



King's Research Portal

Document Version

Early version, also known as pre-print

[Link to publication record in King's Research Portal](#)

Citation for published version (APA):

Wootton, W. (2013). Ancient mosaic techniques and modern conservation: An archaeologist's perspective. (pp. 1-11). King's College, London.

Citing this paper

Please note that where the full-text provided on King's Research Portal is the Author Accepted Manuscript or Post-Print version this may differ from the final Published version. If citing, it is advised that you check and use the publisher's definitive version for pagination, volume/issue, and date of publication details. And where the final published version is provided on the Research Portal, if citing you are again advised to check the publisher's website for any subsequent corrections.

General rights

Copyright and moral rights for the publications made accessible in the Research Portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognize and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the Research Portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the Research Portal

Take down policy

If you believe that this document breaches copyright please contact librarypure@kcl.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.

ANCIENT MOSAIC TECHNIQUES AND MODERN CONSERVATION: AN ARCHAEOLOGIST'S PERSPECTIVE

Will WOOTTON, *King's College London*

This is a preprint of the publication with the permission of the author, the editor (Demetrios Michaelides) and the publisher (Centro Regionale per la Progettazione e il Restauro, Palermo).

ANCIENT MOSAIC TECHNIQUES AND MODERN CONSERVATION: AN ARCHAEOLOGIST'S PERSPECTIVE

WILL WOOTTON, *King's College London*

In this article a couple of connected questions are explored. The first asks why information relating to ancient mosaic techniques is useful or significant, while the second looks at what should be recorded and how the resulting data might be interpreted. This inquiry coincides with the aims of the conference as it emphasises the importance of documentation and how it can expand our knowledge of mosaics within their archaeological and historical context¹.

My focus is upon recording during excavation and the subsequent data analysis, with special emphasis on the relationship between mosaics and their makers. This is valid to archaeologists and conservators alike, because operating as a team can ensure a joined-up approach to the overall planning and implementation of a project². The evidence is drawn from a limited number of mosaics, all tessellated pavements. Their choice was not governed by a coordinated sampling strategy, because material was often unavailable for study or access to it was not granted. The findings, therefore, should not be treated as exhaustive. It is not my intention to be prescriptive, but instead to open up a discussion about methods of data collection, their application and interpretation, as well as their dissemination.

Documentation has been at the heart of the ICCM's recommendations since the first conference in Rome³. There have been, however, few attempts to define a series of guidelines for the excavation and conservation of a mosaic, including the variety of recording options available⁴. There is no doubt that

*The research in this paper was carried out during a doctorate at Oxford University under the supervision of Bert Smith and Andrew Wilson. It was funded by a Cyril and Phillis Long Studentship at the Queen's College and travel grants from the Craven Committee. I am indebted to those who kindly provided access to their mosaics: Andrew Wilson and Paul Bennett (Euesperides, Benghazi), Ilan Sharon, Ayelet Gilboa, Ephraim Stern and Andrew Stewart (Tel Dor), and Richard Osgood (Badminton).

1 The first announcement introduced the theme of the conference with the following text: "It aims to stress how through a systematic and full documentation during the process of conservation, one has the occasion to make observations that deepen one's understanding of a mosaic, the technique or techniques involved in its execution, the archaeological context in which it was found and the historical vicissitudes it has experienced".

2 Sease 2003.

3 The fourth and fifth recommendations from the 1st ICCM meeting read: "...when a mosaic is going to be detached, that a complete cross section of its bedding foundation be preserved" and "the encouragement of the documentation of specific cases of destruction, salvage, and restoration": International Committee for the Conservation of Mosaics. Recommendations. <http://www.iccm.ac.cy/index.php?link=recommendations.php> (21st January, 2009). At the 9th ICCM conference the conclusions and recommendations identified a continued need to, "establish systematic documentation standards and protocols to facilitate decision making and to improve practice", see Teutonico and Nardi 2008, 328.

4 For recent work in the field of conservation, see Corfield 2003.

many mosaics are in urgent need of conservation, in particular those currently stored on concrete backings⁵. When this work is undertaken, it is essential to have a documentation strategy in place. In fact, all projects should consider how they intend to record and disseminate their findings and budget accordingly to account for any increase in time and/or expenditure.

One way to encourage good practice is to understand why we record in the first place. By answering this question, we can make the procedure more transparent and purposeful, hence empowering those encountering the mosaic whether from an archaeological or a conservation perspective. The scholarly literature contains excellent examples of complete analyses of many different types of mosaic⁶. These should serve as a benchmark, but are too often 'snapshots of excellence' providing points of detail but unable alone to give the broader picture.

