PART FOUR

Managing Sites with Mosaics

Conservation and Preservation of Mosaics in Syria: The Case for a Multidisciplinary Approach—or New Strategies for Old Problems

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Abstract: *Syria is a repository for a phenomenal catalogue of cultural heritage that includes a unique and rich corpus of mosaics. Yet today this corpus presents daunting challenges—an entrenched policy of mosaic removal rather than in situ preservation, poor storage conditions, out-of-date conservation techniques, and limited record keeping—for which traditional methods are not always viable. Several new projects have been initiated that include local awareness-raising to encourage in situ preservation and the use of databases for the recording of both new mosaic finds and those on display and in storage. This approach will provide a better understanding of the underlying problems and more effective means to deal with them.*

Résumé : *La Syrie renferme un patrimoine culturel phénoménal comprenant un riche corpus de mosaïques qui aujourd'hui se trouve confronté à des défis considérables – une politique préconisant la dépose des mosaïques plutôt que leur préservation* in situ, *des mauvaises conditions de stockage, des techniques de conservation dépassées, peu d'enregistrement de données – contre lesquels les méthodes traditionnelles ne sont pas toujours appropriées. Plusieurs projets ont été lancés notamment pour encourager la préservation* in situ *et l'utilisation de bases de données pour enregistrer les nouvelles découvertes ainsi que les mosaïques exposées et en réserve. Cette approche permettra une meilleure connaissance des problèmes et des moyens plus efficaces pour les résoudre.*

Syria is a repository for a phenomenal catalogue of cultural heritage, which is the product of a long history of interaction with its neighbors and the region as a whole. An important part of this heritage is a unique and rich corpus of mosaics. There are literally thousands of square meters of Classical- and Byzantine-period mosaic pavements in Syria, which come from public buildings, churches, and private houses. Although some can still be seen in situ, many more have been lifted and even more still lie safely buried and undisturbed in the ground. Of those that have been lifted, only a few are on public view in museums; most are in storerooms awaiting conservation. This corpus presents a daunting challenge in terms of conservation and preservation, in a country where traditional, tried and tested methods are not always viable.

Therefore, it is of vital importance that the management of mosaics and archaeological sites rich with mosaic floors become part of a common strategy of cooperation between the institutional partners and local stakeholders. One of the hoped-for outcomes of the programs outlined in this paper is to present the General Department of Antiquities and Museums (DGAM) with a new strategic approach aimed at improving the integrated management of the mosaic corpus in Syria as well as the sites where they are discovered.

In a paper presented at the conference on mosaics conservation held in 2003 at Piazza Armerina in Sicily, I outlined some of the problems related to the management and preservation of mosaics in Syria (Al-Azm 2004). One of these is that the treatment of choice for the majority of new mosaic discoveries is removal. The main reason for this is the lack of available resources to provide physical protection in the form of a structure to protect mosaics from the elements or a guard to prevent theft or vandalism. Furthermore, as a result of this policy, over a period of forty to fifty years Syria has acquired a backlog of untreated mosaics amounting to a recently revised figure in excess of 6000 square meters and growing, as new discoveries are made every year. Until very recently the most common method of mosaics management in Syria was still removal rather than preservation in situ, and the majority of these mosaics continue to be stored in very poor conditions similar to those described in 2003 (fig. 1).

Since mosaics represent one of the main assets of Roman and Byzantine archaeological sites in Syria, particularly due to their intrinsic historical and artistic value, it is crucial to tackle immediately and effectively the problems of continuing removal, poor storage conditions, and inappropriate conservation methods. The approach being proposed here is a multidisciplinary one based on a strategy that concentrates on the concept of integrated heritage management. It is only through such an integrated management system that these problems may begin to be resolved in a sustainable manner that will eventually permit on-site preservation. Sustainability is critical to the success of any proposed programs and can only be achieved through the tapping of the sites and their local communities for their full potential in terms of socioeconomic development.

For this reason, the approach aims to involve local stakeholders and professionals at all levels. It is hoped that, in addition to providing a better understanding of the causes of these underlying problems and more effective means of dealing with them, a national strategy may be put in place and implemented. Ultimately, for any such national strategy to succeed it will need to incorporate most, if not all, of the following points: (1) the encouragement and marketing of local, typical products related to the history and culture of the area or region as a means of sustainable development; (2) raising awareness about the positive effects of business and employment opportunities related to cultural heritage; (3) training and capacity building in both the public and private sectors regarding the preservation, management, marketing, and promotion of cultural heritage, both objects and sites; and (4) increasing cooperation both among the various institutional partners and with the local stakeholders.

To achieve these aims, the following projects are being implemented in Syria today:

- Recruitment and training of local mosaic conservators.
- Participation in national and regional training workshops.
- Improvement of storage conditions.
- Banning the use of reinforced cement.
- Purchasing and using new and more appropriate materials.
- Encouraging in situ preservation.
- Encouraging local stakeholder participation and education.
- Encouraging and supporting local business initiatives relating to the cultural heritage of the area or region.
- Creating a working Corpus of Syrian Mosaics.

(a) (b)

FIGURE 1 Examples of poor storage conditions: (a) stacking of faced fragments with no supports; and (b) loose tesserae and fragments of damaged relaid panel. Courtesy of Department of Antiquities and Museums (DGAM), Syria.

Several intensive training programs in mosaic restoration and preservation have been instituted in order to build a dedicated core of conservators to carry out the required work and to act as a nucleus for training additional people as the need arises. These programs were organized at the local level within the Science and Conservation Laboratories of the DGAM as well as at the regional and international levels, for example, the Bilad Al-Sham mosaic restoration training programs (Hamdan and Benelli 2005). The Bilad Al-Sham program, which included intensive courses on ancient mosaic restoration and awareness-raising activities on the importance of preserving cultural heritage, involved the antiquities departments of Syria, Lebanon, and Jordan and was supported by the European Union. Furthermore, with the use of cement banned, lighter composite durable frames are now employed using materials such as Aerolam® (an aluminum and fiberglass sandwich panel). The most recent efforts are devoted to encouraging and promoting in situ preservation. These include an element aimed at increasing the awareness of local communities as to the value of having the mosaics preserved and displayed locally. This is being achieved through education projects and stakeholder participation highlighting the benefits of in situ preservation.

