergendo.

Si è tentato così di costruire il prototipo del museo del terzo millennio: la possibilità di rivivere, nella contemporaneità, le epoche precedenti mediante una full immersion sostenuta dall'assoluta scientificità dei dati. Sperimentabile in sette lingue diverse – italiano, inglese, francese, spagnolo, tedesco, giapponese e russo –, con fasce riservate per il francese e l'inglese, la visita, della durata di un'ora e mezza, prevede l'ingresso di gruppi di 15 visitatori per volta su prenotazione: un numero basso, giustificato dalla ristrettezza di alcuni ambienti.

Il sito è aperto tutti i giorni della settimana tranne il martedì, riservato alla manutenzione. Gli interventi di manutenzione continua, d'altronde, se non necessari sulle strutture archeologiche, lo sono sicuramente sulle apparecchiature multimediali che soffrono del particolare microclima, ricco di umidità e di polveri in sospensione. Le visite avvengono ogni

Figura 8 Palazzo Valentini, area delle Terme, ambiente 9: Ricostruzione multimediale del *frigidarium*. Foto: ACC Photo Autuori Carletti Callipari

mezz'ora dalle 9.30 alle 18.30. La gestione del sito è affidata a una Società esterna, la Civita Cultura s.r.l., che gestisce anche il call center per le prenotazioni.

Qualche cenno, da ultimo, va fatto a considerazioni di tipo economico: a fronte di una spesa complessiva di circa 6 milioni di euro, parte dei quali derivanti da un contributo del Ministero dei Beni Culturali–fondi Roma Capitale e della Fondazione Roma, i guadagni provenienti dalle visite devono essere ovviamente valutati sulla lunga scadenza. Attualmente gli introiti sono rappresentati dal canone di concessione e dai biglietti d'ingresso. Il biglietto d'ingresso è di 12 € + prenotazione 1,50 €; fasce ridotte sono previste secondo la normativa vigente. Il contratto stipulato con Civita Cultura s.r.l., a seguito di una gara europea e in vigore da giugno di quest'anno prevede, oltre al pagamento di un canone di concessione annuo, suddiviso per trimestri, il versamento del 10% di ogni biglietto nelle casse dell'Amministrazione Provinciale, che destina gli introiti di canone e percentuale del costo dei biglietti, la cui somma è calcolabile intorno ai 100.000 € all'anno, per utilizzarli in funzione della manutenzione del sito e del Palazzo.

Dai feedback delle visite che incessantemente si susseguono, possiamo asserire che l'obiettivo è stato pienamente raggiunto: una classifica delle Top 25 Destination World indica le *domus* di Palazzo Valentini come la prima attrazione culturale a Roma. Più volta nel corso del tempo si è registrato addirittura il tutto esaurito per ogni fascia del giorno e per ogni giorno del mese.

Un equilibrato utilizzo delle tecnologie multimediali contribuisce dunque all'arricchimento dell'esperienza del visitatore, al quale si propone una chiave di lettura per la comprensione del sito basata sui dati scientifici emersi dallo scavo e per una contestualizzazione nella realtà storica a cui i resti appartenevano, senza privarla di efficacia, anzi rendendola più piacevole e divertente.

Note

1 Per i risultati preliminari degli scavi si vedano principalmente: Baldassarri 2008, 2008–9, 2012a, 2012b, 2012d, 2013. Per la ricerca storica sul Palazzo cfr. fondamentalmente Farina 1985; Amendolea e Indrio 2005; Cicconi 2008; Cola 2012.

2 Per le testimonianze a riguardo: Baldassarri 2013, 401ss., n. 49, con la relativa bibliografia.

3 *Hadr.*, 19, 9: "Cum opera ubique infinita fecisset, numquam ipse nisi in Traiani patris templo nomen suum scripsit."

4 Alcune anticipazioni in Baldassarri c.s.

5 Baldassarri 2008: 56–59; Baldassarri 2012a: 1645–50; Baldassarri 2012d; Quattrocchi 2008a.

6 Baldassarri 2008: 60–67; Baldassarri 2012a: 1637–39; Baldassarri 2012d: 49–54; Lumacone e Quattrocchi 2008.

7 De Spagnolis 1981; Baldassarri 2008–9; 2012a: 1639–45; 2012d: 55–58.

8 Alcuni lavori sono sfociati in contributi all'interno di convegni scientifici: Baldassarri 2012c; Montenero et al. 2013; Colantonio et al. 2013; Silvestri et al. 2014.

9 Le linee guida dell'allestimento dei molteplici settori sono illustrate in: Napoli 2008; Baldassarri e Napoli c.s.

10 Responsabile dell'intervento di ricostruzione del pavimento è stata la Società Capitolium Conservazione e Restauro.

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The Small Basilica Project: Conservation and Display of the Mosaic Floor

Elena Kantareva-Decheva

Abstract: *The Small Basilica project took place in 2010–2013 with the financial support of the America for Bulgaria Foundation, the Ministry of Culture of the Republic of Bulgaria, and the Municipality of Plovdiv. Its main goal was to create a working model for the integration of an in situ archaeological site into a modern urban environment. During the project, a new protective building was constructed; the detached floor mosaics were provided with new foaming epoxy backings, restored, and relaid on-site; and the mosaic floor of the Baptistery, as well as the piscina and architectural details, were conserved in situ.*

The sheltering, conservation, and display of the small Early Christian basilica of Philippopolis project was initiated by the America for Bulgaria Foundation, whose representatives visited Plovdiv in 2010 when they were looking for a suitable large-scale cultural heritage site to fund. They chose the so-called Small Basilica archaeological site, which met their requirements: it was preserved in situ, it was a cultural monument of national significance and great historical and artistic value, and it was public property.

Following high-level talks, a political decision was made for the project funding. In 2010 a three-party contract was signed by the Ministry of Culture of the Republic of Bulgaria, Plovdiv Municipality, and America for Bulgaria Foundation. The main goal of the project was to create a working model for the preservation and integration of an in situ archaeological site into a modern urban environment, in order to support the promotion of cultural heritage and the development of cultural tourism in Bulgaria.

The total cost of the project was €760,000: €610,000 from the America for Bulgaria Foundation, €75,000 from the Ministry of Culture, and €75,000 from the Municipality of Plovdiv. Conservation of the mosaics accounted for 10 percent of the total cost of the project.

The project was implemented from 2010 to 2013 in several stages:

- Planning, construction plans, coordination of plans, issuance of construction permit, 2010
- Conservation and restoration of detached mosaics, 2011–2012
- Conservation and restoration of in situ archaeological ruins: walls, fortification wall, street, ancient building, etc., 2011–2012
- Construction of protective building, 2011–2013
- Re-laying of mosaics on-site and display, 2013
- Construction of supporting infrastructure: park, amphitheater, ramps, car park, etc., 2013.

Archaeological Background

The Small Basilica archaeological complex was discovered in 1988 during the construction of an apartment block in the center of Plovdiv. The archaeological research carried out from 1988 to 1998 resulted in the discovery of an Early Christian basilica dating from the fifth and sixth centuries, a fortification wall with a tower dating from the second through fifth centuries, an ancient street of the *cardines* (main north–south street) system, and ancient residential buildings. Apartment construction stopped in 1988, and the in situ archaeological complex was preserved. In 1995, it was designated a monument of cultural and national significance. The site was called Small Basilica to distinguish it from the much larger Episcopal basilica from the fourth through sixth centuries, which was discovered earlier.

The basilica is a three-nave, single-apse building, 20 meters long and 13 meters wide. The building outline stayed the same during the two construction periods in the fifth and sixth centuries. During the second construction period, the floor level was raised and a baptistery was added to the northern nave (Bospachieva 2002) (fig. 1).

The floors of the three naves, the apse, and the narthex of the basilica from the first construction period in the fifth century are covered with polychrome mosaics with mostly geometric, floral, and figural designs. Floor mosaics also decorate the parts of the baptistery outside the cross-shaped piscina from the second construction period. Traditional Christian symbols, such as the dove and the stag, are depicted on the mosaic. The total area of the preserved mosaics is about 120 square meters (fig. 2).

The main mosaic-laying technique in both construction periods is opus tesselatum. The tesserae were made of natural stones colored in white, red, ocher, yellow, green, gray-green, brown, brown-violet, and black.

Conservation History

After the archaeological discovery and examination of the mosaics in 1991–1992, various conservation and restoration activities were performed. A temporary shelter was built, but it was vandalized and destroyed soon after.

In 1993 and 1994, in order to be protected from vandalism, about 50 square meters of mosaics were detached and lifted from the site, and the remaining 70 square meters of mosaics were reburied. The site was left with no fence and no security guard. During this period a few of the detached fragments were restored. The rest of them were stored untreated until 2011. No documentation is available on the conservation and restoration activities from this period (Kantareva, Bospachieva, and Luk 2007).

In 1998 financial aid provided by the Beautiful Bulgaria project was used to reinforce the walls, cover the baptistery together with its walls, pool, and mosaic floor with a thin concrete slab, and detach about 50 square meters of mosaics because the site was still being vandalized. A fragment in the central nave under the pulpit from the first period, the steps in front of the altar apse, parts of the altar table, and the mosaics in the northern nave were left on-site and reburied. The detached mosaics were moved to storage and left untreated until the restoration in 2011 began. Even then it was clear that due to the long period during which the site was left unguarded, the mosaics were badly damaged (Kantareva-Decheva, Bospachieva, and Luk 2013).

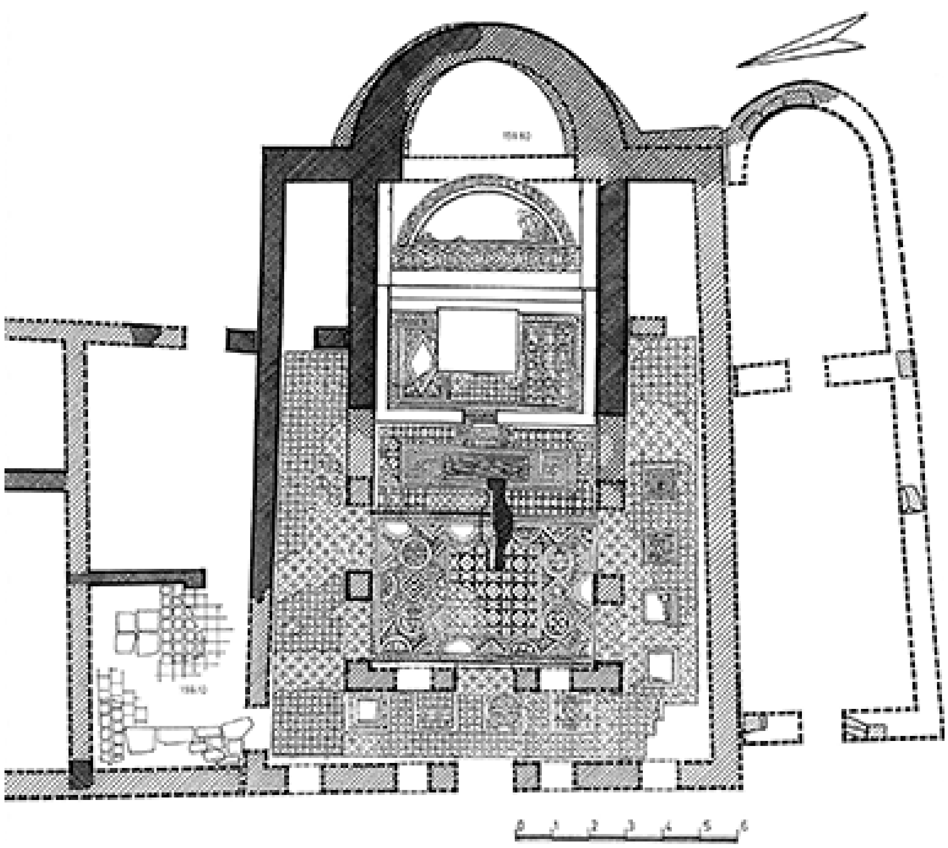

Figure 1 Small Basilica, plan of the first construction period

Figure 2 Baptistery of the basilica dated to the sixth century. Photo: Elena Kantareva-Decheva, 2014

In 2000, the author, together with colleagues from Williamstown Art Conservation Center in Massachusetts, won a grant by the Trust for Mutual Understanding, New York, for a project for the restoration of some of the mosaics in the Small Basilica. In this project two additional fragments were detached and lifted from the northern nave of the basilica and restored.

Restoration of the Mosaic Floor, 2011–2013

In February 2011 we gathered the mosaics, which had been stored in different places, and transferred them to a studio for further restoration. In all, there were forty-eight untreated and fifteen restored mosaics. Since no documentation was available for the mosaics that had been detached in 1992–1994, it was extremely difficult to identify the detached mosaics by their reverse side, among many others, and it took quite a long time to identify the fragments and to find their exact place in the design of the basilica.

In one storage area the mosaics were stored under poor conditions, exposed to atmospheric conditions, and piled one upon the other with no order or systematization. Among the fragments there was evidence of mice and other animals, as well as animal droppings, bones, nutshells, straw, and sticks. All of these factors had deteriorated the state of the untreated fragments, causing loss of adhesion, destroyed facings, detached tesserae, missing tesserae, destroyed fragments, dirt deposits, and powdered mortar between the tesserae and the nucleus.

Previously restored mosaic fragments were in various states of preservation with poor-quality restoration work. All of them had been provided with new supports made of epoxy resin with filler sand and iron reinforcement. The epoxy had been applied directly onto the back of the fragments, with no reversible layer. The fragments had twisted supports, loss of single tesserae, rusty spots resulting from the corroded iron rebar reinforcement of the supports, migration of epoxy to the mosaic surface and facings, and evidence of rough scratches on the epoxy and facing material, thus causing additional deterioration of the tessellatum. Many fragments had been laid on larger supports than necessary, not taking into consideration that they had neighboring fragments that had to be matched and put together (Kantareva, Bospachieva, and Luk 2007) (fig. 3). All these factors made restoration work quite complicated, especially since epoxy is hardly soluble. Therefore, mechanical removal was required.

The mosaic remaining in situ in the northern nave of the basilica was found to be almost completely preserved, though there were a number of new deteriorations caused by plant and root intrusions.

Overall, the price for abandoning the site for twenty-two years and for the poor storage conditions was the loss of one

Figure 3 Previously restored mosaic fragment damaged by migration of epoxy to the mosaic surface and facings. Evidence of rough scratching of the epoxy and facing material, thus causing additional deterioration of the tessellatum. Photo: Elena Kantareva-Decheva, 2011

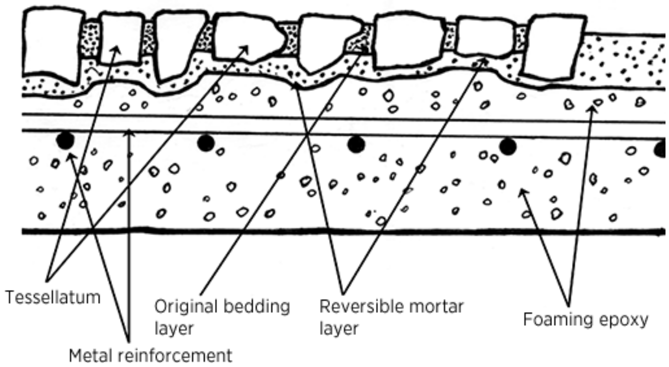

Figure 4 Cross section of the new backing system. Drawing: Elena Kantareva-Decheva

mosaic fragment and the marble tiling of the altar steps, as well as the deterioration of mosaics, walls, pulpit, and so on.

Restoration work on the mosaics started in 2011 and was carried out in two main stages. The first stage involved the detachment of the mosaics in the northern nave, restoration of the detached fragments of floor mosaics, and restoration of the previously treated fragments. The second stage involved re-laying and display of the restored mosaics, conservation of the mosaics preserved in situ, and restoration of the architectural elements, the piscina in the baptistery, among others.

The restoration work in the first stage started with the detachment of the mosaics preserved in situ in the northern nave of the basilica. It was reasoned that because of their poor condition and because the construction of the protective building over the site had already started, it was necessary to detach the mosaics to prevent further damage.

The detached mosaics were restored with a technology proposed by the author and approved by the National Institute for Cultural Heritage. It involved the following activities: the reverse sides of the mosaic fragments were cleaned and consolidated with 1.5% B 72 in xylene, the lacunae were filled with lime-based mortar, a reversible mortar layer was applied, the fragments were framed, metal reinforcement was applied, and new supports were cast (Blackshaw and Cheetham 1982) (fig. 4).

RenCast CW 2215 foaming epoxy system was used for the casting of the new supports. This foaming epoxy system made the fragments lighter and provided enough strength to bear the weight. Another fact to be taken into consideration was price: per square meter, the foaming epoxy is cheaper than aluminum honeycomb (Kantareva-Decheva, Bospachieva, and Luk 2013) (fig. 5).

After the fragments were transferred onto the new supports, the facings were removed, the mosaic surface was cleaned and consolidated with 1.5% B 72, and the interstices and lacunae were filled with lime-based mortar.

The restoration of previously treated fragments took a lot of time and effort. The epoxy resin on the tesselatum was removed with dental drills; the corroded metal frames and the excess epoxy applied on supports were cut off; and the epoxy fills were removed and replaced with mortar ones.

Figure 5 Casting of new fragment backing using RenCast CW 2215 foaming epoxy system. Photo: Elena Kantareva-Decheva, 2011

The second restoration stage started after the protective building over the ruins of the basilica was constructed. The concrete slab covering the baptistery was removed and the mosaics left in situ in the baptistery and the central nave were unearthed. The piscina and the mosaics in the baptistery were in very good condition; new deteriorations were only observed on the preserved brick pulpit that was on top of the mosaic. The mosaic preserved in situ was cleaned and consolidated, the edging was repaired, and the lacunae and interstices were filled with mortar.

The treated mosaics were relaid in the basilica following an evaluation of the condition of its original substructure. A decision was made to preserve it in situ as much as possible. The rudus was carefully scraped off and leveled. Geotextile and rammed sand served as a bedding layer for the fragments, which were placed on top. The preserved in situ fragment under the pulpit in the Naos helped determine the original level and location of the mosaic when putting the fragments together (fig. 6).

Some of the joints between the relaid fragments were filled with mortar, and others were filled with the original tesserae. The lacunae were filled with mortar. Original tesserae were used because the usual practice in the past was to detach a row of tesserae between the fragments instead of cutting them before their lifting.

Display and Interpretation

One of the greatest challenges for the conservation team and for the builders was placing the metal frame of the glass floor over the already restored and relaid mosaic. Its design and placement were necessitated by the limited walking space for visitors, as well as the need to provide close contact with the mosaic. Regarding functionality, the glass floor forms a multifunctional space for the display of the mosaics, on one hand, and, on the other, for organizing exhibitions, presentations, concerts, and other events.

An exposition plan for the future museum inside the protective building was designed along with the architectural plan. The display and interpretation of the site is presented on boards and multimedia screens, giving information about the planning and construction periods of the basilica, the meanings of the symbols of the mosaic ornaments, the mosaic-laying and restoration techniques, and the archaeological ruins surrounding the protective building. Brochures, magnetic puzzles, postcards, and other souvenirs were made in the project. The website romanplovdiv.org was created to give information about the project, the basilica, and other ancient monuments of Philippopolis.

The protective building has a basilica-like structure, made of modern materials. The interior is bare of detail, respecting the monument and the artifacts. The area around the building has been transformed into a small urban park, which displays a section of the east fortification wall with a tower, a part of the ancient street with an adjacent part of a residential building with a courtyard, an ancient well, and the pulpit from the second construction period of the basilica (fig. 7).

Conclusion

The completed on-site archaeological museum was officially opened on September 20, 2013, during the annual event Night

Figure 6 Re-laying the mosaic on-site.
Photo: Elena Kantareva-Decheva, 2011

Figure 7 The protective building of the site seen from the exterior.
Photo: Elena Kantareva-Decheva, 2014

Figure 8 The interior of the museum with the mosaic floor after restoration.
Photo: Elena Kantareva-Decheva, 2014

of Museums and Galleries in Plovdiv. Due to the long administrative process of transferring the property of the archaeological site from the State to the Municipality of Plovdiv, the museum was not opened for visitors until May 2014. The Municipality of Plovdiv entrusted the Old Plovdiv Municipal Institute with the responsibility of operating the basilica. This institute is responsible for all the cultural heritage monuments in the city. There are five full-time employees working at the site: a curator, a tour guide, a sales manager, a janitor, and a maintenance worker. The security, surveillance, and maintenance of the park are provided by the Municipality of Plovdiv.

The Small Basilica archaeological complex has become a favorite destination for Plovdiv's residents and visitors. It has hosted many events, such as the Night of Museums and Galleries in 2013 and 2014, One Architecture Week in 2013, temporary exhibitions, and children's tournaments. Some seven thousand tourists have visited the museum so far, and currently the monthly revenue covers staff wages. The condition of the mosaic over the past year has been exceptionally stable. No maintenance activities have been needed, except for occasional cleaning (fig. 8).

Thanks to the correct political decision to implement the Small Basilica project, this unique modern in situ archaeological museum was built in Bulgaria. As a consequence, the city of Plovdiv put on display another example of its rich archaeological heritage. I dare hope that with this project we contributed at least a little to the selection of Plovdiv as the European Capital of Culture in 2019, a nomination announced by the European Commission in September 2014.

The America for Bulgaria Foundation also declared the Small Basilica project a success. On September 26, 2014, the Foundation and the mayor of Plovdiv announced the start of their next, even bigger project in the field of cultural heritage preservation: the conservation and display of the Episcopal Early Christian basilica of Philippopolis with mosaic floors. The amount of €2,500,000 has been designated for the project. Significantly, the conservation of the mosaics was assigned to the Small Basilica team.

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Le redéploiement de la collection de mosaïques romaines du Proche-Orient conservées au musée du Louvre : De la restauration à la présentation muséographique

Cécile Giroire

Résumé : *Ouvert en 2012, le projet muséographique concernant l'Orient méditerranéen dans l'Empire romain s'est accompagné d'une campagne de conservation-restauration fondamentale de la collection de mosaïques proche-orientales du Louvre.*

Trois aspects intrinsèquement liés pourront être abordés : le coût financier de cette programmation de conservation-restauration, soutenu par la direction du musée du Louvre et par l'intervention d'un mécène extérieur ; le coût esthétique et les partis pris en termes de restauration pour une bonne lisibilité des œuvres et le respect de leur intégrité ; le coût esthétique et les partis pris en termes de présentation muséographique : présentation horizontale ou verticale, signalétique et dispositifs multimédias pour « recontextualiser » des pavements déposés, plus ou moins fragmentaires.

Abstract: *The opening of the Louvre's galleries devoted to the eastern Mediterranean in the Roman Empire in 2012 was accompanied by a substantial restoration and conservation project on the museum's collection of Near Eastern mosaics. The following three aspects of this conservation and restoration project, which are intrinsically linked, are worthy of mention: the financial cost of the project, which is borne by the Louvre Museum and an external patron; the aesthetic cost of the restoration and the decisions taken regarding the restoration process in order to ensure optimum presentation of the mosaics while respecting their integrity; and the aesthetic cost and the decisions taken regarding the exhibition of these works in a museum context, that is, horizontal or vertical display of the mosaics and use of multimedia displays and installations aimed at "recontextualizing" relaid mosaic pavements, some of which can be fragmented to varying degrees.*

L'ouverture en septembre 2012 de nouveaux espaces muséographiques dédiés à l'Orient méditerranéen dans l'Empire romain (Bel *et al.* 2012a et 2012b ; Bel, Giroire et Gombert-Meurice 2012), et dont une des clés de voûte est le redéploiement de la collection de mosaïques proche-orientales du musée (Giroire 2012) (fig. 1), constitue un exemple muséal dans la considération financière de la conservation et de la présentation de mosaïques. Sur un sujet aussi vaste que riche, aux sens propre et figuré, il convient néanmoins d'être synthétique en déclinant cette question financière selon trois axes : la conservation, la lisibilité et la présentation des œuvres, trois thèmes connexes qui rejoignent plus largement les missions fondamentales d'un conservateur du patrimoine responsable de collections muséales.

Les mosaïques du Proche-Orient au musée du Louvre

Au préalable, on ne peut faire l'économie de quelques mots sur la nature et la genèse de la collection de mosaïques du Proche-Orient du Louvre, collection qui s'articule autour de trois ensembles. Le premier concerne le pavement de l'église Saint-Christophe, découvert au lieu-dit Qabr Hiram[1], au sud de Tyr, lors de la mission de Phénicie en 1861 (Renan 1864 : 513–14, 543, 607–31). Ernest Renan met au jour un pavement de mosaïque d'église de grande qualité et dans un remarquable état de conservation. À la demande de Napoléon III, le pavement de 145 m² est déposé par un mosaïste, Taddei, pour rendre possible son transfert à Paris : il est découpé en 161 morceaux qui respectent la composition générale et suivent les motifs (Lemaître 2008 : 271–73). Malgré la demande de l'empereur, la mosaïque n'a pu être présentée au Louvre à son arrivée en France, notamment pour des raisons d'espace. En 1890, le pavement est restauré dans l'atelier d'Auguste Guilbert-Martin à Saint-Denis : le support est entièrement changé, et l'ensemble est redécoupé en 80 panneaux posés sur une dalle de béton armé de 5 cm d'épaisseur insérée dans un cadre métallique. En 1892, la galerie Mollien est réaménagée pour présenter une sélection de panneaux de Qabr Hiram. Les panneaux des trois nefs, regroupés dans des cadres en bois, sont exposés en enfilade, au sol de la galerie, alors que ceux du chœur et des entrecolonnements sont placés au mur, dans un ordre erroné, entourés par des statues et des sarcophages romains. Le relevé de Thobois exécuté lors de la mission de Phénicie (fig. 2) accompagne cette présentation muséographique que des expositions temporaires viennent perturber, jusqu'à entraîner la mise en réserve des panneaux de la mosaïque. À l'exception du tapis de la nef centrale, changé de support en 1979 dans l'atelier municipal de Besançon, dirigé par M. Monterrosso, les 80 panneaux sont restés en l'état jusqu'aux années 1990.

Le deuxième ensemble de mosaïques proche-orientales entre au Louvre dans les années 1930, à l'occasion des fouilles d'Antioche-sur-l'Oronte[2] conduites par une équipe franco-américaine. À l'issue d'un partage assez complexe des résultats de la fouille, 11 mosaïques sont affectées au département des Antiquités grecques et romaines[3]. Elles arrivent physiquement au musée du Louvre entre 1936 et 1939 et sont tout de suite installées dans deux espaces contigus alors en cours de réaménagement, la « salle d'Afrique », qui sera rebaptisée la « Galerie des mosaïques », et la cour du Sphinx, couverte d'une verrière. À l'exception des deux pavements du Phénix et des Saisons, qui sont confiés aux bons soins de la maison Gaudin pour un remontage plus ou moins interventionniste déjà sous-tendu par la question de la lisibilité de l'œuvre, les autres mosaïques d'Antioche sont présentées telles qu'elles sont parvenues du site, dans leur état « après dépose ». Toutes conservent au revers leur dalle de ciment fabriquée en Syrie après leur dépose pour leur transport et sont scellées au mur (au sol pour la mosaïque des Saisons) ceintes par un encadrement en stuc. Cette présentation demeure inchangée, ou presque, jusqu'en 2007.

Figure 1 Le pavement de mosaïque de l'église Saint-Christophe de Qabr Hiram dans les nouvelles salles de l'Orient méditerranéen dans l'Empire romain au musée du Louvre. © Musée du Louvre, Dist. RMN-Grand Palais / Antoine Mongodin / Art Resource, NY

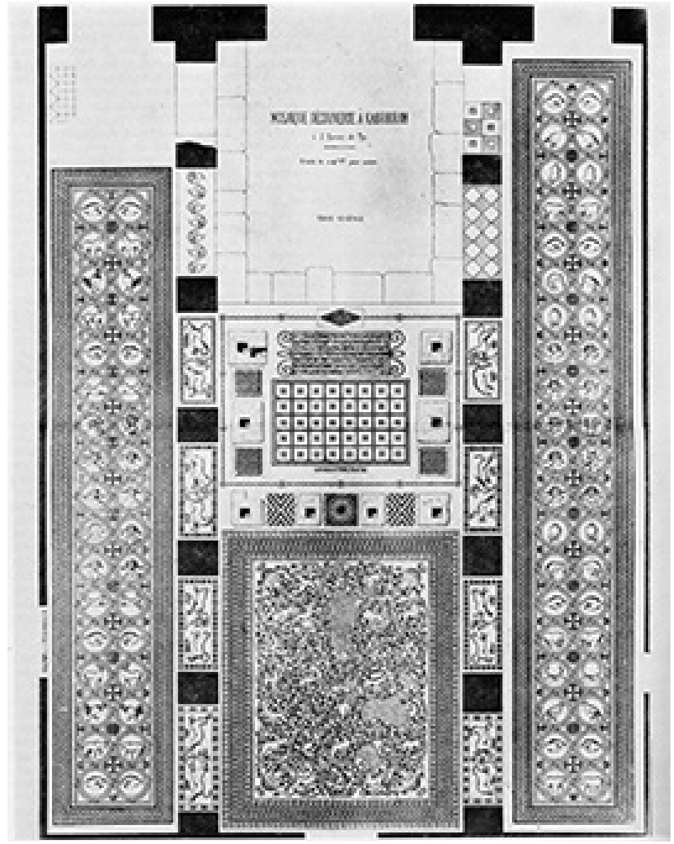

Figure 2 Relevé du pavement mosaïque de l'église Saint-Christophe de Qabr Hiram par J. Thobois. © Musée du Louvre

Un troisième ensemble vient enrichir cette collection déjà importante : il s'agit de fragments de pavements d'église[4], placés sur autant de dalles de ciment armé et installés tels quels dans les salles chrétiennes du musée.

Les mosaïques dans le Grand Louvre

Il a fallu l'émergence, au sein du projet Grand Louvre dans les années 1980, d'un projet muséographique ambitieux pour se pencher sur la collection de mosaïques du Proche-Orient, envisager son redéploiement et, condition *sine qua non*, un programme fondamental de conservation-restauration. Le projet muséographique a été l'élément déclencheur ; il fournit le cadre au redéploiement physique des collections et permet l'établissement de budgets exceptionnels, sur le moyen terme, pour entreprendre une campagne de conservation-restauration fondamentale des collections, de mosaïques notamment.

Premier enjeu : La conservation

L'enjeu de cette campagne était d'abord d'assurer la conservation de fragments de pavements de mosaïque déposés, dont le support moderne, en ciment armé, avait sensiblement vieilli, s'était altéré et provoquait des dommages sur le *tessellatum* antique, notamment des déformations, des fissures et des pertes d'adhérence des tesselles sur le support, voire la chute de tesselles dans les cas les plus critiques. Ainsi, la mosaïque avec personnification féminine[5] était traversée par des fissures liées à la corrosion de l'armature métallique (fig. 3). La mosaïque de l'Amazonomachie[6] présentait quant à elle une fissure du haut en bas qui suivait une barre métallique ; l'armature moderne avait provoqué une déformation du *tessellatum*, particulièrement visible en lumière rasante (fig. 4). Dans le cas singulier de la mosaïque du Phénix[7], la dépose obligeait le démontage d'une recomposition dont on ne savait pas grand-chose. Des documents d'archives, notamment des factures, conservaient la mémoire de l'intervention de la maison Gaudin, qui avait réalisé, en 1936, ce remontage de 5,67 m de haut pour 4,25 m de large. On imaginait cinq ou six panneaux assemblés. Ce sont en réalité 18 panneaux qui ont été réunis, scellés au mur et liés les uns aux autres par des bandes de jonction refaites avec des tesselles antiques (fig. 5).

Figure 3 Dalle de ciment au revers de la mosaïque avec personnification provenant d'Antioche. © Paul Veysseyre, musée de Saint-Romain-en-Gal

Figure 4 Détail de la mosaïque de l'Amazonomachie provenant d'Antioche. © Atelier de conservation et de restauration–Musée départemental Arles antique

Figure 5 Dépose de la mosaïque du Phénix provenant d'Antioche. © Atelier de restauration de mosaïques, musée de Saint-Romain-en-Gal

Du constat au financement

Ainsi, des considérations muséographiques et l'état de conservation des mosaïques justifièrent la mise en œuvre d'une campagne de conservation dont l'ampleur a pu être financièrement évaluée, pour les mosaïques d'Antioche et celles de Syrie chrétienne, grâce au bilan sanitaire établi en 2006 par Marie-Laure Courboulès et Patrick Blanc, de l'atelier de conservation et de restauration du Musée départemental Arles antique.

Cette campagne de conservation-restauration fondamentale nécessita une programmation budgétaire pluriannuelle. Établie par le département des Antiquités grecques, étrusques et romaines, cette programmation budgétaire a, dans un premier temps, été validée par les directeurs successifs du département. Dans un second temps, elle a été défendue auprès de la direction du musée, qui a accordé son soutien à ce projet d'envergure. Le montant des opérations nécessita la mise en place de marchés publics, procédures qui peuvent paraître longues et contraignantes, mais qui demeurent incontournables lorsque l'on engage de l'argent public.

Deux campagnes de restauration se sont succédé. La première concernait le pavement complet de l'église Saint-Christophe de Qabr Hiram. Entreprise sous la houlette de Catherine Metzger[8], elle s'est déroulée entre 1994 et 2004, en deux marchés dont l'attributaire a été l'atelier de restauration de mosaïques de Saint-Romain-en-Gal, dirigé par Évelyne Chantriaux, pour un montant total qui dépassait les 300 000 euros. Son financement a été assuré par la ligne budgétaire dédiée à la restauration, au département des Antiquités grecques, étrusques et romaines, abondée pour cette opération.

La deuxième campagne de restauration a été entreprise quand il a été décidé d'étendre le programme scientifique des nouveaux espaces muséographiques aux mosaïques d'Antioche ; elle intégrait en outre les mosaïques chrétiennes de Syrie. Selon les procédures réglementaires en vigueur, un accord-cadre européen a été lancé en 2008 et a retenu deux prestataires sur cinq candidatures, les ateliers de restauration de mosaïques d'Arles et de Saint-Romain-en-Gal. Le premier a été retenu pour un marché[9], le deuxième pour deux autres[10], pour un montant total de 455 000 euros[11]. Au vu des estimations budgétaires, la troisième étape de ce vaste chantier, concomitante au lancement des marchés publics, a été la recherche de mécénat, entreprise avec succès[12] par le service dédié du musée.

En somme, cette campagne d'une envergure exceptionnelle n'a pu être entreprise qu'avec le soutien de la direction du musée et dans le cadre d'un projet muséographique exceptionnel : l'ouverture de nouvelles salles consacrées à l'Orient méditerranéen dans l'Empire romain et aux arts de l'Islam. Cet ambitieux projet muséographique a aussi pu être porté, au moins partiellement, par un mécénat privé, car les retombées en termes d'image étaient importantes.

Si ce sont d'abord des considérations de conservation et de muséographie qui nous ont conduits dans cette aventure, les interventions ne se sont pas limitées à la stricte conservation. On peut les décomposer en deux phases principales successives : le changement de support, qui relève d'abord de considérations de conservation, et le traitement de surface du *tessellatum*, qui comprend aussi bien le nettoyage, la consolidation, le refixage des tesselles que le traitement des lacunes et des mortiers de fond. Ces opérations relèvent à la fois de la conservation et de la présentation – ou plutôt de la lisibilité – de l'œuvre.

Le coût de la conservation

Le changement de support semblait *a priori* l'opération la plus coûteuse car la plus longue, du fait notamment du retrait mécanique des dalles de ciment armé, qui représente toujours un nombre élevé d'heures de travail. Ce retrait s'effectue d'abord à la disqueuse, qui débite par morceaux la partie la plus importante du ciment armé. Il se termine dans tous les cas au microburin ou microburineur pneumatique, pour dégager la fine couche de ciment qui couvre le revers du *tessellatum*. Si l'on s'en tient aux chiffres fournis par l'atelier de Saint-Romain-en-Gal dans son offre pour le marché de 2008, qui correspondent à une évaluation du travail (ces chiffres sont indicatifs), on obtient les données suivantes :

- pour la mosaïque aux Oiseaux sur un cratère[13], 168 heures pour le changement de support sur un total de 422 heures pour l'intervention complète, soit 40 % pour un panneau de 2,96 m^2 ;
- pour la mosaïque avec personnification[14], 64 heures pour le changement de support sur un total de 142 heures pour l'intervention complète, soit 45 % pour un panneau de 1 m^2.

Le traitement de la surface du *tessellatum* intervient donc quasiment à parts égales dans l'intervention de conservation-restauration.

Le coût de la lisibilité

Une campagne de conservation-restauration a également pour objectif de permettre aux œuvres de garder leur intégrité et d'être lisibles, compréhensibles de la part des visiteurs. Cette réflexion dont l'incidence vaut tant sur les dimensions du support que sur le traitement des lacunes ne peut être menée qu'au cas par cas. La mosaïque de l'Amazonomachie d'Antioche[15] constitue un exemple intéressant, car elle nous a invités à une réflexion assez approfondie sur cette question.

Figure 6 Mosaïque de l'Amazonomachie *in situ* à Antioche. © Antioch Expedition Archives, Department of Art and Archaeology, Princeton University

Figure 7 Mosaïque de l'Amazonomachie provenant d'Antioche, après restauration. © Musée du Louvre, Dist. RMN-Grand Palais / Antoine Mongodin / Art Resource, NY

En effet, ce fragment de pavement permet d'aborder la question fondamentale de la lisibilité sous deux aspects. Le premier rejoint la question de l'intégrité de l'ensemble : il s'agissait de redonner de la cohérence à ces deux fragments de pavement qui étaient originellement jointifs mais qui ont toujours été dissociés dans leur présentation au Louvre. L'étude des archives de la campagne archéologique a été déterminante, notamment les photographies faites sur le site au moment des fouilles : une vue du pavement fragmentaire *in situ*[16] (fig. 6) permet de comprendre que ces deux fragments ont été dissociés au moment de leur dépose ; elle permet aussi de restituer leur positionnement l'un par rapport à l'autre de façon incontestable. L'intervention de conservation-restauration a fourni l'occasion d'étudier l'hypothèse de ce réassemblage. Comme à l'accoutumée, un dialogue constant entre le conservateur responsable de la mosaïque et les restaurateurs en charge de l'intervention a nourri la réflexion et donné lieu à plusieurs restitutions graphiques. Pour redonner aux fragments une lisibilité et atténuer leur nature lacunaire, la restitution graphique qui prévoyait un tracé pour assurer la continuité du registre géométrique supérieur, ainsi que la poursuite de la bordure du panneau figuré, semblait la plus pertinente. Une fois ces deux principes validés, la réflexion s'est portée sur leur mise en œuvre. Un lavis de poudre de marbre a été appliqué au pochoir pour poursuivre le registre géométrique dont le dessin était connu par les photos de la fouille. Une bande d'un mortier différent a été réalisée pour assurer la continuité de la bordure du registre figuré et éviter que le pavement ne semble « flotter » sur son support moderne. Pour redonner à la scène figurée une meilleure lisibilité, il fallait aussi atténuer ses nombreuses lacunes, qui perturbaient la lecture du décor. Ce sont quelque 80 tests qui ont été réalisés pour obtenir des mortiers de chaux dont les teintes s'approchaient au mieux des tesselles et permettaient la continuité du décor. Une trentaine de ces échantillons ont été finalement utilisés. Dans ce cas précis, le coût de la lisibilité a été significatif, même s'il reste difficile à évaluer au regard de l'intervention globale, d'un montant de 48 000 euros (fig. 7).