Central to these analyses is the treatment of mosaics as three-dimensional structures, forming an integral part of the architecture to which they belong. Mosaic construction entails two separate, but not necessarily exclusive, areas of expertise: the laying of the bedding and the setting of the tesserae. It is for this simple reason that both should be carefully recorded. Using this approach, it is possible to make a more complex assessment of the technical issues relating to mosaic production, which can then be set within a range of different contexts. A further advantage is that it can be applied to any mosaic: it does not privilege the 'beautiful' or 'iconographically-interesting' and has no limits geographically or chronologically⁷. All mosaics are treated equally as sources for inquiry.

Techniques are important because they are the tangible remains of the process by which a mosaic was made and, hence, provide access to the craftsmen involved in their production. An excellent example is the work carried out at Deir Ain Abata in Jordan⁸. In the mortar bedding of the nave mosaic of the basilica of Agios Lot, footprints were found belonging to an individual or individuals involved in its creation. The thorough excavation and attentive recording preserved a level of detail, which presents a substantial link to the makers. We can then assess what they were doing and why they were doing it. This evidence serves as a reminder that when approaching a mosaic, we should accept that it is a physical object or structure produced by specific people using particular techniques.

In every mosaic many of these indelible marks remain. They are often the only surviving evidence for the mosaicists and, therefore, form the basis for reconstructing their working lives. Through the careful recording of technical

5 de Guichen and Nardi 2008, 13.

6 Recent studies of *emblemata* are a good example: Guimier-Sorbets 2005; Buitrón and Cifuentes 2008; Long *et al.* 2008; Krougly and Monraval 2008.

7 See, for example, the reconstruction of the techniques and working methods used for the nymphaeum of the Villa Litta (Gallone Galassi *et al.* 1987) or the work on the Texaco Road Map pavement presented by Matero *et al.* at this conference.

8 Chlouveraki and Politis 2003, 151, fig. 2.

data and its dissemination, it is possible to move beyond remarks upon individual cases and instead discern the nature of tradition and innovation within a mosaic, whether regionally or chronologically. This will also impact upon our understanding of the variety of modes used for organising the craft. Bearing this in mind, what should be recorded in order to illuminate these issues? One of the key relationships for reconstructing mosaic production is between the materials, their provenance and the context of their use. This applies equally to the surface and the bedding. Studies of tesserae have become more common in the archaeological, conservation and scientific literature⁹. Key components of this work are clear descriptions of the materials studied and an assessment of their provenance. Both depend upon the available means of the project, whether people with the appropriate skills or access to laboratories with the correct equipment. Hence, good project management and planning are necessary.

Results suggest that geographic location and mineralogical properties are the main selection criteria for tesserae¹⁰. Margherita Bergamini and Cesare Fiori suggest two further factors for consideration: “the availability of materials near the work site” and “the possibility they may come from recovery materials”¹¹. A mosaic from Badminton Park in Gloucestershire, dating to the fourth century AD, will serve as an example (Fig. 1)¹². When excavated, this mosaic was covered with Pennant sandstone roof tiles and carbonised material, the remains of the original oak beams. The surface tesserae were easily characterised: the red are terracotta, the purple from Pennant sandstone, and the creamy-white and bluish tesserae from Lias limestone (Fig. 2).

This identification gives an original provenance for the tesserae. The Pennant sandstone may have been quarried close to the site or alternatively from around Bristol or the Forest of Dean. The villa is positioned on a thick band of Oolitic limestone, which is used for the construction of the foundations and walls. Just to the west is a band of Lias limestone, the same as that used for the tesserae¹³. Such a description does not, however, give the whole story. To the south east of the apse, exterior to the walls, was found a sealed deposit containing material relating to the construction of the floors (position indicated by * on Fig. 1). The contents included Pennant sandstone tesserae in various stages of manufacture from roof tiles, terracotta tesserae alongside more roof tiles and possible sections of hypocaust, and Lias limestone tesserae with a single polished side and traces of mortar still adhering to them.

9 For example: Berger and Joos 1971, 45-51, 85-105; Guimier-Sorbets and Nenna 1992; Bollin and Maggetti 1996; Flügel and Flügel 1997; Bergamini and Fiori 1999; Dekayir *et al.* 2008.

10 Bergamini and Fiori 1999, 204-205.

11 Bergamini and Fiori 1999, 205.

12 Cosh 2004, 4; Osgood 2009.

13 British Geological Survey, Sheets 51N 04W Bristol Channel (S), Scale 1:250 000 (1988) and 51N 02W Chilterns (S), Scale 1:250 000 (1991).