A pilot project for stakeholder participation is being carried out at Maarrat Al-Numan in northern Syria. Maarrat Al-Numan lies in a mosaic-rich area and has a long history of being associated with the production of mosaics. It was the location of an important workshop for the local production of mosaics in the Roman and Byzantine periods. Today there are a number of workshops in and around Maarrat that still produce mosaics that are sold and exported all over the world, in addition to the less than reputable pastime of illegal removal of mosaics. The reason for the latter activity is linked to a large extent to the practice of removal by the DGAM. Local people realize that any discovered mosaic is likely to be removed, and therefore they will gain no benefit from it. Furthermore, since most of these mosaics are located in their fields, near their homes and backyards, local people feel entitled to some benefit from them, which justifies their illicit removal of mosaics. Thus a vicious cycle of removal for protection by the authorities and removal for gain by the inhabitants is perpetuated. A new initiative aimed at local education and stakeholder participation is being tried at Maarrat to break this cycle.

The value of in situ preservation has not been lost on the local people. They are coming to recognize that it is to their advantage if visitors are able to see the mosaics in their original setting on-site and then visit the local workshops, where they may be able to purchase copies. Thus, by involving local stakeholders, we are encouraging sustainable means of income generation based on the concept of in situ preservation, thereby preventing the killing of the goose that lays the golden egg.

Another example of this new approach is an ongoing joint project of the Centre for Archaeological Research at the University of Damascus and the European Centre for Byzantine and Post Byzantine Monuments (EKBBM). The project has two main aims:

- To establish a working database with which to fully document mosaic pavements on-site and in storage in museums in Syria using modern methods.
- To conduct a training course for Syrians to carry out this process.

The end product should be the publication of a usable corpus of mosaics of Syria for future analysis and study.

The project began with eight students being chosen from the University of Damascus for training. Their program included formal lectures and practical sessions in archaeology, art history, conservation, documentation, and management. Once the initial phase of their training was completed, the students were required to begin gathering and recording information about the mosaics (fig. 2). (See also Politis, Al-Azm, and Bakirtzis, this volume.)

FIGURE 2 Training of University of Damascus students. Photo courtesy of Department of Antiquities and Museums (DGAM), Syria.

FIGURE 3 Copying surface patterns. Courtesy of Department of Antiquities and Museums (DGAM), Syria.

FIGURE 4 Measuring dimensions. Courtesy of Department of Antiquities and Museums (DGAM), Syria.

The recording process aims to gather all available information on mosaic pavements in Syria, both treated and untreated, including those that have been conserved and are on display in situ or in museums and those that are in storage, as well as those that have had no intervention beyond being removed and stored (figs. 3, 4). The main sources of information are mosaic pavements on display or in storage. In addition, records kept by the DGAM are used when available. These records include original site plans and photographs of the mosaics in situ prior to their removal (fig. 5). However, this documentation procedure is not intended to include comprehensive analyses, such as art historical analysis, but rather act as an aid for that purpose.

For optimal data storage and management, a relational database was created using Microsoft Access and designed to allow data to be recorded, retrieved, searched, compared, and cross-referenced quickly and accurately. The information can then be made widely available by permitting access to the database through the Internet. The database includes information on the following: the building from which the mosaic was

FIGURE 5A, B Examples of original in situ mosaic photographs. Courtesy of Department of Antiquities and Museums (DGAM), Syria.

(a)

(b)

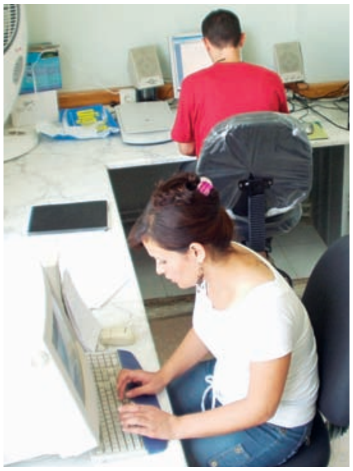

FIGURE 6A Data entry in the database. Courtesy of Department of Antiquities and Museums (DGAM), Syria.