Le coût de la présentation

Le redéploiement de la collection des mosaïques du Proche-Orient s'inscrit dans un chantier très vaste, celui de l'Orient méditerranéen dans l'Empire romain, lui-même associé au chantier des arts de l'Islam. Le coût de la présentation en tant que telle s'avère donc compliqué à évaluer. Rappelons toutefois que les travaux de structure ont été d'envergure, puisque de nouveaux espaces muséographiques ont été creusés sous la cour Visconti du palais pour accueillir les collections du département des Arts de l'Islam et les mosaïques du Proche-Orient. Pour ces dernières, les dispositifs muséographiques consistent en des cimaises plaquées de Silbonit pour les mosaïques présentées verticalement et en des podiums en acier pour les deux pavements présentés horizontalement (figs. 1, 8).

Le budget de l'installation des mosaïques avoisine les 70 000 euros, comprenant leur acheminement, auxquels s'additionne une mission de 16 000 euros d'assistance à l'installation pour les pavements du Phénix et Qabr Hiram.

À la muséographie s'ajoutent la signalétique et les multimédias, indispensables et complémentaires à la présentation des œuvres. Si le coût des cartels reste relativement modeste, de l'ordre de 15 euros par cartel sérigraphié, celui des multimédias est moins anodin, puisqu'il avoisine les 12 000 euros pièce, soit 24 000 euros pour les deux multimédias dédiés au pavement de Qabr Hiram.

Figure 8 Les mosaïques d'Antioche dans les nouvelles salles de l'Orient méditerranéen dans l'Empire romain au musée du Louvre. © Musée du Louvre, Dist. RMN-Grand Palais / Antoine Mongodin / Art Resource, NY

Au Louvre, comme dans toute autre institution muséale, les coûts importants induits par la conservation et la présentation des mosaïques ne peuvent être envisagés autrement que dans le cadre d'une programmation pluriannuelle qui nécessite le soutien du département, et plus largement de l'établissement. Ils demeurent plus faciles à défendre lorsqu'ils s'inscrivent dans le contexte de réaménagements muséographiques, puisqu'ils peuvent être intégrés au budget global et constituer une ligne distincte qui doit être prise en compte dès la genèse du projet. Par ailleurs, ces coûts importants relèvent de dépenses d'investissement et sont à considérer sur le long terme, l'objectif étant d'assurer la pérennité des collections, et dans une moindre mesure celle de leur présentation au public.

Notes

1 Département des Antiquités grecques, étrusques et romaines, Ma 2230–36 ; Baratte 1978, nº 55, pp. 132–44 ; Donceel-Voûte 1988, pp. 411–20 ; Metzger 2012.

2 Aujourd'hui Antakya, en Turquie.

3 – Jugement de Pâris (Ma 3443) : Levi 1947, vol. I, pp. 15–25 et vol. II, pl. I et CXLV; Baratte 1978, nº 43, pp. 87–92 ;

– Phénix (Ma 3442) : Lassus 1938 ; Baratte 1978, nº 44, pp. 92–98 ;

– Saisons (Ma 3444) : Levi 1947, vol. I, p. 226–56 et vol. II, pl. LII–LXI, CXLIIIb–e et CLX–CLXII ; Baratte 1978, nº 45, pp. 99–118 ;

– Amazonomachie (Ma 3457) et décor géométrique (Ma 3463) : Levi 1947, vol. I, p. 308 – nº 46 et nº 47, pp. 118–21 ; 310 et vol. II, pl. LXIXc et CXXIIIa ; Baratte 1978 ;

– Rinceau peuplé (Ma 3458) : Levi 1947, vol. I, p. 366 et vol. II, pl. XCI, XCIIb, CXXXVIIIa–c et CLXXXId ; Baratte 1978, nº 48, p. 121–23 ;

– Perroquets (Ma 3459) : Levi 1947, vol. I, p. 358 et vol. II, pl. LXXXVc et CXXVII ; Baratte 1978, nº 49, p. 123–24 ;

– Personnification (Ma 3460) : Levi 1947, vol. I, p. 167–68 et vol. II, pl. XXXVa et CLVc ; Baratte 1978, nº 50, p. 124–26 ;

– Oiseaux (Ma 3461) : Levi 1947, vol. I, p. 90–91 et vol. II, pl. XVa et CLXXXVIIIc ; Baratte 1978, nº 51, p. 126–28 ;

– Mer poissonneuse (Ma 3462) : Levi 1947, vol. I, p. 190–91 et 601 et vol. II, pl. CLXXXIIIa ; Baratte 1978, nº 52, p. 129–30 ;

– Peltes (Ma 3462) : Levi 1947, vol. I, p. 186–87 et vol. II, pl. XLIIa ; Baratte 1978, nº 53, p. 130.

4 Département des Antiquités grecques, étrusques et romaines :

– Hébreu (Ma 3671) : Baratte 1978, nº 56, p. 146–47 ; Animaux (Ma 3672) : Baratte 1978, nº 57, p. 147–48 ; Gazelles (Ma 3673) : Baratte 1978, nº 58, p. 148–49 ; toutes trois acquises en 1971 ;

– Basilique (Ma 3676) : Baratte 1978, nº 59, p. 149–61 ; don de M. et Mme de Ménil en 1971 ;

– Basilique (Ma 3677) : Baratte 1978, nº 60, p. 151–53 ; acquise en 1971 ; … auxquelles s'ajoutent deux mosaïques acquises en 2000 : Intérieur d'église (Ma 5093) : Bel, Giroire, Gombert-Meurice et Rutschowscaya 2012a : 307 et fig. 296, p. 305 ; scène du livre d'Isaïe (Ma 5094) : Bel, Giroire, Gombert-Meurice et Rutschowscaya 2012a : 307 et fig. 295, p. 304.

5 Ma 3460 ; après restauration : Bel, Giroire, Gombert-Meurice et Rutschowscaya 2012a : fig. 66, p. 105.

6 Ma 3457 ; après restauration : Bel, Giroire, Gombert-Meurice et Rutschowscaya 2012a : fig. 59, p. 100.

7 Ma 3442 ; après restauration : Bel, Giroire, Gombert-Meurice et Rutschowscaya 2012a : fig. 61, p. 101.

8 Conservateur en charge de la collection de mosaïques romaines jusqu'en 2003.

9 Ce marché concernait la restauration de la mosaïque de l'Amazonomachie Ma 3457–Ma 3463 effectuée en 2010–11.

10 Le premier marché, conduit entre 2008 et 2010, concernait six mosaïques d'Antioche (Ma 3442, Ma 3459, Ma 3460, Ma 3461, Ma 3462 et Ma 3464) ; le second, en 2011–12, traitait d'une mosaïque d'Antioche (Ma 3458) et d'autres chrétiennes de Syrie (Ma 3671, Ma 3672, Ma 3673, Ma 3677, Ma 5093 et Ma 5094).

11 Transport compris.

12 L'entreprise JTI a généreusement contribué au financement de ces campagnes, qu'elle s'en trouve ici remerciée.

13 Ma 3461.

14 Ma 3460.

15 Ma 3457–Ma 3463.

16 Les archives des fouilles d'Antioche sont conservées au département d'Art et d'Archéologie de l'université de Princeton. Je remercie vivement Shari Kenfield de m'en avoir permis la consultation.

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PART EIGHT

Posters

The In Situ Mosaics of the Archaeological Museum D. Diogo de Sousa (Bracara Augusta): Problems of Conservation and Maintenance

Maria de Fátima Abraços

Abstract: *The creation, in 1976, of the archaeological site of Braga made possible the realization of dozens of archaeological interventions, revealing the evolution of the Roman city of Bracara Augusta and providing for its protection. The location of the new building of the Museu Regional de Arqueologia D. Diogo de Sousa was preceded by an excavation, which took place in 1990–1991. It was then that the structures of a* domus *with two floors of mosaics were discovered. It was decided to retain the* domus *and integrate it into the crypt of the museum building. In this paper we present some new problems concerning the conservation and the maintenance of these mosaics.*

A 1990–1991 excavation at the Regional Museum of Archaeology D. Diogo de Sousa (MDDS) at the archaeological site of Braga (Roman Bracara Augusta) revealed the structures of a *domus* with two mosaic floors, which was integrated into the crypt of the museum building. One of the mosaics consists of a chessboard, with contrasting colors, and the other has hourglass grid lines. Structures from different eras coexist on the site, but these first-century mosaics are the most well preserved and the more significant remains (Abraços 2011: 828–30).

The Exhibition and Conservation of the Mosaics

In January 1996, technicians prepared for the exhibition of the mosaics and removed the geotextile and sand that were covering the structures with mosaics discovered in 1991. The disassembly of some structures was also done in order to allow a better understanding of the space.

A layer of fine sand was left only in the areas with mosaic to protect the tesserae. The biocide Dipcid, from CIN Paints, was applied in the higher areas that were no longer protected and showed the presence of microorganisms. During the winter, the entry of water was observed along the ceiling to the side walls of the mosaic floor space. The rising damp through the mosaic and the water streaming down the walls were visible. Since 1998, biogrowth has been occurring, due to the entry of light through the skylight and the humidity present in the walls and under the area of the mosaic.

From 1999 to 2004, several cleanings were done with water vapor and sponges, and Dipcid was applied in the whole area of the ruins, which were not protected against the entry of light, in order to try to eliminate the microorganisms. Later, it was concluded that this cleaning process and the application of a biocide were not eliminating the biogrowth. It was also found that the light coming through the skylights together with the humidity made it very difficult to combat the microorganisms.

In 2004, within the scope of my PhD project (Abraços 2005), I visited the MDDS to carry out a study of the mosaics there. At that point, and taking into account the need for a more thorough examination of the mosaic area, a detailed cleaning was performed with scalpels, spatulas, and brushes in order to uncover the tesserae. Samples of white tesserae traces, mortars, mosses, and fungi were collected at different points and brought to be examined in the Department of Mineralogy at the Instituto Superior Técnico in Lisbon (Abraços 2008: 72–74).

Measurements were taken of relative humidity and temperature in late summer and early fall using a thermohydrograph to determine the fluctuations present in this space.

In an attempt to reduce the exposure to natural light, and thus reduce the growth of microorganisms, an application for the acquisition of film to block ultraviolet rays was presented to the director of the Portuguese Institute of Museums. As the response was slow and in an attempt to prevent the spread of microorganisms in the cleaned areas, a black plastic sleeve was placed to protect the windows.

An excavation was undertaken to expose the stone pipeline built under the mosaics. Following this, consolidation of the structures and the mosaics was done. The museum was inaugurated on July 7, 2007 (fig. 1).

In 2011, the entry of water was observed again along the ceiling. The humidity made it very difficult to combat the microorganisms and to resolve the problem of soluble salts. Once again, microorganisms were collected at different points on the mosaics and brought to be examined at the laboratory of the Catholic University of Porto (fig. 2).

Some Solutions

Some solutions for eliminating the incidence of microorganisms are reducing the exposure to natural light, installing a new drainage system for the structures, making impermeable the structure that houses the mosaics, and using ultraviolet lamps for a few hours overnight. However, more funds will be needed to carry

Figure 1 Inauguration of the museum, July 7, 2007. Crypt of the museum showing the foundations of the *domus* with mosaics. Photo: © Archive of the D. Diogo de Sousa Museum (AMDDS)

Figure 2 Mosaic with microorganisms and salts. Photo: © Archive of the D. Diogo de Sousa Museum (AMDDS)

out microbiological studies and to solve the drainage problems in this area.

Acknowledgments

To develop this study, we have had the help of all the staff of the MDDS, but we are particularly grateful to Isabel Silva, director of MDDS, and Maria José Sousa, who facilitated access to the archives and information on conservation and restoration. We want to give special thanks to all the members of Project Rescue Bracara Augusta, University of Minho, who introduced us to the Roman city.

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Archaeometric Analyses of Byzantine Glass Mosaic Tesserae from Three Different Sites in Turkey

Ali Akin Akyol and Yusuf Kagan Kadioglu

Abstract: *There is little known about the history, structural characteristics, and technology of glass production in ancient times in Anatolia. This can be attributed to the limited number of systematic studies conducted in this area up to this time. In this study, the glass mosaics from three different sites were investigated in terms of their raw material characteristics. The main criteria applied in the categorization of the findings have been the size and color characteristics, likely visual traces of production methods, functions, and information with regard to the chemical characteristics and constituents of glass mosaics.*

Elaiussa-Sebaste Archaeological Area Glass Tesserae

The first glass mosaic samples in the set were collected from the Elaiussa-Sebaste excavation (fig. 1). The ancient site of Elaiussa-Sebaste is located in Ayaş, Kumkuyu, on the Mersin road. The city was one of the main harbors of Cilicia Trachea (Aspera) during the Roman era. Following a period of decline at the end of the third century and the beginning of the fourth, the city gained importance in the fifth and sixth centuries and became an important center of the Byzantine Empire in the eastern Mediterranean. Subsequent to earthquakes and the silting up of the harbor, the city was abandoned in the seventh century.

Istanbul Pantokrator Church Glass Tesserae

The second glass mosaic samples were collected from the Molla Zeyrek Mosque, in Istanbul, which once was two former Eastern Orthodox churches and a chapel (fig. 2). It represents the most typical example of architecture of the Byzantine middle period in Constantinople and is, after Hagia Sophia, the second largest religious edifice built by the Byzantines remaining in Istanbul. Between 1118 and 1124 the Byzantine empress Eirene Komnena built a monastery on this site dedicated to Christ Pantokrator. Shortly after the fall of Constantinople the building was converted into a mosque, and the monastery was converted for a time into a madrassa. Until a few years ago, the edifice was in a desolate state, and as a result it was added to the UNESCO watch list of endangered monuments.

Ankara Maltepe Tomb Excavation Glass Tesserae

The third glass mosaic samples were from the Maltepe Tomb Excavation in Ankara (fig. 3). The uncovered tomb located in the Roman and Byzantine necropolis, sited on bedrock (which is embedded in the floor), is an example of a hypogeum-style tomb. The tomb is dated to the early Byzantine period (fourth

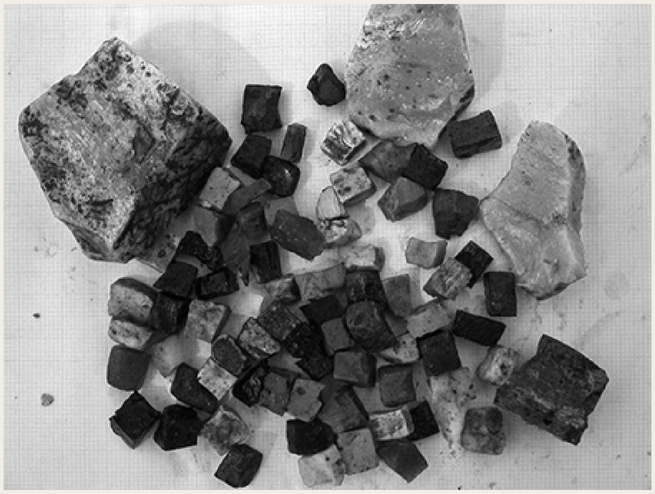

Figure 1 Elaiussa-Sebaste archaeological area glass tessera. Photo: A. Akın Akyol

Figure 2 Istanbul Pantokrator Church glass tesserae. Photo: A. Akın Akyol

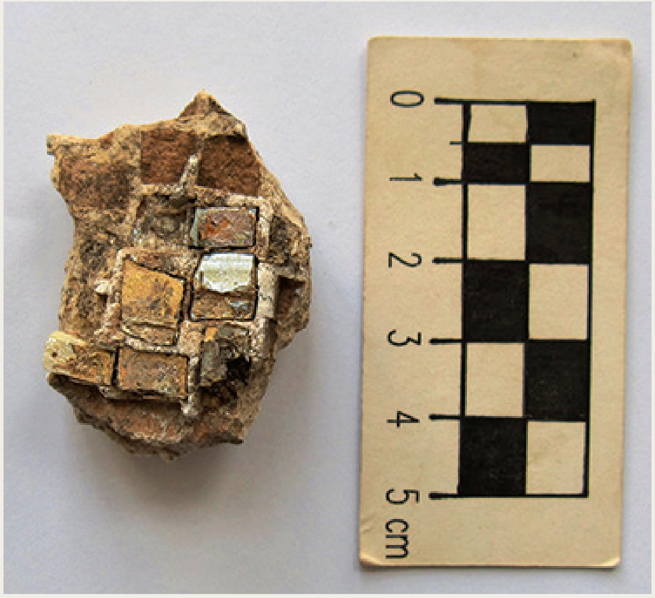

Figure 3 Ankara Maltepe Tomb Excavation glass tesserae.
Photo: A. Akın Akyol

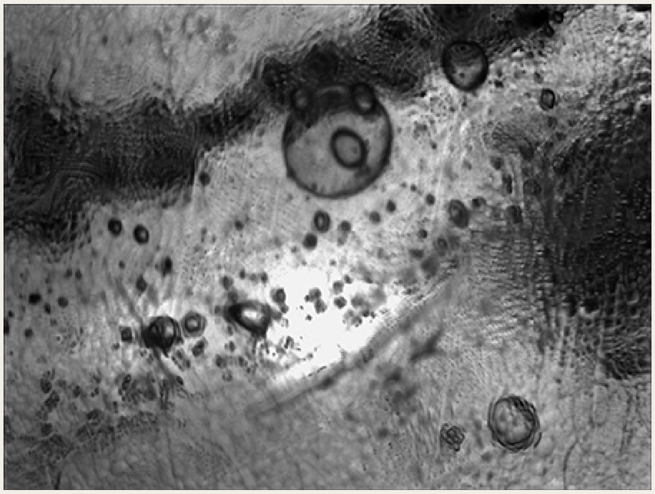

Figure 4 The shape of pores in the structure by microscopic analysis (sample ESK-G11b). Photo: A. Akın Akyol

century CE). Both the architecture and frescoes and the archaeological remains represent a Byzantine example in Anatolia.

Results of Archaeometric Analyses

The glass mosaic samples from the three different Byzantine-period sites: Elaiussa-Sebaste (Mersin), Pantokrator Church (Istanbul), and the Maltepe Excavation tomb (Ankara) were the subject of preliminary archaeometric investigations. In order to understand the production technologies, determine their raw material sources, and identify the chemical contents, the glass samples were analyzed by physical and chemical methods. The samples were primarily grouped visually by their dimension and color and then photographically documented (table 1). The production techniques of the glass mosaic tesserae samples were identified by the shape of the pores (oval shape for molding and casting, elliptical for cylinder methods) in the structures, which were examined microscopically (fig. 4). The elemental (in terms of main and trace elements in the composition of the glass and the coloring elements) and mineralogical structure of the glass samples were analyzed by X-ray fluorescence spectroscopy (PED-XRF) and scanning electron microscopy (SEM-EDX).

The shape and features of the tesserae from these sites were variable in dimensions. The amorphous or exactly cubic tesserae samples from Elaiussa-Sebaste and the Maltepe Tomb Excavation were about 4 to 7 cubic mm, and the ones from the Pantokrator Church were very coarse, about 10 to 12 cubic mm (figs. 1–3).

Complementary analysis showed that all of the samples were typical soda/lime glasses. The high SiO_2 content indicated not only their high mechanical strength and durability but also their high fluxing temperature (table 2). The fact that in certain samples the Na_2O content, which was expected to be higher,

Table 1 Descriptions of the glass tesserae samples (thickness by thickness meter and color by colorimeter / L'a'b color determination system) from Elaiussa-Sebaste archaeological area

	Samples	Locations (Year)	Thickness (mm)	L	a	b	Color*
Glass Tessera	**ESK-G20a**	Agora (2002)	10.60	74.62	-37.90	23.98	G
	ESK-G20b	Agora (2002)	10.70	54.84	-19.65	-16.49	B/G
	ESK-G20c	Agora (2002)	10.65	61.30	-19.56	-16.30	T
	ESK-G20d	Agora (2002)	10.75	30.06	9.05	-40.39	DB
	ESK-G20e	Agora (2002)	10.50	18.59	34.04	21.79	R

* B/G: Blue/Green, DB: Dark Blue, G: Green, R: Red, T: Turquoise.

Table 2 PED-XRF Analysis of the Elaiussa-Sebaste glass tesserae samples

	Element > Sample	SiO_2	Na_2O	CaO	MgO	Al_2O_3	K_2O	MnO	Fe_2O_3	LOI*
		%	%	%	%	%	%	%	%	%
Glass Tessera	**ES-G20a**	55.67	4.85	4.46	0.14	0.53	0.42	0.07	0.29	1.03
	ES-G20b	77.07	7.76	8.34	0.43	0.66	0.89	0.20	0.61	1.76
	ES-G20c	78.47	6.64	7.54	0.42	0.78	0.82	0.17	0.55	1.62
	ES-G20d	73.28	11.13	8.39	0.61	0.93	0.83	0.97	1.73	1.22
	ES-G20e	68.99	9.68	7.00	0.65	0.59	0.66	0.91	2.98	1.11
	Ave.	**74.45**	**8.80**	**7.82**	**0.53**	**0.74**	**0.80**	**0.56**	**1.47**	**1.43**

	Element > Sample	Co	Cu	As	Sr	Zr	Sn	Sb	Pb
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Glass Tessera	**ES-G20a**	13	5271	1.3	340.3	62.7	22000	46.7	174100
	ES-G20b	11	18380	47.2	570.7	59.9	1175	25.7	2847
	ES-G20c	11	15610	36.3	525.5	57.5	959.5	22.1	1862
	ES-G20d	554	2265	23.2	806.4	98	99.5	140	944.5
	ES-G20e	11	10580	211	729.9	122.5	17330	282.3	58370

* LOI: Loss on Ignition at 950°C at furnace.

Table 3 Istanbul Pantokrator Church tessera sample (IPK-G21) SEM-EDX analysis

Element	**Series**	**unn. C [wt. %]**	**norm. C [wt. %]**	**Atom. C [at. %]**	**Error [%]**
Oxygen	K-series	42.98	46.94	69.73	7.8
Sodium	K-series	0.85	0.93	0.96	0.1
Aluminum	K-series	3.61	3.95	3.48	0.2
Silicon	K-series	18.06	19.72	16.69	1.1
Potassium	K-series	2.32	2.54	1.54	0.2
Calcium	K-series	3.20	3.49	2.07	0.1
Manganese	K-series	7.56	8.25	3.57	0.3
Antimony	K-series	2.91	3.18	0.62	0.8
Gold	K-series	10.08	11.01	1.33	0.4
	Total	**91.58**	**100.00**	**100.00**	

was lower than the CaO content is most likely because Na^+ in the glass structure is transferred to the soil reservoir and is replaced by Ca^{2+}. The different rates of Al_2O_3 content of the glass samples were attributed to the different sources of the raw materials in general. The elements Fe, Mn, Co, Cu, and Pb were the colorants for the glasses. It was understood that unlike the Maltepe Tomb Excavation glass, mostly coastal sediments might have been used to produce the glass for the Elaiussa-Sebaste and the Pantokrator Church, due to higher Sr and Zr contents. The tesserae from the Pantokrator Church analyzed by SEM-EDX showed that some of the tesserae were gold coated (table 3).

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Archaeometric Study of the Wall Mosaics of Yeroskipou Ayioi Pente (Cyprus)

Olivier Bonnerot and Demetrios Michaelides

Abstract: *Multidisciplinary research on the materials used in the production of mosaics from Early Christian Cypriot basilicas is under way at the University of Cyprus as part of the NARNIA project (http://narnia-itn.eu). For this study, fragments of mortar as well as detached tesserae from different sites around Cyprus are being studied and compared to similar sites in the eastern Mediterranean. The results provide insight into the technology of tessera making during the fourth through seventh centuries CE. This paper presents an overview of the results of the analysis of samples from the site of Ayioi Pente at Yeroskipou on the southwestern coast of Cyprus.*

The Early Christian (fifth–seventh century CE) site of Ayioi Pente at Yeroskipou on the southwestern coast of Cyprus was discovered during roadwork in 2002 and was briefly investigated by the Cyprus Department of Antiquities before the University of Cyprus undertook its excavation and study. The most remarkable finds include several tombs and ossuaries containing a large number of bronze coins and gold jewelry, a large number of glass vessel fragments, two well-preserved mosaic pavements, and many mosaic fragments and detached tesserae. Although most of the site had been bulldozed before the excavations, the rich finds clearly reflect the importance of the basilica that once stood there (Michaelides 2014: 1–4).

Mortar Analysis

Nine fragments of mortar were analyzed with X-ray diffraction to identify their mineral composition and with mercury-intrusion porosimetry to measure their porosity.

Two types of mortars were identified: four samples were found to be gypsum mortars, and five were found to be lime mortars. The gypsum mortars were made of 14% to 26% calcite, 73% to 85% gypsum, and 0.5% to 8% quartz. Some minor (< 1%) mineral crystalline phases such as hematite and some feldspars were also detected. The lime mortars were made of 93% to 98.5% calcite, 0 to 1.5% gypsum, and 0.5% to 9% quartz. As in the gypsum mortars, some minor (< 1%) mineral crystalline phases such as hematite and some feldspars were also detected.

The lime mortars were found to be more porous (≈ 40% of total volume) than the gypsum ones (≈ 25% of total volume) on average. In addition to the many macropores found in both types of mortar, mesopores (≈ 0.01–0.05 m diameter) are rather numerous in the lime mortar fragments.

Geologically, the site of yeroskipou is on terrace deposits surrounded by the Lefkara and Pakhna sedimental (lime-rich) formations (Geological Survey Department of Cyprus 1995). As the closest evaporite (gypsum-rich) formation is found at Kalavassos around 10 km away, one would expect the exclusive use of lime mortars at yeroskipou. The presence of gypsum mortars cannot be attributed to the deterioration of lime mor-tars as gypsum is not found only on the surface but also in the internal layers of the mortar. Furthermore, the composition of the gypsum mortars is quite consistent. A hypothesis is that the gypsum comes from the alluvium in immediate proximity to the site (fig. 1).

Glass Tesserae Analysis

A selection of fourteen glass tesserae representative of the different colors found was embedded in acrylic resin and analyzed by SEM-EDS for elemental composition, UV-visible spectrometry to measure the color, and Raman spectroscopy to identify the colorants and opacifiers. The samples' colors are plotted in the CIELa*b* color space in figure 2.

Transparent Tesserae

The colorless transparent tesserae were decolorized with manganese. In the transparent yellow tesserae, color is due to Fe^{3+} ions coming from impurities in the sand used for making the glass.

Opacifiers

The tesserae are rendered opaque with tin-based opacifiers. SEM-EDS identified cassiterite (SnO_2) for the blue and red samples; and Raman spectroscopy found lead tin yellow ($PbSn_{1-x}Si_xO_3$) present in the yellow and green samples.

Coloring Agents

The colorants used are Co^{2+} for the dark blue sample, a combination of lead tin yellow opacifier with blue Cu^{2+} and Fe^{2+} for the green tesserae, and nanoparticles of metallic copper for the red tesserae. In the white tesserae with red stripes, the white zones are colored with cassiterite; and the red tesserae are colored with copper nanoparticles.

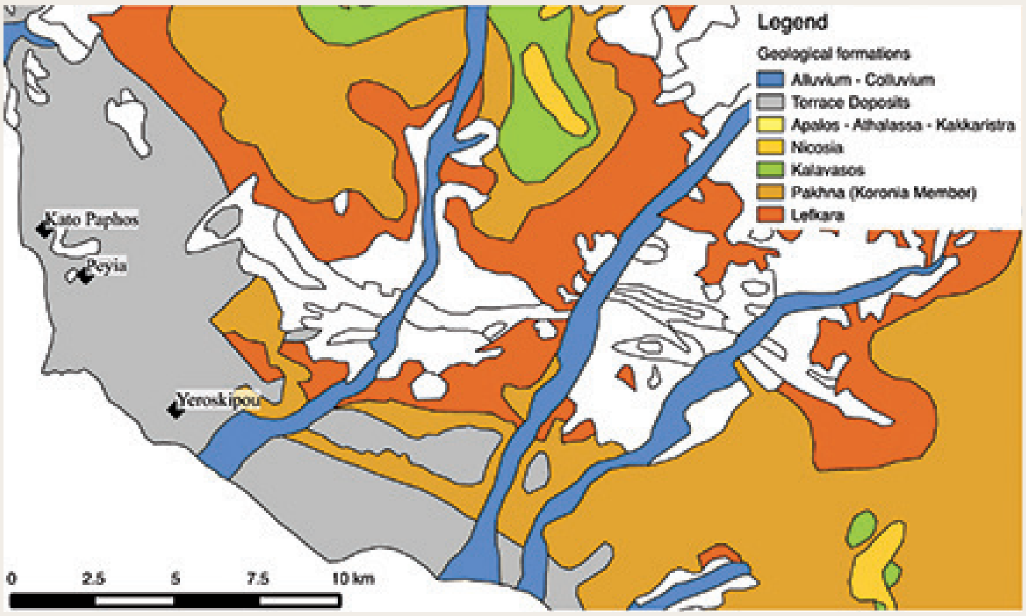

Figure 1 Geological map of the area around Ayioi Pente at Yeroskipou. Adapted from Geological Survey Department of Cyprus 1995

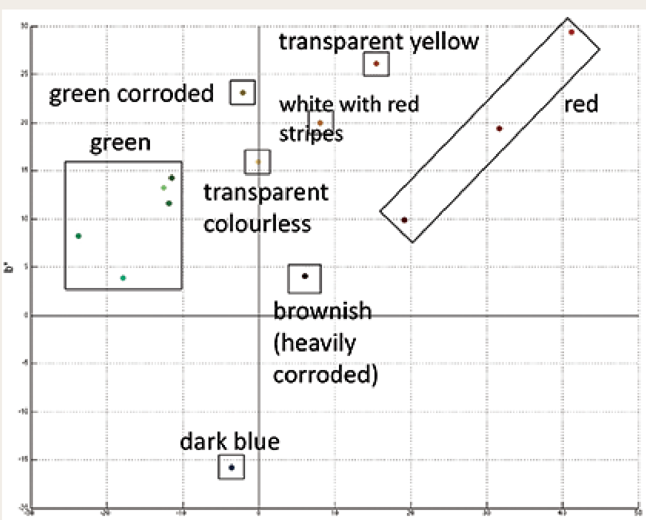

Figure 2 Color of the samples of glass tesserae

Glass Sources

Direct comparison of the samples is difficult as some elements can be present in large quantities due to their role as coloring and/or opacifying agents, which decreases the measured content of the other elements. In order to get comparable results, the raw data were therefore normalized to the following elements characteristic of the bulk glass: silicium, sodium, potassium, magnesium, aluminum, and calcium.

Silica is the main constituent of the glass in all samples. A relatively high amount of alumina (>2%) suggests the use of sand as the silica source. Relatively low quantities of potash and magnesium suggest that all samples were made using natron, a naturally occurring mixture of minerals found mostly in the Wadi Natrun area in Egypt, as a source of alkali. Most samples seem to have a composition close to the so-called group 2 (weak HIMT) identified by Foy et al. (2003), while two samples are closer to the “Levantine 1” group. The assumed origin of the “group 2” type is

Conclusion

The tesserae of the basilica of Ayioi Pente at yeroskipou are typical of the proto-Byzantine period: the bulk glass probably has an Egyptian origin, and the opacifiers used are tin based. There does not seem to be any evidence of the recycling of tesserae dating from the Roman period, as no traces of antimony-based opacifiers, characteristic of earlier opacifying technologies, have been found in any of the samples. A few tesserae, especially the white ones with red stripes, will need further investigation. Concerning the mortar, while most samples are lime mortars, in agreement with the local geology, a number of gypsum mortars have also been found. The presence of the gypsum mortars could be explained by the proximity of the alluvium formation, which may contain gypsum.

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Élaboration d’une base de données SIG des mosaïques romaines du Maroc en vue de leur conservation

Nissma Bouzoubaa et Abdelilah Dekayir

Résumé : *Le patrimoine des mosaïques romaines au Maroc compte un nombre très important. À chacune de ces mosaïques est attribuée une documentation très détaillée concernant sa découverte, ses dimensions, son état de conservation, etc. Un bon nombre de ces mosaïques se trouvent actuellement déposées dans des réserves dans l’attente de leur restauration. L’objectif de ce travail est de construire une base de données SIG qui englobe toute la documentation relative à chacune de ces mosaïques. L’utilisation de logiciels de géoréférenciation (ArcGIS) permet de visualiser ces mosaïques dans l’espace, c’est-à-dire à l’échelle du site archéologique. L’établissement d’une telle base de données facilitera l’accès à l’information de chaque mosaïque pour une bonne gestion et aide à la décision.*

Abstract: *Morocco boasts a rich and extensive heritage of Roman mosaics. Each of these mosaics is assigned a very detailed record documenting their discovery, dimensions, state of conservation, and so on. A good number of the mosaics have been removed from their original site and are currently in storerooms awaiting restoration. The objective of this project is to create a GIS database that will collate all the records for each of these mosaics. Geo-referencing software (ArcGIS) can be used to view the mosaics in situ. The creation of such a database will make it easier to access information about each mosaic and to facilitate management and decision making.*

Volubilis, Lixus et Banasa comptent parmi les plus importants sites antiques du Maroc (fig. 1). L’époque la plus marquante était celle des Romains, durant laquelle ces sites connaîtront de grands projets d’aménagement traduits par une architecture urbaine bien structurée basée sur des édifices civiques. Cette grandeur architecturale qui incarne le degré majestueux de la civilisation romaine s’accompagne de l’art décoratif, marqué par la réalisation de pavements de mosaïques qui ornaient les maisons, les bains et thermes et qui traduisaient quant à elles la finesse, le savoir-faire et le savoir-vivre des Romains. La richesse de ces sites tient à leurs ruines monumentales et à la collection appréciable de leurs célèbres mosaïques, qui séduisent par les motifs, les couleurs des tesselles, les thèmes traités, inspirés de la mythologie ou de la vie réelle.

Les pavements de mosaïques présents dans ces trois sites comptent parmi les plus belles mosaïques du Maroc (Chatelain 1935 ; Zouhal 1991 ; Limane *et al.* 1998 ; Arharbi 2008). Ils se caractérisent par l’empreinte de l’art romain, influencé par l’apport des traditions locales, phénico-puniques et hellénistique.

Toutefois, les données relatives à ces mosaïques restent éparpillées, et l’accessibilité en est limitée voire difficile à cause de la dispersion des publications ou parfois de leur manque d’homogénéité, ou même inédites. Ce bilan fait ressortir la nécessité de mettre en œuvre une base de données qui englobera la totalité des pavements des mosaïques de ces trois sites afin de les faire connaître au grand public et procéder à leur valorisation du point de vue historique, culturel et touristique.

Dans cette optique, le présent travail vise à créer une base de données sur *Access* qui aidera à centraliser, recenser et archiver les données relatives à chacune des mosaïques appartenant à ces trois sites afin de rendre possible leur exploitation. La géoréférenciation des pavements de mosaïques par exemple à Volubilis permettra leur visualisation dans l’espace à l’échelle du site archéologique (McCool 2014).

Les sites à mosaïques du Maroc

Les mosaïques des trois principaux sites archéologiques ont été inventoriées et cataloguées, à savoir Volubilis, Banasa et Lixus (fig. 1).

Description et éléments de la base de données

La base de données créée sur *Access* permet l’enregistrement, le stockage et la gestion de toutes les informations relatives aux mosaïques des sites de Volubilis, Lixus et Banasa dans un but de retrouver instantanément les données recherchées, mener des recherches, procéder facilement à des mises à jour, révisions et rajouts de nouvelles données. Les informations recueillies pour chaque mosaïque des trois sites sont structurées de la manière suivante (tab. 1).

Les tables

La base de données est composée de quatre tables. Chacune de ces tables est créée de manière à contenir des informations spécifiques réparties en champs et enregistrements :

- **Table site** représente les occurrences des sites, caractérisées par le nom de chaque site (entre 1 et 3). Ex. : « ID_Site : 1, nom_complet Volubilis » ;

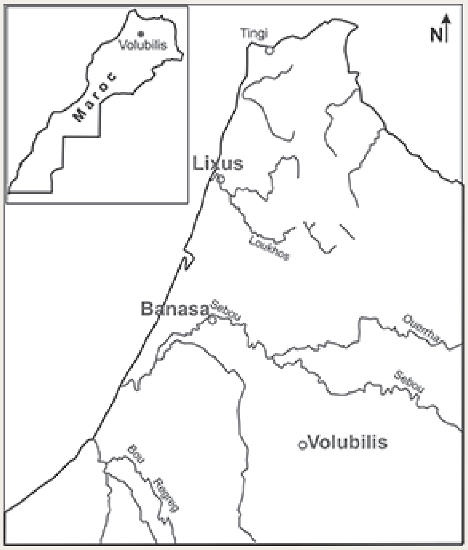

Figure 1 Sites antiques du Maroc.

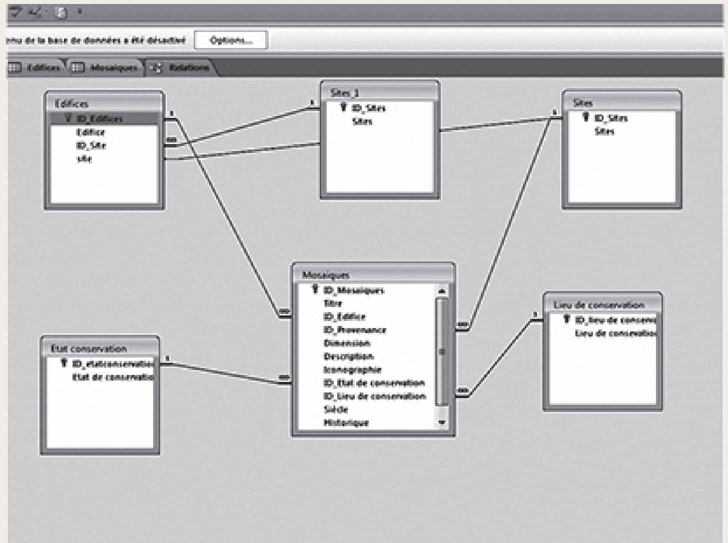

Figure 2 Relations entre les tables.

- **Table édifice** représente les occurrences des édifices qui contiennent la mosaïque, caractérisées par le nom de chaque édifice (entre 1 et 48). Ex. : « ID_Edifices : 3, nom_complet Maison aux travaux d'Hercule » ;
- **Lieu de conservation** représente les occurrences du lieu où est conservée la mosaïque, caractérisées par un chiffre allant de 1 à 5. Ex. : « ID_Lieu de conservation : 1, Lieu_ Conservation in situ ».

Les relations

Les relations permettent de relier les tables entre elles sur des champs en commun afin d'éviter la redondance. Chacune des cinq tables est définie par une clé primaire qui permet d'identifier chaque enregistrement de manière unique. L'intégrité référentielle doit être appliquée, ce qui permet de vérifier que les champs liés dans les deux tables sont parfaitement identiques par leur forme (type de données) et leur contenu (1–∞) (fig. 2).

Interrogation de la base de données

Les requêtes permettent d'extraire de la base de données des informations dont l'utilisateur a besoin en définissant des critères destinés à spécifier le type d'information recherché.