Both the Pennant sandstone and the terracotta tesserae can be securely interpreted as recycled from the roofing tiles. Some of the Lias tesserae present a case of re-utilisation rather than recycling. What we might call second-hand. Analysis of the tesserae provided not only a material characterisation but also an insight into the relationship between the craftsmen and their materials. Once placed within the context of the wider building activity, it becomes apparent that they employed stone and terracotta, which were by-products of the construction of the villa, as well as tesserae reused from an earlier pavement. When the floor was completed the leftover tesserae and associated waste were discarded, suggesting a casual relationship between maker and material.

The characterisation of the tesserae leads us to question why particular materials were chosen, where they came from and what happened between their acquisition, working into form and final use in a mosaic. Examination of the surface, however, does not end with material characterisation and should include the recording of tessera density and close analysis of the laying of the tesserae themselves, the *andamento* of which might give visual clues to particular processes in action, whether breaks in laying, the number of people involved and their different approaches, or the structure of the bedding underneath¹⁴.

Investigations into the bedding of any mosaic are dependent on the state of preservation and the planned intervention. The evidence presented here comes from fragmented pavements or those where the damage provided access to the foundations prior to conservation. Like the studies of tesserae, characterisation of the bedding has become increasingly visible in the scholarship¹⁵. It requires a similar attention to detail when recording the size, shape and density of the inclusions as well as the nature of the mortar. Dependency on detailed scientific analyses is at times a necessity.

Excellent results are forthcoming with a variety of different applications. Analyses of ancient mortars are helping to create those with better characteristics for modern conservation¹⁶. Our knowledge of mortar preparation and material acquisition in antiquity is also increasing¹⁷. Furthermore, the identification of differences in mortar composition and the examination of the interfaces between areas of mosaic can provide key evidence for working practices, which may or may not conform to those visible in surface decoration.

The bedding is often the place where important markers of process have been hidden, either unconsciously or consciously. For example guidelines,

14 For example, the seam on the Hellenistic Hunt mosaic from Palermo (see Wootton 2002, 265, fig. 7 on p. 268) or the relationship between the laying of the tesserae and different mosaicists proposed for the Roman mosaic from Augst (Berger and Joos 1971, 51-52).

15 For example, Alberti and Muscolino 2005; Karatasios *et al.* 2005.

16 For example, Macchiarola and Fiorella 2008; Allen *et al.* 2008.

17 For recent work on the characterisation of lime mortars, see Ortega *et al.* 2008.

whether painted or incised on the *nucleus*, indicate that the mosaicists laid out their designs in advance of decorating the surface¹⁸. Such evidence helps us to locate the craftsmen. It places them on site setting their tesserae by hand directly into the mortar and not creating their mosaics elsewhere in an indirect method.

At Euesperides, a site in modern-day Libya with an abandonment date of the mid third century BC, it is possible to propose sequences for the laying of individual mosaics as well as for a whole suite of pavements from a single building (Fig. 3)¹⁹. The surviving fragments indicated that lengths of wood were used as shutters, a means not only of containing the mortar but also of controlling the layout of the design (Figs 4-5). The impressions left by these wooden batons remained in the mortar where it had dried prior to their removal. When the pavements were later disturbed during modern grave digging, they broke along these lines of weakness.

The fragments from Euesperides not only give us a technique but also a process: the floor was laid in situ, directly and from the centre outwards as indicated by the direction of the mortar slumping under the batons. This evidence proves what intuition might tell us: working from the centre out enabled the mosaicist to lay a pavement without constantly walking on the drying or recently-completed surfaces.

During examination of a fragmentary mosaic from Tel Dor, on the coast of modern-day Israel, the same shuttering technique was found as well as a similar process (Fig. 6)²⁰. This pavement dates to around the end of the second century BC and is, therefore, over a century later. Such a coincidence is not necessarily remarkable and nor is it indicative that all mosaics were made in this way. In fact, there are two other floors, the only ones published to my knowledge, which have been interpreted as showing the reverse.

In the *triclinium* of the Atrium House from Antioch, the direction of the sloping mortar between the scroll border and the figured panel indicated that the central field with the Judgement of Paris was laid after the outer scrollwork²¹. The bedding around the Medusa *emblema* from Alexandria also suggests that the pavement was laid first, whether centre out or the reverse is not resolved, and the *emblema* inserted afterwards²². Such differences are key to our understanding of some of the innate processes of mosaic production. Without further evidence, however, it is difficult to propose more wide-ranging theories on different practices in the Hellenistic and Roman periods or in separate areas of the Mediterranean.

Similar process sequences can be inferred from the composition of the

18 Recent finds were presented at this conference by Chantriaux *et al.* and Rogliano and Breuil. 19 Wilson *et al.* 2003, 197-200; Wilson *et al.* 2004, 154-58.20 Stewart and Martin 2003, 138; Wootton 2008, 261.