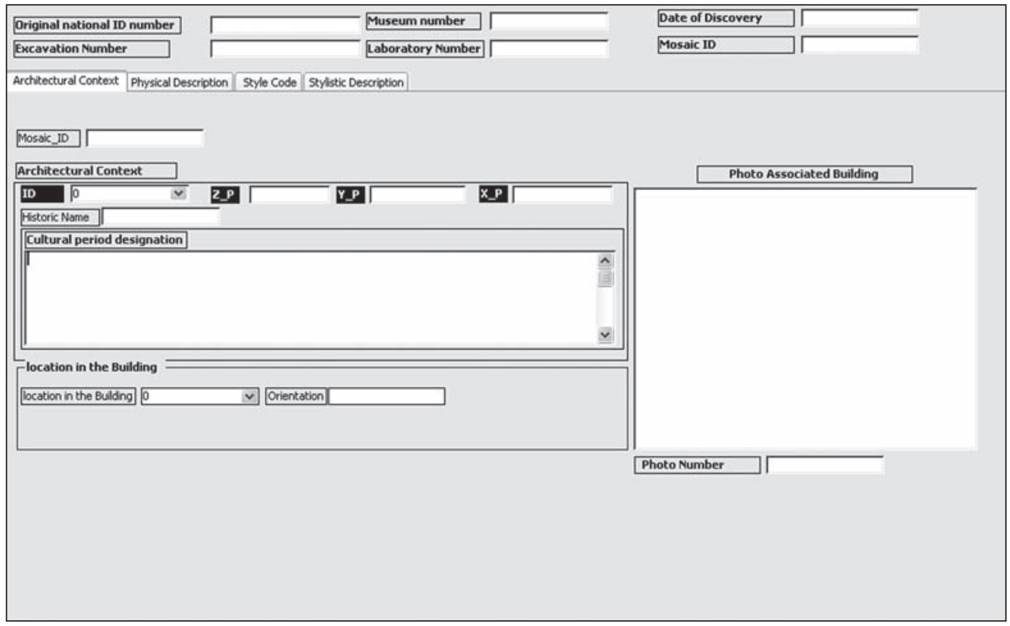

FIGURE 6B Database data entry form. Courtesy of Department of Antiquities and Museums (DGAM), Syria.

recovered (architectural context); the condition of the mosaic; a physical description; a stylistic description; and other information such as dates and publications (figs. 6a, 6b).

The training and recording phases of this project are ongoing. The data are being entered into the database, which is still in its testing stages, by the trainees. It is hoped that one of the outcomes of this project will be a risk map of existing mosaics both in storage and in situ that can be used as a basis for the establishment of an intensive restoration and preservation program to eliminate the massive backlog of stored mosaics, both restored and unrestored, as well as promote new management policies aimed at encouraging and supporting in situ conservation.

In conclusion, it is hoped that through outlining existing problems and the application of a multidisciplinary approach that includes projects such as those outlined above and stakeholder participation as an integral part of its methodology, we may finally begin to see a change in how cultural heritage management in general and mosaic preservation in particular are being dealt with in Syria.

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Um Er-Rasas (Um Al-Rasas): Preservation of the Mosaics at a New World Heritage Site in Jordan

Mervat Ma'moun Ha'obsh

Abstract: *In 2004 the site of Um Er-Rasas was added to the World Heritage List because it represents a masterpiece of the human creative genius, given the artistic and technical qualities of the mosaic floor of the Church of St. Stephen. The existing shelter that covers the church does not provide suitable protection for the mosaics. Therefore, the Ministry of Tourism, with the help of the European Commission, made the decision to construct a new shelter. Numerous studies were first undertaken to identify the critical issues and parameters that should be considered prior to the shelter's design and construction. These include a topographical survey, a geophysical survey using various methods (gravity, magnetic and resistivity, and ground penetrating radar [GPR]), and collection of data regarding climatic conditions, wind loads, the enclosed shelter environment, earthquakes, and water drainage.*

Résumé : *En 2004, le site d'Um Er-Rasas a été inscrit sur la Liste du patrimoine mondial à titre de chef-d'œuvre du génie créateur humain pour les qualités artistiques et techniques du pavement en mosaïques de l'église de St Stéphane. L'abri qui recouvre actuellement l'église ne protège pas correctement les mosaïques et le Ministère du Tourisme, soutenu par la Commission européenne, a donc décidé la construction d'un nouvel abri. De nombreuses études ont d'abord été entreprises pour identifier les questions et paramètres essentiels à prendre en compte avant la conception et la construction de l'abri – notamment étude topographique, examen géophysique utilisant diverses méthodes (gravité, magnétisme et résistivité, et radar géologique [GPR]), avec collecte des données relatives aux conditions climatiques, charges de vent, environnement sous abri fermé, tremblements de terre et drainage des eaux.*

Um Er-Rasas (Kastron Meffa) is a village in southeastern Jordan known for its archaeological remains from the Roman, Byzantine, and early Islamic periods (end of third to ninth century C.E.). It is situated about 30 kilometers southeast of Madaba and north of Wadi Mujib-Arnon, about 12 kilometers west of the modern Desert Highway (Amman-Aqaba Highway). The site was located along the Roman commercial "New Trajan" road, which joined Bosra Al-Sham in the north with Ayla (Aqaba) in the south, passing through Philadelphia (Amman).

The first explorer of Jordan, U. Seetzen, recorded the site in 1807. In February 1872 H. B. Tristram camped at Um Al-Rasas and accurately described the ruins. It was not until 1896, however, that S. Vailhe realized that the large city could be a Roman camp. Based on this notion, J. Germer-Durand identified the ruins as the biblical Mefa'at which, according to Eusebius, was a Roman military station.

In 1986 archaeological work began at the site, which provided epigraphic evidence for the identification of the site as Kastron (Fort) Mefea, a toponym known from Roman and Arabic sources and from the Bible (Piccirillo 1993: 232). The remains that were discovered are primarily from the Iron Age (seventh–sixth centuries B.C.E.) and the Nabataean (third century B.C.E.–106 C.E.), late Roman (third–fourth centuries), late Byzantine (sixth century), and Abbasid (750–1258) periods.

The name "Um Al-Rasas" is related to the arabic root *rass*, meaning the action of putting something on top of something else in perfect alignment, in this case, a strong wall that was built of stones laid over each other. The visible remains of a well-fortified camp of about 10 hectares corresponds to the fortress of Mefa'at. Adjacent to the walled area, to the north, is an open quarter, called the Northern settlement, roughly the same size as the fortress. Eleven of the site's fourteen churches have been excavated. Several contained extraordinary mosaic pavements that have made the site famous. In addition, the stylite tower—named for the monastic movement symbolized by St. Simeon the Stylite—an exceptional monument more than 13 meters high, is well preserved. The tower is the only intact monument from this monastic movement. It is affiliated with a small church and a series of other buildings. Old agricultural fields between this group of buildings and the castrum are exceptionally well preserved.