Spatialisation des données (cas des mosaïques de Volubilis)

Il s'agit de caler les mosaïques dans l'espace en se basant sur leurs coordonnées GPS, ce qui rend facile leur localisation à l'échelle du site. Une fois géoréférencées, les mosaïques sont digitalisées (fig. 3). Cette opération permet de passer du mode raster à celui vectoriel, en vue d'intégrer les différentes informations de chaque *shapefile* attribué à chaque demeure créée *via* la table attributaire afin d'exécuter pour chaque maison une analyse spatiale.

Le lien *hyperlink* permet de relier le *shapefile* des mosaïques créées au niveau de l'*ArcMap* à leurs photos correspondantes (fig. 4).

Tableau 1 Différents composants de la base de données

Intitulé	Désignation
Titre	Le nom affecté à la mosaïque
Dimension	Dimension en mètres (m) de la mosaïque (longueur × largeur)
Sites	Nom du site archéologique où est située la mosaïque
Édifice	Endroit où est localisée la mosaïque
Description	Description exhaustive de la mosaïque
Image	Photo actualisée de la mosaïque
Iconographie	Description des différentes formes qui ornent le pavement de mosaïques (ornements à forme végétale, géométrique) en plus des sujets mythologiques
État de conservation	État de conservation actuel de la mosaïque
Lieu de conservation	Emplacement actuel de la mosaïque (*in situ* – musée – réserves)
Siècle	Datation de la mosaïque
Historique	Historique de la mise à jour de la mosaïque

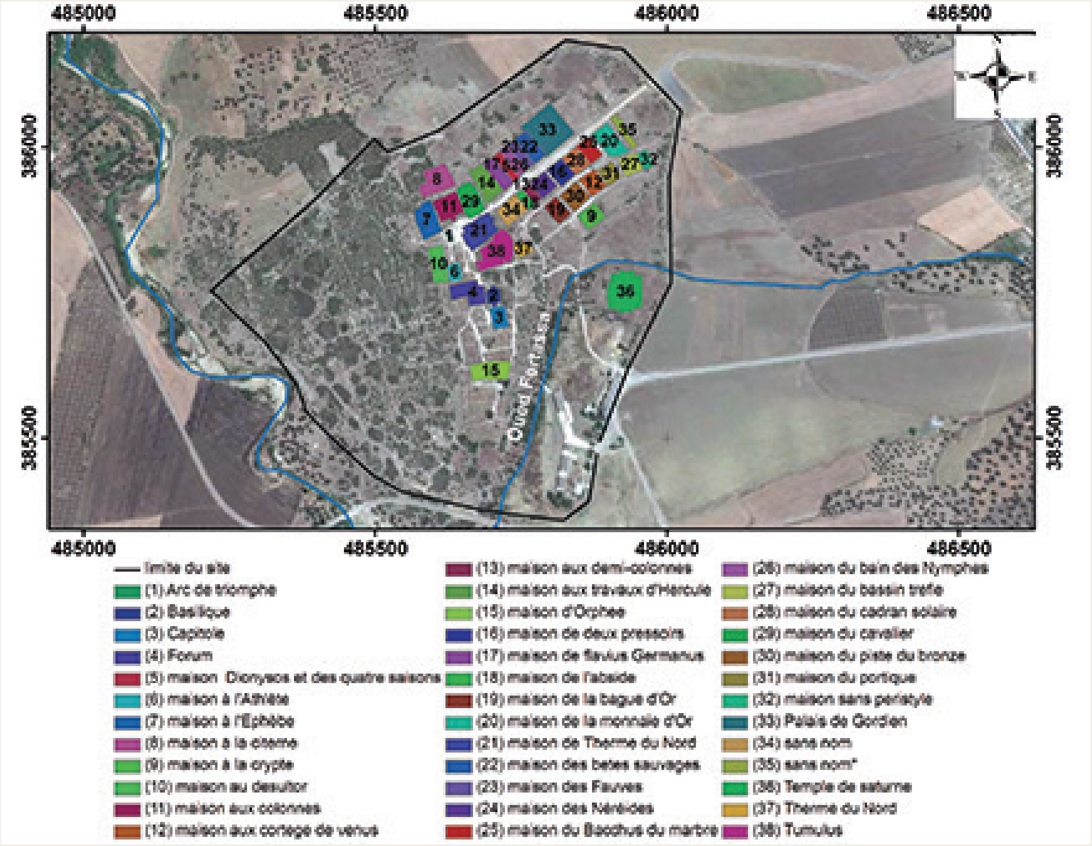

Figure 3 Maisons à mosaïques inventoriées et digitalisées.

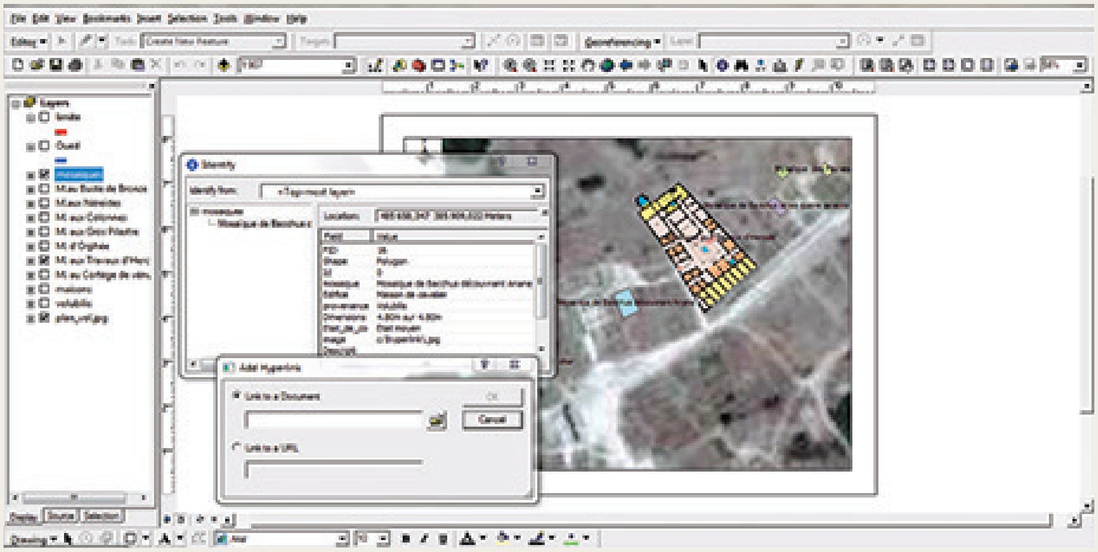

Figure 4 *Hyperlink* localité-photo.

Conclusion

Les sites archéologiques du Maroc comptent un nombre important de mosaïques romaines dont certaines ont été déposées et placées dans des réserves dans l'attente de leur restauration. D'autres ont été laissées *in situ* et ont subi une dégradation et une perte importantes.

Afin de cataloguer l'ensemble de ce patrimoine mosaïstique, l'outil informatique s'est montré d'une importance capitale. Le système de base de données (BD) a permis de faire un inventaire détaillé des mosaïques en partant de l'échelle de la mosaïque jusqu'à l'échelle du pays en passant par le site archéologique. Cette BD permettra aussi un accès instantané à toute la documentation relative à chaque mosaïque (historique des interventions, géométrie, minéralogie, etc.) et serait d'une grande utilité dans la signalétique des sites archéologiques. L'utilisation des SIG permettra de visualiser ces mosaïques dans l'espace et d'interroger en même temps la documentation couplée. Cette BD sous *Access* et sa spatialisation sous *ArcGIS* sont d'une utilité primordiale dans la gestion de ce patrimoine et son aide à la décision.

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Cost and Benefit as Decision Criteria for a Mosaic Conservation Project at the Museum at the Lowest Place on Earth, Jordan

Stefania Chlouveraki and Theocharis Katrakazis

Abstract: *This paper discusses the multidimensional attributes of "cost" through the preliminary evaluation of an ongoing mosaic conservation initiative/project at the Museum on the Lowest Place on Earth (MuLPE) in Jordan. Acknowledging the weight that cost bears in project planning and decision making, it is argued that such a term is best understood when context-specific and not in isolation. Built on the need for shared decisions among conservation professionals and diverse stakeholders, the aim of this paper is twofold. It focuses on the evaluation of treatment options for the mounting and exhibition of an excavated mosaic floor via a cost analysis and on the various benefits of a conservation strategy that ensures the preservation and exhibition of the mosaic's stratigraphy, provides high versatility to the exhibition, and promotes dynamic participation and training of local staff as well as visitor engagement.*

Costs and Benefits of Conservation Decisions

Conservation is best understood as a means to manage material change of cultural heritage assets while preserving the values they convey. Addressing values and change and their interdependent link, planning methodologies have been developed to facilitate the conservation decision-making processes (Nardi 1992; Demas 2002; Burra Charter). However, good planning does not necessarily result in perfect decisions. The decisions conservators make are often subject to (limited) human rationality and to cultural and sociopolitical contexts (Michalski and Rossa-Doria 2011), as well as human and financial resources. Indeed, decisions are far from being objective or unbiased; this is especially the case when conservation problems are examined in isolation or approached in a routine manner (Stanley-Price 2009).

Conservation decisions do bear a relative cost, whether technical, cultural, and/or financial. This is often reflected in the heritage assets themselves, which stand as silent witnesses of the actions undertaken—or not—to preserve them. One could argue that identifying and balancing these cost attributes may be a case-specific response to the increasing need for sustainable decisions. *But how do we balance diverse and conflicting parameters in practice; how do we define what is the acceptable degree of compromise?* Unlike rhetoric, practice encourages a hands-on problem-solving approach in which sustainable decisions are not a result of automated processes. As such, treatment options can be analyzed, discussed, and evaluated, focusing on their benefits or effects.

The Mosaic Conservation Project: The Case of the Diakonikon Mosaic Floor

The mosaic pavement was unearthed during the excavation seasons in 2000 and 2001 at the Monastery of Agios Lot in Deir Ain Abata, Jordan. The floor was discovered *ex situ* in the collapsed debris of the Diakonikon building, broken into more than nine hundred sections, the majority of which preserved the original bedding layers, including the statumen. The attempt to conserve a mosaic floor while preserving its stratigraphy, in an extensively fragmented condition, soon faced a series of dilemmas. In fact, part of the statumen was inevitably removed as handling and transportation from the steep mountain slope was not feasible otherwise (Chlouveraki and Politis 2001; Chlouveraki, Giannakaki, and Politis 2014).

Detailed documentation during the in situ first-aid treatment provided the information for the first significant fragment reassembling (matching/reconstruction) in 2002. After the completion of the construction of the Museum at the Lowest Point on Earth (MuLPE) in 2010, safe and permanent storage for the mosaic fragments was provided, and an inventory, condition survey, and rehousing project established the foundation for further study, mounting, and display.

The Decision-Making Approach

In the quest for the most appropriate mounting solution for this mosaic, three options were considered: two standard methods with long application histories (options A and B) and a third one (option C) guided by the experience gained and the lessons learned through this project (table 1).

In an attempt to contextualize analysis and discussion, a set of decision parameters was drawn. Addressing parameters such as retreatability, versatility, and accessibility, along with other aspects of cultural and financial natures, enabled the conservation team to examine possible treatments in a wider framework (table 2).

Following this, a decision-making matrix was built (table 3), allowing an integrated evaluation of the proposed treatment options (see Michalski and Rossa-Doria 2011). For each option, parameters were individually evaluated and scored using a numerical scale (0–5). Further discussion, however, demonstrated that not all parameters bore the same weight. In fact, acknowledging

Table 1 Treatment options considered

	Brief Description	Conservation Materials	Cost Estimates
Option A	Mounting on honeycomb panels by foaming epoxy resin	Honeycomb panel/s, known as Aerolam, or Hexlite	**High**
		Expanding foam epoxy resin	
Option B	Mounting on honeycomb panels by lime-based mortar	Honeycomb panel(s), known as Aerolam, or Hexlite	**Medium**
		Lime-based mortar	
Option C	Mounting on dental plaster cast supports	Dental plaster	**Medium-Low**
		Expanded clay pellets	
		Aluminum panel net	
		Ethafoam sheets 2 mm	

Table 2 Explanation of the decision parameters and their meaning in the case study

	Criteria	Evaluating . . .
Technical aspects	Retreatability	the permanence of the mounting option. To what extent are future modifications feasible?
	Versatility	the mobility of the mounting system. To what extent is it detachable and transferable?
Cultural aspects	Accessibility	the amount and type of information (tangible and intangible) that is revealed and/or represented through the mounting option
	Integrity and authenticity	the impact on the integrity and authenticity. How much of the excavated/original material is compromised by the conservation-mounting option?
Financial aspects	Availability of materials	the availability of materials through local suppliers. Locally sourced materials to ensure continuation and long-term sustainability of the project.
	Required qualifications	the complexity of mounting. What are the qualifications needed to undertake such a project? Can the option be executed by trained local technicians?
	Monetary cost	the overall financial cost of the mounting option, along with its long term maintenance

Table 3 The decision-making matrix

		DECISION PARAMETERS							
		Retreatability	Versatility	Accessibility	Authenticity and Integrity	Materials Availability	Required Qualifications	Monetary Cost	Overall Scores
Options	Option A	2.5	3 × 1.5	3	3	1	2	1	17
	Option B	2.5	3 × 1.5	1	2 = fail	3	3	3	19/ failed
	Option C	4	4 × 1.5	4	4	5	4	3.5	30.5

that each case presents unique qualities, it was the context and its interpretation that guided their valorization.

How much can one compromise the original stratigraphy of a mosaic, when such information is rarely found in museum exhibits? What might be the cost of a nonversatile option when further reconstruction is foreseen?

As such, versatility was assigned a ×1.5 weight, while authenticity and integrity were given a precondition so that for any score equal to or below 2.5 the treatment option was excluded.

The Implementation of Option C

This mounting technique was initially designed during the planning phase and developed after testing. The mosaic fragments were grouped in sections smaller than 0.5 m^2, documented, well insulated, and prepared for mounting. Fully detachable, retreatable, and easily transferable cast supports were created using dental plaster reinforced with clay pellets and a thin stainless steel net (figs. 1, 2). A significant portion of the mosaic, including floral and animal depictions, Greek inscriptions, and part of the geometric border, along with the bedding stratigraphy, became accessible to the public (fig. 3).

The Benefits: An Overview of the Last Three Seasons

The mosaic is conserved and a large part of it presented and accessible to visitors and scholars. The original bedding mortars are preserved, and since the mosaic fragments are not permanently fixed on the cast supports they can be easily removed from the exhibition for study purposes.

A wide window allows a view from the exhibition room to the laboratory where the conservation of the mosaic is ongoing, thus engaging the visitors and communicating the conservation work that is undertaken on the mosaics. Visitors, members of the local community, and schoolchildren can visit the laboratory upon request.

The presentation is adaptable. The mounting method used permits the addition and integration of new fragments as soon as their original location in the mosaic is found. The process of piecing together a mosaic puzzle by matching its fragments is slow but rewarding and quite promising (fig. 4).

Figure 1 Casting dental plaster molds. Photo: S. Chlouveraki

Figure 2 Fully detachable, retreatable, and easily transferable cast supports. Photo: S. Chlouveraki

Figure 3 Engaging the public. Photo: T. Katrakazis

Figure 4 The resulting mosaic preservation, which allows for easy integration of new fragments. Photo: S. Chlouveraki

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Conservation and Display of a Twentieth-Century Large Wall Mosaic

Yanna Doganis and Amerimni Galanos

Abstract: *A large wall mosaic, designed by Y. Tsarouchis, an influential Greek artist in the 1960s, constitutes the artist's only work in this medium. The donation of the mosaic to the Benaki Museum marked its fourth move and necessitated dismantling and conservation in preparation for its reexhibition. The conservation work aimed to retain the integrity of the panel with respect to its composition and execution. Conservation included cleaning, stabilization of loose tesserae, replacement of previous infills, and replacement of the steel frame with a new backing system.*

Description

The mosaic panel (4.68 × 2.98 × 0.58 m), titled *The Spirit of Measure and Proportions*, depicts an angel–master craftsman holding a ruler and overseeing the construction of a "modern" concrete structure; on the far end, the neoclassical structure is a nostalgic reference to the past. Y. Tsarouchis (1910–1989) was an important painter who played a major role in defining modern Greek identity, a prominent representative of the Generation of the 1930s who modernized the arts in the cultural realm. The composition, characteristic of his second-period paintings—bold forms rendered without perspective in a basic color palette—is created in a "novel" medium, with small ceramic, stone, and enamel tesserae.

Commissioned for the courtyard of the Doxiadis Associates' headquarters in Athens in 1960, the panel was moved to a sheltered area in the same courtyard soon thereafter. In 1994, it was transferred to a private residence and displayed in the garden in a concrete free-standing frame with marble cladding. In 2009, it was donated to the Benaki Museum.

The mosaic was executed with the "indirect" method, in forty-one sections that follow the outlines of the composition, rather than a regular grid. The assembly joints, discernible in archival photographs, are the original ones; hence the undulating surface of some sections was incurred during the initial laying, which suggests that the panel was always transported as an entity with its original backing system. The tesserae were originally laid in a setting bed of gray Portland cement mortar approximately 0.5 cm thick. The backing consisted of reinforced concrete with embedded wire mesh and steel bars attached to a steel frame (fig. 1), constructed of 3-mm-thick steel angle plates measuring 40 × 40 mm. Two horizontal and five vertical T-shaped 2-mm-thick plates were attached to the frame.

Condition

The primary concern was the corrosion of the metal elements of the original frame and of the rebars, which produced severe cracking in the concrete mortar. The three rows of tesserae on the lower edge of the panel were loose due to humidity retention in this area, which contributed to the corrosion of the metal frame and also provided favorable conditions for biological growth. A few previous repairs such as the replacement of loose or missing ceramic tesserae were distinguished by the difference in material.

Documentation

The condition of the mosaic panel was documented on orthophotographs superimposed on measured drawings (scale 1:10) produced with a combination of equipment and digital manipulation. Materials and condition were rendered on color-coded maps (fig. 2). The condition maps included execution method/evidence such as the assembly joints, surface deformation, deposits such as salt crusts, and losses such as missing, loose, and infill tesserae. Documentation included photographic records, assessment reports, and a journal for the duration of the three-month project.

The Project

The primary aim of the conservation work was to replace the backing of the mosaic panel in order to reduce damage incurred

Figure 1 Cross section of the panel.

Figure 2 Materials and condition mapping. Copyright © Lithou Sintirissis Inc.

by the oxidized metal rebars and to reduce its total weight. The conservation program was based on a premise of minimum intervention in order to retain the authenticity of the composition and the integrity of the panel, in terms of both materials and execution. Despite its size, it was treated as one entity. The assembly joints were preserved, as was the surface deformation present in some sections.

Prior to dismantling, the panel was cleaned with soft bristle brushes and water, and the biological growth was removed by mechanical means. Gauze and hemp were used for the facing with a 10 percent acrylic adhesive solution in acetone. The free-standing concrete frame's marble cladding was removed and a buttressed timber panel fitted onto the panel's surface. The surrounding concrete structure was cut, and the panel was suspended on a crane with reinforced suspension straps in order to stabilize it during the dislodging of the remaining metal frame elements.

A heavy-duty worktable was designed (5 × 3.4 m) to support the panel, which was initially set facing up. The facing materials were removed, and missing tesserae were replaced with tesserae of similar color and texture and set with a white Portland cement and marble powder mortar in a ratio of 1:1 by weight, for reasons of compatibility with the original setting bed. Loose tesserae were set with a commercially available hydraulic lime grout. A layer of vulcanized rubber latex was applied to the surface with gauze facing in order to avoid the seepage of materials used for the new backing to the front. The panel was flipped with a crane, and a rotary saw with aligned guides was used to make parallel cuts for the removal of the concrete backing mortar (fig. 3). The concrete backing was removed, leaving in place a 3- to 4-mm-thick layer of the setting bed. A concentrated latex dispersion was used as a primer on the remaining setting bed, followed by the application of a 3- to 4-mm-thick layer of a cementitious thin-bed adhesive mortar with glass spheres, used to level the surface. An intervention layer of two layers of gauze adhered with acrylic emulsion and a sheet of polyethylene foam were used for reasons of reversibility. The honeycomb aluminium panels were attached with epoxy adhesive and threaded teflon pins. The steel frame consisted of T-shaped plates in a 3 × 5 m grid and a framing plate measuring 4 × 60 mm with metal brackets.

The panel was transferred to the museum's sheltered entrance and hung suspended on steel rods and attached onto brackets set along its lower edge approximately 2 to 3 cm from the wall surface (fig. 4). The rubber latex facing was removed, and salt deposits were cleaned with an ultrasonic pick.

Conclusion

The unique mosaic panel was treated as one entity, with the primary aim of reducing its load and designing a display system according to current conservation principles and methods, so that it can be easily dismantled should the need arise. Conservation work addressed the damages incurred by the panel's long exposure in the open air, the most important being the oxidation of the metal elements used for the backing. The replacement of the backing resulted in a reduction in load of 50 percent (table 1).

Table 1 Load calculations (kg)

	Tesserae Layer	Backing System	Metal Elements	Total Wt.
Old backing system	220.6	685	250	1,155.6
New backing system	220.6	226	150	596.6

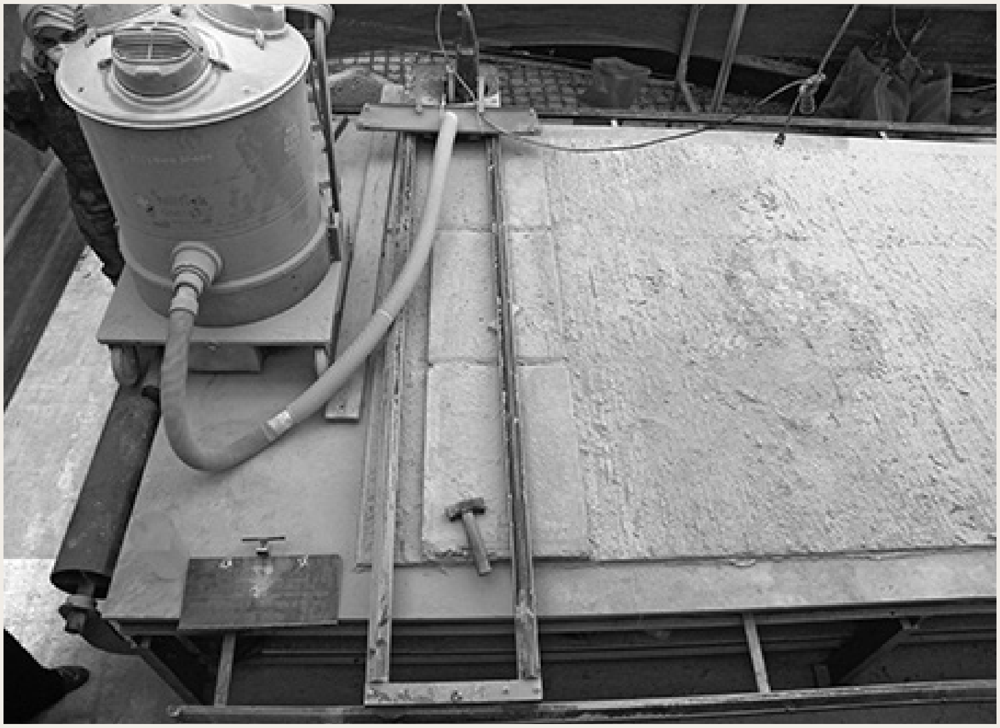

Figure 3 A rotary saw with aligned guides was used to ensure the uniform in-depth removal of concrete backing mortar. Copyright © Lithou Sintirissis Inc.

Figure 4 Mounting of the panel. Copyright © Lithou Sintirissis Inc.

The Facsimile or Digital Model: Is It Useful to Heritage Professionals?

Sabah Ferdi and Mehdi Chayani

Abstract: *This poster deals with the issues of developing a type of heritage object via the substitute of an original object or its 3D model. It is worthwhile to consider whether scanning is limited to producing a substitute or a clone instead of serving as a mere storage medium for the original heritage object.*

In the case of using a digital model as a storage medium, the only issue would be to produce a representation that may be considered a faithful reference for the authentic object.

But the challenge is also elsewhere: the substitute, or “digital clone,” will not just be interchangeable with a museum object; its role is also to increase the observation points of a refined representation of the texture of the material of objects that are too fragmentary or fragile, or even missing. Moreover, through a digital clone, the potential for dissemination of information about heritage can be increased tenfold via the Internet. Finally, on an emergency excavation, where archaeologists are subject to stringent time constraints and operate under the threat of imminent development work, it is a method that will accelerate the field surveys. To open the way for a new archaeology, “preventive” action and accuracy of readings in 3D are necessary.

Protocol and Objective of a Close Range Photogrammetric Mosaic Survey

It is useful for several reasons to digitize discovered mosaics before undertaking restoration and consolidation work:

- The photogrammetric survey of a mosaic involves a specific shooting protocol. To achieve adequate coverage of the subject, several steps are required to produce a good-quality 3D model. The photographs need to be captured every 15 to 20 degrees.
- There should be a 50 to 70 percent overlap between two successive photographs.
- The photographs should be as clear as possible.
- The lighting needs to be as homogeneous as possible. We have achieved the best result when photographing outdoors on a cloudy day.

Then the photographs must be processed by a dedicated software intended for photogrammetry.

A 3D model textured with digital mosaic tesserae will enable

- analysis of subsidence and slumps in the mosaic grid;
- creation of orthophotographs that replace manual drawings at 1:1 scale, traditionally performed by manual tracing, hence eliminating the risk of further damage from physical contact;
- measurements of the mosiac;
- easy access to information for researchers, by having a mosaic digital copy with three-dimensional enriched information.

The Cost?

The cost of a full workday for a photogrammetric acquisition depends on several steps: the digitization, the data processing, the post-processing, and the documentation (orthorectified images, 2D vector graphics, dense point cloud, mesh models, etc.).

Example: A Floor Mosaic in the Affrescos Villa, Tipasa

Digitization

To produce a digitization of a floor mosaic covering an area of 5 × 6 m, we needed at least 15 to 30 images, all high resolution (1 texel for every 1/10 mm). The total time spent to record the floor mosaic was 10 to 15 minutes. (See fig. 1.)

Data Processing

The second step of the work is data processing with a photogrammetric software. Algorithms detected key features in all the photos and matched them to calculate the spatial position and orientation of the camera and to generate at the end of the process a dense point cloud of the mosaic. This dense point cloud constructed has 10,474,471 points and required around 20 to 30 minutes to process.

Data Post-Processing

After processing the data, the dense point cloud needs to be cleaned, georeferenced, meshed, and mapped with the oriented pictures. It is possible after that to generate different graphic results and documents such as orthorectified images of the floor mosaic in high resolution that shows us all the details of the tesserae. The total time spent for the post-processing was 30 to 40 minutes.

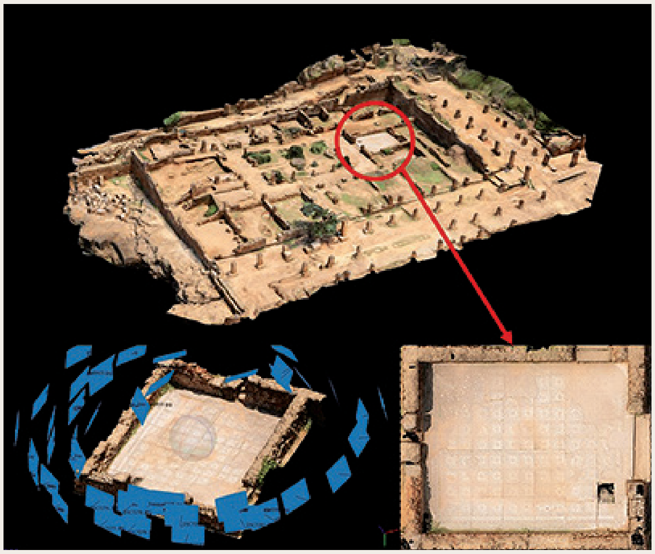

Figure 1 A 3D model created with photogrammetry technique and orthoimage of the floor mosaic in the Affresco Villa, Tipasa (Algeria), extracted from the 3D model. Credit: Mehdi Chayani/Archeovision

For the example described above, the cost of the process from the photogrammetric acquisition to the digital model is difficult to evaluate but can be estimated between €400 and €1,000.

Conclusion

The establishment of a 3D model collection is useful in cases of salvage archaeology, clandestine excavations, and archaeological damage to keep records of cultural heritage. We envision a kind of technological watch of a new type for the safeguarding of the mosaic heritage of Algeria.

The 3D digital tool allows us to increase our knowledge of mosaics. It is a form of preventive conservation before disappearance can occur. In addition, it can assist with the classification of mosaics under optimal conditions.

Finally, this digital technique plays an important role as a communication and awareness tool, by facilitating the dissemination of knowledge among researchers and sharing the importance of cultural heritage with the public.

Nondestructive Techniques (NDT) as Rapid and Cost-Efficient Tools for Mosaic Conservation

Ekaterini Ftikou, Panagiotis Theodorakeas, Eleni Cheilakou, and Maria Koui

Abstract: *Mosaics represent an important part of our world cultural heritage. The awareness of increasing damage, which can lead to irretrievable loss, has resulted in great efforts worldwide for their preservation. In situ diagnosis is a key issue in the preservation of heritage sites. The present study assesses the state of deterioration of the mosaic pavement of the Roman Villa located in the National Garden of Athens, Greece. The nondestructive techniques used are Infrared Thermography (IR-Thermo) and Ground Penetrating Radar (GPR).The detection of large voids and discontinuities in the substrate of the mosaic led to proper conservation planning, avoiding costly and possibly unsuccessful interventions. The results obtained constitute a valuable database of information that can be used for the long term maintenance of this in situ mosaic.*

The present study evaluates the use of infrared thermography (IR-Thermo) and ground penetrating radar (GPR) techniques to survey the substrate of the mosaic floor in room C on the northeast side of a fifth-century Roman villa in Athens, Greece. Its dimensions are 5.65 m × 4.10 m, and during previous interventions, a part of the tessellatum detached and was relaid in situ on a new support (Chrisopoulos and Anamaterou 2006: 17–20).

Current Condition

Through microscopic observation of the mosaic, linear breaks were visible at its surface and may also penetrate into its lower layers. Moreover, slightly deformed or missing parts of the tessellatum layer were observed in some areas. Some tesserae have lost their adhesion to the bedding layer and gap-filling new mortars have decayed. Surface deposits were visible with the naked eye. The deterioration phenomena are more aggressive along the northern area of the mosaic, where moisture accumulation occurred.

Experimental Nondestructive Testing

In situ testing was performed by means of the following nondestructive testing and evaluation (NDT&E) techniques in order to detect the decay patterns and evaluate the substrate of the mosaic:

- IR-Thermo: Passive infrared thermographic investigation was performed using a ThermaCAMTM SC640 long wave thermography system (7.5–13 μm).
- GPR: For the radar measurements, a GSSI TerraSIRch SIR System-3000 with a 1.6 GHz high-frequency antenna in reflection mode was used.

Results and Discussion

IR Thermography Results

Since a moist, porous material presents emittance variations, as well as brightness variations, moisture detection and assessment by means of infrared thermography is feasible. The main purpose of this survey was to apply thermographic testing in order to investigate for moisture accumulation on the mosaic pavement. Visual observations revealed local regions of detached tesserae, and the climate conditions where the mosaic is placed are also harsh during wintertime. Here it should be mentioned that this mosaic's thermographic investigation was performed at noon, when solar energy was directly heating the structure, producing a transient thermal regime. Figures 1 and 2 show the area examined and the thermal image with colors representing temperature variations, respectively. Considering that the testing scenario

Figure 1 View of the mosaic investigated. Photo: Ftikou Ekaterini, 2014

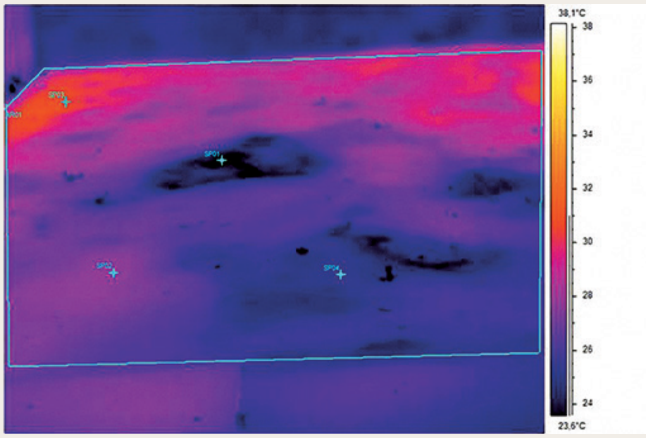

Figure 2 Thermal image from the mosaic region

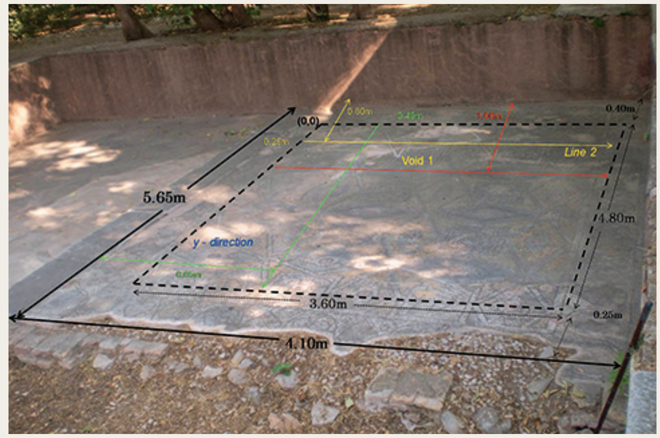

Figure 3 2D radar data acquisition along single profile lines in the x- and y- directions of the mosaic c. Photo: Ftikou Ekaterini, 2014

was applied in a "dynamic" manner, temperature uniformity was observed along the northern area of the mosaic, indicating that the deterioration phenomena are more aggressive due to the presence of moisture and/or incompatible conservation material (cement-based mortar). Specifically, the temperature ranged from 21.7°C to 31.3°C. The temperature measurements at the selected points of the examined area (AR01) are given in table 1.

Ground Penetrating Radar Results

Two-dimensional radar data were acquired along single parallel horizontal (following the x-direction) and vertical (following the y-direction) profile lines (fig. 3) covering an area of 3.60 m × 4.80 m (indicated by dotted lines in fig. 3). The distance between consecutive survey lines was 0.40 m. The depth of the viewing window was approximately 0.50 m, corresponding to an electromagnetic wave velocity equal to about 0.07 m/ns.

The GPR data acquired were processed using RADAN 7 software. From the shape of the diffraction hyperbolas, the average electromagnetic (EM) wave velocity was evaluated to be about 0.063 m/ns.

Discontinuity in the medium over the depth of 0.10 m from the top of the surface is indicated (fig. 4), which can probably be attributed to heterogeneities, such as voids along the second layer (rudus) and the third layer (nucleus) of the mosaic. The stronger reflections appear to have a length of about 1.80 m along the x-directed line 2 and a depth from about 0.03 m to 0.10 m (Void 1, fig. 4a, b). This area is also related to previous restoration work, where part of the tessellatum has been relaid on the new support. Therefore, reflection may be also due to the presence of a different material matrix.

Discontinuity in the medium over the depth of 0.30 m is also indicated, likely corresponding to the bottom of the first layer (statumen) of the mosaic. Strong reflections are visible in depths from 0.20 to 0.40 m. These are located along the x-directed line 4 extended from 0.0 to 0.20 m, from 0.60 to 0.80 m and from 1.20 to 1.60 m additionally (red dotted frame, fig. 4b). Because they do not have a defined shape and due to the type of their reflection, they are probably related to water-filled voids. Some of these reflections are visible at a depth of 0.30 m along the y-directed line 15 (fig. 4c).

Table 1 Temperatures of the selected spots and selected area measured by thermal analysis

Labeled Spots	Value [°C]	Min.	Max.	Max.-Min.	Average	Standard Deviation
Image		21.7	31.3	9.5		
SP01	23.8					
SP02	22.8					
SP03	30.4					
SP04	27.8					
SP05	29.9					
SP06	24.2					
SP07	25.0					
AR01		21.7	31.3	9.5	26.9	1.5

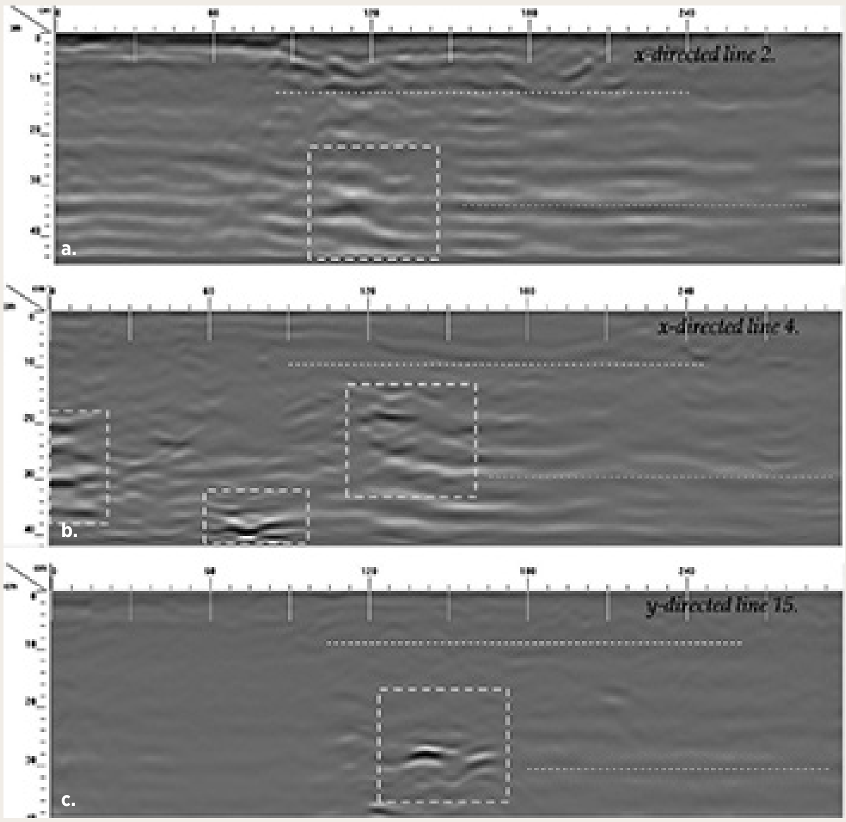

Figure 4 Migrated patterns of 2D profiles from x-directed lines 2 and 4 (a), (b), and y-directed line 15 (c) applied on the mosaic

Conclusion

Summarizing the results derived from the present study, it can be concluded that the NDT&E techniques used can provide essential information about the structure of the mosaic and its state of preservation. The detection of large voids and discontinuities in the substrate of mosaic pavements is fundamental for mapping deterioration phenomena and to aid conservation planning, schedule interventions, and avoid costly and possibly unsuccessful conservation work. The results obtained constitute a valuable database of information that can be used for the long-term maintenance of this in situ mosaic. Supplementary measurements should be performed to analyze the mortar, by means of advanced investigative techniques such as scanning electron microscopy (SEM), X-ray diffraction (XRD), and differential thermal analysis (DTA-TG).

Acknowledgments

We wish to acknowledge the Doc-Culture research project, “Development of an Integrated Information Environment for Assessment and Documentation of Conservation Interventions to Cultural Works/Objects with Nondestructive Techniques (NDTs),” which is coordinated and managed by the Chemical Engineering School of the National Technical University of Athens (NTUA), MIS: 379472. The three-year project began in April 2012 and is cofinanced by the European Union (European Social Fund [ESF]) and Greek national funds through the Operational Program “Education and Lifelong Learning” of the National Strategic Reference Framework (NSRF)—Research Funding Program: THALES.