21 Becker and Kondoleon 2005, 35-36, fig. 27.

22 Guimier-Sorbets 1998, 127-29. A similar process has been proposed for a new *emblema* also from Alexandria, see Guimier-Sorbets 2005, 567-68.

bedding. At Euesperides, all the mosaics had finely-crushed terracotta in their mortar²³. One mosaic (Room 2 on Fig. 3), however, also contained large pieces of terracotta, spread evenly across the foundations. It was the only pavement to do so. A single other pavement (Room 3 on Fig. 3) used large pieces of terracotta for the surface and by inference it might be proposed that the pavement with the terracotta in the bedding was laid after the one with it in the surface: the leftover material being recycled as an aggregate.

A construction deposit, similar to that found at Badminton Park except it was sealed under a lime mortar floor, perhaps the courtyard, confirmed this initial suggestion (position indicated by * on Fig. 3)²⁴. The stratigraphic relationship between the materials showed that the mosaicists completed the two floors furthest from their working surface first (Rooms 2 and 3), before then moving back towards the pavements closest (Rooms 1 and 4). Similar pieces of evidence can be found at sites in Britain, Switzerland and Tunisia, where material from working surfaces has, in the case of Morat-Combette, also been used to assess tool types and cutting techniques²⁵.

Another example comes from Tel Dor, where small white limestone tesserae were found in the bedding of the outer areas of the mosaic (Fig. 7). These tesserae, about 0.3 x 0.3 cm, were much smaller than the tesserae of the adjusting border but exactly the same size as those of the decorative borders and central field. It can be proposed, therefore, that the craftsman completed the inner areas of the pavement first and subsequently discarded tesserae, which were no longer of use to them, under the outer parts.

The nature of the aggregate should not be taken for granted and nor should the mortar. Our two-dimensional drawings, and the ancient literary sources upon which they are often based, lead us to believe that the bedding of a mosaic varies within relatively small degrees²⁶. A generalising approach will flatten out the evidence and miss important details. The mosaic from Badminton Park is a cautionary tale. During investigation into the bedding, accessible where the oak beams had smashed into the floor following destruction, it became clear that the mosaic was laid onto a couple of millimetres of lime mortar set on top of a single layer of compacted sand about 3.5 cm thick (Fig. 8). This, in turn, sat on the natural clay.

The foundations of this pavement are extremely modest, provoking a number of questions. Is there an intended technical advantage, for example sand is used during the laying of modern paving slabs to avoid cracking when they settle? Is this a lower-level commission: a villa owner with ambition but

23 Wilson *et al.* 2003, 200; Wilson *et al.* 2004, 156.

24 Wilson *et al.* 2004, 154-55.25 Britain: Boon 1950, 27; Switzerland: Agustoni 2001; Tunisia: Darmon 1980, 79.

26 Three-dimensional diagrams are beginning to appear, for example a drawing by Haim Kapschitz and modified by Elsa Bourguignon was used in an online publication from the Getty. The Getty Conservation Institute and the Israel Antiquities Authority 2003. Illustrated Glossary: Mosaics In Situ Project. http://getty.edu/conservation/publications/pdf_publications/mosaicglossary.pdf (21st January 2009).

without the finances to pay for the appropriate materials or the best craftsmen? Were the makers multi-skilled individuals, commissioned not only to build the extension but also to complete the decoration of the walls and floors? Or was the sand purposefully hidden by unscrupulous mosaicists taking advantage of a period of increasing wealth, and the desire and aspiration of a villa owner wanting to show off their status with a mosaic?

Technical data provide a different angle with which to approach the material evidence and, in these cases, open up a range of opportunities to situate the construction of the mosaics within a varied contextual framework. There are many possibilities for this work, which do not just impinge on archaeological or scientific research, and the applications mentioned earlier to conservation. Research on techniques can be used with great success within museums, for example, to give the visitor a better understanding of the production history behind the object they are looking at²⁷.

Furthermore, experimental archaeology, such as replica reconstructions, and contemporary mosaic making can enhance our understanding of the applications and implications of these techniques. How was it, for example, laying the lead strips for the reconstruction at Letoon and what does that say about their use in the Hellenistic period?²⁸ Modern mosaicists have a deep knowledge of the practical aspects of mosaic, which should not be underestimated. Collaborative projects with these artists might assess the economics of production by documenting the labour times of skilled practitioners²⁹.

It is essential to document fully, collaborate and share information if we are to attain a more complex and nuanced understanding of ancient mosaic techniques³⁰. The 'snapshots of excellence' need to be augmented before we can answer the broader questions about working practices and tradition in mosaic production, which can, in turn, illuminate the lives of the craftsmen who made the mosaics we work upon. Recording and dissemination are key processes³¹. We should be explicit about why and how we do both, so that there is a clear direction for planning our interventions, preserving the mosaics and the data they contain for future generations as well as expanding our knowledge of antiquity.