In 2004 Um Al-Rasas was inscribed on the World Heritage List based on the following criteria: (i) it "represents a masterpiece of the human creative genius, given the artistic and technical qualities of the mosaic floor of St. Stephen's church"; (iv) it "presents a unique and complete example of stylite towers"; and (vi) it "is strongly associated with monasticism and the spread of monotheism, including Islam, in the whole region" (World Heritage Center 2004).

The Existing Shelter

The St. Stephen complex within the site consists of four churches: the Church of St. Stephen, the Church of Bishop Sergius, the Church of the Aedicula, and the Church of the Courtyard (fig. 1). The floors of the Churches of St. Stephen and Bishop Sergius are paved with exceptional ancient Byzantine mosaics (fig. 2). All of the Church of St. Stephen and the choir of the Church of Bishop Sergius have been protected by a closed, covered superstructure. So far this has helped not only to protect and conserve the mosaics but also to provide public access to them. Constant and regular visitation has given a

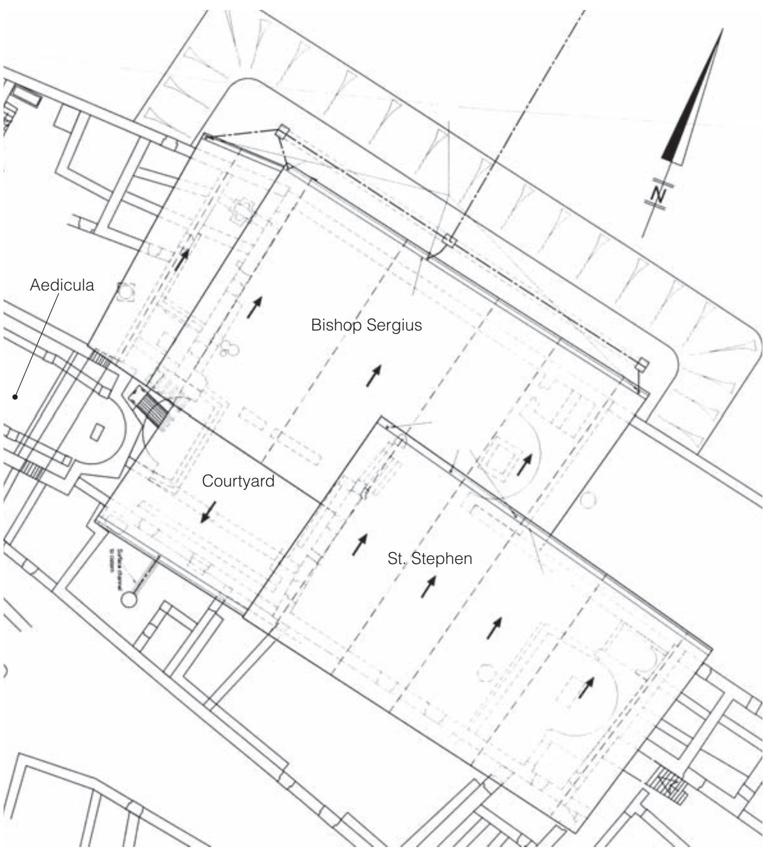

FIGURE 1 The St. Stephen's complex and proposed drainage system. Courtesy of Halcrow Group, Ltd.

FIGURE 2 The mosaics of the Church of St. Stephen. Photo by Mervat Ma'moun Ha'obsh.

FIGURE 3 The existing shelter structure. Photo by Mervat Ma'moun Ha'obsh.

certain celebrity status to the site, its religious buildings, and their beautiful mosaics. The continuing increase in the number of visitors from around the world demonstrates the wide interest shown by the international community (SECA 2001).

The shelter's structure is made of a steel frame with a pitched roof supported by columns and lattice trusses approximately 4 meters apart. The roofing is a saddle roof made of thin steel plates. The supporting columns are founded outside the original walls, within unexcavated zones. The shelter elevations are pierced with large glass openings. Only one access point allows visitors to enter, on footbridges raised about 1.20 meters above the floor. The building is 7.50 meters high, and all the side panels are light yellow-green (figs. 3, 4).

Although the shelter protects the mosaics from bad weather, it does not mitigate other problems, such as water and air infiltration and poor air circulation, lighting, and water drainage. In addition, the visual impact of this huge shelter on the site and the architectural quality of the interior volume need to be adequately addressed. The beams are a conventional lattice truss with iron corners. Parts of the beams were welded on-site. Some of the shelter parts are noticeably old and require replacement in the near future. Finally, the indoor walkways are built too high above the mosaics and constitute another negative characteristic of the shelter.

The shelter has been in position for about eighteen years, and it has kept the mosaics in good condition. There is some significant accumulation of salts on the mosaic along the south side, indicating that this area might have suffered from evaporation and the drawing up of salts through the ground.

FIGURE 4 The interior of the existing shelter. Photo by Mervat Ma'moun Ha'obsh.

The existing system of ventilation (taking into account the broken glazing) is adequate in that it keeps the shelter reasonably cool for much of the year, with the exception of the north wall. The mosaics and the church walls appear to be dry and in a good, sustainable condition, and there are no rust stains on the mosaics from leaks in the roof or from condensation.

Risks to the Mosaics

The greatest risks to the mosaics are excavation by robbers, mechanical damage caused by cleaning or by tourists walking on them, standing water, salt encrustation, mold and algae, temperature variations, bird droppings, and water from condensation or a leaking roof.

Salt crystallization cycles eat into the surface of the tesserae, resulting in serious damage. It is caused by water evaporating from the surface of the mosaic that has been drawn through the soil and contains dissolved salts. The level of risk depends on the water content of the soil as well as the concentration of salts. The material beneath the mosaic floor needs to be dry at all times to prevent salt crystallization cycles. Salt crystallization was observed in the north side of the Church of Bishop Sergius, where the external ground is about 0.9 meter above the mosaic, and water penetrates through the wall. A proper drainage system will solve this problem. Maintaining a balanced temperature inside the shelter enclosure and dry soil under the mosaic floor will also prevent salt crystallization.