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Darwin, les vers et les mosaïques : Approche taphonomique de la conservation des mosaïques *in situ*

Patrice Georges-Zimmerman

Résumé : *Le dernier livre de Darwin, publié en 1881, est intitulé* La Formation de la terre végétale par l'action des vers avec des observations sur leurs habitudes*. Il met alors en évidence l'action cruciale des vers de terre dans la formation des sols. Plusieurs fouilles archéologiques nourrissent sa réflexion. Mais Darwin documente également les dommages que les vers causent aux pavements mosaïqués. En étant minés par les vers, ces derniers s'affaissent systématiquement, surtout s'ils sont liés à des murs fondés peu profondément (création de vides secondaires). Cette approche taphonomique peut avoir son importance pour la conservation des mosaïques* in situ*.*

Abstract: *Darwin's last book, published in 1881, is titled* The Formation of Vegetable Mould*,* through the Action of Worms, with Observations on Their Habits*. In this work, Darwin highlights the crucial role of earthworms in soil formation. His thoughts on the matter were informed by several archaeological digs. However, Darwin also documented the damage caused by earthworms to mosaic pavements. Eaten away by worms, mosaic pavements disintegrate gradually over time, especially if located next to unstable walls (leading to the creation of secondary cavities). This taphonomic approach may well have an important role to play in the conservation of mosaics in situ.*

> Les archéologues ne se doutent probablement pas de ce qu'ils doivent aux vers pour la conservation de bien des objets anciens.
>
> Charles Darwin, 1881

Peu de temps avant de mourir, Darwin rédige son dernier livre, *La Formation de la terre végétale par l'action des vers avec des observations sur leurs habitudes* (The Formation of Vegetable Mould, through the Action of Worms, with Observations on Their Habits), publié à Londres le 10 octobre 1881. Il met alors en évidence l'action cruciale des vers de terre dans la formation des sols. L'idée maîtresse de cet ultime ouvrage est formulée près de cinquante ans auparavant. En effet, dès 1837, devant la Société géologique de Londres, Darwin expose que « [...] chaque particule de terre formant l'assise sur laquelle pousse le gazon sur un terrain de pâture ancien est passée par les intestins des vers ; d'où il suit que le terme “terre animale” serait à certains égards plus approprié que celui de “terre végétale” » (Tort 2001 : 22)[1].

De la formation des sols... à l'enfouissement d'anciens édifices

Les vers de terre sont caractérisés par un corps mou, segmenté de plusieurs petits anneaux presque cylindriques munis de soies minuscules, et vivent principalement dans la terre végétale superficielle[2]. C'est cette terre qui passe et repasse par l'intérieur de leur corps et est remontée à la surface. L'accumulation des déjections à la surface (turricules) est à l'origine de l'« enfouissement » et du « camouflage » des anciens édifices (fig. 1).

L'observation d'une pierre provenant d'un four à chaux situé dans une prairie près de Leith Hill, détruit trente-cinq ans avant sa visite, permet notamment à Darwin d'expliciter la part de responsabilité des vers de terre dans l'enfouissement des édifices anciens (fig. 2). « De simples fossoyeurs, écrit Patrick Tort, les vers deviennent ainsi conservateurs des archives de l'humanité, ajoutant leur strate protectrice à l'étage géologique de la civilisation » (Tort 2001 : 26).

Plusieurs fouilles archéologiques réalisées en Angleterre en cette fin du XIX^e^ siècle nourrissent la réflexion de Darwin[3]. C'est ainsi le cas des investigations menées sur la ville romaine de Silchester, dans le Hampshire. Des copies des coupes stratigraphiques, qui permettent de documenter les dommages que les vers causent aux pavements mosaïqués, sont transmises à Darwin (figs. 3, 4).

Action des vers

Les vers minent les pavements mosaïqués, en profitant notamment des lacunes. Avec le temps, les pavements mosaïqués s'affaissent systématiquement, surtout s'ils sont liés à des murs fondés peu profondément. Les galeries creusées, verticales et permanentes créent en effet des vides secondaires préjudiciables en raison de leur impact sur la porosité, l'agrégation et la densité du sol. Selon Darwin, l'enfoncement, dont une partie peut toutefois être liée au tassement du sol, est ordinairement plus grand dans le milieu des pavements que près des murs.

Conclusion

En étudiant les vers de terre, dont l'importance pour les sols et la société a évolué au fil du temps, « d'une reconnaissance profonde à une ignorance marquée » (Blanchart *et al.* 2005 : 147), Charles Darwin pose de fait les bases de la taphonomie (du

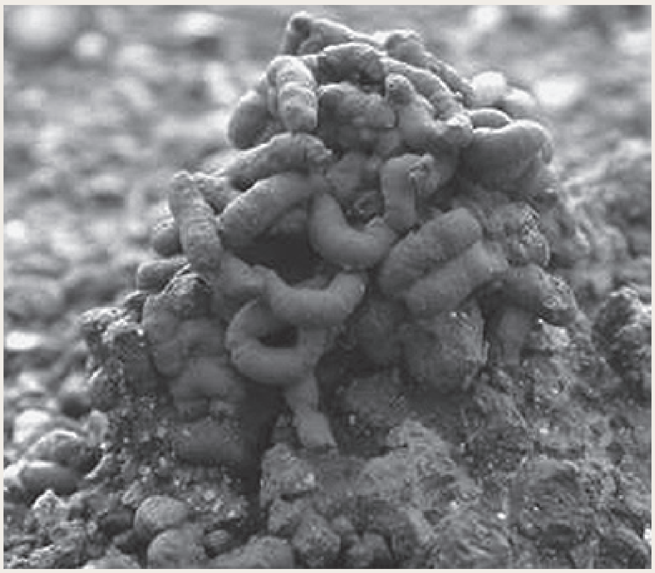

Figure 1 Turricules. Les vers vivent principalement dans la terre végétale superficielle. C'est cette terre qui passe et repasse par l'intérieur de leur corps et est remontée à la surface. L'accumulation des déjections à la surface est à l'origine de l'enfouissement des anciens édifices, les vers profitant des lacunes dans le cas des mosaïques. © P. Georges-Zimmerman, Institut national de recherches archéologiques préventives (Inrap)

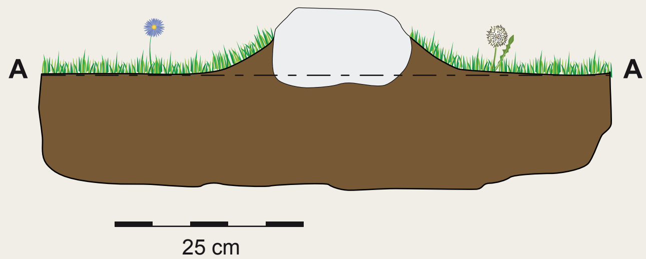

Figure 2 Enfoncement de pierre. Section transversale d'une grande pierre, qui était restée sur une prairie pendant 35 ans. A–A : niveau général du champ. Échelle initiale : ½ pouce (1,27 cm) pour 1 pied (30,48 cm). La bordure couverte de gazon consistait en une fine terre végétale qui avait, à un endroit, 7 pouces (17,78 cm) d'épaisseur. L'ensemble de la pierre s'était affaissé pendant ces 35 ans, du fait du minage des vers de la couche sous-jacente, d'environ 1 pouce (3,81 cm). © G. Diquero-Bats, Inrap d'après Darwin dans Tort 2001 : fig. 6

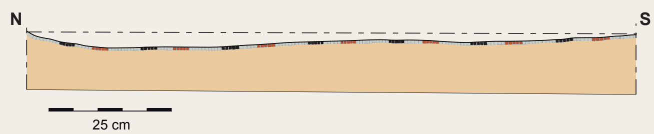

Figure 3 Affaissement du pavement. Section nord-sud du parterre affaissé d'une pièce pavée de tesselles, à Sichelster (Angleterre). Échelle initiale : 1/40. Cette section, au travers d'une pièce de 18 pieds 4 pouces de long (5,58 m), révèle une subsidence maximale de 5 pouces ¾ (14,6 cm) dans la moitié nord sous son niveau originel (conservé aux abords des murs). En plusieurs endroits, les tesselles étaient écartées des murs. © G. Diquero-Bats, Inrap d'après Darwin dans Tort 2001 : fig. 13

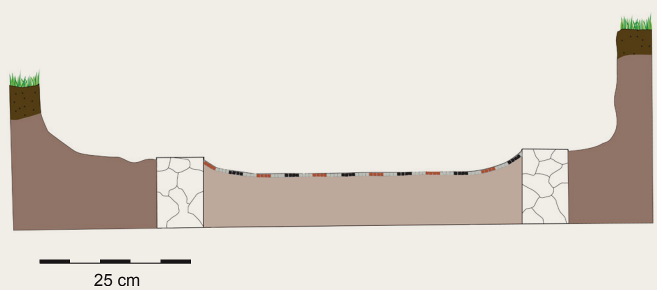

Figure 4 Subsidence. Section nord-sud du parterre affaissé d'un corridor pavé de tesselles, à Sichelster (Angleterre). Échelle initiale : 1/36. Cette section révèle un déambulatoire d'une cour rectangulaire large de 7 pieds 9 pouces (2,36 m). Le champ, qui était en pâturage, avait à cet endroit une pente du nord au sud, d'un angle de 3° 40'. La coupe montre la nature du sol de chaque côté du corridor ; le sédiment comporte des pierres et d'autres débris. Le pavage s'est affaissé au milieu jusqu'à 7 pouces ¾ (19,68 cm). © G. Diquero-Bats, Inrap d'après Darwin Tort 2001 : fig. 14

grec τάφος, *taphos*, « enfouissement », et νόμος, *nomos*, « loi »), avant même que le mot ne soit forgé par le paléontologue Ivan Efremov en 1940[4]. Son travail a des implications de première importance pour la conservation/restauration des mosaïques *in situ*. Sur la base de ses observations sur des ruines et mosaïques romaines en Angleterre, que l'expérience de l'archéologie préventive permet de compléter, cela pourrait permettre, à terme, d'apporter quelques recommandations pour gérer sur le long terme les mosaïques conservées *in situ* sous nos latitudes (milieu tempéré et humide), en tenant compte de l'écologie du milieu de découverte.

Notes

1 « On the Formation of Mould », *Transactions of the Geological Society of London*, 2e série, 3e partie, 5, 1840 [lu le 1er novembre 1837], reproduit dans Barrett 1977 : 52. Cité par Tort 2001 : 22, no 8.

2 Ils peuvent ramper en arrière aussi bien qu'en avant ; ainsi, à l'aide de leur queue enfoncée, les vers peuvent se retirer rapidement dans leurs galeries.

3 Pourtant, selon les recherches de Patrick Tort, ayant réalisé la préface de l'édition française la plus récente de l'ouvrage de Darwin, l'archéologie n'avait jusqu'alors intéressé Darwin qu'en tant que ses monuments conservaient des informations sur les êtres vivants – quand par exemple ils attestaient l'ancienneté de la domestication d'un animal au sein d'une civilisation (Tort 2001 : 26).

4 Dans une acception plus large que la définition d'Ivan Efremov, désignant l'étude du passage des restes ou produits des organismes vivants de la biosphère à la lithosphère (Efremov 1940), la taphonomie est aujourd'hui la discipline certes de la paléontologie, mais aussi de l'archéothanatologie (Boulestin, Duday 2005). Elle étudie de fait la formation des gisements fossiles et tous les processus qui interviennent depuis la mort jusqu'à la fossilisation d'un organisme.

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Conserver, dérestaurer les mosaïques d'Alexandrie : Nouvelles problématiques, nouvelles découvertes

Anne-Marie Guimier-Sorbets et Hana Tewfick

Résumé : *Deux pavements des collections du Musée gréco-romain d'Alexandrie ont été confiés au Centre d'études alexandrines par le Conseil suprême des antiquités de l'Égypte pour des travaux de conservation nécessitant une dérestauration. En effet, ces deux pavements sont entrés au musée au début du XXe siècle et y ont été exposés après leur transfert sur des plaques de béton armé de barres de fer. Nous évoquons les difficultés dues à l'absence de documentation sur les interventions précédentes, et dans le cas de matériaux fragiles. Nous indiquons les solutions mises en œuvre ou encore en attente, ainsi que les acquis scientifiques de ces travaux en cours.*

Abstract: *Two mosaic pavements from the collections of Alexandria's Graeco-Roman Museum have been entrusted to the Centre d'études alexandrines (Alexandria Research Center) by the Conseil suprême des antiquités (Egypt's state body for antiquities) for conservation work and de-restoration. These two pavements have been with the museum since the beginning of the twentieth century, when they were relaid on concrete slabs reinforced with iron rods and put on view to the public. We discuss the challenges arising from the absence of records documenting these interventions, as well as from the difficulties involved in dealing with fragile materials. We outline the solutions that have been adopted or are awaiting adoption, as well as the scientific findings of this ongoing conservation work.*

Pavement aux cubes illusionnistes de Thmouis (Delta), d'époque hellénistique (MGR nº 21737)

Ce panneau d'*opus tessellatum*, bordé d'une file de tours crénelées, est orné d'une composition triaxiale de losanges (fig. 1) ; la disposition des cinq couleurs des losanges forme à la fois une composition de cubes en perspective et un quadrillage oblique ; la restitution du motif illusionniste avait fait l'objet d'études préalables (Daszewski 1985) avec une première restitution des couleurs (Guimier-Sorbets 2004, 2007). Les contours des losanges et des tours crénelées sont cernés de lames de plomb ; les losanges blancs, noirs, jaunes et rouges sont en tesselles de pierre. L'examen préalable aux travaux de restauration a permis de voir que de la peinture recouvrait tous les losanges et que cette peinture se trouvait aussi bien sur les joints du mortier interstitiel que sur la surface des tesselles. À la suite de restaurations anciennes non documentées, il est difficile de déterminer si les tesselles des losanges bleus sont en pierre blanchâtre et/ou en faïence, et si

Figure 1 Thmouis, mosaïque aux cubes, avant restauration. Photo : A.-M. Guimier-Sorbets

leur couleur est entièrement due à la peinture qui les recouvre. Des examens photographiques mettant en évidence la fluorescence dans l'infrarouge permettent de montrer qu'elle recouvrait tous les losanges conservés de la ligne bleue, et de déterminer que cette peinture est à base d'un pigment artificiel, le bleu égyptien, selon la méthode d'analyse photographique mise au point par G. Verri 2009 pour les peintures antiques (fig. 2). Ce panneau d'époque hellénistique peut être daté du IIe siècle av. J.-C.

Dimensions : L. 2.65 m, W. 0.67 m

The condition of the panel with the old restorations is as follows: The panel fixed on a concrete base reinforced with iron bars, the color of tesserae becomes faded and the interstices between them full of dirt and cement, with different cracks on the mosaic's surface.

During the cleaning of the surface of the mosaic panel with soft brushes, after having removed the reinforced concrete, applied the lime mortar on the back of the panel, and fixed it on the new support (honeycomb), we observed:

- *Presence of traces of paint on the surface of the tesserae and in the mortar between them. We found few traces of Egyptian blue and our observations were confirmed by infrared photography,*
- *The remnant colors are stable, but the residue of the cement from the previous restoration is interfering with the original colors,*

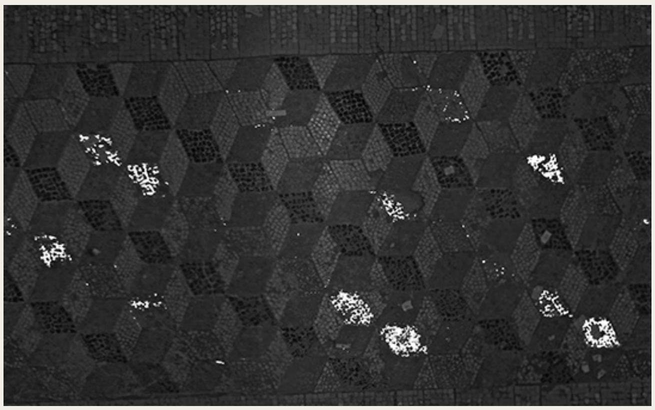

Figure 2 Thmouis, mosaïque aux cubes, en cours de restauration, éclairage infrarouge. Photo : A.-M. Guimier-Sorbets

- *If we try to get rid of the cement residue mechanically we will lose the remnants of the colors. So we stopped the cleaning until a suitable technique is found to remove the cement or lessen its appearance.*[1]

Pavement au fleuron de Chatby (Alexandrie), d'époque impériale (MGR nº 10200)

Le panneau central d'un pavement découvert à Alexandrie, dans le quartier de Chatby, au tout début du xxe siècle, a été déposé puis exposé dans le Musée gréco-romain (fig. 3). Il figure un grand fleuron circulaire, inscrit dans un carré ; la trame géométrique du fleuron est animée par des éléments végétaux. Dans les écoinçons sont placés des canthares d'où s'échappent des rinceaux. Lors de la première exposition, le motif de méandre bordant le panneau central a été modifié sur un côté, et, par la suite, des dégradations et des travaux de maintenance ont modifié l'apparence du panneau. Nous n'avons retrouvé que quelques photographies, assez récentes, mais aucune information écrite sur les interventions successives des restaurateurs.

Le pavement est de bonne facture et le motif, élégant. Par comparaison stylistique, on peut le dater de la seconde moitié du Ier siècle ou du début du IIe siècle apr. J.-C. Son rendu à plat, en noir et blanc, le rattache au courant stylistique qui s'est développé à Rome au début de l'époque impériale, tandis que l'emploi de touches de couleur, rouges et jaunes, et de quelques dégradés pour marquer le volume rappelle le style naturaliste des mosaïstes alexandrins de l'époque hellénistique.

Figure 3 Alexandrie, mosaïque au fleuron avant restauration, avec limites de découpe en rouge et emplacement des lames de plomb en jaune. Photo : A. M. Guimier-Sorbets

Le nettoyage du pavement a permis d'observer la présence de lames de plomb dans certains endroits du panneau (en jaune sur la photographie) ; la dépose de l'ancien support a mis en évidence les interventions successives des restaurateurs, utilisant divers types de ciment et de plâtre (fig. 4). L'examen des lames de plomb, uniquement placées dans des zones refaites, et sans aucune altération, montre qu'elles ne sont pas antiques mais dues à l'une des restaurations modernes, sans que nous

Figure 4 Alexandrie, mosaïque au fleuron, en cours de restauration, détail du revers avec lame de plomb. Photo : H. Tewfick

puissions préciser davantage le moment de leur insertion au cours du xx^e siècle.

Dimensions : L 3.03 m, W 2.25 m. Cut in two parts for the conservation work (limits in red in fig. 3).

During the re-restoration of the mosaic floor and with the complete absence of documentation about the old restoration, we found the following:

- *The technique of execution within the cube of one corner is completely different from the other one: the mortar used to fix the tesserae of the first one was plaster, with thick lead strips between the rows of black and white tesserae, but on the other cube tesserae were fixed by cement mortar without a lead strip,*
- *This difference was also evident in other sections of the mosaic panel, in the white-and-black border of the square of the meander, with small pieces of the lead strips at different distances; also, inside the leaf of the flower, plaster was used with a thick lead strip placed to determine the shape of the flower. The edges of the tesserae fixed with plaster range from semiregular to broken,*
- *The presence of lead strips in different sections of the mosaic panel with plaster and broken tesserae indicates that the old restoration used this technique to complete the missing parts, especially the pattern.*

Our goals: To get rid of the cement between the tesserae; to adjust the level surface of the mosaic; to replace the cement in the lacunae with lime mortar; to clean the old plaster and let it remain, as is, as evidence of the old technique used to complete lacunae.[2]

Notes

1 Présenté en anglais à la conférence.

2 Présenté en anglais à la conférence.

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Dérestauration d'une mosaïque inédite dans les thermes de l'Est, Caesarea (Cherchell, Algérie)

Mohamed Chérif Hamza et Frédérique Marchand-Beaulieu

Résumé : *Après avoir diagnostiqué l'état de conservation d'une mosaïque de plus de 40 m² appartenant au complexe thermal romain de Cherchell, les restaurateurs ont pu mener un travail de nettoyage puis de dérestauration du tapis. L'étape suivante a été de consolider cette mosaïque polychrome à décor de filets. Le poster expliquait de façon très précise les différentes étapes du travail et un tableau du coût approximatif de l'intervention, qui s'est déroulée au printemps 2012.*

Abstract: *Having diagnosed the state of conservation of a mosaic from the Roman thermal baths at Cherchell measuring over 40 square meters, restorers were able to carry out cleaning and re-restoration of the piece. The next step was to consolidate the polychrome mosaic, which is designed with a crisscross motif. This poster details the various stages of the work and also gives an approximative table of costs for the intervention, which took place in spring 2012.*

Dans le cadre de l'aménagement du site des thermes de l'Est à Cherchell, une équipe de restaurateurs algériens s'est déplacée sur le site pour diagnostiquer l'état de conservation des pavements et prendre les mesures nécessaires afin de restaurer et de préserver les pavements *in situ*, en avril et mai 2012. Lesdits thermes de l'Est se trouvent dans une propriété privée, et les panneaux de mosaïque exhumés depuis les années 1900 n'ont subi aucune procédure de restauration ou de consolidation, mis à part quelques interventions entreprises par les propriétaires de la maison telles que la pose de ciment sur les lacunes ou les bordures.

Présentation du site et de la mosaïque

C'est le chercheur A. Ravoisié qui signala le premier ce monument, fouillé ensuite par V. Waille en 1893. Les dimensions de l'édifice sont de l'ordre de 60 m de longueur est-ouest et 40 m de largeur nord-sud pour une superficie d'environ 2 400 m². La mosaïque se trouve dans une salle au nord du bâtiment, et ses dimensions (irrégulières) sont de 6,2 m (côté nord) × 6,5 m (côté est) × 8,8 m (côté sud) × 7,37 m (côté ouest). Son décor tricolore est en tesselles blanches (calcaire), rouges (brique) et noires (schiste). Il s'agit d'un quadrillage oblique de filets triples dentelés bichromes ; les bordures sont des bandes rouges, blanches et noires (fig. 1).

Figure 1 Le pavement avant restauration. Photo : M. C. Hamza

La documentation

La première opération effectuée sur place est la documentation ; elle demeure une des composantes essentielles pour un travail d'entretien efficace. Nous avons donc rempli une fiche de constat d'état, réalisé des plans puis effectué la couverture photographique.

État du pavement

Nous avons noté plusieurs types de dégradations provoquées par l'exposition permanente aux intempéries. Depuis sa découverte, à la fin du XIXe siècle, la mosaïque est en effet restée à l'air libre, ce qui a occasionné différents dommages :

- apparition d'une épaisse couche de mousse et de lichens sur l'ensemble de la surface ;
- apparition de quelques herbes disséminées dans les bordures ;
- affaissement du *tessellatum* constaté dans plusieurs endroits envahis de racines d'arbres ;
- autres dégradations liées au facteur humain : trous réalisés pour la pose d'une structure métallique servant de sèche-linge, anciennes restaurations du XIXe siècle qui ont eu un effet négatif sur la mosaïque, en particulier à cause de l'utilisation abusive du ciment.

Les interventions

Notre méthodologie s'adapte au constat fait sur le terrain et se résume en deux phases d'intervention. Première phase : le nettoyage mécanique de la surface (fissures et lacunes) (fig. 2) ; l'élimination des dépôts (terre et ciment) ; le démantèlement de la structure métallique. Seconde phase : le comblement des lacunes et des fissures avec un mortier hydraulique (chaux éteinte + sable de rivière + brique pilée) (fig. 3) ; la pose de solins ; l'abattage des arbustes avoisinants et le renforcement des bords de la mosaïque.

Le pavement ainsi consolidé et restauré pourra servir désormais à une étude plus précise (fig. 4).

Le thème principal de ce XII^e Colloque étant le coût des activités de restauration et de conservation des mosaïques, voici un tableau récapitulatif du coût approximatif de l'opération (170 400 dinars, soit 1 700 euros) (tab. 1). Ce travail a été financé par l'Office de gestion et d'exploitation des biens culturels protégés (OGEBC, ministère de la Culture, Algérie).

Tableau 1 Répartition du coût approximatif de la restauration

Temps de travail	1 mois de travail à 5 jours par semaine et 8h par jour.
Ouvriers	3 à 4 ouvriers (70 000 dinars—700 euros)
Techniciens-restaurateurs	2 personnes (90 000 dinars—900 euros)
Matériel	4 sacs de chaux (2 400 dinars) ; 8 sacs de sable (8 000 dinars) ; 2 sacs de briques pilées (récupération)
Chiffre global	170 400

Figure 2 Nettoyage de surface. Photo : M. C. Hamza

Figure 3 Comblement des lacunes dans une des bordures et pose de solin dans une lacune. Photo : M. C. Hamza

Figure 4 Le tapis de mosaïque après l'intervention de dérestauration et de restauration. Photo : M. C. Hamza

Seasonal Reburial of Mosaics: At What Cost?

Maria Krini, Kassiani Pantazidou, Georgia Sotiropoulou, and Ioanna Vitsou

Abstract: *The floor mosaics at the site of Olympia measure 650 square meters and are exposed to an outdoor environment. The maintenance plan that followed conservation includes the annual reburial of the mosaics during the winter months and their open-air display during the spring and summer months when visitation of the site increases. A survey for the evaluation of the condition of these mosaics, ten years after completion of their conservation, is currently in progress. A new reburial strategy with different materials and the costs of different reburial options are also being examined.*

Olympia, one of the most significant sanctuaries of ancient Greece, lies in the valley of the Alpheios River in the western Peloponnese. Olympia became the most important religious and athletic center in Greece, holding the Olympic Games every four years to honor Zeus, to whom the site was dedicated. The floor mosaics of Olympia measure about 650 square meters and are exposed to an outdoor environment. The majority of the mosaics are dated to the Roman period, and they cover floors in public buildings and baths. A few earlier examples of pebble mosaics have also survived.

The mosaics project began in 2001, with thorough documentation, a survey, and conservation planning. The conservation interventions lasted three years and were completed in 2004, a few months before the opening of the XXVIII Olympic Games in Greece. The majority of the mosaics were treated in situ, with the exception of those that had severe stability problems and had to be detached, treated, and relaid on new mortar layers.

The maintenance plan that followed conservation included the annual reburial of all mosaics during the winter months and their open-air display during the spring and summer months when visitation at the site increases. The stratigraphy of the original reburial design was a plastic net sheet in contact with the mosaic surface, a 6 cm-thick layer of perlite, another plastic net sheet, and then a 5 cm-thick layer of sand. The covering and uncovering procedure was followed for all mosaic floors at the archaeological site. However, the financial constraints of the following decade resulted in a shortage of seasonal personnel to perform maintenance works on the site. There were often delays in the presentation of the mosaics, and since 2009 all of the mosaics were kept covered for the whole year.

To assess the efficacy of these season reburials, ten years after the completion of their conservation, two mosaic ensembles were selected, the Kladeos Bath complex and the Kronion Bath complex mosaics, which were in the poorest condition before conservation. In the 2001–2004 conservation project, the mosaics of these complexes were detached and relaid on new substrates and lime-based mortars and placed back on site.

When uncovering the Kladeos Bath mosaics, which lay in the most humid area of the site, a very thin weed root net was discovered on the central mosaics, spread over several parts of the surface, especially along the edges (fig. 1). It was not penetrating the mortar layers and was removed easily. Larger plants were scarce. The reburial stratigraphy here was different, maybe due to a shortage of materials at some point. The upper layer of net was replaced instead with a thick plastic sheet. After careful removal of soil and roots from the surface, the mosaic revealed minor problems, such as some loose tesserae, which were stabilized with mortar (fig. 2). The uncovering of the Kronios Bath mosaics revealed good overall condition, with the surface almost completely intact (fig. 3).

In spring 2014, the original reburial scheme was reassessed. A new plan is being discussed with the managers of the site: a selection of mosaic floors adjacent to visitors' routes will be uncovered every year; for the other mosaics of the archaeological site a rotation plan will be put in place for their periodic

Figure 1 Vegetation growth on the edge of a covered mosaic in the Kladeos Bath complex.

Figure 2 The central mosaic of the Kladeos Bath complex after removal of the reburial material and treatment of the surface. © Hellenic Ministry of Culture and Sports

Figure 3 The uncovering of the mosaic of the Kronios Bath complex. © Hellenic Ministry of Culture and Sports

Figure 4 Application of the new reburial materials on the central mosaic of the Kladeos Bath complex. © Hellenic Ministry of Culture and Sports

examination and condition survey. Mosaics in areas that are less frequented or closed to the public will be uncovered approximately every five years. For the mosaics that will be exposed every year, easier and less time-consuming methods are being examined.

Three different reburial schemes are currently being tested. The first is a nonwoven polyethylene sheet (Tyvek® Soft) over the mosaic surface topped with a 3 cm layer of sand. The second is a woven polypropylene sheet (black "Velliground") on the mosaic surface covered with sand as well with the same thickness. The above have been applied to the Kladeos Bath central mosaic (fig. 4), and the original method with the plastic net has been applied to a mosaic of the same complex and to the Kronion Bath mosaics.

The selection of the new materials was based on experience at other archaeological sites in Greece that have mosaics in similar environmental conditions and where short-term reburial has proved successful. The cost of the materials used in each case is similar, but the cost translated to working hours varies. Covering or uncovering a mosaic floor with the original reburial method can take up to 30 minutes per square meter, twice the time needed to cover or uncover the mosaics with the new reburial schemes. In spring 2015 the mosaics will be uncovered, and we will have the first results of the new seasonal reburial scheme.

Acknowledgments

We would like to thank the 7th Ephorate of Prehistoric and Classical Antiquities, especially the director, Ms. G. Chatzi, and the staff working on mosaic conservation and maintenance.

Copy at the Site, Original in the Museum: Sociopolitical Context, Circumstances of the Preparation and Display of the Mosaics, and Impacts, Villa Romana Baláca, Hungary

Brigitta Maria Kürtösi

Abstract: *The finds of the Villa Romana Baláca are a significant part of the Roman heritage in Hungary. The excavations began in 1906. Four mosaic floors were brought to light in the main building. The most representative multicolored mosaic pavement was displayed in the Hungarian National Museum. About a hundred years later, in the frame of a tourism development project, managed by the EU, an authentic replica (70 square meters) was made for the original site. The increase in visitor numbers at the site since June 2012 is meaningful. Archaeometrical investigation is underway as part of the author's doctoral research.*

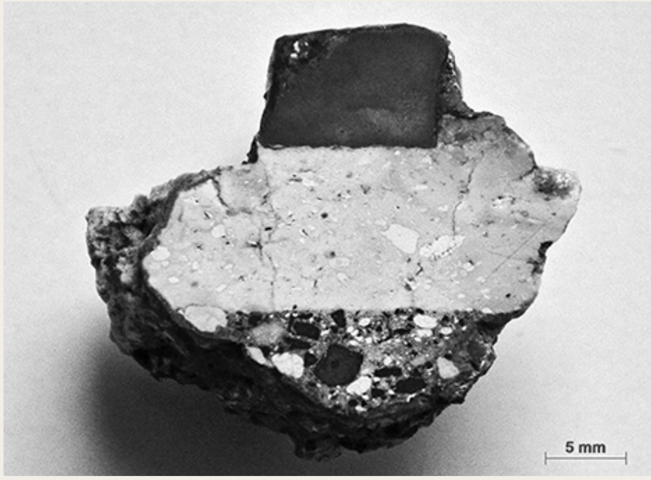

Figure 1 Fragment from a former mosaic floor (Villa Romana Baláca, room no. 24, 82.1.1718). Photo: B. M. Kürtösi

Four mosaic floors—opus tesselatum, probably dating to the Severan period—were found in the main building of the Villa Romana Baláca. During the first quarter of the twentieth century all of them were lifted and backed with concrete. The work was performed under the umbrella of the Hungarian National Museum, where the most representative multicolored mosaic pavement is displayed. In 1984 a protective building was constructed at the site, and three mosaics were brought back from different regional museums to be displayed at the original site. Only one room of the Roman villa has remained empty. Finally, about one hundred years after the mosaic floors were discovered, in the frame of a mainly tourism development project, managed by the European Union, an authentic copy of the multicolored mosaic pavement was created for the original site. The copy was undertaken by a five-member team of conservators and artists over a period of one year.

Archaeometric investigation of the original mosaic was the first step in finding the most authentic solution for creating the copy. In the *tablinum* the original basic structure has remained more or less intact and precisely documented.[1] It is important to study the context of the cultural, historical, and scientific values by understanding the concept of the arrangement and the technologies used by the Roman masters. Information is hidden in the architectural ensemble for which the mosaic pavements were made, including the mosaic stratigraphy. Based on XRD analysis, the supranucleus contains calcite, derived from quicklime. The nucleus is made of two visibly different layers. The upper, pinkish-hued stratum consists of splintered dolomite fragments and crushed tiles as aggregate, and brick powder as a pozzolanic in the lime-based binder matrix. The lower layer is whitish without significant quantities of ceramic particles. The rudus contains rough stones and earthenware fragments. Examination of different mosaic fragments derived from the archaeological site, Villa Romana Baláca, showed a highly conspicuous phenomenon in the bedding mortar used by the Romans (figs. 1, 2).[2] The color differences between calcite- and Portlandite-rich areas evidence the so-called Liesegang pattern formation. The very small pores ($r \leq 0.1$ micron) have the main role in the development of these banded patterns. A number of well-known investigations of laboratory samples showed that the Liesegang patterns are present only in mortars prepared with long-term aged lime putty.[3]

One of the most representative elements of the mosaic is a green stone, a kind of volcano sediment, which is present in the palette of three mosaic pavements at Baláca. This circumstance signals a common origin, probably the same workshop and construction period. The original multicolored mosaic surface was burned, and this has caused alteration in the colors of some types of tesserae. The alteration of the iron oxide content and the other organic ingredients of the raw materials become highly visible in the yellow, ocher, red, and brown limestone tesserae. The extent of the color change is affected by the structure and petrography of the initial stone materials. During the creation of the replica, these aesthetic changes were not replicated; instead, the original use of color was imitated. Through studying the original mortar layers and the tesserae of the mosaic, similar materials and technologies were used to create the copy.

The mosaic design was divided into sections based on its motifs. All of them were assigned a code consisting of a letter and a number for easy identification. This system resulted in a map that was a useful aid during the work. The replica was made by the indirect method. Using a temporary support consisting of thin

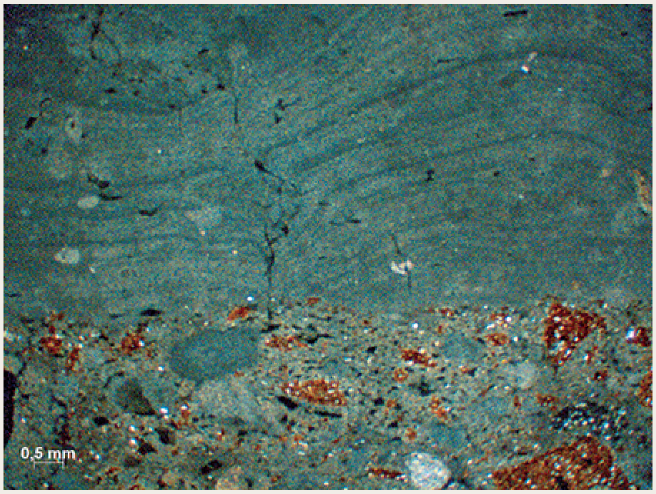

Figure 2 Detail of thin section of the mosaic fragment in cross-polarized light shows the so-called Liesegang phenomenon. The upper part shows the bedding mortar; the lower part is the first nucleus layer. Photo: B. M. Kürtösi

Figure 3 Our team at work (left to right): Brigitta Maria Kürtösi, painting conservator; András Ferenc Pintér, painter; Miklós Ernő Balázs, mosaicist; Béla Dohárszky, sculptor. Photo: By courtesy of Dr. István Bóna DLA habil

plastic film with our drawn to scale (1:1) graphic documentation of the original setting characteristics, a layer of gauze glued with a mixture of polyvinyl-acetate and methyl-cellulose in a ratio of 1:3 was put in place. The tesserae were fixed on this easily removable, thin composite with the same adhesive. Because the temporary support was cut into sections it was easy to handle. After the atelier work, we paved the room with these panels on-site (fig. 3). A new substrate was prepared over the bumpy remains of the original foundation one year before the mounting of the new mosaic. We set the prefabricated motifs "dryly" to check our measurements. We systematically marked out the elements with charcoal and assigned their codes to the floor; in essence, we enlarged our graphic map previously prepared in the museum. A

Figure 4 General view of the replica at the original site surrounded with visitors, Villa Romana Baláca, room no. 20. Photo: B. M. Kürtösi

lime-based mortar with metakaolin mixed with local quartz sand was used for the bedding mortar.

The large increase in visitors to the site is the result of marketing efforts financed by the project tender. The most successful elements of the development are the website, the reconstruction of the Roman dining room with original fresco fragments and furniture, and the replica of the *tablinum* mosaic (fig. 4).

Notes

1 *Tablinum*, room no. 20 of the main building of the villa.

2 Villa Romana Baláca—Development of cultural tourism and visitor-friendly features of the Roman villa of Baláca, KDOP-2.1.1/B 09-2010-0022 ID.

3 Performed by István Sajó, Environmental, Analytical, and Geoanalytical Research Group, Szentágothai Research Centre, University of Pécs.

Acknowledgments

Work on the replica was performed by Brigitta Maria Kürtösi, István Bóna, András Seres, Miklós Ernő Balázs, András Ferenc Pintér, and Béla Dohárszky. István Bóna, Hungarian University of Fine Arts, was supervisor of the author's doctoral research. The on-site mounting of the mosaic sections was performed with the help of Miklós Túri.

Intervention d’urgence : Transfert d’une mosaïque déposée et exposée dans un édifice public à la maison de la Volière à Carthage

Fatma Naït Yghil

Résumé : *Il s’agit d’une mosaïque représentant le thème de* xenia *qui était exposée au sol de l’édifice de la Municipalité de Tunis depuis le début du* XX*e siècle. Ce dernier étant en projet de réaménagement, les responsables concernés ont fait appel à l’Institut national du patrimoine pour restaurer cette mosaïque. L’équipe technique de la conservation-restauration de la mosaïque du Musée national du Bardo a été chargée de cette mission. J’ai proposé alors de la récupérer et non de la restaurer et la laisser* in situ*. La direction générale est allée dans ce sens, et on a pris une décision collective avec le directeur du développement muséographique et le conservateur du site archéologique de Carthage de l’exposer après sa dépose dans la nouvelle salle d’interprétation de la maison dite « de la Volière » à Carthage (lieu de sa découverte). Devant un cas pareil, comment faire pour une opération de conservation et de restauration non planifiée et non programmée sur le plan budgétaire mais qui est d’une extrême urgence et d’une grande importance pour la sauvegarde du patrimoine mosaïstique tunisien ? Quels ont été les coûts des opérations de dépose, d’emballage, de transport et de repose ?*

Abstract: *Depicting a xenia motif, this mosaic had been on display in the floor of the municipal buildings of Tunis since the beginning of the twentieth century. As the building was due to undergo renovation, Tunisia’s National Heritage Institute (INP) was called on to restore the mosaic. This task was entrusted to the technical team responsible for the conservation and restoration of mosaics at the Bardo National Museum. I proposed lifting the mosaic and re-laying it in situ rather than restoring it. This approach was supported by the board of the museum, and a joint decision was made with the museum’s development director and the conservator of the archaeological site of Carthage to exhibit the mosaic once it had been relaid in the new interpretive room of the Villa de la Volière in Carthage (site of the mosaic’s discovery). Faced with such a scenario, we discuss how to undertake a conservation and restoration project that has not been planned or covered in the budget but that is extremely important and pivotal for the preservation of Tunisia’s rich heritage of historic mosaics. We also look at the costs involved in removing, packaging, transporting, and re-laying the mosaic.*

Découverte lors des fouilles de 1903 par P. Gauckler (Direction des antiquités de Tunisie), cette grande mosaïque (4,77 m × 3,55 m) pavait le *triclinium* de la maison dite « de la Volière » à Carthage (fig. 1). Datable du début du IV^{e} siècle apr. J.-C., elle représente dans ses médaillons des *xenia* : de haut en bas et de gauche à droite, une corbeille de roses, un gros cédrat, des poires, une daurade, des concombres, un lapin, deux poissons, deux canards, deux grappes de raisin, un coq et une poule, deux demi-pastèques, un chevron, un mérou, trois grenades, treize pommes, deux poissons, des figues, deux poissons, deux poissons et une variété de fleurons.