27 The gallery of mosaics at the Rheinisches Landesmuseum in Trier includes a display, which shows the various bedding layers of a mosaic and indicates their function (visited in August 2007).

28 Erdek 2008, 398, fig. 3.

29 There has been limited success so far, see the overview in Cookson 1984, 120-22, but the costings in DeLaine 1997, 181, Table 20 on p. 182, for the Baths of Caracalla provide an important step forward.

30 Recent work on data sheets for recording and their online application can be seen in Ghedini and Clementi 2001; Ardovino *et al.* 2005; Clementi 2005; Kniffitz *et al.* 2006.

31 Teutonico and Nardi 2008, 328, refer to the importance of facilitating the sharing of data: "Attention should be given to the development of documentation strategies that permit improved sharing of information, perhaps through more effective use of digital technologies and the Web".

Fig. 1: Mosaics from the apse-ended room and adjoining corridor, Badminton Park, Gloucestershire, England. * indicates the position of the construction deposit (Photogrammetric survey. Downland Partnership. By courtesy of South Gloucestershire Council).

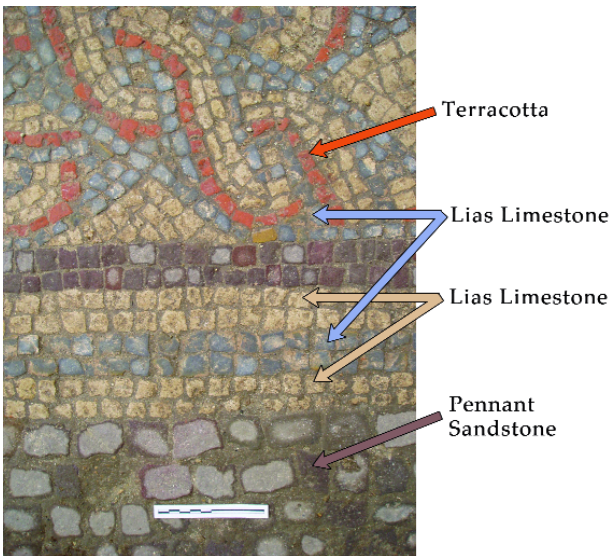


Fig. 2: Detail of the mosaic in the apse-ended room showing material types, Badminton Park. 10 cm scale (Photo: W.T. Wootton).

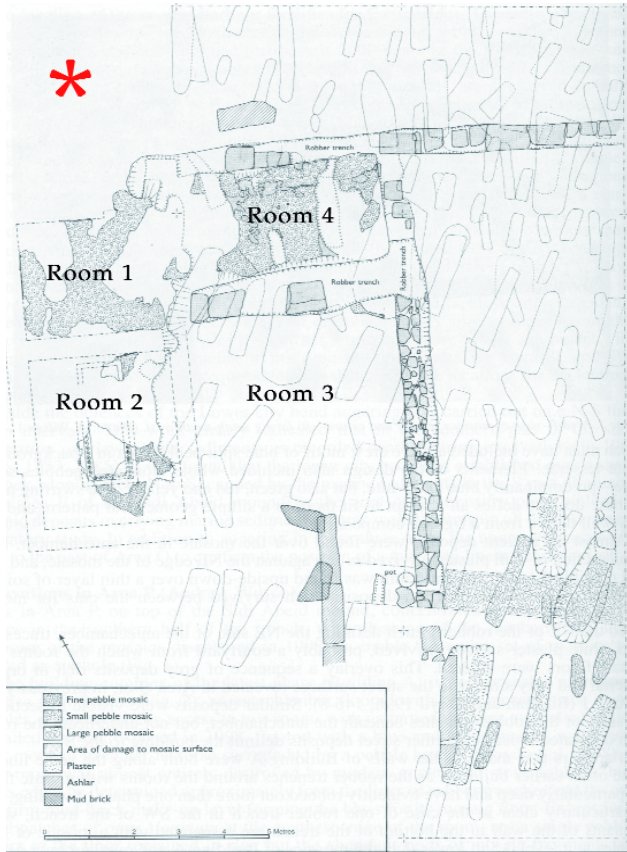


Fig. 3: Plan of the final-phase Building A, Euesperides (Benghazi), Libya. * indicates the position of the construction deposit (after Wilson *et al.* 2001, fig. 2).