Concerning the conservation and protection of the mosaics, the Ministry of Tourism and Antiquities (MoTA) has appointed a committee to review all the issues concerning the design of the shelter. The committee consists of a MoTA technical team, a Department of Antiquities (DoA) archaeologist and conservation engineer, and the UNESCO representative in Jordan. Relevant studies were conducted before developing the shelter design.

Preliminary Studies

Topographical Survey

A full topographical survey was conducted on the site, especially in the St. Stephen complex and the surrounding area, to find ways to resolve the water drainage problems. Detailed elevations (inside and outside the complex) and plans for the complex were carried out. The topographical survey will help to solve the water drainage problems.

Geophysical Surveys

In February 2005 the Geophysics Division of the Natural Resources Authority of Jordan conducted geophysical surveys at Um Al-Rasas. The objective of the study was to map buried structures, locate buried artifacts, identify target zones quickly (thereby reducing the required amount of costly excavation), and evaluate the applicability of geophysics as an archaeological aid for studying historic sites in Jordan (Natural Resource Authority 2005).

Total magnetic field, gravity, resistivity, and ground penetrating radar (GPR) measurements were collected. However, magnetic and gravity methods were complicated by the presence of the shelter over the Church of St. Stephen. It is therefore recommended that the shelter be removed in order to run detailed gravity and magnetic measurements over the site area. The resistivity survey showed an area of low resistivity to the north of the complex, indicating that there is higher moisture content in this area. A curved structure was identified below the Church of St. Stephen.

Issues in the Design of the New Shelter

Critical issues were considered in the design of the new shelter, aimed at preserving the mosaic floors of the entire complex. Some of the following problems have already been identified: climatic conditions, seasonal storms that deposit dust on the mosaics, safety and security of the shelter enclosure both for the mosaics and for visitors, water drainage, light, ventilation, cavities under the mosaic from some sort of structure (perhaps a cistern or tunnel), and additional loads on the existing ancient walls. Solutions to these problems were sought, taking into consideration ICOMOS charters and regulations regarding interventions on archaeological sites (ICOMOS 1966, 1990, 1999).

Climatic Conditions

The site is in an arid area. It is hot and dry in summer, which usually lasts for about six months. There is no rain for four months, which means low relative humidity and a high evaporation index. There is regular rain in winter and high relative humidity and a lower evaporating index.

Wind Loads

Analysis of the available data at the nearest location, Queen Alia Airport, from 1991 to 2000 shows an average wind speed of 20 kilometers per hour (10.5 knots). The data do not provide peak wind speed values; therefore, wind load has been calculated in accordance with the Jordanian wind code, which specifies a maximum wind speed of 126 kilometers per hour. The fact that the site is exposed, with few wind breaks, was taken into account when considering the shelter design and the wind speed parameter. Strong winds come from the south and southwest. All these loads were taken into consideration when designing the columns.

Enclosed Shelter Environment

The main reason for building a shelter is to protect the mosaics from direct solar radiation and rain at all times. The roof of the shelter will be extended to the south side to prevent direct solar radiation, and it will be ventilated naturally, using the cross flow of wind to provide air movement. The internal temperature and humidity will reflect external conditions. The cross flow of wind from the south and west will change the air inside the shelter about six times per hour, thus dissipating the increased humidity and temperature resulting from the presence of visitors.

Based on modeling of the internal environment, it is expected that with a well-ventilated lightweight shelter the internal temperature will approximate the external air temperature. The combination of the internal heat from visitors and solar gains from the roof will account for a maximum temperature rise of 2°C above the ambient external air. The model predicts that the average internal temperature will be 25°C, exceeding 36°C only 7 percent of the year.

The internal relative humidity will follow approximately ambient conditions and is expected to be between 5 and 10 percent lower than in the external environment due to the slightly higher internal air temperature.

Earthquakes

Information regarding earthquakes was taken into consideration, since the area was destroyed by one in the past, as evidenced by collapsed arches at the site.

Water Drainage

When archaeological excavations were conducted on-site, soil was deposited north of St. Stephen's complex. The existing ground level next to the Church of Bishop Sergius is about 0.9 meter above the mosaic level, which was the main reason for the change in the natural drainage of rainwater. During the winter, standing water was observed on the pavement in the Church of Bishop Sergius, and dampness has been observed on the north side of the Church of St. Stephen, causing damage to the mosaics.

The Shelter Design

The concept behind the shelter enclosure is that it behave substantially like an open shelter, with adequate ventilation provided by two rows of windows. The shelter will be built using a lightweight material placed directly onto the ancient walls that were restored five years ago. The designer and the archaeologists decided that building on the ancient walls will give the true dimension of the complex while not endangering the unexcavated archaeological area around the complex. Since the walls need consolidation, lime grout will be used to fill the voids.

Structure

The shelter is designed as a gravity structure to be supported by the existing church walls. The steel frame has wall plates at the bottom to distribute vertical loads into the walls. The frame is braced to transfer horizontal loads along the axes of the walls, with minimum loads distributed across the width of the wall (fig. 5). Horizontal loads in the north/south direction are transferred to the gable walls through roof bracing. The gable walls are braced, and they transfer the loads into the walls. The columns and beams act as moment-resisting frames with no bracing. The roof is extended at the sides to prevent direct light and rainwater exposure (Halcrow Group 2005).

Glass Walls

Most of the north and south walls will be made of glass. The glass adds to the feeling of a lightweight structure and has the following advantages: transparency to reduce visual impact of the structure and natural light for viewing the mosaics. It will also allow visitors to connect the view outside the complex with the interior. Bands of windows along the top and bottom of the walls that can be opened will provide air circulation and ventilation. Existing doorways will be glazed, offering views into the interior. The wall between the courtyard and the Church of Bishop Sergius will also be glazed.