Figure 1 Photo d’archives. Mosaïque du *triclinium* de la maison de la Volière au cours de la fouille en 1903. Courtesy Bardo Museum Archive

Les tesselles sont en marbre, calcaire et pâte de verre. Densité fond : entre 110–140 dm^2. Densité motifs : 220 dm^2.

Depuis sa dépose, au début du XX^{e} siècle, la mosaïque était exposée au sol du grand hall du premier étage de la Municipalité de Tunis. Au cours des travaux de réaménagement de l’édifice, les responsables ont fait appel à l’Institut national du patrimoine pour la restauration du pavement (mai 2013).

Après une mission d’expertise, de diagnostic, de documentation (fig. 2) et de recherche bibliographique menée par l’équipe technique de la conservation-restauration de la mosaïque du Musée national du Bardo, la décision a été prise pour sa récupération et non pas seulement sa restauration *in situ*. La direction générale de l’Institut national du patrimoine a obtenu l’accord de la Municipalité de Tunis pour l’accomplissement de ce projet. La

Figure 2 Documentation graphique. Mosaïque du *triclinium* de la maison de la Volière à la Municipalité de Tunis.

Figure 3 Changement du support.

nouvelle salle d'interprétation de la maison de la Volière (lieu de sa découverte) à Carthage fut choisie pour abriter la mosaïque (figs. 3, 4).

Il s'agit en effet d'une intervention urgente de restauration non planifiée et non programmée sur le plan budgétaire, mais qui est d'une grande importance pour la sauvegarde du patrimoine mosaïstique tunisien. Pour toutes ces raisons, les coûts des opérations de dépose, d'emballage, de transport et de repose ont été en grande partie assurés par les différents départements de l'Institut national du patrimoine, qui a en outre payé la copie d'une partie de cette mosaïque (2,5 m × 2 m) en contrepartie pour la Municipalité et dont le coût est de 2 400 TND (1 053,27 euros).

Figure 4 Exposition de la mosaïque dans la nouvelle salle d'interprétation de la maison de la Volière (lieu de sa découverte).

La durée des travaux est de cinq mois environ (septembre 2013–mars 2014).

Le coût total de cette opération est estimé à 31 470,900 TND = 13 806,50 euros.

Les salaires sont comptés sans celui du responsable du projet, dont la présence a été régulière mais non continue.

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The Villa of the Birds in Alexandria after Fifteen Years of Presentation and Display

Ewa Parandowska

Abstract: *The Villa of the Birds is a unique, in situ display of four Roman mosaics in Alexandria, Egypt. To protect these polychrome figural mosaics in their original architectural context, a shelter was constructed in 1999 thanks to USAID funds. However, certain environmental threats were disregarded. Over the past six years the Polish Archaeological Mission has spent more than US$50,000 on several modifications for the shelter structure and drainage system. This was done to secure a stable climate inside the shelter so as to avoid continued deterioration of ancient walls and thus protect the condition of the mosaic floors.*

Four early Roman mosaics are presented in the Villa of the Birds, located in the archaeological park at Kom-el Dikka in the center of the modern city of Alexandria. When a shelter was built in 1999 the choice of conservation techniques and approaches was driven by the decision to treat the mosaic floors on the original bedding and to save their architectural context. The total project cost was US$100,000, financed by the Egyptian Antiquities Project of the American Research Center in Egypt (ARCE) under its grant from USAID.

Construction of the shelter and conservation of the mosaics, at the request of ARCE, was carried out using only locally produced and available materials. The mosaics are situated at the lowest point of the excavations, 10 m below the modern street level and 1.2 m below the level of the entrance to the pavilion. Before sheltering, the excavated remains of the Villa were endangered by rainfall running down the surrounding escarpment slopes. Construction of a pavilion with a metal roof structure, damp-proofing of inner walls provided by roofing felt, and the drainage system with pierced, narrow tubes initially installed proved insufficient to stabilize a microclimate during the few years of exposure. Seasonal and daily variations in temperature and changing humidity in the shelter were observed. Lack of air conditioning and continuous professional maintenance resulted in intensive salt crystallization on the ancient wall remains and mosaic surfaces, causing slow deterioration of the multicolored tesserae and lime mortar bedding. To avoid further damage, the fine panther centerpiece of one of the mosaics (20 × 22 cm) had to be detached, consolidated, and reassembled in 2010.

Mosaics uncovered and displayed under a shelter require regular assessment and protective treatments. Conservators of the Polish Archaeological Mission, financed by the University of Warsaw, who are responsible for the Kom el-Dikka excavations and preservation work seasonally, two to three months per year. Currently, the Supreme Council of Antiquities is not able to contribute to the costs of maintaining the site.

In spite of limited time and budget, several important modifications of the Villa of the Birds shelter have been carried out since 2009. Immediate interventions on the roof cladding, doors and windows, ventilation, and drainage system were urgently required. An electronic monitoring device to monitor relative humidity, temperature, and dew point, as well as a high performance industrial ventilator, were purchased and installed. Furthermore, a polyethylene vapor diffusion retarder under the existing roof was installed and the rainwater disposal system redesigned. These changes had a positive effect on the microclimate and contributed to the decrease in the level of dampness and salt crystallization.

In 2012, an innovative drainage system around one of the mosaics was implemented, and has so far proved to be sufficient. The following year, the same system was implemented around the foundations of two other mosaics. A deep trench, up to about 1 m deep, was dug around the mosaic's edges, and a new layer of bitumen coating was applied on the foundations of the surrounding walls. The trenches were left open and covered with metal grills hidden under a layer of washed and sifted gravel. Additional drainage was provided in narrow trenches where pierced, 8 to 15 m-wide PCV pipes were placed and buried under gravel (figs. 1–4).

Regardless of the initial requirements of ARCE to use only locally available materials, recent conservation treatment was conducted with the use of several imported materials, among others:

- Araldite, paraloid, and aluminum honeycomb support was used for consolidation and re-laying of the panther emblem.
- Remmers KSE 300 (in ethanol 1:1) was used to consolidate the stone tesserae.
- Remmers Restoration mortar mixed with sand was used to protect mosaic edges.

Despite these recent interventions one cannot assume the deterioration of the sheltered structures will be prevented. Qualified personnel should be included in long-term financial planning to secure permanent maintenance of the excavated remains, including the shelter and mosaics. Although the Polish Mission

Figure 1 New installation of deep trenches around mosaic edges. Photo: E. Parandowska

Figure 2 New drainage system with pierced tubes inserted into the bedding layer. Photo: E. Parandowska

Figure 3 Placement of metal grills over the trenches around mosaic edges. Photo: E. Parandowska

Figure 4 Grills hidden under a layer of gravel. Photo: E. Parandowska

conducted basic training for ten employees of the Egyptian Supreme Council of Antiquities, there is no guarantee that they will be able to provide regular, independent assessment or maintenance of the site. Many external factors, for example, climate changes in Egypt, daily power cuts, and budgetary constraints, are worrying and pose risks for the excavated structures.

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Workshop for Conservation and Documentation of Roman and Late Roman Mosaics in Stobi (2012–2015): Approach to Sustainability and Rehabilitation

Angela Pencheva

Abstract: *This joint project of the National Institution of Stobi (FYROM) and the Balkan Heritage Foundation (Bulgaria) is an educational course with emphasis on conservation, restoration, and documentation of Roman and late Roman mosaics found in the late Roman city of Stobi. The course is designed primarily for beginners in conservation and restoration but also for experienced students wanting to refresh or develop their skills and knowledge. The funding of the project enables the conservation of one entire or partly preserved mosaic, of different size, per year.*

Approximately 1,560 square meters of the excavated territory of Stobi (near Gradsko, FYROM), the ancient capital of Macedonia Secunda, are covered by entirely or partly preserved mosaics, dated mainly between the second and sixth century CE.

The first preventive conservation of these mosaics began in the 1930s and continued sporadically in the following decades. Some of the mosaics were maintained in situ; others were stored in fragments in the site's storage area. Today many of the mosaics and fragments require urgent conservation and preservation due to damage caused by the weather and lack of either proper or continuous maintenance in past decades.

In 2009, the National Institution (NI) of Stobi started a long-term program funded by the government for complete conservation and exhibition of the mosaics preserved in situ. Since 2012, the Workshop for Conservation and Documentation of Roman and Late Roman Mosaics, organized by the National Institution (NI) of Stobi and the Balkan Heritage Foundation, has significantly contributed to the program through either complete or partial conservation of one endangered mosaic per year.

Project and Course Description

The project is composed of two main elements: conservation and education. In its current form, the project was started in 2012 and envisions one annual, two-week educational course that combines basic practical and theoretical modules on mosaic conservation and documentation. Under the guidance of the conservation team of NI Stobi, the participants go through each stage of the mosaic documentation and conservation process. Generally these stages are an initial condition assessment report; technical, photographic, and digital documentation; cleaning of the mosaic's surface; consolidation of the mosaic's front and back; the application of gauze and burlap with organic glue; cutting the mosaic into fragments; lifting and removing the old mortar from the back of the mosaic and replacing it with new mortar; and setting up the mosaic on a new support. Sometimes it is not possible to complete work on all the removed mosaic fragments in the time frame of the course, and the NI Stobi conservators finish it afterward.

Included in the course agenda are guided visits to two other ancient cities in the area, Heraclea Lyncestis (near Bitola) and Lychnidos (Ohrid). Both sites have preserved examples of mosaics in situ that date approximately to the same period as those at Stobi (fourth to sixth century CE).

In 2014, an optional third week for the conservation and documentation of mural paintings was added to the main course on mosaic conservation and documentation. It is focused on the conservation of fresco fragments excavated in the past three decades.

The workshop is suitable for students in art conservation, classical archaeology, anthropology, and art history. Students receive 6 or 9 credit hours from the New Bulgarian University.

Conservation Project and Financial Framework

The financial framework of the conservation project depends on the number of participants because the entire budget for the project comes from their fees. The costs of the complete conservation of the mosaics have to be covered by this financial framework. For this reason particular mosaics are chosen for conservation during the project, based on their current state of preservation, damage, and size.

Even a small-scale mosaic workshop (i.e., 5–6 participants) in Stobi is fully self-financed as expenses for accommodation and food are low. Participants are accommodated in bungalows owned by NI Stobi, and food is prepared in the camp's kitchen (table 1).

Outcomes

In 2012 and 2013 two of the mosaics in the most representative building with mosaics at Stobi, the Theodosian Palace (figs. 1–3), were consolidated. In 2014 the project focused on the conservation of a couple of mosaic fragments that decorated one of the small rooms in the late phases of the Episcopal Basilica in Stobi (fig. 4). Mosaic fragments from the same building are on the project's agenda for 2015.

Figure 1 Participants in the workshop, 2013. Courtesy Balkan Heritage Foundation

Figure 2 Return of one of the conserved mosaics in the Theodosian Palace, 2013. Courtesy National Institution of Stobi

Figure 3 Mosaic floors in the Theodosian Palace (4th century CE) before the last conservation campaign. Courtesy National Institution of Stobi

Figure 4 Conserved mosaic fragment from the Episcopal Basilica (4th–6th centuries CE). Courtesy National Institution of Stobi

Table 1 Results at a Glance

Year	2012	2013	2014
Number of Participants	7	13	5
Total Fees (in euros)	€9,100	€16,900	€6,500
Conserved Mosaic (in square meters)	21	25	12
Total Cost (in euros)	€9,830	€11,250	€5,000
Materials (in euros)	€5,830[1]	€6,750	€3,000
Labor (in euros)[2]	€4,000	€4,500	€2,000

The course appeared to be a successful self-financing concept that provided comprehensive knowledge and practical experience for students and volunteers and, at the same time, made possible the planned conservation of endangered mosaics and mosaic fragments.

Notes

1. Half of the material expenses were covered by the budget of another conservation project.
2. The process of conservation completion of all the mosaic fragments continues usually between one and two weeks after the end of the mosaic course. The students are trained by two conservators and another two are additionally hired to help with the finalizing activities. The wages of three of them are covered by the project's budget.

The Cost of Conservation of the "Musical and Athletic Games" Mosaic Floor

Christos Pilalis and Dimitris Pilalis

Abstract: *The mosaic "Musical and Athletic Games" is one of the most important mosaics exhibited in the Archaeological Museum of Patras. It was discovered in 1896 during an excavation in the area of Psila Alonia (Patras) where it was gracing the floor of a 2nd century* CE *Roman villa. In 1938 it was transferred and placed indoors at the old Museum of Patras. In 2010, it was removed once more and placed permanently in the Archaeological Museum of Patras. The cost of materials and maintenance is an important parameter for selecting the conservation method. The purpose of this paper is to record the cost of materials used for the conservation process, from the detachment until the final placement of the mosaic in the Archaeological Museum of Patras. The total cost includes the cost of personnel: maintenance staff, skilled craftsmen, and conservators.*

The protection and conservation of cultural heritage both on a national and an international level are the fundamental principles of a conservator's work. Mosaic floors of the Hellenistic, Roman, and Byzantine periods constitute a significant part of the rich Mediterranean cultural heritage, not only for their artistic merit, but also for providing important insights into past societies.

The conservation of the mosaic floors exhibited in the Archaeological Museum of Patras included an assessment of their pathology and the factors that had contributed to their damage, with the aim of proposing specific measures to be implemented for their handling and for their exhibition in the museum. To that end, an alternative to the conventional method of placing the mosaics on the floor was adopted, and they were instead displayed on upright panels. These are purpose-built metallic structures capable of supporting the weight of the mosaic and providing anti-seismic protection. The upright surfaces are covered with 4.4 cm-thick plywood boards placed at a 5 percent positive angle. The mosaic floors were initially removed in a number of sections, according to their size and decorative motif. Each section was conserved separately and was, likewise, separately mounted on the panel.

The "Musical and Athletic Games" mosaic floor, measuring 6.0 × 2.7 m, is probably the most important mosaic floor exhibited in the Archaeological Museum of Patras and is among those placed on an upright panel (see fig. 1). This mosaic floor is a significant example of the local cultural heritage, displaying activities that took place in the Roman amphitheater, one of the most prominent monuments in Patras. On an international level, these musical and athletic games had close connections with the capital of the empire, Rome, of which Patras was a high-ranking colony.

Figure 1 "Musical and Athletic Games" mosaic on display in the Archaeological Museum of Patras. Photo: C. Pilalis

The mosaic floor was found in 1896, during the excavation of a second-century CE villa, near Psila Alonia Square. Its decoration is unique and, as far as mosaic floors are concerned, unparalleled. It has two decorative zones, with friezes of human figures, flanked by quirk and astragalus motifs (fig. 2).

In 1938 it was lifted and removed from its original site and placed in the old archaeological museum in Patras. In 2008 it was removed once more, and in 2012 it was placed in its present position in the new museum.

The "Musical and Athletic Games" mosaic floor is part of a total of 400 square meters of mosaics conserved during that period. The cost should be considered an estimate, given the fact that both the time and human resources needed are based on personal estimates. In short, the conservation process for the mosaic floor and the corresponding cost is as follows:

A) Removal of the mosaic and transportation to the new Archaeological Museum

- Two conservators and two technicians were needed for a total of 25 days.
- The museum van was used for transportation.

Various materials used included plywood, adhesives, marking pens, and packing materials, with a total cost of €600.

Figure 2 “Musical and Athletic Games” mosaic, detail. Photo: C. Pilalis

B) Conservation work in the new museum laboratory

- Drawing of the sections.
- Removal of old mortar.
- Placement of grid and aluminum frame.
- Placement of new mortar.
- Two conservators and two technicians were needed for a total of 82 days.

Various materials used included cutting disks, metal grid, aluminum rods, mortars, and adhesives, with a total cost of €5,200.

C) Suspension of the mosaic floor

- Placement of the floor sections on the wooden panel.
- Replacement of tesserae in the joints between the sections.
- Filling the gaps with mortar.
- Cleaning of the mosaic surface.
- Two conservators and two technicians were needed for a total of 76 days.

Various materials used included bolts, mortars, and cleaning agents, with a total cost of €300.

The conservation of a mosaic floor is a time-consuming process that requires a significant number of conservators, with salaries being the major cost to be taken into consideration. For the conservation of mosaic floors of comparable size in the Archaeological Museum of Patras, the ratio between material costs and personnel salaries has been estimated at 1:10. Programming, methodology, and experience are the defining factors if a change in that ratio is to be achieved.

The Mosaics on the Archaeological Site of Feliks Romuliana

Marijana Protić and Nemanja Smičiklas

Abstract: *This paper presents the collection of ancient mosaics on the archaeological site of Felix Romuliana in Zajecar, which is on the UNESCO World Heritage list. The Romuliana mosaics are some of the most beautiful ancient mosaics in the territory of Serbia. During research at the site, over 500 square meters of floor mosaics were discovered. After conservation treatments over the years, the mosaics were covered with a layer of sand. Some fragments are sporadically opened to be presented to the public.*

Felix Romuliana, also known as Gamzigrad, is an archaeological site, spa resort, and UNESCO World Heritage Site in Serbia, located south of the Danube River, near the city of Zaječar. It is the location of the ancient Roman complex of palaces and temples Felix Romuliana, built by Emperor Galerius. The main area covers 40,000 square meters (10 acres).

The director of the City Museum of Zaječar, Vekoslav Popović, initiated systematic archaeological research in 1953. Dragoslav Srejović, an academic, was in charge of the research in 1970, and he is regarded as positioning the monument among world archaeology. The complex was identified in 1984, when in the southwest of the site an arch with the inscription FELIX ROMULIANA was discovered.

Archaeological excavations on the site have unearthed the remains of a Roman compound with two temples, two palaces, and a building with a corridor that include exceptionally fine mosaics. Several valuable hoards of Roman gold coins have been unearthed at the site, and it continues to yield important Roman treasures and artifacts.

The floor mosaics from Romuliana are of the highest quality of mosaic art of the Tetrarchy period, and there is no doubt that their creators were masters of the highest rank. Mosaic floors with geometric designs follow traditional patterns. Figural mosaics are characterized by sensuous forms, accented illusionism, rich colors, and theatrical effects. A beautiful mosaic with a personification of Dionysos is unique among all known representations of this divinity in the world. In addition, some mosaics feature a maze and lion hunters (venators). All these mosaics tell the life story of Galerius: his journey from pastor to emperor to god.

Mosaics from the Galerius Palace (fig.1)

Mosaic from Room A

In the vestibule of the palace a mosaic floor was discovered that has the character of a long and stretched-out carpet. It is made of opus tessellatum and has a decorative character. Within the braid, which creates more rows of parallel square fields, there are a variety of geometric, symbolic representations and still lifes. The predominant motifs are an octagon and a circle, which have different ornaments, rosettes, swastikas, stars, and various kinds of braided patterns. The most important motif is a maze with towers, an octagonal shape inscribed in a rectangle, which was detached in 1953 and has been exhibited in the City Museum of Zaječar ever since.

Mosaic from Room D

The mosaic floor in the hall with the apse is based on the concept of a single carpet, which takes into account the composition of the interior architecture. A central elongated field, reserved for emblems with figural compositions, corresponds to the width of the apse. The decorative framework consists of borders with double braid around which flows a wider strip of meanders. North and south of the emblem, the mosaic consists of purely geometric motifs, circles and squares that intersect to create crosses (fig. 2). The final external borders, which frame the apse part of the mosaic, have the motif of a spiral vine, with alternating stacking of heart-shaped leaves, olive leaves, pomegranates, and grapes. The central mosaic field consists of three partially preserved emblems, which are mutually articulated by a transverse strip of double braid, in conjunction with the framework edge. The eastern emblem depicts a fight with a partially preserved panther, in a wild leap; the western emblem depicts the struggle of three hunters with a lion. Both are longitudinally placed for observation from the south side of the room. Between them the transverse emblem is placed, for viewing from the west side, and it presents a forest idyll of which is preserved only a fragment of the body of a dog under leafy trees. All of the emblems from this room were detached in 1953 and are now exhibited in the City Museum of Zaječar.

Figure 1 Layout of the Galerius Palace. Drawing: Marijana Protić

Figure 2 Part of the mosaic from room D. Photo: Marijana Protić

Mosaic from Room G

This apse room with a floor mosaic depicting the god Dionysos, was made in opus tessellatum, with both stone and glass tesserae. The emblem at the entrance to the room represents Dionysos, who sits in the company of a leopard next to the vine motif. The contour drawing is firmly guided, and details are carefully presented. The beast is shown in profile, the human figure in three-quarter view. Great attention has been paid to the movement, but its most striking quality is its color. This mosaic is luxurious and dynamic in its color palette. The entire room was framed by a triple braid. There were several emblems, one of which, depicting the god Dionysos, was preserved. A partial smaller one shows the rear of a four-legged animal in the grass (fig. 3). The rest of the mosaic between the emblems is filled with a variety of geometric shapes, rosettes, swastikas, checkering, and braids. The emblem of Dionysos was detached and is exhibited at the City Museum of Zaječar; an incomplete copy was made and placed in situ.

Figure 3 Emblem of the mosaic from room G. Photo: Marijana Protić

Mosaic from Room N

The circular mosaic of the *stibadium* represents illusionistic movement, made of opus tessellatum in four colors. The concentric circular patterned floor consists of triangles, squares, and braids in black, white, red, and ocher. The illusion pulls one toward the central rosette edged with a braid. The outer edge consists of squares, separated from the illusionistic display by a triple braid. This mosaic was first to be conserved. Now, after conservation work in 2014, it has been displayed for visitors (fig. 4).

Other Mosaics

In areas C, F, and H, only small mosaic fragments are preserved. These are also made in opus tessellatum, and have geometric motifs. Although only partially preserved, they contain sufficient information to enable some form of reconstruction. Apart from these mosaics, there are approximately 50 square meters of mosaics that were investigated in the temple of Romula and reburied, as well as 30 square meters of mosaic fragments lifted from their original places that will be preserved and displayed onsite as a permanent exhibit.

Figure 4 Mosaic from room N, after conservation and restoration treatment. Photo: Marijana Protić

Conservation, Restoration, and Presentation of Two Mosaics from Room 16, Imperial Palace, Sirmium

Marijana Protić, Nemanja Smičiklas, and Vladimir Bulajić

Abstract: *This paper presents the conservation and restoration work on the only figurative mosaic with an image of the god Mercury and the process of a second restoration of the mosaic in room 16 of the Imperial Palace Sirmium in Sremska Mitrovica (Serbia), as well as problems and solutions related to their presentation.*

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 third and early fourth century. Our understanding of the remains of this imperial palace site in Sirmium has been limited by the space available for archaeological excavation given that it is situated in the center of modern Sremska Mitrovica.

The remains of the imperial palace were first revealed by salvage excavation in 1957 in preparation for the construction of an apartment building near the modern center of Sremska Mitrovica. Work was halted on the construction project, at first temporarily and then permanently when a complicated arrangement of radiant heating ducts, drainage channels, and mosaics pavements was revealed. Additional excavations were conducted in 1974 and 1976. At that time conservation and restoration work took place on some of the excavated mosaics.

These mosaics were made using the opus tessellatum technique. The majority of them consist of geometric polychrome pavements that are characteristic of the late empire and in urban and rural buildings of the upper classes (Werner 2009).

The only figurative mosaic found at the archaeological site of the imperial palace, Sirmium Sremska Mitrovica, is a mosaic with the image of the god Mercury (fig. 1). It was discovered during archaeological surveys in the 1970s. The mosaic was discovered in an older layer of room 16, dating to the end of the third century, under a layer of the mosaic floor decorated with geometric motifs dating to the beginning of the fourth century. During excavations in the 1970s, both mosaics were lifted from the original site. It was decided that the older, figurative mosaics would be preserved for display under museum conditions and the newer mosaic, more than 70 percent preserved, would be put back in its original place and displayed in situ.

In 2013, after almost forty years, work began on the conservation and restoration of both mosaics. The mosaic depicting the god Mercury was removed from storage, and conservation and restoration work began for the first time; the mosaic found in the second layer underwent new conservation work because of the poor state of the previous conservation measures and the amount of degradation it suffered.

Figure 1 Mosaic depicting the god Mercury. Photo: Marijana Protić

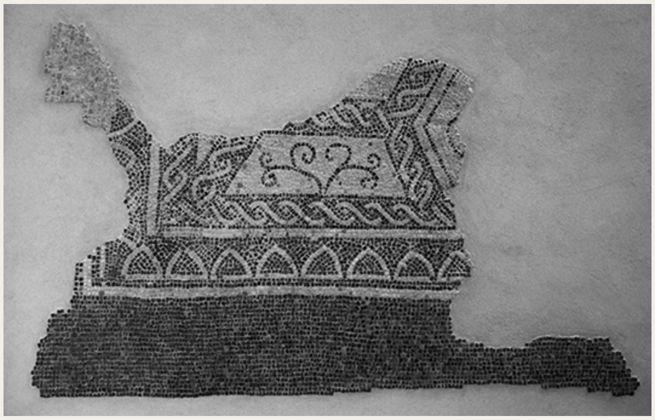

Figure 2 Second part of the mosaic in room 16. Photo: Marijana Protić

The mosaic with the image of Mercury was conserved with the now-classic method of placing it on an aluminum honeycomb backing using lime mortar and epoxy resins. The figure of the god and most of the braid forming the frame and hexagonal fields, which most likely contained figural scenes, were made using glass tesserae, which greatly complicated the conservation process. Glass tesserae were treated from the back with a mild solution of paraloid in acetone, while the face of the surface was treated with nano-lime. Since the fragments of the mosaics represented two diagonally positioned corners of the room, it was necessary to find a way to present them so that they would be comprehensible

Figure 3 Presentation of the mosaic on the wall above room 16. Photo: Marijana Protić

to visitors. It also should be mentioned that fragments of the mosaics significantly differ from one another, even though they belong to the same period and were discovered in same room. The fragment depicting Mercury is meticulously executed, with very fine tesserae, rich in color and mainly made of glass, while the fragment opposite him is rough (fig. 2), made exclusively of natural stone and tesserae of twice the size, humble in color, but very accurate in drawing so it fits perfectly into a whole picture of reconstruction. It was decided to present the mosaic on the wall above room 16 (fig. 3) where it was found, placing fragments in their proper positions, and to reconstruct the rest of the room around them. The reconstruction was performed on panels with polyurethane foam, on which was applied a layer of lime mortar, identical to the one used on the original fragments. Then the drawing of the basic shape of the mosaic was reconstructed, using pigments and lime binder (fig. 4). In this way, visitors are given the opportunity to look at the whole mosaic and understand its position in room 16, as well as its position in the Imperial Palace.

The mosaic from the more recent layer was detached, and the fragments were placed on a thin support of aluminum honeycomb using lime mortar and polymer. The cracked and uneven concrete floor from the previous conservation, on which the mosaic had been laid, was replaced by a new, solid and even stratigraphy. In order to avoid direct contact of the fragments with concrete, aluminum box profiled bars 5 cm high were laid under the mosaic, which permits air flow. Fragments were then returned to their original place, and missing parts were partially reconstructed using a polymer mortar, which was later colored with watercolors.

Figure 4 Reconstruction of the mosaic from the older layer with two fragments incorporated. Photo: Marijana Protić

Acknowledgments

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Presentation and Display of the Butrint Mosaics

Erjona Qilla and Evjeni Thomagjini

Abstract: *This paper explores the issues surrounding the presentation and display of the Butrint mosaics to the public and the conservation work that has been ongoing for years. It sets out a brief history of Butrint, the challenges of preserving and displaying the mosaics, the effects of tourism, and the impact of visitors' desire to see the mosaics. It is important to consider the need to develop cultural tourism as a tool for emphasizing the value of cultural heritage while still putting the safeguarding of that heritage first. Butrint today is facing the challenges of preserving and displaying these treasures.*

Butrint (Albania) contains some of the most important archaeological remains in this section of the Mediterranean. It is a complex site that contains natural, historical, and architectural components. The remains also include unexcavated areas that could be important for generating increased tourism in Albania and a source of academic study for future generations.

Butrint lies 3 kilometers from the Corfu Straits, on a low hill almost surrounded by the waters of Lake Butrint and the Vivari Channel, which connects it to the Ionian Sea. The walled area of Butrint covers a 16-hectare site, with another 8 hectares of ancient suburbs located on the Vrina Plain beyond the channel. The plain is punctuated by small villages; to the north and east are surrounding mountains.

With the fall of the communism in 1991 and the disruption that followed, financial, material, and human resources for the conservation of Butrint were no longer available. One of the first tasks for the authorities and foreign partners, such as the Butrint Foundation, was a conservation program to prevent damage to the monuments caused by fast-growing vegetation.

Butrint gained World Heritage status in 1992. In the absence of adequate central government funding from 1991 until the creation of the Butrint National Park in 2000, Butrint was supported by the Butrint Foundation, a British charity, funded by Lord Rothschild, the Sainsbury Family Charitable Trust, and the Packard Humanities Institute. This support aided the Albanian institutes of cultural heritage in the task of routine conservation and safeguarding the site for visitors.

Through the years the Butrint National Park, with the help of its institutional supporters, has carried out a program to manage the woodland of Butrint and make many monuments of the site more accessible. The park is very conscious of its mission to preserve the varied monuments and has actively sought ways to present the mosaics to visitors. In Butrint and the suburb area twenty-seven mosaics have been identified: nineteen are located within the walls of the ancient town, seven are located at the archaeological site on the Vrina Plain, and one is located at the archaeological site of Diaporit.

Butrint today is facing the challenges of preserving and displaying this resource. Three main factors affect the condition of the mosaics in Butrint: time, water, and vegetation. All the factors of decay are linked, but the most important is water: groundwater and rainfall that affect masonry and buildings. Geoseismic events caused the lowering of the ground level from the third century CE levels (Hernandez and Condi 2008), and many buildings are seasonally or continually below the present fluctuating water level, which creates a margin in mosaic pavements that produces a cycle of wetting and drying and salt deposition and crystallization. Obviously vegetation is an associated problem. Plants grow everywhere. The problems caused by the water can be managed by reburial.

In addition, we must consider the need to develop cultural tourism. The impact of visitors has emphasized the fragility of these pavements and has encouraged targeted research in order to determine the best methods for conserving them.

A major campaign of mosaic conservation began in 2006. Remedial action was to follow on the mosaics where required. In addition, an operation has been undertaken on the mosaics from the 2004–2005 excavations on the Vrina Plain (fig. 1) and Diaporit. Basic stabilization and conservation was carried out on the mosaics in the Early Christian basilica and Roman townhouses. Fifty percent of the basilica nave mosaic's surface was damaged by postholes, graves, and the like; elsewhere the pavement was disrupted by unstable foundations coupled with fluctuating groundwater levels, which had resulted in slumping, cracking, and detachment of tesserae. After the conservation work, because of these problems, it was decided that the mosaic should remain covered.

In 2006 the mosaic pavement in the Butrint baptistery and adjacent trapezoidal room were exposed for photogrammetric recording. The apparently good condition of the baptistery mosaic belied ongoing deterioration, including subsidence, cracking, new lacunae, crumbling glass tesserae, and detachment of tesserae. These problems were determined to be the direct result of fluctuating saline water tables, growth of microorganisms and salt crystallization beneath protective plastic sheeting, and the rapid

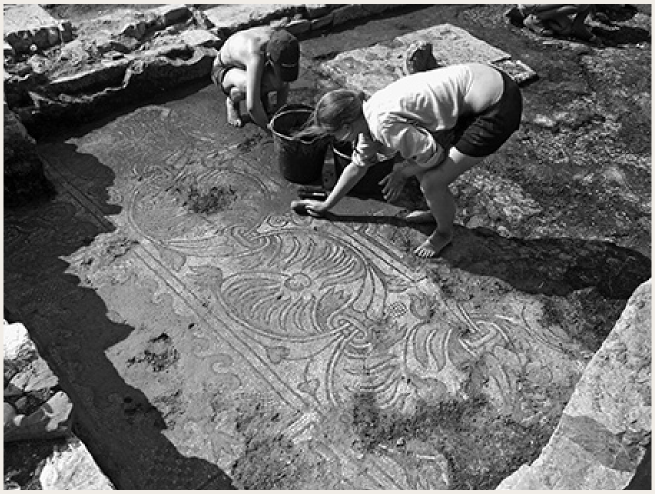

Figure 1 The Vrina Plain basilica mosiac during cleaning. Photo: Butrint Foundation

Figure 2 Room 18, east vestibule, mosaic with female and male masks after conservation (Triconch *Domus*). Photo: Agron Islami Institute of Monuments and Butrint Foundation

drying caused by exposing and cleaning the pavement. The mosaic remains buried beneath netting and sand. The mosaic pavement of the trapezoidal hall was in a considerably worse state of repair due in part to inadequate foundations and the poor technique employed for laying the tesserae but also, fundamentally, due to the same processes as those affecting the baptistery mosaic.

Archaeological excavations at the Triconch Palace revealed a number of mosaics in the late Roman residence. In 2007 four mosaic pavements were uncovered, cleaned, and documented. An exciting discovery was made in the eastern vestibule of the long southern gallery and the main third- to -fourth-century entrance to the property. Under a later mortar floor were striking, finely executed images of Greco-Roman theatrical masks (fig. 2) (Mitchell 2011). These are buried below netting and sand but remain under threat from the seasonal flooding to which all parts of the Triconch Palace are prone. Further pavements were conserved in 2010 in the western peristyle portico, an adjoining, colonnaded entrance vestibule room, the apsidal triclinium room (or reception hall) (fig. 3), and the vestibule and gallery.

A pavement found in the Roman bath near the theater is one of the few mosaics in Butrint that has been displayed to the public every summer because it is above the water table. This is a mosaic from the second century, decorated with geometric figures in black and white with red edging. Physical inspection

Figure 3 Room 24, reception hall, mosaic during conservation (Triconch *Domus*). Photo: E. Thomagjini, Butrint National Park

revealed a need for further conservation, especially in the areas where inappropriate hard cement-based mortars were used in prior interventions.

Most of the mosaics are now buried under a sufficient depth of sand to help prevent roots from penetrating (fig. 4), though

Figure 4 Room 16, west portico of peristyle, after conservation (Triconch *Domus*). Photo: Agron Islami Institute of Monuments and Butrint Foundation

regular maintenance is fundamental to preventing plant maturation. The fluctuating water table levels remain the most significant threat to future preservation. General public display of the Butrint mosaics is not considered an option, because of the distress caused by uncovering and covering, but intermittent display might be considered for special events.

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The Corpus of the Mosaics of Albania: The Conservation Challenge of Butrint

Marie-Patricia Raynaud, Agron Islami, Klejdi Zguro, Didier Dubois, and Astrid Maréchaux

Abstract: *The corpus project began in 2013 (under the direction of A. Islami, conservation, and M.-P. Raynaud, study of the mosaics). Albania is home to a rich inventory of mosaics, from the Hellenistic to the Byzantine period, but these have remained mostly unknown. The aim of this corpus is to manage the conservation of all Albanian pavements and publish an inventory. The first volume will cover the mosaics of Butrint. This paper presents the specific conservation problems on this site, where the environmental context presents a diversity of pathologies, such as the presence of salt water for most of the year, which needs particular responses in terms of scientific conservation and restoration.*

Corpus of the Mosaics of Albania

The corpus project concerns a rich and largely unknown archaeological and art historical resource (Raynaud 2014). For reasons of conservation and security, very few of the pavements are seen by visitors. Many of the pavements have been lost or are covered by a layer of sand, and thus their restoration and publication in a scientific series is the dual purpose of the project; preservation, study, and documentation will be performed at the same time in the field.

Mosaics in Albania date from the Hellenistic period to the early Middle Ages and have been found at sites throughout the country (fig. 1). The pavements often represent the best-preserved remnants of the buildings they originally embellished. Albania was situated at the midpoint of the Rome to Constantinople Via Egnatia, which circulated ideas, artistic repertoires, workshops, and trade (Muçaj and Raynaud 2005). The main sites where mosaics are found are Butrint (27 mosaics from various periods); Byllis (five basilicas from the sixth century, covered with mosaics); Saranda (a synagogue transformed into a church); and Apollonia and Durrës, two major harbors on the coast. In addition, many isolated sites exist. The publication of the discoveries found throughout the country or in museums will be a major contribution to broadening the popularity of in situ mosaics as well as attracting investment in a context of increasing tourism interest.

At each mosaic site we will gather all the documentation on previous interventions; conduct full documentation in the field, including description and observation of phases and restorations; examine the state of preservation and consolidation; and implement repairs. Technical and archaeometric analyses will be performed if necessary.

The work of publication follows, with the preparation of texts and illustrations, including a synthesis of specific themes (iconography, recognition of workshops, results of analyses, comparisons, chronology). The publication of six to eight volumes is expected. It will respect the precepts of various scientific corpuses of mosaics published to date by the national branches of the Association Internationale pour l'Étude de la mosaïque antique (AIEMA), in a large format with plans, reconstructions, and illustrations, and a high-quality systematic inventory and scientific synthesis.

Context and General Condition of the Mosaics in Butrint

Water and Salts

The site is close to the sea and at the same level as a nearby lagoon and thus is constantly affected by the high saltwater table.

Figure 1 Map of Albania showing sites where mosaics have been found.

Figure 2 Butrint: view of a mosaic showing pooling water after a strong thunderstorm. Copyright © Corpus Albania—Mishko Tutkovski

Figure 3 Butrint: view of the Triconch complex in spring showing deep standing water. Copyright © Corpus Albania—Evjeni Thomagjini

No efficient means of draining the water seems available, and rainwater pools on the surfaces of the mosaics (fig. 2). Moreover, drainage is difficult to plan because of the omnipresent ruins, and regular seasonal flooding occurs (fig. 3).

Parts of the site are under the level of the current sea table for most of the year. This phenomenon is due to an important depression in the tectonic plate that occurred sometime between the fifth and seventh centuries. Seismic activity during this period significantly changed the profile of the landscape, and as a consequence, mosaics suffered damage in later periods of occupation (e.g., from postholes for the construction of stilt houses).

Crystallization of salts during wet-dry cycles occur when the mosaics are uncovered, and salts migrate very quickly to the surface of the tessellatum (fig. 4) due to rapid drying of the surface.