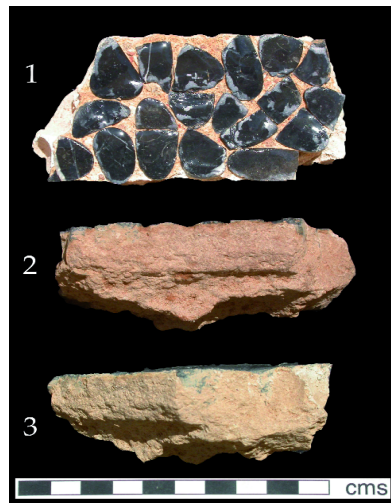


Fig. 4: Fragment from the outer black band showing the use of shuttering, Room 3, Building A, Euesperides. 1. Surface; 2. Side profile; 3. Angled profile (Photos: W.T. Wootton).

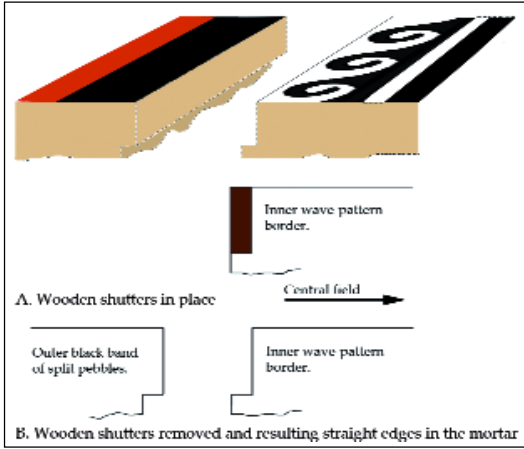


Fig. 5: Reconstruction drawings of the shuttering used between the wave-pattern border and the black band, Room 3, Building A, Euesperides (Drawings: W.T. Wootton).

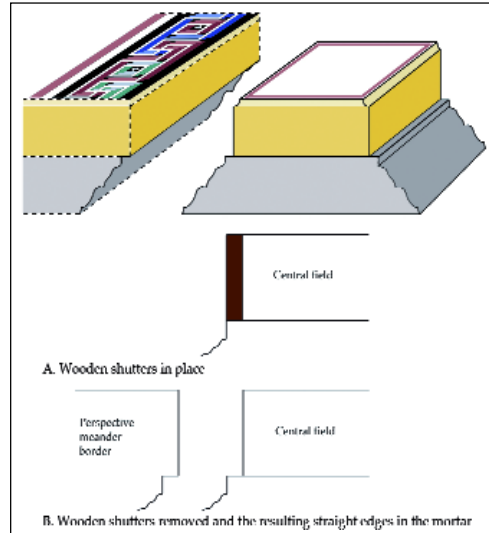


Fig. 6: Reconstruction drawings of the shuttering used between the central field and the perspective meander border, Dora (Tel Dor), Israel (Drawings: W.T. Wootton).

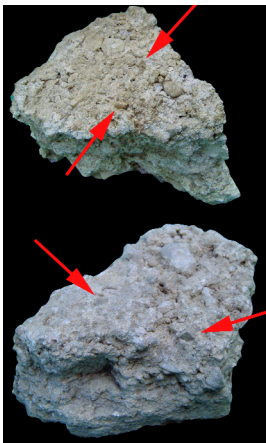


Fig. 7: Small tesserae in the base of the mortar bedding of two fragments from the outer border of orthogonal tessellation, Dora (Tel Dor) (Photos: W.T. Wootton).

Fig. 8: Detail of the bedding from the mosaic in the apse-ended room, Badminton Park. 10 cm scale (Photo: W.T. Wootton).