Supporting Walls

The new walls will be built directly onto the ancient walls. They will be thinner than the existing walls so that the form of the standing archaeology can be read from inside and outside the building. The texture and color of the render will be simple and smooth in order to provide a strong contrast with the rough stone texture of the ancient walls.

The majority of stone walls on the site were built without mortar: dry stones were placed one on top of one another

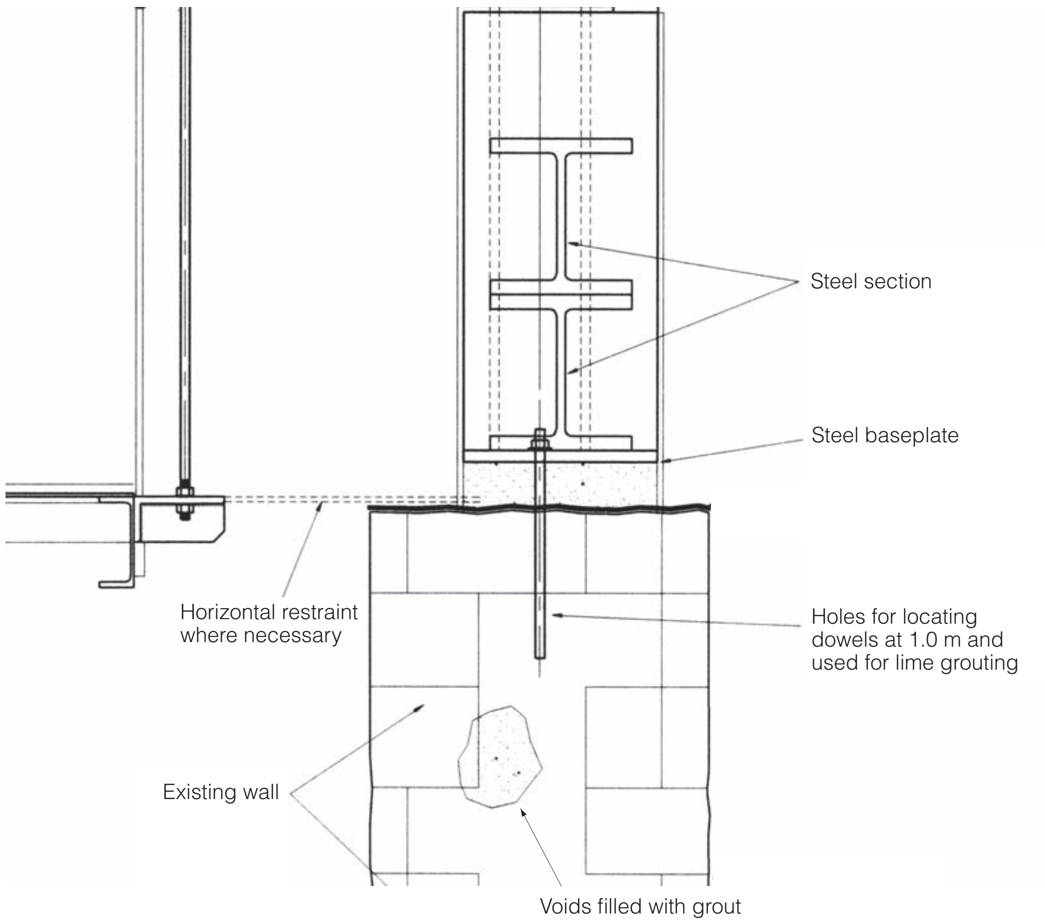

FIGURE 5 The proposed wall structure of the new shelter. Courtesy of Halcrow Group, Ltd.

and then wedged together with small stones. The core of the wall is filled with soil and stone chips. The consolidation of walls using a mortar of cement and reddish sand has already taken place, and although it is not the proper technique, any attempt to remove the mortar would damage the ancient stones. Consolidation will be carried out on those walls around the churches that are to support the new structure. Cavities in the walls will be filled with injections of lime-based slurry (see fig. 5). Holes will be drilled in the top of the walls at approximately 1-meter centers horizontally and at 0.5–1.0-meter lifts vertically. Wet clay can be used temporarily to retain the grouting material within the wall. Where walls are subject to weathering, joints should be pointed up with a lime–sand–stone dust mortar (1 part lime putty, 1 part local sharp sand, ¼ part local fine sands, ¾ part limestone dust), taking care to keep mortar off the face of the stonework. This will increase the stability of the wall by transferring the load from stone to stone evenly and by retaining the core material (Halcrow Group 2005: 25–26).

The new concrete applied on top of the existing walls will be beneficial to the structure, and the continuous load will stabilize the top of the walls by providing a mechanical key. (Note that a separating layer will prevent chemical bonding between the new and the ancient material. Removable stainless steel dowels will provide the necessary sheer connection. This construction system is reversible.)

Water Drainage

A proper drainage system for surface water will prevent the collection of water under the mosaic, and leveling the ground around the complex will help do this naturally. Rainwater will be collected from the roof and discharged through rainwater downpipes to ground level and into a gulley with a U-shaped silt trap and then into a piped system belowground. The pipe will collect any groundwater above the pipe level and discharge it away from the complex. Since the roof over the Church of the Courtyard is lower than the others, rainwater in this case will be collected and discharged into the ancient cistern near the church and will not be discharged to the gulley (see fig. 1).

Interiors

The height of the structure reflects the hierarchy of the original basilica spaces. Based on the semicircular arch and column spacing, the Church of Bishop Sergius was lower than St. Stephen's and apparently considered less important. A level ceiling will be provided under the trusses to add simplicity to the roof interior. Translucent hangings along the line of columns as well as the front of the apse will indicate the original form of the arcade and the apse.