Bacteria Proliferation

In 2011, because of the influx of water, a mosaic was urgently reburied. Three years later some parts of the tesserae surface were found to be covered by a thin black-blue film. Analysis remains to be performed, but it could be a form of cyanophycae. Above the pavement is a large tree, and the disintegration of the leaves by the bacteria could be partly the origin of this deposit. Manual cleaning does not seem effective. Nevertheless, the bacteria seems to disappear when the mosaic dries out, but it reappears as soon as the water comes back.

Questions remain: What other methods for cleaning are possible? Which biocide is effective where salts are present while not damaging historical mortars? The search for an effective and safe cleaning method is ongoing.

Treatments

For filling small lacunae and cracks and reinforcing the edges, a suitable hydraulic mortar (hydraulic lime + inert aggregate) was used. For large lacunae, mortar fills were laid with decreasing granulometry of stones or gravel, from the bottom to the top of the gaps. In order to increase cohesion and structural consolidation and flexibility, a high-quality plastic and fiberglass net was placed between the layers of mortar to act as “reinforcement.”

Various biological sediments and calcite deposits, which have a significant impact considering the environmental humidity, were both mechanically and chemically removed. Ion exchange resins such as Amberlite were used for surface cleaning tests, to remove salt incrustations.

However, other solutions for remaining salt incrustations in damp environments are being sought, as well as methods other

Figure 4 Butrint: salt crystallization on an opus tesselatum. Copyright © Corpus Albania—Astrid Maréchaux

than the use of percussion tools, which can easily damage mosaic surfaces, for the removal of calcite.

Suggestions

A hydrogeological study of the whole site of Butrint would help in planning for climate conditions in the long term. A better and careful study and monitoring of the water table levels and rainwater could be implemented, in order to improve our understanding of the fluctuations and plan measures for mitigation. Mitigation could include drainages, channels, or a seawall that would consider the entire site as a sort of polder, creating land from an area covered by water by surrounding it with a dam. The uncovering, maintenance, conservation, and presentation of mosaics should be planned and implemented during low water level periods (ideally the water table should be 20 cm under the level of the tessellatum).

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The Mosaic Pavement of the Four Seasons at the House of Jason Magnus, Cyrene

Abdalsalam S. M. Sadoun, A. Bader Al-Beraiki, and Ashraf Sulaiman Bulkasim

Abstract: *Three conservator-restorers in the Department of Antiquities of Libya, involved in the Mosaic Conservation Course, Libya, 2014–2016, under the framework of the MOSAIKON Initiative, discuss different case studies related to mosaics. A critical analysis of the conservation problems of mosaics and a proposal for their conservation is presented. The proposed conservation intervention includes direct action on the mosaic and preventive measures.*

The Four Seasons Mosaic at the Archaeological Site of Cyrene

The archaeological site of Cyrene, in eastern Libya, originated as a Greek colony in 631 BCE and became a Roman province in 74 BCE. Since 1982 Cyrene has been a World Heritage Site. The House of Jason Magnus, a large building dating to the second century CE, is rich with mosaics and opus sectile floors, with approximately twenty-four known mosaics.

Within the didactic activities of the Mosaic Conservation Course (MCC), a conservation assessment of the mosaics was carried out, with particular attention to the only figurative mosaic still on-site, the Four Seasons mosaic. Measuring 6.70 × 6.20 m, it depicts the personifications of the seasons surrounding a representation of a Nereid.

The mosaic was protected in the 1960s: walls were built around it, and the structure was covered with a roof of galvanized sheets. Windows with bars at eye level have allowed the mosaic to be seen while maintaining closed access. At the entrance a locked iron gate was placed.

Current Conservation Condition

In 2011, given the lack of security for the site, the entrance gate to the structure was broken and two of the Four Seasons figures were stolen (fig. 1). The roof, damaged over time and never repaired, does not provide protection against rainwater. The external system for collection and runoff of rainwater has collapsed, and water infiltrates at the base of walls. In the mosaic itself, there are large detachments from the original support and tesserae are loose. In addition to the lacunae of the stolen parts, tesserae along the borders continue to detach because of vegetation growth; erosion of the tesserae and insoluble deposits are occurring, and discoloration on the surface is also present.

Figure 1 The corners of the Four Seasons mosaic, with two pieces missing, Cyrene, Libya. Photo: Courtesy of the Department of Antiquities, Libya

Proposed Intervention

Two lines of action can be adopted:

1. The long-term proposal consists of replacement of the roofing system with a newly designed shelter and water collection system and implementation of a complete conservation intervention on the mosaic.
2. A short-term solution is repair of the roof with the same materials, creation of an efficient system to collect rainwater, and direct first-aid intervention on the mosaic.

A Mosaic Floor from Tukrah (Taucheira)

The archaeological site of Tukrah is on the sea northeast of Benghazi. A Greek city founded in 620 BCE, it became part of the Roman Empire in 96 BCE. During the Byzantine period, it was an important religious center. There are remains of two Byzantine churches and thermal structures dating to the same era.

Archaeological excavations conducted in 1972 by the University of Benghazi discovered in the southern church a Byzantine mosaic (sixth century CE) depicting the emperor Justinian and a scene with the personification of the struggle between Good and Evil.

Figure 2 The south church mosaic in storage, Tukrah, Libya. Photo: Courtesy of the Department of Antiquities, Libya

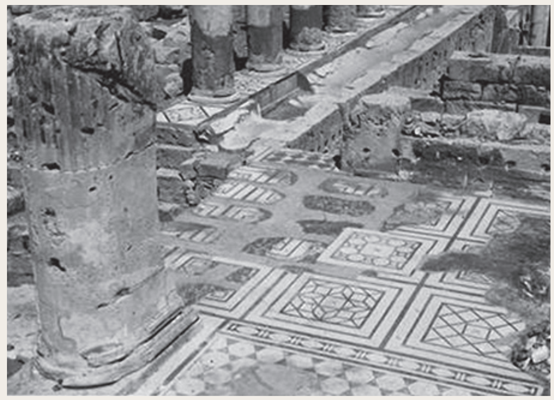

Figure 3 Palace of the Columns, Tulmaytha, Libya. The floor of the reception hall in 1949. Photo: Courtesy of the Department of Antiquities, Libya

After its discovery the mosaic was detached, mounted on reinforced concrete panels, and transported to a building next to the sea, which was built in the 1930s for storage. The mosaic is mounted on two large panels; one panel sits on the floor and the other is on the wall (fig. 2). Underneath the Byzantine mosaic an older mosaic was discovered, but this was left in situ and backfilled.

Current Conservation Condition

The mosaic left in situ and backfilled is in very stable condition. On the contrary, the mosaic in the deposit is in disastrous condition. The building is collapsing due to extensive corrosion of the reinforced concrete structure because of the proximity to the sea and because of overall neglect. Consequently, water infiltrates the building, directly on the mosaic on the floor. Through fractures in the masonry, moisture enters into contact with the mosaic panel on the wall.

The mosaic panels suffer from corrosion, cracks, detachment of tesserae, and efflorescence of soluble salts, resulting in an almost 50 percent loss of tesserae.

Proposed Intervention

The condition of the mosaic necessitates immediate transport of the panels to a more suitable depository, which can provide stable storage conditions. Preventive protection, such as gluing cotton gauze on the surfaces, is required before removing the panels from the current position in order to avoid collapse of the detached tesserae. As a second step, a complete conservation intervention is required. The reinforced concrete support has to be removed, and the mosaic should be mounted on aluminum honeycomb panels, using lime-based mortars. Finally, the mosaic could be put on display in a museum near the site.

The Mosaics of the Palace of the Columns at the Site of Tulmaytha (Ptolemais)

The archaeological site of Tulmaytha is in northeastern Libya. Founded in the third century BCE, it grew in the Roman period, playing a strategic role until the seventh century CE. The Palace of the Columns, a rich house dating to the second–first century BCE, was discovered in the 1930s (fig. 3). Many rooms and corridors were originally decorated with geometric mosaics. After excavation most of them were detached and relaid in situ on reinforced concrete backings.

Figure 4 The same floor of the Palace of the Columns in 2014. Cement supports are still in place, but there is an almost complete loss of tesserae.
Photo: Courtesy of the Department of Antiquities, Libya

Current Conservation Condition

The mosaics suffer the problems of artifacts restored with reinforced concrete, exposed outdoors in a moist and salt-rich environment, without shelter and without regular care and maintenance plans. Due to the iron used in the cement support, entire portions of the surfaces are now destroyed. The expansion caused by the oxidation of the iron, along with continuous contraction and expansion caused by direct insolation of the surfaces, has resulted in extensive detachments and fractures and in the almost total loss of the tessellatum (fig. 4).

Proposed Intervention

There are many possible solutions to save these mosaics. Many of them depend on whether or not the site is kept open to the public and on available resources.

If the site is closed to the public the most practical solution would be complete documentation of the surfaces in their present state, removal of vegetation and roots, consolidation of tessellatum, filling the gaps with lime mortars, and reburial of the mosaic.

If the site remains open to the public, preventive conservation measures have to be implemented first, to reduce the impact on the surface from trampling and eliminate problems associated with the stagnation of rainwater, such as designing routes with walkways and systems for channeling rainwater. Direct action on individual mosaics would be designed according to their characteristics (e.g., the presence or lack of reinforced concrete in the substrate) and should include documentation, cleaning, removal of cement and iron, consolidation with lime-based materials, filling of lacunae, and protecting the edges with lime-based mortars.

The Conservation of an Opus Sectile Wall Decoration at the Latrine in Magnesia on the Meander (Aydin – Turkey)

Yasar Selçuk Şener, Orhan Bingöl, and Mesut Yilmaz

Abstract: *The conservation of an opus sectile wall decoration at the site of Magnesia on the Meander, Turkey, took place in 2009–2012. The preparation period started with assembling all the pieces and determining the design. This work, conducted in 2009 and 2010, resulted in seven panels, approximately 7 meters in length. The conservation work, which involved fixing the opus sectile pieces on a new support and mounting them on movable panels, was carried out in 2011. The assemblage of the panels and placement back in the latrine building was completed during the 2012 excavation season.*

At the site of Magnesia on the Meander, Turkey, an opus sectile wall decoration from a latrine structure dating to the late Roman–early Byzantine period was revealed during excavation work in 1993–1994. According to the existing ruins and excavation work, pieces of the opus sectile, understood to be parts of the wall decoration of the structure, were scattered, and some were broken when they were found.

Conservation

The pieces belonging to the opus sectile decoration, whose composition was determined by existing documents and findings from the excavation or were existent, were prepared for exhibition by being attached to a new support in the form of seven separate portable panels 7 meters in length. In 2012, the latrine building on-site was covered with a shelter, and the opus sectile panels, having been mounted on the north wall of the building, were exhibited.

Backing of the Opus Sectile Panels

In order to assemble the opus sectile fragments, which had different thicknesses, on the panels it was first necessary to level them. In this work a mixture of fine-grained quartz sand and a PVA-derived resin, Mowilith D 50, was used. For the application of the leveling mortar, the panels were placed facedown. On their back surfaces, a Mowilith D solution was applied with a brush to strengthen the connection between the panel surface and the mortar. Then the prepared mortar was spread on the surface with spatulas.

Once the leveling mortar dried, the pieces were assembled by turning them onto the Aerolam and their levels were checked. On the pieces that were not level, correction mortar was applied.

The pieces constituting the opus sectile decoration are composed of one almost square panel and other comparatively smaller rectangular panels placed alternately (one large and one small, seven panels in total). Given the weight of the opus sectile decoration and the difficulty of lifting and exhibiting it, it was decided to attach it onto a new support in the form of seven separate panels, which would make up one composition when assembled. It was decided to use Aerolam as the support due to its light, firm, and flat structure.

In the first stage of attaching the work onto the new support, carrier panels were prepared. To facilitate the process, on each Aerolam panel a sketch was made of the general dimensions of the opus sectile decoration that would be placed on it.

To attach the panels to the Aerolam, a two-component epoxy resin, Araldit MTU, and its hardener, HY 956 (hardening/resin, 1/5), were used. To the prepared mixture an appropriate amount of stream sand was mixed to reduce its fluidity.

In the attachment procedure Araldit MTU was spread on the spaces outlined, starting from one side. The pieces were placed on their respective panels while continuously checking their levels. After the work, we waited twenty-four hours for it to dry.

The process of attaching the second panel began with the side that joined the first panel so that unity in the decoration was achieved with the pieces continuing from the previous panel.

After attaching the plates on Aerolam, a two-layered elevation level was visible beneath the opus sectile, composed of Araldit and leveling mortar. However, the outward face of the sides of this layer had a porous and indented look. To straighten this surface of the sides, padding was made with the same leveling mortar.

For covering the Aerolam honeycomb texture and the holes created by the missing pieces, Mowilith D 50 resin was spread with a brush to form a thin and homogeneous membrane on the surface and also on the visible sides of the leveling mortar. Sand was applied with a fine sifter (1 mm hole size) onto the surface. This procedure was repeated a few times until a homogeneous surface was achieved.

Figure 1 Piecing together the opus sectile, 2009–10. Photo: Orhan Bingöl

Figure 2 Attaching the panels to the new support, 2011. Photo: Orhan Bingöl

Figure 3 Leveling the panels and determining the composition, 2010. Photo: Orhan Bingöl

Figure 4 Mounting the opus sectile panels in place, 2012. Photo: Orhan Bingöl

Mounting of the Latrine Opus Sectile Panels

Mounting the work was carried out in 2011. A total of seven panels (two 112 × 170 cm, two 72 × 170 cm, one 72 × 115 cm, and one 123 × 115 cm), the restoration of which was completed in 2011, were mounted on the north wall of the latrine building. Once the mounting of the panels was completed, the remaining thin gaps were filled with the mortar used to level the opus sectile panels. The final procedure was sifting sand onto the surface to even out the differences in appearance and achieve aesthetic unity.

Conservation and Presentation of Mosaics at the Villa of the Birds in Kom el Dikka, Alexandria: "A Unique Place in Egypt"

Eman Mohsen Ahmed Shahawy

Abstract: *The mosaics of the Villa of the Birds at Kom el Dikka, Alexandria, Egypt, are preserved in situ. The mosaics were discovered in 1970 but reburied in 1974 for temporary protection. Conservation and display of the mosaics began in 1998 by a Polish mission with the Supreme Council of Antiquities, financed by the Egyptian Antiquities Project of the American Research Center in Egypt, under its grant from the U.S. Agency for International Development (USAID). The plan was to organize paths for visitors and build a shelter for the protection of the mosaics. New stairs for visitors were built to provide views of the landscape, and a new system was built to control rainwater. The site was officially opened in January 2000.*

The Villa of the Birds is located at the archaeological site of Kom el Dikka in Alexandria, Egypt. In addition to the villa, the site contains an amphitheater, Roman baths, auditoriums, cisterns, and domestic quarters. The archaeological site is known by several names: Kom Aldakka, which means a hill resulting from accumulation of rubble and sand; Kom Al-Dimas, which means the hill of dead bodies (it was occupied by an Islamic cemetery from the eighth to the thirteenth century); and the most popular one, Kom el Dikka, "hill that contains benches." This name was explained few years ago by the discovery of more than twenty rooms with stone benches lining their walls. These rooms are interpreted as study rooms or classrooms.

The Polish Mission began excavations in November 1960 in cooperation with the Egyptian Antiquity Service represented by Henry Ryad, the director of the Graeco-Roman Museum. The excavations began in the northwest part of the site. The first layer revealed Islamic tombs; other layers revealed remains of Byzantine buildings, corridors, and storage for the imperial bathroom and another bathroom dated to the early Roman period.

In the southern part of Kom el Dikka, the residential quarter was discovered, including luxurious houses and villas as well as simple houses. The luxurious houses were in use during the first and second centuries CE but were destroyed in the third century by either an earthquake or a military attack, so these houses were abandoned in the first half of the fourth century. In the middle of the fourth century, the luxurious houses were replaced by simple houses and small workshops, which remained in use until the seventh century.

Figure 1 The panther mosaic, which consists of geometric decoration, branches of plants, and *emblema* with panther. Photo: Eman Shahawy

Among the luxurious houses, house (A) contains floor mosaics from which it got its modern name, Villa of the Birds. The Villa of the Birds is dated to the first half of the second century. It was built during the reign of Emperor Hadrian, but it was destroyed by fire at the end of the third century. The collapsed ruins of the building covered the floor and fortunately saved the mosaic floors. After 450–550, simple houses, stores, and shops were built over the ruins of the villa, which contributed further to the preservation of the mosaic floors.

The Villa of the Birds has four panels. In chronological order, they are the panther, dated to 100 CE; the rosette, dated 133, according to a piece of coin found under the panel that was dated to the reign of Emperor Hadrian; and the birds and the dining room, both of which are dated to later times.

The Panther

The floor is divided into two separate parts: the large part on the south side (2 × 2 m) consists of the whole of the frame and the *emblema*. The panel has an approximately square shape. At the edge is a pattern of circles in black and white, then branches of plants, then the complete emblema with a panther (fig. 1). The whole floor is 4 × 2.30 m, while the emblema is 1.20 × 1.20 m. The

Figure 2 The rosette mosaic, which is black and white and decorated with a sexfoil rosette. Photo: Eman Shahawy

Figure 3 The birds mosaic, with a geometric pattern in black and white and seven squares with different birds. Photo: Eman Shahawy

outside part is executed in opus tessellatum, while the emblema is executed in opus vermiculatum. It has lost about 20 percent of its area. The emblema was executed with fine tesserae from colorful marble stones, including white, black, brown, and red; the turquoise color is made of glass faience, which is rare in the implementation of Roman mosaics but was common in Egypt. The lower edge of the emblema was restored in antiquity, so it is missing the original design, which seems to have been a hunting scene, of which a small goat beside the left foot of the panther remains.

In an attempt to keep the panther preserved, the Polish Mission tried to reduce the humidity rate on the floors as follows:

- Carefully cutting the panther from its original place, then placing it on a honeycomb support to protect it from salts, humidity, and the environment.
- Setting plastic 5 cm-diameter PVC perforated pumps in place.
- Separating the walls of the villa around the floors to reduce the effects of contact with the surrounding environment.

The Rosette

The entire rosette floor is 4 × 3.90 m (fig. 2). It has lost approximately 15 percent of its area. It is located in the northeast corner of the villa. The design is a circle in a square (1:52 m^2). The corners of the square are cut off by triple black filets, turning the inside field into an octagon. It is decorated inside with a sexfoil rosette. The floor is executed in opus tessellatum in black and white. The outside edges are decorated with crosslets.

The Birds

The birds mosaic is composed of geometric decoration (3.10 × 95 cm) and squares with birds (2.26 × 2.26 m) (fig. 3). It has lost 30 percent of its surface: some of the geometric decoration and two squares with birds. Originally there were of nine squares, only seven of which have been found. In addition, parts of the geometric frame with rhombus decoration are missing. The tesserae in the geometric decoration appear regular (0.6–1.0 cm), as do the tiny glass and stone tesserae composing the figures (0.3–0.6 cm). The central panel is a square, decorated along the outside with nine small squares (each 45 cm). It is decorated on the inside with white and black bands (4 cm wide). The seven remaining squares depict different kinds of birds: a wild duck, a parrot, a waterbird, two pigeons drinking from a cup, a pigeon spreading its wings, and a peacock. There is a bird in each square, with two squares of decoration, and another square that depicts part of a bird. Each square is similar to the others in their outer decoration.

Dining Room

The dining room panel is large (7.50 × 6.20 m) and is executed in two styles, opus tessellatum and opus sectile (fig. 4). The slabs used for this floor represented a variety of contrasting materials: white and gray marble, green and red porphyry, and local limestone. Most of the slabs are lost; only some traces are still there, and they show it fixed on terracotta.

Figure 4 The dining room mosaic, executed in black-and-white opus tessellatum and opus sectile of different stones. Photo: Eman Shahawy

The conservation problems of the mosaics in the Villa of the Birds are humidity, salts, fungi, and microorganisms that lead to the detachment of the tesserae. The mosaics undergo periodic conservation.

Exhibition of the Mosaics

The conservation of the mosaic was part of a larger project to restore what has been uncovered of the villa building itself. The plan was to organize a path for visitors and build a shelter for the protection of visitors and the remains. The shelter was made of glass fixed between the original walls of the rooms of the villa. The walls themselves are maintained and protected by the shelter as well. New stairs for visitors were built to open views to the landscape, and a new system to control rainwater was installed. The site was officially opened to the public on January 22, 2000.

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SEE Mosaics Project: From Survey to Professional Network, 2011–2014 Activities and Plans

Branislava Lazarević Tošović and Maja Franković

Abstract: *The countries of southeastern Europe all face similar problems and concerns regarding cultural heritage conservation. The regional survey "Mosaic Conservation and Training of Conservators in Southeast Europe" was launched in 2011 with the aim of defining needs for conservation of ancient mosaic pavements and developing educational programs in the field of mosaic conservation at the regional level. This survey has grown into the SEE Mosaics Project led by the Central Institute for Conservation in Belgrade. In an endeavor to reinforce the mosaic conservation profession in the region, the project includes colleagues from eight countries in southeastern Europe.*

Figure 1 Meeting of the survey team during the final phase of the regional survey "Mosaic Conservation and Training of Conservators in SE Europe," September 22–24, 2011, Ohrid. Photo: Central Institute for Conservation in Belgrade

The SEE Mosaics Project aims to raise awareness at the regional level, among both professionals and national authorities in southeastern Europe, of the need for more organized and active protection of ancient mosaic heritage. It also seeks to reinforce the mosaic conservation profession in the region.

In 2011 and 2012, the regional survey "Mosaic Conservation and Training of Conservators in SE Europe" was conducted. The objective was to determine the capacities of the region regarding ancient mosaic heritage and its state of conservation, as well as conservation resources, to enable efficient planning and implementation of conservation and capacity-building projects in Southeast Europe. The survey involved forty-four institutions responsible for mosaic safekeeping and conservation from Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Montenegro, Former Yugoslav Republic of Macedonia (FYROM), Serbia, and Slovenia (fig. 1). Data were gathered on the current mosaic conservation practice and on the state of conservation of ancient mosaics from thirty-nine archaeological sites and thirty-two museums. They were input into a database that can be searched online to draw various reports based on survey results (www.seemosaics.org). Statistical analysis of the survey results gave a clear picture of capacities and needs for conservation and presentation of mosaic heritage in SE Europe.

The second phase of the project aims to further develop a network of professionals involved with mosaic conservation that was created during implementation of the survey, as well as to promote the mosaic heritage of SE Europe and institutions involved in its conservation.

Figure 2 Group photo of participants of SEE Mosaics II "Forum and Workshop for Mosaic Conservation and Training of Conservators in Southeast Europe," September 2–6, 2013, Ohrid. Photo: Central Institute for Conservation in Belgrade

So far, two meetings have been held in Ohrid, in 2011 and 2013 (fig. 2). The idea was to create contacts and exchange experiences between professionals and institutions involved with the conservation of mosaic heritage. The meetings involved colleagues from seven countries from the region—Albania, Bosnia and Herzegovina, Bulgaria, Croatia, FYROM, Serbia, and Slovenia—as well as colleagues from Italy, France, Hungary, and the United States. Participant presentations and topics of dis-

Figure 3 Study visit to the House of Miladinovi Brothers in Struga where mosaics from the Early Christian basilica in Oktisi are exhibited, September 2013. Photo: Central Institute for Conservation in Belgrade

Figure 4 Study visit to the Heraclea Lyncestis archaeological site, September 2011. Photo: Central Institute for Conservation in Belgrade

cussions showed that conservation practice in the region is well developed; there are colleagues in all countries who strive to not only maintain but also enhance it through their work. Different issues of mosaic conservation and presentation, regarding mosaics on sites and in museums, were also debated during study visits (figs. 3, 4).

Both meetings contributed to defining directions in which the SEE Mosaics Project should be developed. One of the first activities in the next phase of the project will be developing the SEE Mosaics website to serve as an information source for activities related to mosaic conservation in the region. It should also become a meeting point for people involved with mosaic research and conservation and a tool for wide promotion of the mosaic heritage of SE Europe, still not well known outside the region. Expanding and strengthening the network of mosaic conservation experts in the region is equally important for information exchange and encouraging collaboration. This will be achieved by organizing regular meetings of professionals involved in this field.

Last, fostering collaboration projects and the development of training programs in mosaic conservation will contribute to capacity building and improvement of conservation practice in the region. Joining forces through collaboration on regional projects will enable conservation professionals from the region to develop their knowledge in areas outside their original area of expertise and, in the process, solve specific conservation problems. This manner of collaboration would be especially beneficial for the transfer and exchange of experiences between countries. The project should also aim to provide training programs in mosaic conservation with the objective of developing and putting into practice mosaic conservation projects. The double objective of such programs could have greater impact on ameliorating the state of mosaic heritage in the region: dissemination of knowledge regarding state-of-the-art methodologies and techniques of mosaic conservation while at the same time conserving mosaics on sites and in museums where the program is implemented.

We believe that information exchange through the SEE Mosaics website, professional meetings, seminars, and collaboration on conservation projects and training programs is an efficient and feasible way to improve both the state of mosaics and the state of the conservation profession in the region, which can be achieved even with limited funds. The SEE Mosaics Project will strive to develop further activities to meet these objectives.

Lifted Mosaics: Analysis of Stability and Supports

Branislava Lazarević Tošović, Maja Franković, Markus Santner, and José A. Alonso

Abstract: *Historically, different supports have been used for the backing of lifted mosaics, with more or less success in meeting requirements posed by a mosaic's size, weight, environment, and planned use. While the adequacy of potential materials regarding compatibility with mosaic materials and their stability to environmental conditions are the areas of a conservator's expertise, questions regarding mosaic weight and stability, support strength, deformation, and how they act together require engineering knowledge and experience. This poster attempts to clarify such questions by analyzing lifted mosaic stability according to its dimensions and type of support with a view to establishing criteria to be considered when designing new supports, contemplated from both the engineering and the conservation perspective.*

When a mosaic is lifted and removed from its original location, it begins to be considered movable heritage. The goal of its conservation and restoration is usually to enable presentation in museum conditions. To allow museum preservation of a mosaic, a new support should provide structural stability and enable handling while preserving the authenticity of the original material. Ideally, the new mosaic support should have the following characteristics:

- compatibility of new material with original material (historical mortar and tesserae)
- retreatability (to allow application of new treatments or to be relatively easily removable if necessary)
- good adherence to the original material and between layers
- good strength and resistance to bending posed by handling
- lightweight (to facilitate handling)
- stability to environmental conditions (good aging properties)
- low cost
- safe for health and environment
- monitoring program (reference areas for tracking condition changes)

To meet these requirements, the support of a lifted mosaic is usually composite and layered. Historically, different supports have been used for the backing of lifted mosaics with more or less success in meeting requirements posed by the mosaic's size, weight, environment, and planned use. Over the years, restoration of detached mosaics on honeycomb aluminum supports became the standard in mosaic conservation, with variations only in the composition of intermediate layers. The field is still the subject of research. New challenges lie in the desire to use natural, low-cost materials and traditional technologies as an alternative to synthetic materials.

Example 1: First layer of lime putty/pozzolana/siliceous sand mortar 1/1.5/1.5, a polypropylene net; second layer of lime putty/puzzolana/siliceous sand 1/1/2 reinforced with fiberglass and honeycomb panel. Pros: Mortar based on traditional technology, easy to work with, good durability and aging properties, allows outdoor presentation (with preventive conservation measures undertaken), lower costs. Cons: weight, quality of material is not controlled, curing takes weeks and must be monitored.

Example 2: First layer of NHL mortar 1/3; second layer of epoxy resin with glass microballoons, fiberglass reinforcement and honeycomb panel. Pros: Good resistance to bending of epoxy-glass/microbaloons mixture, layers can be relatively thin, lighter panels, good durability and aging properties, allows outdoor presentation (with preventive conservation measures undertaken). Cons: cost medium to high, difficult to work with, second layer is not environmental and not health-friendly.

The natural hydraulic lime (NHL) mortars have physical characteristics very similar to those of the original mortar that formed the *nucleus* of the mosaic but with much better mechanical properties. Also, hydraulic lime has the quality control of an industrial product. NHL mortars can be used as supports without honeycomb panels, so it makes sense to evaluate their strength.

Criteria to Be Considered When Designing New Supports for Lifted Mosaics

The main weakness of stone materials and mortar is their tensile strength, which occurs on the underside of the mortar reinforcement. To evaluate the performance of a mosaic panel, the first things to consider are the loads:

- static: its weight, expressed in kg/m^2
- dynamic: those generated by the handling and transport of a mosaic panel. They are difficult to evaluate, so it is customary to consider a load equivalent to static.
- safety factor: in addition to the previous two loads, a safety factor is applied, as a precaution in the case of rough handling or unexpected loads.

To calculate the stress of a mosaic panel, the sum of static and dynamic load is multiplied by the safety factor. To simplify the calculation, geometrically rectangular panels are estimated; it is assumed that mosaic panels will be moved by conservators from the perimeter, so the calculation criteria are based on slab supported on all sides. Finally, the maximum size of a mosaic panel that could be stable under these conditions is estimated.

Calculations

To analyze the weight of a mosaic panel, we considered a slab that consists of tessellatum 20 mm thick and a layer of NHL 5 reinforcement mortar 30 mm thick. Limestone density is variable between 2,300 and 2,700 kg/m^3, so for this study we calculated a medium density of 2,500 kg/m^3. Approximate density of a lime mortar depends on binder/aggregate proportions. For mosaic backing reinforcement, we considered a layer of NHL 5 lime mortar with siliceous fine sand (proportion B/Agg 1/1,3, according to EU-EN459). Total static weight in that case is 110 kg/m^2. Since dynamic load is considered the same as static, total dynamic weight is 110 kg/m^2.

We considered rectangular shapes of different dimensions, from 100 × 100 cm to 400 × 400 cm. For the calculation of the bending moments (x and y axis), a continuous load on its surface in both directions was considered. We used the classic method for slab calculation double-checked with the crack lines method. According to it, we calculated the maximum bending moment M in both directions x, y. With that figure, we calculated the flexural strength per meter of the section. Then, dividing the maximum bending moment, we calculated the maximum bending tension (sigma) and compared it to the maximum flexural strength of each mortar mixture. Finally, we calculated the deflection in the middle point of the slab (w), in order to check excessive deformations.

Reinforcement with NHL5 Mortar

The calculation of the strength of a 30 mm NHL 5 mortar slab with the static and dynamic loads considered, a piece of 150 × 150 cm has a maximum bending strength of =1,701 N/mm^2, lower than its maximum capacity of 1.72 N/mm^2. According to the Saint-Astier data sheet, NHL 5 lime mortar with siliceous fine sand in proportion B/Agg 1/1.3 has minimum flexural strength of 2.30 N/mm^2. For security, we applied a security coefficient of 0.75. Total flexural strength for the NHL5 mortar is 1.72 N/mm^2.

Reinforcement with NHL 5 and Light Aggregates

Using light aggregates decreases the weight of the mortar but also diminishes its strength. The strength of a 30 mm NHL 5 mortar with light aggregates slab was calculated, with the static and dynamic loads considered. A panel of 200 × 200 cm has a maximum bending strength of 1.12 N/mm^2, lower than its maximum capacity of 1.32N/mm^2. We have not found any studies of lime mortars with light aggregate strength, so we used our own data from strength tests and the experience from the concrete cement building industry.

Reinforcement with NHL 5, Light Aggregates, and Fiberglass Bars

The strength of light mortars can be balanced with fiberglass bars, which absorb tensile strength (resistance to traction). The strength of a lime mortar slab increases by incorporating fiberglass bars of 2 mm diameter at 7 cm intervals. It could resist a 300 × 300 cm reinforced mosaic. Incorporating a mesh of fiberglass bars of 2 mm diameter on each 3 cm could support a 400 × 400 cm reinforced mosaic. We have not found any studies of lime mortars reinforced with fiberglass bars, so we used our own data from strength tests and the experience from the concrete cement building industry.

Conclusions

NHL mortars with light aggregates and reinforced with fiberglass bars might be a good alternative to the methods given in examples 1 and 2. These mortars are compatible and reversible materials, stable to weathering, accessible, sustainable, and cheaper than high-tech-based solutions. Traditional solutions such as adding a timber grid to the lime reinforcement could also be acceptable. The timber absorbs the tensile strength (resistance to traction), so the thickness of lime mortar could be reduced from 3 cm to 2 cm. NHL mortars reinforced with fiberglass, such as the building industry's glass fiber reinforced concrete (GFRC), could be another interesting line of investigation. However, no papers, research, or tests have been found about NHL mortars and fiberglass, and we think this would be an interesting line of research.

Fighting Agrosti, the “Mosaic Exterminator,” In Situ: An Interdisciplinary Cost Analysis of the Conservation and Presentation of the Early Christian Mosaic at the Apollo Erethimios Sanctuary in Rhodes

Dimitris Tsipotas, Nektaria Dasakli, and Pavlos Triantafyllidis

Abstract: *Due to limited funding for the conservation project of the Early Christian mosaic in Theologos, Rhodes, we have been involved in an extensive, continuous struggle to make decisions based on financial costs. In assessing the costs, we concluded that there were diverse and alternative mosaic conservation methods and materials that could achieve identical or similar acceptable results to the costlier methods. The costs of these methods and materials, especially in the elimination of flora, particularly agrosti, a local weed, are presented in this paper.*

The Sanctuary of Apollo Erethimios is located on the northwest side of Rhodes, near the village of Theologos (Tholos). Excavations in the sanctuary in the period 1980–1990, with the collaboration of the Ephorate of Prehistoric and Classical Antiquities and the Department of Archaeology of the University of Ioannina, brought to light part of the construction of the Early Christian basilica, including a cruciform baptismal font surrounded by mosaic floors with geometric patterns around it (Chronika CE 46, 1991, 485–86) (fig. 1).

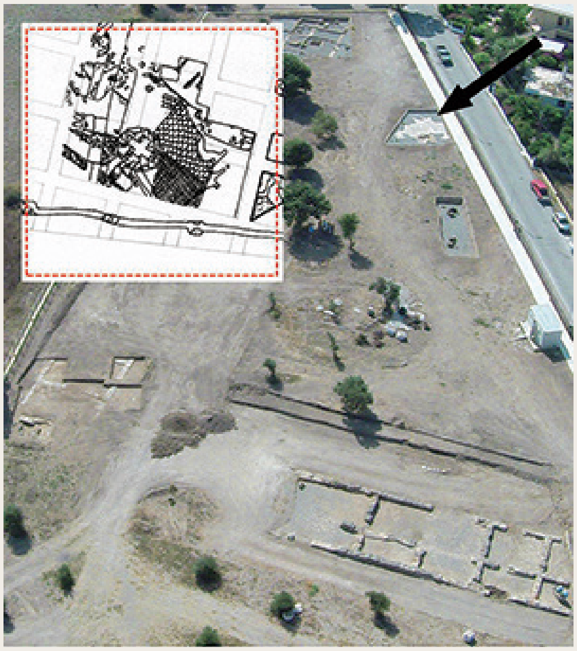

Figure 1 Aerial view indicating the mosaic site and in the upper corner, the plan of the mosaic area. Author’s personal archive

Materials Analyses

During the study of the basilica, documentation of the baptismal font and the mosaic construction and materials, as well as their preservation state, was carried out (Maniatis 2011; Schnabel 2009; Philokyprou and Ioannou 2008). Identification of the stone and mortar substrates and tesserae by chemical and XRF analyses was performed (Donais et al. 2010: 146–47; Philokyprou and Ioannou 2008: 1). The color of the mortar and tesserae was digitally identified by their RGB values’ characterization by image editing software (Elsen 2006: 1416). Mortar samples were observed using a digital microscope and image processing software to identify their inclusions, calculate the size of their aggregates, the mortar-aggregate proportion, and their preservation state in general (Schnabel 2009; Blaeuer and Kueng 2007: 1199–1207: Elsen 2006: 1416).

Overall Condition

The mosaic’s overall condition was documented as general deterioration, loss of cohesion in all the substrates’ interfaces, cracks, losses, vigorous growth of plants and root systems, extensive biological attack, and soluble and insoluble deposits (GCI and IAA 2003) (fig. 2).

What Cost?

Cost is an amount that has to be paid or given up in order to get something. In business, types of costs are usually the monetary value of effort, material, resources, time, and utilities consumed, risks incurred, and opportunity forgone in production and delivery of a good or service (www.businessdictionary.com/definition/cost.html).

What Is Agrosti?

Agrosti (á-gro-sti) is couch grass (*Agropyron repens, Triticum repens*). “Repens” means that which crawls or sneaks. This is a plant that has shallow, creeping roots and flat, hairy leaves. It is very difficult to remove, as the roots grow to a length of more than 25 cm and get entangled, and each severed piece of rhizome can develop into a new plant.

Figure 2 General view of the agrosti over the mosaic

Figure 3 Condition of the mosaic before conservation. Author’s personal archive

Fighting Agrosti

Mosaic strata create the perfect ground for agrosti’s roots’ “crawling abilities.” In soil, it may be possible to loosen the earth around the plant and carefully pull out the complete rhizome, but this is quite difficult to do in a mosaic without dislodging the tesserae (fig. 2).

Extermination of agrosti can be accomplished by spraying with weed killers containing glycophosphate, according to rhs.org.uk, followed by a second spraying after two weeks. Glycophosphate or glyphosate is the primary ingredient used in many weed killers, including Roundup®, as stated on the MSDS sheet (http://greenhouse.ucdavis.edu/pest/pmsds/Roundup.pdf).

Rather than sprayed over the surface, aquatic solutions (2% v/v) of the product were injected under the basilica mosaic, between the largely detached strata and in cracks, crevices, and lacunae, thus avoiding contact with the tesserae, and prior to mortar injections. The product was also added to the water used for mortar injections at a 5% v/v ratio.

Major health precautions were taken during these formulations and applications.

Overall Costs of Conservation Methodology

The way agrosti was to be eradicated played a major part in deciding on a cost-based conservation methodology. In situ injections are very low cost, as opposed to the high costs associated with mosaic detachment and reattachment.

In situ “extermination” of the agrosti was consequently regarded as low cost in terms of effort, resources, time, utilities, risks, delivery of the service, and, above all, the archaeological material benefit, as well as health. It is nonhazardous after rigorous precautions and environmentally friendly due to the restricted area of application. Almost 45 m^2 of mosaic was treated, using 10 liters of the product, which produced 500 liters of solution. It took two weeks for two rounds of application.

The mosaic conditions, as well as the external climatic conditions in which the construction will remain exposed and its archaeological significance—which dictates minimum intervention and reversibility principles—all favored the in situ overall conservation approach that required less time, effort, and financial resources (fig. 4).

Figure 4 Condition of the mosaic six months after conservation.
Author's personal archive

Conclusion

The state of the mosaic six months after the conservation procedures is shown in figure 4. It seems that the use of the product, employing the methods discussed above, has been effective in preventing growth of flora within the mosaic structure. The maximum period of time that the mosaic retains its resistance to agrosti and other weeds remains to be established.