BIBLIOGRAPHY

- Agustoni, C., 2001, « Tesselles et déchets de taille à Morat-Combette », in D. Paunier and C. Schmidt (éds), *Actes du VIIIème Colloque International pour l'étude de la mosaïque antique et médiévale, Lausanne (Suisse): 6-11 Octobre 1997*, Lausanne, 480-89.
- Alberti, L. and Muscolino, C., 2005, "The conservation of the mosaics of San Vitale in Ravenna, Italy, 1989-1999: construction technique and treatment methodology", in Bakirtzis 2005, 169-80.
- Allen, G.C., Edwards, D.D., Ciliberto, E. and La Delfa, S., 2008, "The medieval mosaics in St Mark's Basilica, Venice. An investigation into lime mortar/tesserae adhesion", *The Journal of the Building Limes Forum* 15, 8-14.
- Ardivino, A.M., Gagetti, E. and Masseroli, S., 2005, "Una scheda come strumento di tecnologie esecutive e di successioni di restauri nel mosaico antico", in Bakirtzis 2005, 245-53.
- Bakirtzis, Ch. (ed.), 2005, *Wall and Floor mosaics: Conservation, Maintenance, Presentation, VIIIth Conference of the International Committee for the Conservation of Mosaics (ICCM), Thessaloniki 29 October-3 November 2002*, Thessaloniki.
- Becker, L. and Kondoleon, C., 2005, *The arts of Antioch: art historical and scientific approaches to Roman mosaics and a catalogue of the Worcester Art Museum Antioch collection*, Worcester, Mass.
- Ben Abed, A., Demas, M. and Roby, T. (eds), 2008, *Lessons Learned: Reflecting on the Theory and Practice of Mosaic Conservation: Proceedings of the 9th ICCM Conference, Hammamet, Tunisia, November 29-December 3, 2005*, Getty Conservation Institute, Los Angeles.
- Bergamini, M.L. and Fiori, C., 1999, "Characterization of limestones, marbles and other stones used in ancient mosaics", in M. Schvoerer (éd.), *Archéomatériaux: marbres et autres roches. Actes de la IVème Conférence Internationale de l'Association pour l'étude des marbres et autres roches utilisés dans le passé, Bordeaux, France, 9-13 octobre 1995*, Talence, 199-207.
- Berger, L. and Joos, M., 1971, *Das Augster Gladiatorenmosaik*, Augstz B.L.
- Bollin, R. and Maggetti, M., 1996, "Petrographic and isotopic evidence in provenance studies of tesserae from the Galloroman villa, Vallon, Fribourg, Switzerland", in S. Dermirci, A.M. Özer and G.D. Summers (eds), *Archaeometry 94, the Proceedings of the 29th International Symposium on Archaeometry, Ankara 9-14 May 1994*, Ankara, 197-202.
- Boon, G.C., 1950, "The Roman Villa in Kingsweston Park (Lawrence Weston Estate) Gloucestershire", *Transactions of the Bristol and Gloucestershire Archaeological Society* 69, 5-58.
- Buitrón C.M. and Cifuentes, M.A.M., 2008, « Conservation d'un ensemble d' *emblemata* du Musée Archéologique National », in Ben Abed, Demas and Roby 2008, 75-84.
- Chlouveraki, S.N. and Politis, K.D., 2003, "The documentation and conservation of the nave mosaic in the basilica of Agios Lot at Deir Ain Abata, Jordan", in Michaelides 2003, 149-56.
- Clementi, T., 2005, "Una banca dati computerizzata per il mosaico: risultati del test sui pavimenti Romani di Padova (Italia)", in Bakirtzis 2005, 255-64.
- Cookson, N.A., 1984, *Romano-British Mosaics: a reassessment and critique of some notable stylistic affinities* (BAR British Series 135), Oxford.
- Corfield, M., 2003, "A framework for the documentation of *in situ* mosaic conservation projects", in Michaelides 2003, 123-48.
- Cosh, S.R., 2004, "Roman mosaics in 2003", *Mosaic: the journal of the Association for the Study and Preservation of Roman Mosaics* 31, 4-5.
- Darmon, J.-P., 1980, *Nymfarum domus : les pavements de la maison des nymphes à Néapolis (Nabeul, Tunisie) et leur lecture*, Leiden.
- De Guichen, G. and Nardi, R., 2008, "Mosaic conservation: fifty years of modern practice", in Ben Abed, Demas and Roby 2008, 9-14.
- Dekayir, A., Amouric, M., Olives, J. and Chergui, A., 2008, "Study of the mineralogical and chemical characteristics of materials used in the construction of Roman mosaics in Volubilis, Morocco, with a view toward their conservation", in Ben Abed, Demas and Roby 2008, 348-53.
- DeLaine, J., 1997, *The Baths of Caracalla: a study in the design, construction, and economics of large-scale building projects in imperial Rome*, Portsmouth, RI.
- Erdek, S.Y., 2008, "The lifting of a mosaic from the site of Letoon and its replacement with a replica", in Ben Abed, Demas and Roby 2008, 397-401.
- Flügel, E. and Flügel, C., 1997, "Applied microfacies analysis: provenance studies of Roman mosaic stones", *Facies* 37, 1-48.