Visitor Walkways

Visitors will view the mosaics from a raised walkway suspended from the roof.

Lighting and Security

The shelter will be provided with a lighting system under the visitors' walkways and also hung from the roof. ICCROM standards regarding lighting will be taken into consideration (Alcantara 2002). A security system with lighting and cameras will be used on the site.

Monitoring

Once the shelter is constructed, there will be full monitoring of the interior environment, including temperature variation, as the mosaics need to be kept at an even temperature in equilibrium with the ambient conditions. Monitoring will also include wetness from condensation or leaking from the roof, water evaporation, ventilation, and a full observation of salt efflorescences. These measures will prevent any negative impact on the mosaics from the shelter.

Site Management Context

Building the shelter is one of the issues that MoTA is addressing as part of the maintenance and conservation program. The management plan of the site that MoTA is developing will also include (1) protection of the site by designating it a protected area, which will entail new planning regulations for the surrounding areas; (2) development of a site management unit responsible for all aspects of the site; (3) visitor management; (4) marketing; (5) research and development; and (6) a participatory approach to the development of projects for the benefit of the local community. It is the hope of the Ministry of Tourism and Antiquities that the site will be preserved and developed in a sustainable way in partnership with the local community.

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Conservation and Restoration of the Nikopolis Mosaics: A Program for Integrated Management and Presentation of the Archaeological Site

Konstantinos L. Zachos

Abstract: *The excavations at Nikopolis, the "victory city" established by Octavian Augustus in northwestern Greece, have brought to light numerous Roman and early Christian monuments, many with mosaic floors. The mosaics are important not only for their artistic, symbolic, and technical values but also for the methodologies and conservation techniques applied since their discovery. Ten years ago the Greek Ministry of Culture initiated an integrated program for the management and presentation of the site, with the preservation of the mosaics being one of the key actions. This paper presents the methodology and specific processes for the conservation of the mosaics while attempting a comparison between old and recent approaches in this field.*

Résumé : *Les fouilles de Nikopolis, « ville de la Victoire », ont mis au jour de nombreux monuments romains et paléochrétiens comportant des pavements en mosaïques. Les mosaïques sont importantes pour leurs valeurs artistiques, symboliques et techniques, mais aussi pour les méthodologies et techniques de conservation appliquées depuis leur découverte. Le Ministère de la culture grec a mis en place un programme intégré pour la gestion et la mise en valeur du site dont la préservation des mosaïques constitue une des actions clés. Cette communication présente la méthodologie et les processus de conservation, et tente une comparaison entre les anciennes et les nouvelles approches dans ce domaine.*

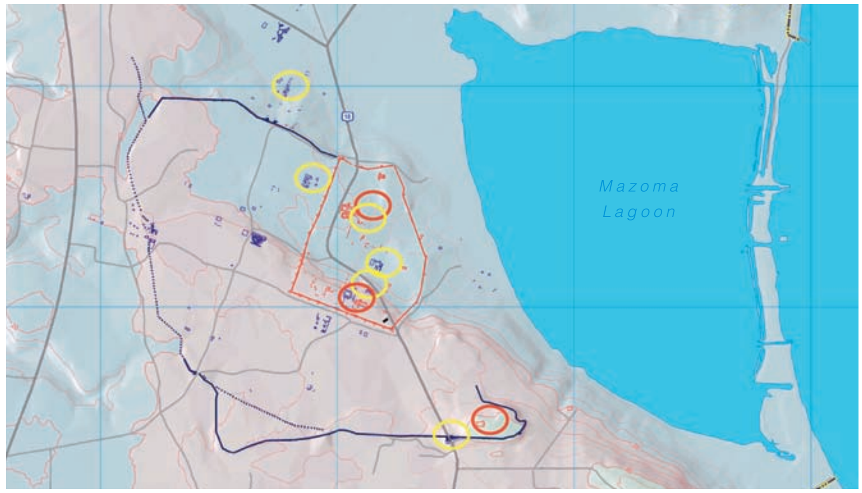
The Site

Nikopolis received its name, "victory city," following the famous sea battle of Actium in 31 B.C.E. It is located in northwestern Greece, on a narrow strip of land between two seas, the Ionian to the west, which provides an open route to Italy, and the Ambracian Gulf to the east, which affords access to the hinterland of Epirus. To the south, beyond the peninsula of modern Preveza, lies the promontory of Actium, the place of an ancient sanctuary of Apollo. The geographic position of the new city, together with its status as *civitas libera*, granted by the founder Octavian, contributed to its development. Nikopolis soon became the social, political, and economic center of its provincial region and flourished for more than one thousand years (Chrysos 1987).

The extended archaeological site, which covers some 1300 hectares, is spread across a picturesque plain, framed in the north by a chain of low hills known today as the Michalitsi hills. Octavian had pitched his military camp on one of these hills during the days preceding the final collision of the two great navies. This location was later chosen as the site for the erection of the Trophy—or Victory Monument—of Actium, an extensive and monumental stone structure forming a kind of open-air sanctuary dedicated to Apollo, Mars, and Neptune (Murray and Petsas 1989; Zachos 2001a, 2001b, 2003).

The town plan was organized according to the regular division of *insulae*, separated by roads that intersect at right angles. The public buildings in the center of the city were surrounded by private houses, and a sophisticated system of water channels and cisterns distributed fresh water, entering the city at its western gate, through an impressive aqueduct covering a distance of about 50 kilometers (Doukelis, Dufaure, and Fouache 1995). Successive barbarian raids from the fourth to the sixth century C.E. forced the inhabitants to reduce the city to one-sixth of its original size and to relocate it to the northeastern section of the Roman city. Nikopolis not only survived but continued to flourish, as attested by the ruins of luxurious basilicas decorated with unique sculptures and mosaic floors

FIGURE 1 Map of Nikopolis. Circles indicate the major monuments where mosaics were found (yellow for Roman, red for early Christian). Projection: Transverse Mercator Datum: GRS87
Map by Dimitrios Kalpakis, 2002.