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Le balnéaire de Cornebarrieu (Haute-Garonne, France) : De la fouille à la restitution

Frédéric Veyssière et Carole Acquaviva

Résumé : *Le pavement d'un édifice thermal découvert en 2005 lors d'un diagnostic archéologique réalisé à l'occasion d'un projet d'aménagement au nord-ouest de Toulouse a été intégralement prélevé en 2007. Une partie a été restaurée puis présentée au public dans le cadre de l'exposition « Permis de construire : Des Romains chez les Gaulois », au musée des Antiques de Toulouse, en 2013–14. Suite à cette exposition, un projet de restauration de l'ensemble du pavement et une construction d'un musée sur la commune de découverte sont envisagés par le musée de Toulouse et les collectivités territoriales concernées, afin des Antiques présenter au public.*

Abstract: *Uncovered in 2005 as part of an archaeological survey for a redevelopment plan in northwestern Toulouse, the entire mosaic floor of a bathhouse was lifted in 2007. A section of the floor was restored and then placed on public display as part of a special exhibition on Roman buildings in Gaul,* Permis de construire : Des Romains chez les Gaulois, *at the Toulouse Museum of Antiquities in 2013 and 2014. Following on from this exhibition, the museum and relevant local and regional authorities are embarking on a project of restoration for the entire mosaic floor. They are also planning the construction of a museum in the area where it was discovered, with the aim of putting the mosaic on public display.*

Présentation

Une opération d'archéologie préventive menée par l'Inrap en 2007 a permis la fouille et l'étude d'un petit complexe thermal de plan rectangulaire de 5,25 m sur 5,75 m, d'époque tardo-républicaine (Veyssière *et al*. 2013) ; sa construction associe une ossature de bois avec une maçonnerie.

Ce bâtiment est constitué de deux pièces : un *apodyterium* avec l'empreinte d'une banquette maçonnée et un *caldarium* doté d'un *labrum*, ainsi qu'une baignoire chauffée dont seuls les substructions et le *praefurnium* ont été retrouvés. Le sol est réalisé en *opus signinum* à tesselles blanches et noires, représentant un décor de méandres, de quadrillage losangé et de fleuron à six feuilles inscrit dans un méandre circulaire de svastikas et de carrés à point central (fig. 1). Les caractéristiques du bâtiment et le mobilier amphorique récolté plaident en faveur d'une construction dès le début du Ier siècle av. J.-C. (Marty 2008 : 719–37 ; Veyssière, Viers 2011 : 231–40 ; Viers, Veyssière 2012 : 115–25).

L'*opus signinum* à tesselles, constitué d'un béton de fragments de terre cuite et d'amphores dans un mortier de chaux, est coulé sur un hérisson de galets plantés dans l'argile du substrat. L'ossature de bois et les substructions de la baignoire font office de coffrage à sa mise en œuvre. Les tesselles dessinant les motifs sont incrustées dans un rechapage de mortier de tuileau fin d'une épaisseur de 1 cm.

La dépose du pavement

Le traitement de cet *opus signinum* diffère des pavements traditionnels d'*opus tessellatum*. La surface étant principalement constituée de béton de tuileau, la présence isolée de tesselles ne suffit plus à assurer une bonne solidité de la surface. Malgré de larges fissures et des perturbations postérieures, l'*opus signinum* est relativement en bon état.

Afin d'assurer sa consolidation, avant son prélèvement, deux couches de consolidant inorganique (silicate d'éthyle) ont été passées avec un large pinceau directement sur le pavement.

La totalité du pavement a été entoilée d'une première gaze de coton puis d'une seconde couche de toile de jute avec de l'acétate de polyvinyle dilué à 50 % dans de l'éthanol.

Le plan de découpe prévu en 17 panneaux a dû être doublé à 35 du fait de l'importante épaisseur du pavement prélevé avec le *statumen*. Il a été effectué selon les fissures existantes, quand cela était possible. La prédécoupe a été réalisée au burin et au marteau

Figure 1 Nettoyage de la surface du pavement. © Inrap. F. Veyssière

Figure 2 Allégement du mortier au revers, avant restauration. © Inrap. F. Veyssière

Figure 3 La surface est épurée de tous les résidu de colle et de concrétions. © Inrap. F. Veyssière

aux endroits où le décor en tesselles était important et à l'aide d'une scie à disque ailleurs.

Des barres métalliques ont été encastrées entre l'assise de galets et la couche de béton de tuileau, ou le plus souvent directement sous les galets. Une fois le panneau désolidarisé de son assise, une plaque de contreplaqué de bois découpée aux dimensions du panneau a été déposée sur sa surface. Avant retournement, elle a été fixée avec des serre-joints ou des sangles.

L'ultime étape a consisté à retirer les galets restés ancrés, ainsi que le surplus de mortier antique, afin d'alléger les panneaux au maximum pour le transport.

Les différentes étapes de la restauration

Les deux panneaux restaurés concernent le décor central de la rosace.

Le travail de désépaississement du revers est une opération longue et délicate, car il y a des risques de fissures profondes. Le mortier antique a été allégé au revers des panneaux à l'aide du burin ou de la disqueuse (fig. 2).

Deux couches de protection ou dites « d'intervention » ont été posées au dos des panneaux allégés. C'est un mortier synthétique composé de sable, d'acétate de polyvinyle et de billes d'argile

Figure 4 Dernière retouche sur le pavement, avant exposition. © Inrap. F. Veyssière

concassée. Après le collage de ces deux panneaux entre eux, un nouveau support (panneau de nid d'abeille) a été collé au revers.

Les panneaux ont été retournés, et la toile de jute et la gaze ont été retirées à l'aide d'éthanol. Le nettoyage de la surface est aussi une étape sensible ; du fait de sa porosité, nous l'avons appréhendée comme une peinture murale. La surface a été épurée de tous les résidus de colle et de concrétions (fig. 3). Les fissures et les lacunes les plus gênantes pour la lecture du motif ont été rebouchées avec un enduit à base de chaux, de poudre de tuileau et de poudre de marbre. En toute dernière intervention, une couche de cire microcristalline est posée au pinceau. Il n'a pas été nécessaire de faire un enduit de présentation autour, puisque le pavement a été intégré dans un sol plastique imprimé du reste du décor.

Le coût de la dépose du pavement et de la restauration de 4 m^2 (sur les 20 m^2 déposés) s'élève à 20 000 euros environ : 11 000 euros de dépose ; 9 000 euros pour la restauration.

Dans le cadre d'une exposition au musée Saint-Raymond, musée des Antiques de Toulouse, une évocation grandeur réelle a été réalisée sous le contrôle scientifique des archéologues et de la conservatrice-restauratrice, afin d'intégrer le décor de fleuron restauré (fig. 4).

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Conservation of In Situ Mosaics at the Site of Eshmun, Lebanon

Myriam Ziadé and Samar Karam

Abstract: *This project consisted of the in situ conservation of four Roman mosaic pavements that are part of a Roman stairway at the site of Eshmun, Lebanon. The work focused on two main activities: the restoration of the mosaics and the construction of a new stairway adjacent to the archaeological one. The aim of this project has been the preservation of these mosaics in their archaeological context, leading to a better understanding of their historical significance, as well as to a better appreciation of the site as a whole.*

The site of Eshmun is located in the village of Bqosta, in the south of Lebanon. It is situated in a valley of citrus groves on the al-Awwali River, a region locally known as "Boustan esh-Sheikh." The site is dedicated to the healing god Eshmun and was constructed near a spring that was used in purification and healing rituals. It is the only Phoenician site in Lebanon that has retained more than its foundation stones. The construction of the site dates to the end of the seventh century BCE, and it was continuously occupied up until the Byzantine period (seventh century CE).

The Roman stairway at Eshmun is covered with four in situ mosaic pavements, some of which are unique in their motifs. It is a main attraction of the site, frequently used by tourists, as it leads to the highest viewpoint of the archaeological site. The work undertaken on-site focused on two main activities: the restoration of the mosaics and the construction of a new stairway adjacent to the archaeological one. The aim of this project has been the preservation of these mosaics in their archaeological context, leading to a better understanding of their historical significance, as well as to a better appreciation of the site as a whole (fig. 1).

The four mosaics are separated by three to four steps made of uncut limestone slabs. They date to the Roman period and are opus tessellatum, mostly using white stone tesserae of 2 to 3 cm, with a center area of yellow stones framed by fired clay or red stones, of slightly smaller size (1 to 2 cm).

The mosaics were completely covered and hidden by high vegetation and obscured by microorganisms. It was a massive task to clear all the vegetation in the surrounding areas of the mosaics. The major branches of the bushes growing on the Roman staircase and the mosaics were cut using shears. The roots of the bushes were very strong, deep, and resistant. Fuel oil was applied twice with a syringe to the roots. After a few days the roots had dried up. It was then possible to cut them and partially remove them without damaging the mosaics. The void was then filled with a lime-based mortar and the tesserae were put back in place. The infestation of gray and black microorganisms obscured the surface. A biocide was applied: Sanitex first®, an algicide found on the Lebanese market used as a dental medical supply. The product needed about a month to be efficient. The surfaces were then cleaned with brushes, sponges, and water. The tougher residues were removed with a scalpel, and the interstices were cleaned with wooden and metal hand tools. Some deposits were softened and removed with the application of a saturated solution of ammonium carbonate. After application the surfaces were thoroughly rinsed with a brush and water. After the removal of deposits and microorganisms, the surfaces became visible and clear. A more exhaustive documentation could be made, with condition assessments and graphic and digital recordings.

The cleaning and removal of all the dirt and soil in the interstices revealed the extent of the deterioration of the bedding layer, causing some of the tesserae to be very unstable. The mortar prepared for the filling of the interstices between tesserae as well as for the reintegration of detached tesserae was made so as to be similar in tonality and composition to the original mortar. The interstices and the cracks were filled, just under the surface level of the stones. Areas where the bedding layer was missing, making the tesserae unstable, had to be filled with new mortar so as to secure the tessellatum. The tesserae were carefully removed while respecting and documenting their original position. The surface under the stones was cleaned and the soil accumulation removed until mortar was found. Then new mortar was applied to form a bedding layer, and the tesserae were put back in their respective places. When voids could be heard by tapping on the mosaic, consolidation was done by injecting a lime-based mortar.

The last step consisted of removing the previous modern mortars used to fill lacunae and replacing it with the same lime mortar used for the filling of the interstices. It was applied in two layers, filling the deeper areas with the mortar containing larger aggregates up to a centimeter below the surface layer, then applying the finer, final layer up to a few millimeters below the original surface. In the same way, the previous edging was removed and

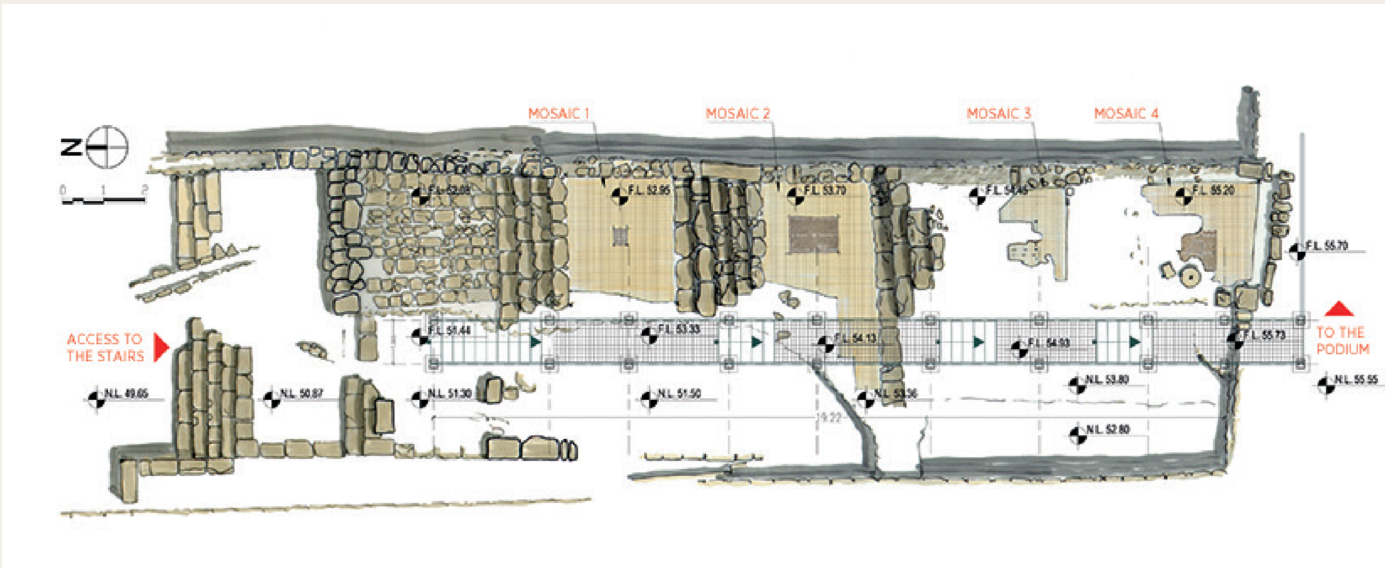

Figure 1 Plan of the Roman stairway and the new stairway. Plan: Architect Falah Wakim

Figure 2 Evolution of the work. Photo: Myriam Ziadé

replaced. The new edging was also done in two layers, as some areas were very deep and needed inclusions of larger stones to create a level base for the final mortar. The first layer of mortar contained larger aggregates than the final layer (fig. 2).

Alongside the archaeological stairway, a new stairway was constructed. This is now the only way to get to the top of the site, thus allowing visitors to see the mosaics without stepping on them (fig. 3). It is important to note that the impact of a modern

Figure 3 The Roman stairway and the new stairway. Photo: Myriam Ziadé

Figure 4 The new stairway on-site. Photo: Myriam Ziadé

structure on the archaeological site was well studied. As a result, the shape of the stairway and the materials used in its building have not affected the authenticity of the site (fig. 4).

Acknowledgments

This project was financed by the Lebanese government and the Getty Foundation. It was carried out by a multidisciplinary team composed of two archaeologists from the Directorate General of Antiquities, a conservator, and an architect-restorer.

Authors

Maria de Fátima Abraços received a PhD in art history from the Universidade Clássica de Lisboa. She is a member of and associate researcher at the IHA, Universidade Nova de Lisboa, a member of AIEMA, and a founding member of APECMA, the Association for the Study and Preservation of Ancient Mosaics in Portugal. She has participated in publications and proceedings of national and international symposia.

Carole Acquaviva. Après des études en archéologie et histoire de l'Art, elle est diplômée de la Maîtrise des Sciences et Techniques (désormais Master) de Conservation-Restauration des Biens Culturels en 2001, de Paris-I-Sorbonne. Elle est spécialisée dans la restauration des pavements de mosaïque, mais également dans celle des enduits peints et des céramiques archéologiques.

Ali Akin Akyol received his BA (chemistry, 1997), MSc (archaeometry, 2000) and PhD (archaeometry, 2009) degrees from Middle East Technical University in Turkey. He became an instructor in the field of restoration and conservation at Ankara (2000) and Gazi universities (2013), where he directed the historical materials research laboratories. He has been giving lectures on inorganic historical materials since 2000.

A. Bader Al-Beraiki has been a mosaic restorer at the Department of Antiquities, Superintendency of Benghazi Antiquities, since 2013. In 2014 he attended the Mosaic Conservation Course (MCC) Libya, held within the framework of the MOSAIKON Initiative.

Livia Alberti is a conservator trained at the Central Institute for Conservation in Rome (ICR), working as a partner of the private company, Consorzio Arké, and as a consultant for many institutions in Italy and abroad. She has worked in the field for thirty years, mainly in mosaic and mural painting conservation, including fifteen years of collaboration with the Getty Conservation Institute.

Yael Alef is an architectural conservator at the Israel Antiquities Authority and a PhD candidate in the Department of Geography in Bar Ilan University. She received her master's in conservation from the University of Leuven, where she wrote her thesis on the evaluation of shelters over mosaics. She currently takes part in the research conducted by the Getty Conservation Institute, Historic England (previously English Heritage), and the Israel Antiquities Authority on the protective performance of shelters over mosaics.

José A. Alonso is a conservation engineer working as an independent consultant in cultural heritage conservation and restoration projects. Main works undertaken are the Roman amphitheater of Segobriga (Cuenca, Spain), the Baroque church of San Andrés (Madrid, Spain), and the Toledo city walls, as well as feasibility reports on the conservation strategy for historic cities.

Elisavet Anamaterou is head of the conservation project for the Daphni mosaics. She has studied conservation and has been working in the Hellenic Ministry of Culture in the mosaics conservation sector since 1987. She has also served as head of the Department of Conservation of Prehistoric and Classical Antiquities and of the Department of Conservation of Modern Monuments.

Simonetta Angiolillo si è laureata alla Sapienza di Roma con Antonio Giuliano e ha seguito il corso di perfezionamento alla Scuola Archeologica Italiana di Atene con Doro Levi e Luigi Beschi; è professore di Archeologia greca e romana all'università di Cagliari. In particolare si interessa della Atene arcaica, di problemi di romanizzazione, del mosaico e della scultura di età romana.

Stefania Arangio is an associate researcher at the Sapienza University in Rome. She has been developing her research in Italy and in the United States. Her work focuses on the safety and reliability of structural systems, with specific attention to structural integrity and monitoring and assessment of historic structures.

Paola Baldassarri ha una formazione in Archeologia Classica conseguita e perfezionata a Roma (Università degli Studi "La Sapienza"), in Grecia (Scuola Archeologica Italiana di Atene), a Vienna (Albertina). Studiosa di arti figurative e architettura romana, membro di équipes di scavo in Italia, Grecia e Turchia, è archeologa di ruolo presso la Provincia di Roma e dirige i cantieri di scavo a Palazzo Valentini.

Aïcha Ben Abed received her doctorate from the University of Aix-en-Provence and a post-doctoral degree from Paris IV-Sorbonne. She has been director of Sites and Monuments at the Institut National du Patrimoine (INP), director of the Bardo Museum, and director of the Tunisian-French project for the conservation and valorization of the site of Dougga. Aïcha is the author or coauthor of six volumes of the *Corpus of Tunisian Mosaics* and several books and articles on architecture and mosaics in Tunisia. She helped establish the collaboration between the INP and the Getty Conservation Institute for the training of technicians in the field of in situ mosaic conservation. She is now the regional coordinator for the MOSAIKON initiative.

Anna Bertral i Arias is a conservator-restorer of archaeological material. She has a degree from the School of Conservation and Restoration of Catalonia, specializing in archaeological material, and a bachelor's degree in history from the University of Barcelona. She has a master's degree in classical archaeology from Rovira i Virgili University, the Autonomous University of Barcelona, and the Catalan Institute of Classical Archaeology.

Beril Biçer-Şimşir received a BS degree in civil engineering from the Middle East Technical University in Ankara, Turkey, and an MS degree in civil engineering, with a specialty in the area of construction materials, from the University of Illinois at Urbana-Champaign. She currently works as an associate scientist at the Getty Conservation Institute, where her research interests include lime-based hydraulic repair mortars and grouts.

Orhan Bingöl studied classical archaeology in Ankara and Würzburg (doctorate) and from 1977 to 2012 worked at Ankara University. He has contributed papers at several symposia and colloquia in Europe and the United States and has published nearly one hundred articles and six books. Since 1984 he has directed the archaeological excavations at Magnesia on the Meander and is now director of the Department of Archaeology at Karabük University.

Matjaž Bizjak is affiliated with the Museum and Galleries of Ljubljana, located in Ljubljana, Slovenia.

Patrick Blanc. Restaurateur spécialisé dans les mosaïques et peintures murales antiques et médiévales depuis la fin des années 1970, Patrick Blanc dirige l'Atelier de conservation et de restauration du Musée départemental Arles antique qui intervient pour la sauvegarde de mosaïques et de peintures en France et dans de nombreux pays du pourtour méditerranéen dans le cadre de coopérations avec les institutions publiques chargées du Patrimoine.

Antonietta Boninu, archeologa, direttore coordinatore della Soprintendenza per i beni archeologici per le province di Sassari e Nuoro fino al 2012. Ha pianificato, programmato, redatto e diretto numerosi progetti di ricerca, di scavo e di conservazione di monumenti, di reperti archeologici e di esposizioni museali, curando una serie di pubblicazioni. Collabora con l'Università, con Istituti Nazionali e Internazionali.

Olivier Bonnerot graduated from the École Nationale Supérieure de Chimie de Paris. He holds a master's of engineering in chemistry and a master's of research in analytical chemistry from the University Pierre et Marie Curie in Paris. Since 2011 he has been working in Cyprus on the analysis of mosaic material, as part of the NARNIA project.

Franco Bontempi is a professor of structural analysis and design at the School of Engineering, the Sapienza University of Rome. His research is focused on various aspects of the analysis and design of structures: safety and reliability, assessment of historical heritage, computational mechanics, structural dynamics, and identification.

Nissma Bouzoubaa. Docteur à l'Université Moulay Ismail. Responsable du Centre d'Etudes Doctorales à la dite université. Titulaire d'un Master en Géophysique et Géotechnique à la Faculté des Sciences en 2008. Membre de l'ICCM depuis 2011. Sa thèse de Doctorat s'intéresse à l'étude de la minéralogie des tesselletums et au catalogage des mosaïques romaines du Maroc sous forme de base de données.

Vladimir Bulajić, with over twenty years of experience, is a conservator-restorer and adviser at the Institute for the Protection of Monuments of Serbia. He has worked on numerous significant historical monuments over the years and became deputy chief of staff ten years ago. He graduated from the Refinement University of Cetinje and received an MSc degree from the Faculty of Applied Arts and Design in Belgrade.

Julia Burdajewicz received an MA degree from the Faculty of Conservation and Restoration of Works of Art in the Academy of Fine Arts in Warsaw, where she has worked since 2013 as an assistant professor. She specializes in on-site archaeological conservation, especially mosaics and wall paintings, as well as graphic documentation methods. She has worked on several archaeological sites across the Mediterranean.

Cristina Caldi is a graduate of the Central Institute for Conservation in Rome (ICR) and specializes in stone and mosaic conservation. She has taught conservation at the University of Urbino from 2001 to 2012 and works privately on conservation projects on stone, mosaics, wall plaster, and wall painting in Italy and abroad and, in particular, projects involving training.

Alba Canu. Funzionario conservatore restauratore del Ministero per i Beni e le attività Culturali e il Turismo e opera nel Centro di Restauro di Sassari della Soprintendenza per i Beni Archeologici della Sardegna. In attività dal 1977, interviene e coordina l'ambito della conservazione, restauro, diagnostica e monitoraggio delle aree archeologiche del centro nord della Sardegna e del patrimonio mobile di competenza ministeriale.

Ermanno Carbonara is a graduate of the School for Restoration of Mosaics in Ravenna, Italy. Since 2001 he has worked privately as a conservator specializing in wall and floor mosaic conservation. His projects have included the Basilica of Sant'Apollinare in Classe and the Basilica Sant'Apollinare Nuovo in Ravenna. He has collaborated with the Getty Conservation Institute on its mosaic conservation training projects since 2008.

Roberto Cassio. L'approccio al mosaico e al restauro di mosaici antichi, avviene già in giovane età insieme al padre Antonio, proseguendo poi stabilmente al termine degli studi. Dal 1993 è responsabile del laboratorio per il restauro del mosaico dei Musei Vaticani. Dal 2011 partecipa come docente ai corsi realizzati dal CCA, Centro di Conservazione Archeologica di R. Nardi "Mosaic Conservation Courses", nell'ambito dell'iniziativa *MOSAIKON*.

Évelyne Chantriaux. Diplômée en architecture à l'ENSBA de Paris en 1978, elle se spécialise en restauration de mosaïques en lien avec le Service de Restauration de la Direction des Musées de France. Elle est recrutée en 1980 par le Conseil général du Rhône pour monter et diriger l'atelier de restauration de mosaïques de Saint-Romain-en-Gal. Membre du bureau de l'ICCM depuis 1986.

Moheddine Chaouali est titulaire d'une thèse de IIIème cycle de la faculté des Lettres de l'Université de Provence, Aix-Marseille I. Chargé de recherches archéologiques et historiques à l'Institut National du Patrimoine de Tunis. Responsable des sites archéologiques situés dans le gouvernorat de Jendouba au nord ouest de la Tunisie tels que Bulla Regia, Chemtou, Thuburnica, Borj Helal, Tabarka.

Medhi Chayani is an engineer at Archeovision UMS 3657 CNRS and at Consortium 3D SHS of the TGIR Huma-Num.

Eleni Cheilakou is a chemical engineer. She has a PhD in materials characterization, decay inspection and conservation of historic artifacts, from the Materials Science and Engineering Department, National Technical University of Athens (NTUA). She is a researcher at the Nondestructive Testing Laboratory of the Chemical Engineering School, NTUA. Her scientific area of expertise is the development and application of analytical and nondestructive testing and evaluation techniques.

Giovanni Antonio Chessa. Assistente restauratore, si è formato presso l'Istituto d'Arte e l'Accademia di Belle Arti di Sassari. Dal 1979 nei ruoli del Ministero per i Beni e le attività Culturali e il Turismo, Centro di Restauro di Sassari della Soprintendenza Archeologia della Sardegna. Svolge attività in laboratorio, sul campo in tutto il territorio di competenza e sul patrimonio archeologico sommerso.

Stefania Chlouveraki, PhD, is a lecturer in the Department of Antiquities and Works of Art Conservation, Faculty of Fine Arts and Design, Technological Educational Institute (TEI), Athens. She has directed a series of conservation/training projects in Greece, Jordan, and Syria and has worked in Oman. She was the head conservator at the INSTAP Study Center for East Crete from 1997 to 2014.

Maria Rita Ciardi. Diplomata presso l'Istituto Centrale del Restauro nel 1989, specializzata nel 1990 in conservazione dei materiali lapidei. Dal 1990 è presidente e direttore tecnico del consorzio L'Officina di Roma. Docente a contratto presso l'Università di Urbino, corso di laurea Magistrale in conservazione dei beni culturali. Svolge attività di restauro su aree archeologiche come Ostia Antica, Palatino, Pompei, Nora.

Francesca Condò. Architetto, Scuola di specializzazione in restauro dell'Università Sapienza di Roma, Dottorato di ricerca sui restauri delle ville di età romana. Ha lavorato a progetti di restauro e allestimento museale. Dal 2012 lavora stabilmente per il MiBACT presso la Soprintendenza per i beni archeologici di Sassari e Nuoro.

Vesna Crnoglavac is a senior curator in charge of the classical antiquity collection at the National Museum in Nis, Serbia. She has been working at the archaeological site of Mediana, where, since 2000, she has been involved in excavation, the processing of archaeological material, and visitor management. She is a member of ICCM and participated in the conferences in Morocco in 2011 and Sardinia in 2014.

Francesco Antonio Cuteri. Archeologo, Dottore di Ricerca in Archeologia. Già professore a contratto di Archeologia e rilevamento dell'edilizia storica e di Archeologia Classica e Medievale presso l'Università Mediterranea di Reggio Calabria. Coordina dal 1998 lo scavo archeologico nelle Terme ellenistiche di Kaulonia. Principale ambito di ricerca: Miniere e metallurgia antica e medievale.

Ascanio D'Andrea, archaeologist, topographer, and Geographic Information Systems expert, has contributed to numerous surveying campaigns and the creation of databases during archaeological interventions. Since 2002 he has been director of Surveying and GIS specialist with Akhet Srl. He is the information manager for the Herculaneum Conservation Project, regularly lectures for ICCROM, and is an instructor and consultant for the GCI and the MOSAIKON Initiative.

Carla D'Angelo is a restorer who graduated from the ICR in 1973, specializing in wall paintings. Since 1978 she has worked at the Italian Ministry of Culture and since 1992 for ISCR in the Restoration Laboratory for mosaics and stucco. She also teaches restoration of mosaics and stucco at the ISCR High School.

Nektaria Dasakli is a conservator of antiquities and works of art, with an MA in museum studies from Athens University. She has worked as a conservator of antiquities at the excavation of Dispilio Kastoria, the 4th Ephorate of Byzantine Antiquities, the Epidaurus Monuments Conservation Committee, and the KB Ephorate of Prehistoric and Classical Antiquities of Rhodes. She has also been a tutor in conservation of antiquities in higher education and participated as a speaker at international conferences.

Barbara Davidde Petriaggi, an underwater archaeologist, is currently director of the Underwater Archaeological Operations Unit and of the Department of Archaeology at the ISCR. Since 2010 she has been an adjunct professor at the Roma Tre University, where she teaches courses in underwater archaeology. An author of several scientific papers, she also published, with Roberto Petriaggi, *Archeologia sott'acqua: Teoria e pratica* (Rome-Pisa, [2007] 2015).

Alessandra De Natale. Restauratrice libero professionista, collabora con diverse Soprintendenze italiane e aziende di settore; membro di una missione conservativa nel Sultanato dell'Oman. Specializzata nella conservazione di pavimenti musivi, superfici decorate e reperti mobili in ambito archeologico; specializzata nel rilievo e nella grafica per l'archeologia e l'editoria di settore.

Principale ambito di ricerca: studio delle tecniche esecutive dei mosaici di età ellenistica.

Abdelilah Dekayir. Docteur de l'Université d'Aix-Marseille III en 1994 et Professeur à l'Université Moulay Ismail de Meknès (Maroc). Membre de l'ICCM depuis 2009. Il s'intéresse à la minéralogie et la chimie des matériaux naturels utilisés dans la construction des mosaïques romaines et les processus responsables de leurs dégradations (chimique et mécanique). Responsable de nombreux projets de recherches et auteurs de plusieurs publications ayant trait aux mosaïques romaines.

Maria Deliprimi has a degree in conservation of antiquities and works of art. She has been working in mosaics conservation since 1998 and has participated in the Daphni mosaics conservation project since 2000. She is currently responsible for organizing the mosaics conservation project of Daphni.

Martha Demas is a senior project specialist at the Getty Conservation Institute. She received her master's degree in historic preservation planning and her PhD in archaeology. In addition to her involvement in the Mosaics In Situ and MOSAIKON projects, she has participated in many of the GCI's international field projects, including in China, Egypt, and Tanzania, and in developing methodologies and guidelines, with a principal focus on conservation and management of archaeological sites.

Maria Graziella Dettori. Funzionario conservatore restauratore del Ministero per i Beni e le attività Culturali e il Turismo fino al 2014, ha operato nel Centro di Restauro di Sassari della Soprintendenza per i Beni Archeologici della Sardegna, curando la conservazione e il monitoraggio di monumenti archeologici e di collezioni museali anche per mostre ed esposizioni temporanee.

Yanna Doganis has been practicing conservation since 1980. She was instrumental in establishing the conservation team at the Parthenon on the Acropolis, which she managed from 1986 to 1997, at which time she cofounded a private conservation practice that has been active in the field, in Greece and abroad, consulting, drawing up proposals, and managing projects on archaeological sites, in museums, and in private collections.

Didier Dubois is a photographer, specializing in archaeology. He has been part of the team of the Corpus of the Mosaics of Albania since 2013 and has created a specific monopode and a drone adapted for making orthogonal photographs of the mosaics.

Adel El-Turki is a senior research fellow at the University of Bristol, England, and a conservation scientist at the Department of Antiquities, Libya. His research focuses on the characterization of mortars and metal and nonmetal materials using artistic spectroscopic techniques. He has been a professor of conservation and management of mosaics and cultural heritage for various scientific institutions in Libya and in Tunisia.

Sabah Ferdi is director of research and president of the scientific council of the CNRA (National Research Center for Archaeology). She is a specialist in classical iconography and museology. She is a member of the board of AIEMA (International Association for the Study of Ancient Mosaics) and was inspector of the Archaeological Heritage and Museum of Algeria.

Fabiano Ferrucci dal 2001 insegna Restauro presso l'Università degli Studi di Urbino; diplomato e specializzato presso l'Istituto Centrale del Restauro nel 1991, si è laureato inoltre con indirizzo Storico Artistico all'Università di Roma "La Sapienza". Numerosi gli interventi di restauro realizzati negli anni presso importanti aree archeologiche quali: Pompei, Ostia Antica, Velia, Paestum, Ercolano, Nora, Fori Imperiali.

Susan Fox is collections manager at the Roman Baths Museum, Bath & North East Somerset Council, where she has worked for seventeen years. Previously she worked at the Roman Legion Museum, part of the National Museum Wales. She has a degree in archaeology and a master's degree in museum studies. Her main study interest is Roman archaeology.

Maja Franković is a senior conservator at the Central Institute for Conservation in Belgrade. Her responsibilities include the development and implementation of projects in the field of mosaic and stone conservation of museum collections and archaeological sites as well as training programs on archaeological conservation. She has worked in various aspects of conservation, including preventive, remedial treatments, and condition assessments.

Leslie Friedman is an architectural conservator at the Getty Conservation Institute, working principally on the conservation of archaeological sites and architectural surfaces. She is the project manager of the MOSAIKON courses on the conservation and management of archaeological sites. Friedman completed undergraduate and graduate studies in anthropology and archaeology and holds an MSc in historic preservation from the University of Pennsylvania. A member of a number of ICOMOS scientific committees, she also serves on the board of the Architectural Specialty Group of the American Institute for Conservation.

Ekaterini Ftikou is a conservator and a PhD candidate in the Materials Science & Engineering Department of the National Technical University of Athens (NTUA). Since 2006 she has worked at the Hellenic Ministry of Culture. She has been involved with work and research projects on the study, characterization, and conservation of cultural heritage objects and monuments (mosaics, sculptures, historic building materials, etc.).

Amerimni Galanos received an MSc in historic preservation from Columbia University and worked as a conservator at the Parthenon and Erechtheion on the Acropolis from 1990 to 1997, at which time she cofounded a private conservation practice that has been active in the field, in Greece and abroad, in consulting, drawing up proposals, and managing projects for archaeological sites, museums, and private collections.

Gabriella Gasperetti. Archeologa, laurea presso l'Università degli Studi "Federico II" di Napoli, Scuola di specializzazione in Archeologia Classica dell'Università degli Studi di Lecce. Dal 1991 è funzionario archeologo del Mibact, dapprima presso la Soprintendenza per i beni archeologici di Napoli e Caserta, poi presso quella di Sassari e Nuoro. Dal 2012 è responsabile della tutela di *Turris Libisonis*.

Flavia Gazineo. Diagnosta e restauratrice di beni culturali per la ditta Mantella Giuseppe Restauro Opere d'Arte. Specializzata nello studio archeometrico e nella conservazione di manufatti lapidei naturali ed artificiali presso l'Università della Calabria (UNICAL, Arcavacata di Rende, Italia). Principale ambito di ricerca: studio dei materiali e delle tecniche esecutive di beni appartenenti al patrimonio storico-artistico ed archeologico.

Daniela Gennari graduated from the ICR, specializing in restoration of stone materials and mosaics. In 2003 she received a degree in technologies for the conservation and restoration of cultural heritage from Tuscia University. Gennari is dedicated to the restoration of mosaics and stucco at ISCR and teaches restoration of mosaics and stucco at the ISCR High School.

Patrice Georges-Zimmermann, archéo-anthropologue à l'Institut national de recherches archéologiques préventives (Inrap ; France), consacre une partie de ses recherches au domaine de la taphonomie appliquée en particulier aux structures funéraires. Il est membre permanent de l'UMR 5608 du CNRS-TRACES de l'Université Jean Jaurès de Toulouse (équipes *Terrae* et pôle Afrique).

Fotini Getimoglou is a conservation technician, specializing in mosaics conservation. She has been a member of the conservation team since the beginning of the mosaics conservation project at the Daphni monastery, in 2000. She is currently responsible for organizing the mosaics conservation work at the Daphni monastery.

Bianca Maria Giannattasio has taught classical archaeology at the University of Genova since 1986. She has been involved in excavations in Liguria, Sicily, and Sardinia. Since 1990 she has organized surveys and excavations, with a particular interest in pottery. She is the author of 86 publications, including articles and monographs.

Cécile Giroire. Formée à l'École du Louvre et à l'université Paris-IV, puis l'Institut national du Patrimoine, Cécile Giroire rejoint en 2003 le département des Antiquités grecques, étrusques et romaines où elle est en charge des collections de mosaïques et d'arts mineurs d'époque romaine. Elle a parallèlement assuré le commissariat de plusieurs expositions sur l'art romain et enseigne à l'École du Louvre.

Gabriele Gomez de Ayala is a researcher specializing in the development of innovative technologies such as underwater laser scanning. He also produces documentaries for the promotion of cultural heritage. He collaborates with ISCR in the field of underwater archaeology.

Anne-Marie Guimier-Sorbets, professeur d'archéologie et d'histoire de l'art à l'Université de Paris Ouest-Nanterre – ArScAn (France), présidente de l'AIEMA depuis 2015.

Maja Gutman is with the Institute for the Protection of Cultural Heritage of Slovenia, Restoration Center, in Ljubljana.

Mohamed Chérif Hamza. Enseignant chercheur, à l'institut d'archéologie et restaurateur de mosaïque, Mohammed Chérif Hamza a dirigé plusieurs campagnes de restauration de mosaïques *in situ* en Algérie et à l'étranger (au Maroc) et publié des articles sur la restauration et la conservation des mosaïques *in situ* tout en participant également à de nombreux colloques nationaux et internationaux.

Marion Hayes. Formée à l'université de Paris I, en archéologie et en conservation-restauration des biens culturels, elle est titulaire du Master de conservation-restauration. Elle intègre en 1987 l'Atelier de restauration de mosaïques de Saint-Romain-en-Gal. Membre de l'ICCM depuis 1987.

Robin Hodgson, PMAICCM, FIIC, is a conservator of furniture and wooden objects and sole proprietor of RH Conservation Engineering. Hodgson works internationally to design and manufacture conservation equipment, develop skills in electronics and toolmaking, and fabricate metals and composites (including custom formulations of epoxies).

Maria Teresa Iannelli. Archeologo direttore presso la Soprintendenza per i Beni Archeologici della Calabria. Responsabile della ricerca archeologiche sul sito di Kaulonia e direttore del Museo Archeologico di Monasterace Marina. Principale ambito della ricerca: le sub colonie locresi di Hipponion/Vibo Valentia e Medma, Kaulonia e relativi territori.

Aleksandar Ilić is a founder and software developer at Appollo Fortyone, a mobile development studio specializing in writing and launching Android and iOS apps. He received a BSc in computer sciences at the School of Computing in Belgrade, Serbia. He has worked on dozens of projects for international companies.

Agron Islami is a researcher, mosaics conservator, and head of the Department of Art, Institute of Cultural Monuments, Tirana, Albania. Since 1975 he has worked in mosaics conservation on most of the sites in Albania. He has been co-leader of the team working on publication of the Corpus of Mosaics of Albania since 2013.

Maher Jbaee works at the General Directorate of Antiquities and Museums (DGAM) in Damascus, Syria, and has been head of the Mosaic Conservation Laboratory of the DGAM since 2000. He studied archaeology at the Faculty of Arts and Archaeology at the Lebanese University. He received a degree in archaeology in 1999 and a master's degree in classical archaeology from the Lebanese University in 2013.

Yusuf Kagan Kadioglu received his BA in geology from Ankara University and MSc and PhD degrees in geochemistry from Middle East Technical University in Turkey. In 2013 he became an instructor in petrology and field geology at Ankara University, where he directs the Earth Sciences Application and Research Center. He has been giving lectures on petrography since 1989.

Elena Kantareva-Decheva is an associate professor at the Academy of Arts in Plovdiv, Bulgaria, currently managing the conservation of the archaeological sites with mosaics in Plovdiv. She holds a master's degree in conservation and has over twenty years of experience in the conservation of mosaics. She was previously on the staff of the National Institute for Cultural Monuments and the Archaeological Museum of Plovdiv.

Electra Karagiannidou graduated from the Department of Conservation of Antiquities and Works of Art in Athens. She holds an MSc in cultural organizations management. Since 1992 she has been working at the Greek Ministry of Culture in the conservation of Byzantine icons and wall paintings and has, in addition, been co-supervisor for the conservation of major monuments in Thessaloniki and northern Greece.