- Gallone Galassi, A., Rezende De Castro, S., Rosa, M. and Formica, L., 1987, "Conservation works and scientific investigations of pebble mosaics of Villa Litta in Lainate (Milan)", in *ICCM IV: Mosaicos No. 4: Conservación in situ, Soria 1986*, Madrid 1987, 299-319.
- Ghedini, F. and Clementi, T., 2001, "Proposta di scheda informatizzata per una banca dati sul mosaico", in A. Paribeni (ed.), *Atti del VII Colloquio dell'Associazione italiana per lo studio e la conservazione del mosaico, Pompei, 22-23 marzo 2000*, Ravenna, 661-72.
- Guimier-Sorbets, A.-M., 1998, « Le pavement du triclinium à la Méduse dans une maison d'époque impériale à Alexandrie », in J.-Y. Empereur (éd.), *Alexandrina 1 – Études alexandrines* 1, Cairo, 115-39.
- Guimier-Sorbets, A.-M., 2005, « Un nouvel embléma Alexandrin (terrain du Patriarcat grec orthodoxe) », in H. Morlier (éd.), *La mosaïque gréco-romaine IX* (Collection de l'École française de Rome 352), Paris, 567-77.
- Guimier-Sorbets, A.M. and Nenna, M.-D., 1992, « L'emploi du verre, de la faïence et de la peinture dans les mosaïques de Délos », *Bulletin de correspondance hellénique* 116, 607-31.
- Karatasios, I., Theoulakis, P., Colston, B., Watt, D., Lampropoulos, V. and Kilikoglou, V., 2005, "Analytical and microscopic techniques for the study of mortars from the floor mosaics of Thebes, Greece", in Bakirtzis 2005, 209-22.
- Kniffitz, L., Grimaldi, E., Maino, G. and Ferriani, S., 2006, "Per una base di dati multimediale in rete dedicata al mosaico", in C. Angelelli (ed.), *Atti del XI Colloquio dell'Associazione italiana per lo studio e la conservazione del mosaico, Ancona, 16-19 febbraio 2005*, Tivoli, 23-30.
- Krougly, L. and Monraval, J.M., 2008, « Un embléma provenant d'Utique conservé au Musée du Louvre », in Ben Abed, Demas and Roby 2008, 362-64.
- Long, L., Blanc-Bijon, V., Blanc, P. and Courboules, M.-L., 2008, « L'embléma découvert en mer, au large d'Agde : technique de fabrication – traitement de conservation », in Ben Abed, Demas and Roby 2008, 340-43.
- Macchiarola, M. and Fiorella, G., 2008, "The study of hydraulic lime mortars for the conservation of mosaics", in Ben Abed, Demas and Roby 2008, 273-80.
- Michaelides, D. (ed.), 2003, *"Mosaics make a site": The Conservation in situ of Mosaics on Archaeological Sites. Proceedings of the VIth International Conference of the International Committee for the Conservation of Mosaics, Nicosia, Cyprus 1996*, ICCROM Rome.
- Ortega, L.A., Zuluaga, M.C. and Alonso-Olazabal, A., 2008, "Geochemical characterisation of archaeological lime mortars: provenance inputs", *Archaeometry* 50.3, 387-408.
- Osgood, R., 2009, "The first Badminton House: discovery of a Late Roman mosaic in South Gloucestershire", *Transactions of the Bristol and Gloucestershire Archaeological Society*, 127, 205-13.
- Sease, C., 2003, "Planning for conservation of an *in situ* mosaic, before, during and after an excavation", in Michaelides 2003, 67-82.
- Stewart, A. and Martin, S.R., 2003, "Hellenistic discoveries at Tel Dor, Israel", *Hesperia: the journal of the American School of Classical Studies at Athens* 72, 121-45.
- Teutonico, J.M. and Nardi, R., 2008, "Summary conclusions and recommendations", in Ben Abed, Demas and Roby 2008, 327-29.
- Wilson, A.I., Bennett, P., Buzaian, A.M., Buttrey, T.V., Fell, V., Found, B., Göransson, K., Guinness, A., Hardy, J., Harris, K., Helm, R., Kattenberg, A., Morley, G., Swift, K., Wootton, W. and Zimi, E., 2003, "Euesperides (Benghazi): preliminary report on the spring 2003 season", *Libyan Studies* 34, 191-228.
- Wilson, A.I., Bennett, P., Buzaian, A.M., Fell, V., Found, B., Göransson, K., Guinness, A., Hardy, J., Harris, K., Helm, R., Kattenberg, A., Tébar Megias, E., Morley, G., Murphy, A., Swift, K., Twyman, J., Wootton, W. and Zimi, E., 2004, "Euesperides (Benghazi): preliminary report on the spring 2004 season", *Libyan Studies* 35, 149-90.
- Wootton, W.T., 2002, "Another Alexander mosaic: reconstructing the Hunt mosaic from Palermo", *Journal of Roman Archaeology* 15, 264-74.
- Wootton, W.T., 2008, "Piecing it back together: the fragmentary Hellenistic *vermiculatum* mosaic from Tel Dor", in D.C. Kurtz, C. Meyer, D. Saunders, A. Tsingarida and N. Harris (eds), *Essays in Classical Archaeology for Eleni Hatzivassiliou 1977-2007*, Oxford, 259-68.