Samar Karam has been working at the Ministry of Culture–Directorate General of Antiquities since 1996. She is regional manager of archaeological sites and historical monuments in northern Lebanon. She studied arts and archaeology and touristic sciences and completed several training courses on the management and development of archaeological sites, implementation of the World Heritage Convention, rehabilitation of museums, and conservation of mosaics.

Theocharis Katrakazis is an archaeological conservator. He holds an MSc in conservation studies from University College London (UCL) and a BSc in archaeological conservation from the Technological Educational Institute (TEI) in Athens. He has been involved in conservation projects in Greece, Cyprus, Syria, Jordan, and Turkmenistan.

Hande Kökten has been a professor in the Conservation Program at Başkent Vocational School, Ankara University, since 1991 and is currently the director of the institution. She specialized in conservation training, preventive conservation, and conservation of mosaics in particular. She is a member of IIC, ICCM, and ICOM.

Maria Koui is a professor of spectroscopic and nondestructive methods and techniques for the characterization of materials in the Materials Science and Engineering Section, National Technical University of Athens. She is the author and coauthor of two European patents and more than one hundred published papers. She has long cooperated in research programs and activities with more than twenty foreign and Greek universities, research centers, and industries.

Katarina Toman Kracina is affiliated with the Museum and Galleries of Ljubljana, located in Ljubljana, Slovenia.

Sabina Kramar is with the Slovenian National Building and Civil Engineering Institute in Ljubljana.

Myriam Krieg est diplômée (MA) en conservation-restauration (Berner Fachhochschule - Hochschule der Künste Bern et Haute Ecole Spécialisée de Suisse occidentale – Haute Ecole de Conservation-Restauration Neuchâtel). Depuis 1999, elle travaille au Site et Musée Romains d'Avenches, dans les domaines de la conservation-restauration des mosaïques, des enduits peints et du petit mobilier archéologique.

Maria Krini has an MSc in conservation and in museum studies. As a conservator, she has worked at several archaeological sites and museums, and since 2000 she has worked in the Directorate of Conservation of Ancient and Modern Monuments of the Hellenic Ministry of Culture. Her main areas of specialization are mosaics conservation and conservation policies.

Brigitta Maria Kürtösi graduated as a painting conservator at the Hungarian University of Fine Arts in 2010. She is carrying out her postgraduate studies on excavated mosaic finds. She deals with archaeometric investigation of Roman and medieval mosaic heritage from Hungary, focusing on glass, stone, and mortar analyses and preparation techniques. She has participated in conservation projects on mosaics and wall paintings.

Christophe Laporte. Membre de l'ICCM depuis 1987. Après des études d'archéologie et d'histoire de l'art antique et médiéval à l'université Lyon II, il intègre l'équipe de Jean-François Reynaud au sein de la même université. Il rencontre la mosaïque et Evelyne Chantriaux en 1983, se forme à son contact. Il ne cesse depuis d'oeuvrer à la conservation des mosaïques.

Vincenzo Angeletti Latini has a degree in architecture. His interests are architectural and archaeological surveys and he has taught courses in drawing and relief at the Sapienza University of Rome. Since 2000 he has been an architect at the Italian Ministry of Cultural Heritage and Activities and Tourism, where he has designed and directed many restoration projects on historic buildings and archaeological sites.

Branislava Lazarević Tošović is an archaeological conservation specialist in the Department for Archaeological Sites at the Central Institute for Conservation in Belgrade. She has been involved in preventive conservation and conservation treatments in many projects for archaeological sites, both on-site and on archaeological objects.

Martina Lesar-Kikelj is with the Institute for the Protection of Cultural Heritage of Slovenia, Restoration Centre, in Ljubljana.

Sílvia Llobet i Font is a project manager at Àbac. She has a bachelor's degree in art history from the University of Barcelona and a degree from the School of Conservation and Restoration of Catalonia, specializing in archaeological material. She is currently enrolled in the master's program in conservation and restoration project management at the University of Barcelona.

Filomena Lucci is an architect specializing in the restoration of monuments and landscapes. She is the director of the Tourist Centre of the Marine Protected Area of Baiae (Naples, Italy). She collaborates with ISCR in the field of underwater archaeology.

Basem Mahamid is director of the Madaba Archaeological Directorate, Department of Antiquities, of Jordan. He worked at the Umayyad Medina project in the Amman Citadel from 1996 to 2001 and has conducted several excavations in Jordan. In addition, he worked as a site manager at Um Al-Rasas and directed conservation training courses. He teaches excavation and conservation at the Madaba Institute for Art and Mosaic.

Despina Makropoulou studied art and archaeology at the University of Thessaloniki and earned a doctorate in Byzantine archaeology from the University of Athens. She began working for the Greek Archaeological Service in 1979. From 2006 to 2010 she was the director of the newly created Ephorate of Byzantine Antiquities of Thrace (15th EBA) and afterward, until October 2014, headed the Ephorate of Byzantine Antiquities of Thessaloniki (9th EBA).

Dorcia Manconi. Dal 1976 e fino al 2012 Funzionario Archeologo presso la Soprintendenza per i Beni Archeologici dell'Umbria si è occupata della tutela e della ricerca scientifica in numerosi municipi romani alla sinistra del Tevere. Relativamente ad essi ha seguito progetti, scavi, restauri, mostre, diretto i musei statali presenti, collaborato nella ricerca con l'Università di Perugia. Ha inoltre diretto per 5 anni il Museo Archeologico Nazionale di Perugia.

Giuseppe Mantella. Restauratore di beni culturali dal 1994, per conto di numerose Soprintendenze italiane e missioni archeologiche in Israele, Cina, Malta e Albania. Attivo dal 1999 a Malta nel restauro degli interni della Co-Cattedrale di St. John e su opere del pittore Mattia Preti. Curatore di mostre ed eventi ed autore di numerose pubblicazioni scientifiche. Insignito nel 2013 del Cavalierato al merito della Repubblica Italiana per meriti culturali.

Frédérique Marchand-Beaulieu. Entrée au CNRS en 2006 comme assistante ingénieure, Frédérique Marchand-Beaulieu est archéologue et infographiste au sein du laboratoire Aoroc de l'ENS de Paris. Après avoir travaillé pendant dix ans sur des sites en Italie, Croatie, Hongrie ou Grèce, elle a intégré des chantiers CNRS en France, en Algérie, au Maroc ou en Italie où elle travaille régulièrement.

Astrid Maréchaux studied conservation at the University Paris 1 Panthéon-Sorbonne and received a master's degree in conservation of cultural heritage in 2014. She specializes in the conservation of archaeological objects and mosaics and has worked in France and abroad (Cyprus, Serbia, Albania, Croatia, Greece), both on-site and in museums.

Demetrios Michaelides is professor emeritus of classical archaeology at the University of Cyprus, where he was the first head of the Department of History and director of the Archaeological Research Unit. He has published around 130 articles and excavation reports and is the author, editor, or coeditor of nineteen books. He was president of ICCM for the period 1996–2014.

Fatma Naït Yghil. Chargée de recherches en histoire et archéologie romaines à l'Institut National du Patrimoine. Responsable scientifique de la collection de mosaïques au Musée National du Bardo. Diplômes universitaires à la Faculté des Sciences Humaines et Sociales de Tunis : Maîtrise en histoire (2000), Diplôme d'Etudes Approfondies (DEA) en histoire ancienne et archéologie antique (2004), Doctorat en histoire ancienne et archéologie antique (2009).

Roberto Nardi received his degrees in archaeology from the University of Rome and in conservation from the Istituto Centrale per il Restauro, Rome. In 1982 he founded the Centro di Conservazione Archeologica (CCA). He has directed over fifty projects and courses in fourteen countries and has published eighty technical articles. Currently he is president of the ICCM.

Jacques Neguer has an MS degree in engineering science and chemistry from the Polytechnic of Sofia, Bulgaria, and a specialization in mosaics conservation from the ISCR, Rome, Italy. Between 1979 and 1992 he was a conservator in the National Institute for Historical Monuments, Sofia. Since 1993 he has been a conservator in the conservation department of the Israel Antiquities Authority, becoming head of the Art Conservation Section of the department in 1994. He is a member of ICCM and ICOMOS–Israel.

Vojin Nikolić has an MSc in technology engineering. For more than twenty years he has been employed at the Institute for the Protection of Cultural Monuments of Serbia, in the physical-chemical laboratory, where he is currently chief of the Department for Painting. He has worked on the most important cultural monuments in Serbia and on monuments of Serbian culture abroad (Romania, Greece), preparing and implementing conservation and restoration projects and conducting analyses of monuments.

Kassiani Pantazidou has a degree in conservation of antiquities and works of art. She is a mosaics conservator at the Directorate of Conservation of Ancient and Modern Monuments of the Hellenic Ministry of Culture and Sports. She was a member of the conservation team throughout the Olympia mosaics project.

Ewa Parandowska graduated from the Academy of Fine Art, Warsaw, Poland. She headed the Sculpture Conservation Studio of the National Museum, Warsaw (1976–2010). She has extensive experience in archeological conservation through various projects of the Polish Center of Mediterranean Archaeology in Cairo. She has worked in the Mediterranean, Africa, and Asia and has collaborated with ICCROM, Leiden and Uppsala Universities, the Metropolitan Museum, and the American Research Center in Egypt.

Angela Pencheva is a PhD candidate in classical archaeology, HU Berlin. Since 2008 she has been a program manager at the Balkan Heritage Foundation and since its beginning in 2012 she has been project coordinator of the BH and NI Stobi joint project, workshop on documentation and conservation of Roman and late Roman mosaics.

Christos Pilalis studied conservation at the Technological Institute of Athens. Since 1992 he has worked as a conservator of prehistoric and classical antiquities. He is currently head of the conservation of mosaics at the Archaeological Museum of Patras. He has participated in conferences and seminars and has been involved in the installation of archaeological exhibitions in Greece and abroad.

Dimitris Pilalis was born in Patras, Greece. He studied conservation of antiquities and works of art at the Technological Institute of Athens and graduated in 2013. He has worked on the conservation of mosaics in Skala, Kefalonia, and is currently working as a conservator for the Ephorate of Antiquities, Aetolia-Acarnania and Lefkada.

Gian Franco Priori is a technician in the Biology Laboratory of ISCR. He is a scientific scuba diver collaborating with the Underwater Archaeology Operation Unit.

Marijana Protić is a painter and conservator-restorer, with eighteen years of experience as adviser at the Institute for the Protection of Cultural Monuments of Serbia in conservation and restoration of all painting techniques, mosaics, canvas and mural paintings, icons, and frescoes. She graduated from the Faculty of Applied Arts and Design in Belgrade as a painter and also received a master's degree in conservation and restoration.

Montserrat Pugès i Dorca is head of Interventions in Heritage at the Barcelona City Council's Archaeological Service. He has a bachelor's degree in fine arts from the University of Barcelona, specializing in the restoration of archaeological material. He is a founding member of CETEC-Patrimoni, an interuniversity organization dedicated to research on changes to and the conservation of heritage materials.

Erjona Qilla is an archaeologist at Butrint National Park and is involved in several archaeological projects in southern Albania. She is currently finishing a master's degree at Tirana University. She has participated in training courses, including Restoration and Conservation of Archaeological Monuments, University of Bologna; and Conservation and Management of Archaeological Sites with Mosaics, Getty Conservation Institute as part of the MOSAIKON Initiative.

Gaia Quattrociocchi completed a three-year regional course on the restoration of mural paintings in 2006. She received a master's degree in science applied to cultural heritage in 2013, with a study on the ancient masonry of the Maya Devi Temple in Lumbini, Nepal. Since November 2013 she has been in a PhD program in the engineering of materials at the Sapienza University of Rome.

Marie-Patricia Raynaud is a researcher-engineer at the Centre National de la Recherche Scientifique. She is experienced in archaeology and has worked in Albania since 1999. She is co-leader of the team working on the publication of the Corpus of Mosaics of Albania and is the author of various publications on mosaics, including the *Corpus of the Mosaics of Turkey* (2009, 2012).

Hamida Rhouma-Ghmari est architecte, directeur du département des monuments et des sites antiques à l'INP Tunis. Titulaire d'un DESS en Architecture du Patrimoine. Elle élabore des études et pilote des projets de restauration des monuments historiques et de valorisation des sites archéologiques (Dougga, Bulla Regia). Elle est Secrétaire Général du Comité National Tunisien d'ICOMOS, et membre-expert du Comité scientifique international d'ICOMOS des paysages culturels.

Sandra Ricci is a biologist who has worked at the ISCR (Rome) since 1981 where she directs the Marine Biology Area. She received a master's degree in natural science and a PhD in evolutionary biology at the Sapienza University of Rome. Her research focuses on marine bioerosion due to endolithic and epilithic marine organisms affecting submerged archaeological artifacts in the Mediterranean Sea.

Gionata Rizzi is an architect who studied at ICCROM and received an MA from the University of York. He works on architectural conservation projects throughout Italy and abroad, including experimental shelters for Herculaneum and the design of the new shelter over the mosaics of Villa del Casale in Piazza Armerina, Sicily. He has been a consultant for UNESCO, ICCROM, the World Monuments Fund, and the Getty Conservation Institute and has taught at the University of Pennsylvania and the University of Milan.

Thomas Roby is an architectural conservator in the Buildings and Sites Department of the Getty Conservation Institute, where he is manager of the MOSAIKON Bulla Regia Field Project and Technician Training Courses in the conservation of mosaics on sites. He is also an instructor in MOSAIKON courses on the conservation and management of archaeological sites.

Elena Romoli. Architetto Specializzato in Restauro dei Monumenti e Dottore di Ricerca in Conservazione dei Beni Architettonici, è Funzionario Architetto presso il MIBACT, dal 2000 al 2003 in Soprintendenza Beni Architettonici di BS-CR-MN, dal 2004 in Soprintendenza Beni Archeologici di CA-OR. Si occupa del restauro di siti archeologici urbani (Nora, Tharros), di necropoli, nuraghi, di edifici monumentali (Basilica Sant'Andrea, Mantova).

Daniela Rovina, dal 1979 è funzionario archeologo della Soprintendenza Archeologica di Sassari, e dal 2006 dirige il Centro di conservazione e restauro della stessa. Ha diretto diversi scavi ed ha curato numerose pubblicazioni, soprattutto di ambito altomedievale e medievale.

Carlotta Sacco Perasso is a conservation scientist working at the ISCR (Rome) as a research collaborator. She received a master's degree in science and technology for the conservation of cultural heritage at the Sapienza University of Rome. She specializes in marine science.

Abdalsalam S. M. Sadoun has been working as a mosaic restorer for the Department of Antiquities, Superintendency of Cyrene Antiquities, since 2010. In 2012–2013 he attended the MOSAIKON course on conservation of mosaics in situ, held in Tunisia, and in 2014 he attended the Mosaic Conservation Course (MCC) Libya 2014, within the framework of MOSAIKON.

Maria Laura Santarelli is a professor at the Research Centre in Science and Technology for the Conservation of the Historical-Architectural Heritage at the Sapienza University of Rome.

Markus Santner is a restorer in the Austrian Federal Office for Protection of Monuments. His responsibility is supervision of conservation and restoration projects in Austria, as well as working on research projects (standards for documentation in restoration). He has been involved in the projects at the St. John's Chapel in Pürgg, Styria, and the Bishop's Chapel in Gurk, Carinthia.

Juni Sasaki has a PhD in world cultural heritage studies. She is currently a research fellow of the Japan Society for the Promotion of Science at the Center for Conservation Science and Restoration Techniques, National Research Institute for Cultural Properties, Tokyo. She is conducting a mosaic survey in Turkey, focusing on Hagia Sophia and Aya Irini.

Antonino Secchi. Assistente restauratore, dal 1979 nei ruoli del Ministero per i Beni e le attività Culturali e il Turismo, Centro di Restauro di Sassari della Soprintendenza Archeologia della Sardegna. Svolge attività in laboratorio, sul campo in tutto il territorio di competenza e sul patrimonio archeologico sommerso.

Selçuk Şener is a professor of conservation and restoration. He completed his PhD degree at the Department of Art History, Ankara University, in 2000. Previously, in 1989–1992, he undertook studies in the conservation of archaeological materials at Salemi, Sicily, Italy. In 1992 he completed the specialization program on restoration of lapidei materials (ICR, Rome) and in 1996 and 1997 on conservation of mural paintings (CEPMR, Soissons, France).

Daniele Sepio, archaeologist and topographer, is an expert in 3D survey and management of archaeological excavations. He has contributed substantially to excavation and surveying campaigns during archaeological interventions throughout Italy. He was a founding partner of Akhet Srl in 2002.

Eman Mohsen Ahmed Shahawy is an archaeologist with the Ministry of Antiquities in Alexandria, as well as a PhD student in Greek and Roman archaeology, Faculty of Arts, Alexandria University. She is a specialist in mosaics.

Maurice Simon. Deux fois lauréat du concours du Meilleur ouvrier de France en mosaïque (1986 et 1994), il complète sa formation en restauration et en archéologie à l'Université Lyon 2 et intègre en 1989 l'Atelier de restauration de mosaïques de Saint-Romain-en-Gal. Membre de l'ICCM depuis 1990.

Nemanja Smičiklas is a painter and conservator-restorer with twenty years of experience as an adviser at the Institute for the Protection of Cultural Monuments of Serbia in conservation and restoration of all painting techniques, mosaics, canvas and mural paintings, icons and frescoes. He graduated from the Faculty of Applied Arts and Design in Belgrade as a painter and also received a master's degree in conservation and restoration.

Carol Snow is deputy chief conservator and the Alan J. Dworsky Senior Conservator at the Yale University Art Gallery, where she is responsible for conservation of the encyclopedic collections that span ancient to contemporary objects. She also undertakes research, teaches, and serves as mentor to emerging professionals. She has worked on mosaics in the field and in museums.

Georgia Sotiropoulou has a degree in conservation of antiquities and works of art. She is a mosaics conservator in the Directorate of Conservation of Ancient and Modern Monuments of the Hellenic Ministry of Culture and Sports. She has participated in the conservation documentation team of the Olympia mosaics project.

Catherine Stephens is currently an associate research scientist at the Metropolitan Museum of Art in New York. At the time of this project, she was a senior conservation scientist at the Institute for the Preservation of Cultural Heritage (IPCH) at Yale University. She has a PhD in macromolecular science and engineering, and her specialties include studying the degradation and structure-property relationships of polymers.

Ashraf Sulaiman Bulkasim has been a mosaic restorer for the Department of Antiquities, Superintendency of Benghazi Antiquities, since 2010. In 2012–2013 he attended the MOSAIKON course on conservation of mosaics in situ, in Tunisia, and in 2014 he attended the Mosaic Conservation Course (MCC) Libya 2014, held within the framework of MOSAIKON.

Ertugrul Taciroglu earned a BS degree in 1993 from Istanbul Technical University and MS and PhD degrees from the University of Illinois at Urbana-Champaign (UIUC) in 1995 and 1998, respectively. After a stint at the Center for Simulation of Advanced Rockets (UIUC) as a postdoctoral research associate, he joined the Civil and Environmental Engineering Department at the University of California, Los Angeles, in 2001. His research activities span the disciplines of theoretical and applied mechanics and structural and geotechnical earthquake engineering.

Noé Terrapon est spécialisé en conservation-restauration des mosaïques, des fresques et des monuments. Il a travaillé à Ostie comme consultant pour l'Université de Lyon II puis comme responsable de laboratoire dans le cadre de la restauration des fresques, des stucs et des mosaïques. Il est actuellement responsable de ces domaines au Site et Musée Romains d'Avenches et collaborateur associé de l'Université de Liège.

Jeanne Marie Teutonico is currently associate director, Programs, at the Getty Conservation Institute in Los Angeles. An architectural conservator with over thirty years of experience in the conservation of buildings and sites, she was previously on the staff of ICCROM in Rome and of English Heritage in London. Teutonico holds a BA (Hons) in art history from Princeton University and an MSc in historic preservation from Columbia University, Graduate School of Architecture, Planning and Preservation. She is published widely and serves on the board of the ICCM.

Hana Tewfick, diplômée de Chimie, responsable du service de conservation-restauration du Centre d'Etudes Alexandrines (Egypte).

Panagiotis Theodorakeas received a PhD in the field of nondestructive testing from the Materials Science and Engineering Department, National Technical University of Athens. His scientific area of expertise is thermographic nondestructive testing for the characterization of materials and structures. He has been involved with the development of integrated methodologies using different nondestructive testing and evaluation techniques applied to materials and constructions.

Evjeni Thomagjini has worked as a conservator at Butrint National Park and is involved on conservation projects on Roman and Byzantine mosaics. She received a master's degree in cultural heritage and is currently working toward a PhD at Tirana University. She participated in the training programs Conservation and Restoration of Historic Buildings in Romania and Gjirokaster and Disaster Risk Management Plan on World Heritage Sites organized by UNESCO.

Elena Torok is a project conservator at the Yale University Art Gallery. She has an MS in art conservation from the Winterthur/University of Delaware Program in Art Conservation with specializations in objects conservation and preventive conservation.

Pavlos Triantafyllidis is an archaeologist and head of the KB Ephorate of Classical Antiquities, Rhodes, Greece. He received a diploma in archaeology from the University of Ioannina, a master's degree from the Institute of Classical Archaeology, University of Vienna, and a PhD from the University of Ioannina. As a postdoctoral researcher at Athens University, his research focused on the sanctuary of Atavyros Zeus in Rhodes.

Dimitris Tsipotas received a PhD from the Faculty of Design, Crafts and Visual Arts, Brunel University, UK, in 2010. Since 2002 he has worked as a conservator of antiquities and works of art and since 2009 has been teaching conservation of antiquities and works of art in the Department of Wood and Furniture Design and Technology, Technological Educational Institute (TEI), Thessaly, Greece, as well as at public and private vocational training institutes. He has supervised several diploma theses, published in journals, and presented papers at conferences in Greece and abroad.

Elena Vasić Petrović has been acting director of the Institute for the Cultural Heritage Preservation of Nis since 2012. She received the title of architect-conservator in 2005 and a license as a chief designer from the Chamber of Engineers of Serbia in 2007. She is a member of the Society of Conservators of Serbia, the Chamber of Engineers of Serbia, and ICCM.

Frédéric Veyssière. Obtient un DEA de Géologie à Toulouse avant de travailler en Archéologie. Archéologue Inrap, depuis 1987, responsable d'opération en Midi-Pyrénées. Ses principaux travaux portent sur les périodes protohistorique récente (quartier St-Roch à Toulouse) et antique en milieu rural (villae du Barricou à Beauzelle et d'Estoube à Lectoure, balnéaire de Cornebarrieu).

Ioanna Vitsou has a degree in conservation of antiquities and works of art. She is a mosaics conservator in the Directorate of Conservation of Ancient and Modern Monuments of the Hellenic Ministry of Culture and Sports. She has participated in the conservation documentation team of the Olympia mosaics project.

Anjo Weichbrodt est diplômé (MA) en conservation-restauration des surfaces architectoniques de la Scuola universitaria professionale della Svizzera italiana (SUPSI). En 2011 il a été sélectionné pour le Graduate Internship Program du Getty Conservation Institut où il a travaillé pour l'initiative MOSAIKON. Il est régulièrement actif pour le Site et Musée Romains d'Avenches en Suisse et dans le monde Arabe.

Mesut Yılmaz completed a degree on the conservation of cultural properties at Ankara University, Başkent Vocational School, and a degree in architecture at Gazi University. Since 2006 he has been involved in the Magnesia Meandrum Excavation Conservation Project.

Katarina Žagar is the owner of Restoration and Artistic Creation in Domžale, Slovenia.

Lina Završnik is with the Slovenian National Building and Civil Engineering Institute in Ljubljana, Slovenia.

Klejdi Zguro is a conservator for the Archaeological Service Agency, Tirana, Albania. Since 2009 he has worked on many mosaic conservation projects. He has been a member of the in situ mosaic team working on the Corpus of Mosaics of Albania since 2013.

Myriam Ziadé is an archaeologist at the Directorate General of Antiquities in Lebanon and regional manager responsible for the regions of Saïda and south of Mount Lebanon. She received a master's in archaeology from Saint Joseph University–Beirut in 2004. She has participated in several excavations in Lebanon and was responsible for the guided tours in the Musée de Préhistoire, Beirut, from 2000 to 2006.

Chiara Zizola si è diplomata nel 1994 in conservazione dei dipinti, stucchi, mosaici e superfici architettoniche presso l'ICR, Istituto Centrale per il Restauro di Roma (attuale ISCR). Lavora nel CCA, Centro di Conservazione Archeologica di Roma dal 1989, dove ricopre il ruolo di project manager.

Martina Zuena received a master's degree in science and technology for the conservation of cultural heritage from the Sapienza University of Rome in 2014. Her thesis was on the evaluation of mechanical properties of hydraulic binders modified with basalt fibers. She is currently in a PhD program in chemical science at Ca' Foscari University of Venice.

Bernarda Županek is affiliated with the Museum and Galleries of Ljubljana in Ljubljana, Slovenia.

Conference Participants

Name	Surname	Affiliation	Country
Komait	Abdallah	Directorate General of Antiquities and Museums	Syria
Maria Fatima	Abraços	Instituto História ArteUniversidade Nova de Lisboa	Portugal
Dorothy	Abramitis	Metropolitan Museum of Art	United States
Carole	Acquaviva	Restauratrice, indépendante	France
Ali Akın	Akyol	Gazi University	Turkey
Bader Omer	Al-Beraiki	Department of Antiquities	Libya
Livia	Alberti	Consorzio Arkè, Roma	Italy
Yael	Alef	Israel Antiquities Authority	Israel
Basem	Al-Mahmid	Department of Antiquities	Jordan
Mohamad Moutaz	Alshaieb	Directorate General of Antiquities and Museums	Syria
Mashhour A A	Altfiehat	Department of Antiquities	Jordan
Nemr	Al-Zoubi	Department of Antiquities	Jordan
Borhan	Alzraa	Directorate General of Antiquities and Museums	Syria
Elisavet	Anamaterou	Hellenic Ministry of Culture	Greece
Aristodemos	Anastasiades	Ministry of Education	Cyprus
Simonetta	Angiolillo	Università degli Studi di Cagliari, Dipartimento di Storia, Beni Culturali e Territorio	Italy
Paola	Baldassarri	Provincia di Roma, Dip. II, Servizio 2 Manutenzione e ristrutturazione dei beni patrimoniali	Italy
Taieb	Belgasem	Institut National du Patrimoine	Tunisia
Lotfi	Belhouchet	Institut National du Patrimoine	Tunisia
Aïcha	Ben Abed	Institut National du Patrimoine	Tunisia
Beril	Bicer-Simsir	The Getty Conservation Institute	USA
Patrick	Blanc	Musée départemental Arles antique Conseil général des Bouches du Rhône - Direction de la Culture	France
Veronique	Blanc-Bijon	Aix Marseille Université / CNRS, Centre Camille Jullian , Aix-en-Provence	France
Antonietta	Boninu	Former director, Soprintendenza per i beni archeologici per le province di Sassari e Nuoro	Italy
Olivier	Bonnerot	University of Cyprus Archaeological Research Unit	Cyprus
Hana	Bristow	Durham University	England
Julia	Burdajewicz	Faculty of Conservation and Restoration of Works of Art, Academy of Fine Arts, Warsaw	Poland

Name	Surname	Affiliation	Country
Roberto	Cassio	Musei Vaticani	Vatican City
Evelyne	Chantriaux	Conseil Général du Rhône	France
Moheddine	Chaouali	Institut National du Patrimoine	Tunisia
Lorenzo	Chilin	Artandcraft di Lorenzo Chilin, Rome	Italy
Farhani	Chihaoui	Institut National du Patrimoine	Tunisia
Stefania	Chlouveraki	Department of Antiquities and Works of Art Conservation, T.E.I. of Athens	Greece
Skevi	Christodoulou	ICCM, University of Cyprus, Archaeological Research Unit	Cyprus
Maria Rita	Ciardi	L'Officina Consorzio	Italy
Kusi	Colonna-Preti	Independent conservator	Spain
Andreina	Costanzi Cobau	CCA (Centro di Conservazione Archeologica Roma)	Italy
Vesna	Crnoglavac	National Museum in Nis	Serbia
Francesco A.	Cuteri	Soprintendenza Beni Archeologici Calabria	Italy
Gillian	Darley	Independent scholar	UK
Barbara	Davidde Petriaggi	Istituto Superiore per la Conservazione ed il Restauro	Italy
Gael	De Guichen	ICCROM	Italy
Rayna	Decheva	Academy of Arts	Bulgaria
Abdelilah	Dekayir	Faculty of sciences, Moulay Ismail University	Morocco
Kathryn	Drury	MA Candidate, Cultural Material Conservation, University of Melbourne	Australia
Adel	El-Turki	Department of Antiquities, Tripoli	Libya
Sabah	Ferdi	CNRA (National Research Center for Archaeology)	Algeria
Susan	Fox	Roman Baths Museum	UK
Maja	Frankovic	Central Institute for Conservation, Belgrade	Serbia
Leslie	Friedman	The Getty Conservation Institute	USA
Ekaterini	Ftikou	School of Chemical Engineering, National Technical University of Athens	Greece
Amerimni	Galanos	Lithou Sintirissis EPE	Greece
Elizabetta	Garan	l'Institut national de recherches archéologiques préventives	Italy
Gabriella	Gasperetti	Soprintendenza per i beni archeologici per le province di Sassari e Nuoro	Italy
Patrice	Georges	Inrap (Institut national de recherches archéologiques preventives)	France
Raffi	Gergian	Directorate General of Antiquities	Lebanon
Bianca Maria	Giannattasio	Università degli Studi di Genova, Dipartimento di Antichità, Filosofia, Storia	Italy
Fred	Girardet	RINO Sàrl	Switzerland
Cécile	Giroire	Musée du Louvre Département des Antiquités grecques, étrusques et romaines	France
Margarita Maria	Gore		Italy
Francesca	Guiducci	CCA (Centro di Conservazione Archeologica, Roma)	Italy
Anne-Marie	Guimier- Sorbets	Université de Paris Ouest- Nanterre	France
Fryni	Hadjichristophi	Department of Antiquities	Cyprus
Marion	Hayes	Atelier de restauration de mosaiques de St Romain en Gal	France
Nihad	Hendawi	The Jordan Museum	Jordan

Name	Surname	Affiliation	Country
Wasif	Hwari	Yarmouk University	Jordan
Maria Teresa	Iannelli	Soprintendenza per i beni Archeologici della Calabria	Italy
Agron	Islami	Institute of Cultural Monuments	Albania
Monther	Jamhawi	Department of Antiquities	Jordan
Maher	Jbaee	Directorate General of Antiquities and Museums	Syria
Mohammad	Kaeed	Directorate General of Antiquities and Museums	Syria
Anthi	Kaldeli	Department of Antiquities	Cyprus
Vassiliki	Kaltapanidou	9th Ephorate of Byzantine Antiquities of Thessaloniki	Greece
Elena	Kantareva- Decheva	Academy of Music, Dance and Fine Arts	Bulgaria
Electra	Karagiannidou	9th Ephorate of Byzantine Antiquities of Thessaloniki	Greece
Samar	Karam	Directorate General of Antiquities	Lebanon
Theocharis	Katrakazis	European Center for Byzantine and Post-Byzantine Monuments	Greece
Mikal	Kindt	Conservator of fine arts	Belgium
Hande	Kokten	Ankara University	Turkey
Tublu	Komi N'kégbé Fogâ	Centre d'Etudes Linguistiques et Historiques par Tradition Orale Université de Lomé Université de Lomé	Nigeria
Myriam	Krieg	Etat de Vaud Site et Musée Romain Avenches	Switzerland
Maria	Krini	Hellenic Ministry of Culture Directorate of Conservation	Greece
Brigitta Maria	Kürtösi	Hungarian University of Fine Arts	Hungary
Chistophe	Laporte	ARM (Atelier de Restauration de Mosaïques), St Romain-en-Gal	France
Branislava	Lazarevic Tosovic	Central Institute for Conservation, Belgrade	Serbia
Jamel	Lazid	Institut National du Patrimoine	Italy
Luigi	Leurini		Italy
Sílvia	Llobet i Font	Àbac. Conservació- Restauració, S.L.	Spain
Adriana	Lubenova	Plovdiv University	Bulgaria
Alessandro	Lugari	Soprintendenza Speciale per i beni Archeologici di Roma	Italy
Cynthia	Luk	Saving Cultures in Peril	USA
Despina	Makropoulou	9th Ephorate of Byzantine Antiquities of Thessaloniki	Greece
Dorica	Manconi	Archeologa, Libera ricercatrice	Italy
Elisavet	Mantzana	19th Ephorate of Prehistoric and Classical Aniquities Hellenic Ministry of Culture	Greece
Frédérique	Marchand- Beaulieu	CNRS (Centre Nationale de la recherche scientifique)	France
Astrid	Marechaux	Université Paris 1 Panthéon- Sorbonne	France
Sate Ahmed	Masadeh	Department of Antiquities	Jordan
Demetrios	Michaelides	Professor Emeritus of Classical Archaeology, University of Cyprus	Cyprus
Ashraf Bulkasim	Mohammed	Department of Antiquities, Tripoli	Libya
Maria	Molinas i Daví	Àbac.Conservació- Restauració, S.L.	Spain
Fatma	Nait Yghil	Institut National du Patrimoine	Tunisia
Roberto	Nardi	CCA (Centro di Conservazione Archeologica, Roma)	Italy
Jacques	Neguer	Israel Antiquities Authority	Israel

Name	Surname	Affiliation	Country
Vojin	Nikolic	Institute for Protection of Cultural Monuments of Serbia, Belgrade	Serbia
Oussama	Nofal	Directorate General of Antiquities and Museums	Syria
Ziyad Aziz Mohammad	Othman	Department of Antiquities	Jordan
Maryam	Ouali	Etudiante	Belgium
Anis	Oueslati	Institut National du Patrimoine	Tunisia
Kassiani	Pantazidou	Hellenic Ministry of Culture, Directorate of Conservation	Greece
Maria	Papantoniou	University of Cyprus	Cyprus
Ewa	Parandowska	Polish Center of Mediterranean Archaeology in Cairo	Poland
Maria	Parani	University of Cyprus	Cyprus
Angela	Pencheva	Humboldt University, Berlin; Balkan Heritage Foundation	Bulgaria
Andréas	Phoungas	ARM (Atelier de Restauration de Mosaïques), St Romain en Gal	France
Christos	Pilalis	Archaeological Museum of Patras	Greece
Dimitrios	Pilalis	Ephorate of Antiquities, Aetolia-Acarnania and Lefkada	Greece
Stella	Pissaridou	Department of Antiquities	Cyprus
Konstantinos	Politis	Hellenic Society for Near Eastern Studies	Greece
Gianmario	Porcheddu	CCA (Centro di Conservazione Archeologica, Roma)	Italy
Marijana	Protic	Institute for Protection of Cultural Monuments of Serbia, Belgrade	Serbia
Montserrat	Pugès Dorca	Servei d'Arqueologia de Barcelona ICUB	Catalunya
Erjona	Qilla	Butrint National Park	Albania
Flavia	Ravaioli	CCA (Centro di Conservazione Archeologica, Roma)	Italy
Hicham	Rguig	Conservateur au site de Chellah, Ministère de la Culture	Morocco
Hamida	Rhouma	Institut National du Patrimoine	Tunisia
Shannah	Rhynard-Geil	Durham University	UK
Sandra	Ricci	Istituto Superiore per la Conservazione ed il Restauro	Italy
Diamanto	Rigakou	21st Ephorate of Byzantine Antiquities	Greece
Gionata	Rizzi	Studio Architetto Rizzi	Italy
Ahmed	Rjoob	Ministry of Tourism and Antiquities	Palestine
Thomas	Roby	The Getty Conservation Institute	USA
Elena	Romoli	Soprintendenza per i Beni Archeologici di Cagliari e Oristano	Italia
Daniela	Rovina	Soprintendenza per i Beni Archeologici delle Province i Sassari e Nuoro	Italy
Abdalsalam	Sadoun	Department of Antiquities, Tripoli	Libya
Juni	Sasaki	National Research Institute for Cultural Properties, Tokyo	Japan
Y. Selçuk	Şener	Gazi University	Turkey
Mohammad A Y	Sh'Yyab	Department of Antiquities	Jordan
Eman Mohsen Ahmed	Shahawy	Ministry of State Antiquities, Alexandria	Egypt
Hamadi	Sillini	Institut National du Patrimoine	Tunisia
Maurice	Simon	Atelier de Restauration de Mosaïques	France
Nemanja	Smiciklas	Institute for Protection of Cultural Monuments of Serbia, Belgrade	Serbia

Name	Surname	Affiliation	Country
Katherine	Snow	Durham University	UK
Carol	Snow	Yale University	USA
Georgia	Sotiropoulou	Hellenic Ministry of Culture	Greece
Catherine	Stephens	Yale University Institute for the Preservation of Cultural Heritage	USA
John	Stewart	English Heritage	UK
Maria Adreina	Storici	CCA (Centro di Conservazione Archeologica, Roma)	Italy
Ertugrul	Taciroglu	University of California, Los Angeles, Civil & Environmental Engineering Department	USA
Noé	Terrapon	Site et Musée romains d'Avenches	Switzerland
Jeanne Marie	Teutonico	The Getty Conservation Institute	USA
Afroditi	Tiligada	Hellenic Ministry of Culture	Greece
Anna	Tomkowska	Academy of Fine Arts in Warsaw	Poland
Elena	Torok	Yale University Art Gallery, Department of Conservation	USA
Dimitris	Tsipotas	Ephorate of prehistoric and classical antiquities, (Thessaloniki)	Greece
Firas	Tubaishat	Department of Antiquities	Jordan
Elena	Vasic Petrovic	Institute for cultural heritage preservation, Nis	Serbia
Frédéric	Veyssière	Inrap (l'Institut national de recherches archéologiques preventives)	France
Anjo	Weichbrodt	Site et Musée romains d'Avenches	Germany
Denis	Weidmann	Archéologue Cantonal Honoraire	Switzerland
Sehrigul	Yesil-Erdek	Isik University	Turkey
Katarina	Zagar	Restoration and Artistic Creation	Slovenia
Klejdi	Zguro	Regional Directorate of National Culture, Durres	Albania
Myriam	Ziadé	Directorate General of Antiquities	Lebanon
Chiara	Zizola	CCA (Centro di Conservazione Archeologica, Roma)	Italy
Bernarda	Zupanek	Museum and Galleries of Ljubljana	Slovenia

The Getty Conservation Institute

In recent years, as funding for culture and conservation continues to be reduced, we must develop new and innovative approaches to preserving our mosaic heritage. At the twelfth triennial meeting of the International Committee for the Conservation of Mosaics, held in Sardinia in October 2014, leading archaeologists, conservators, and art historians met over five days to address the theme “Conservation and Presentation of Mosaics: At What Cost?” They presented more than eighty papers and posters covering a broad array of issues and a diversity of sites in the Mediterranean region. This volume contains the proceedings of that conference.

Jeanne Marie Teutonico is associate director, Programs, at the Getty Conservation Institute. Leslie Friedman is a project specialist at the GCI. Aïcha Ben Abed is former head of monuments and sites at the Institut National du Patrimoine of Tunisia. Roberto Nardi is president of the ICCM.

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