(Pierrepont White 1986–87). What is known about Nikopolis from literary sources ends in about the eleventh century. The only references after that are the descriptions of travelers who passed through from time to time, because the ruins of the victory city continued to attract anyone interested in ancient history.

Excavations at Nikopolis began in 1913 and have continued intermittently until the present, albeit with long interruptions and uneven intervals of intensiveness, with the result that only a relatively small portion of the city has been unearthed. But even these limited excavations have brought to light a considerable number of Roman and early Christian monuments. Floor and wall mosaics—either complete or in a fragmentary condition—have been found in several buildings. The long period of time they cover makes their study important not only for their artistic, symbolic, and technical particularities but also for the methodologies and restoration techniques that have been applied to them since they were initially discovered. Indeed, Nikopolis preserves one of the most important groups of mosaics in the Balkan peninsula. In 1991 the Greek Ministry of Culture initiated an integrated program for the management and promotion of the archaeological site, with the preservation of the mosaics being one of the key actions within its framework.

Managing the Mosaics of Nikopolis

This paper presents the concept and methodology together with the specific processes employed in the conservation and restoration of the mosaics while at the same time attempting a comparison between old and recent approaches in the field. It concludes with the prospects for future approaches, in the context of overall management of the entire archaeological site.

The monuments where mosaics have been found include many from the Roman and early Christian periods. Figure 1 shows the mosaics representing the Roman period of the city (marked with yellow), which were found in private houses, public edifices, and grave monuments, and the mosaics from the Christian era (marked with red), which primarily adorned religious buildings and private houses.

The treatment of the Nikopolis mosaics may be summarized as consisting of two main categories: the treatment of those mosaics uncovered after 1990, when the extensive program for the investigation and promotion of the archaeological site was initiated; and the treatment of mosaics excavated up until the 1970s. For convenience, the treatment of mosaics is presented below according to the two main chronological groupings—Roman and Byzantine.

The Mosaics of the Roman Era

Immediately after mosaics are uncovered, one of the two following protocols is put into action:

- The mosaic undergoes the process of conservation-restoration using modern methods, or
- after partial exposure and surface cleaning (sufficient to gather details of stratigraphy, degree of preservation of the mosaic surface, identification of the theme depicted, etc.), the mosaics are stabilized, as necessary, and covered with geotextile and gravel and then protected beneath a temporary but durable covering

of sheet metal to avoid further exposure to natural or human impact.

In the latter case, the mosaics await an overall approach to their conservation-restoration when the monument to which they belong is included in a subprogram of excavation research, restoration, and public promotion.

Two examples of how mosaics in this latter category are being dealt with will suffice. At Basilica B, also known as the Basilica of the Bishop Alkison, excavation and research in the apse brought to light a mosaic floor from an earlier structure of the Roman period. The mosaic, first identified beneath the foundations of the basilica, depicts a hunt scene, with a small Eros holding a bow and arrows while a deer, wounded by the little hunter's bow, lies to the right. In trial trenches opened outside the apse, the poorly preserved continuation of the mosaic floor was encountered. It is clear that the mosaic must have belonged to an important building in the Roman city. The basilica and the Roman edifice beneath it were located in an area rich in springs and underground water, as several wells incorporated into the basilica complex indicate. A marble cylindrical altar dedicated to Asklepios, which was reused as a wellhead in the basilica complex and is still in situ, suggests the probable function of the Roman building. Its floor was decorated with geometric and floral motifs, similar to those found in other Roman buildings. Five partially preserved male figures are depicted in the central *emblema*. One is dressed in a short tunic and rests his right leg on a base while holding a double ax in his right hand. After initial conservation, the mosaic was covered with geotextile and gravel, and sheet metal was placed over it to provide protection pending future investigation that is to encompass the entire area surrounding the basilica.

The Central Baths, located in the heart of the Byzantine city, form a large complex probably dating to the second century C.E. Subject to numerous repairs, this building was in continuous use throughout the history of the city, and a large part of the complex is visible today. In the course of conservation work on the walls of the building, including extensive clearance of undergrowth, a trial trench was opened in the large, central Room A in order to gather information concerning the depth and condition of the floor. The trial trench revealed a partially preserved mosaic floor. Its decoration consists of zones with geometric and floral decorative motifs that create frames within which various scenes are represented. Part of a scene with dolphins may be discerned in the northwest corner, and a lotus blossom is in the southeast corner. For technical reasons and due to limited resources, it was not possible to fully uncover such an extensive mosaic in this large room, which has a total area of 372 square meters. Following what may be termed "conservation first aid," the mosaic was covered, just like the one in Basilica B, until such time as it can be incorporated into a more comprehensive program of excavation, restoration, and presentation of the Central Baths, with all the necessary prerequisites to support a major conservation project for the mosaics.

As for the immediate treatment of those mosaics revealed by recent excavation, a typical example is that from the House of Manius Antoninus, which presents at least two building phases (fig. 2). The first phase has been assigned to the second century C.E., based primarily on the dating of the mosaics; the second, building-reconstruction phase has been dated to the middle of the third or the beginning of the fourth century C.E. Preliminary investigation of this house began in 1972 when a mosaic floor was accidentally discovered by a local farmer cultivating a plot of land. The excavations brought to light the south section of the house, an area of 360 square meters (Vokotopoulou 1973). There are several reception rooms with mosaic pavements, smaller service rooms, and part of a rectangular interior courtyard, or atrium, with an *impluvium*. The mosaic pavements of the reception areas, decorated with polychrome geometric and floral motifs, are preserved in a fragmentary condition. The floor pavement of the large reception area (Room 11) stands out with its design of eight-rayed stars. Of the central *emblema*, only the southeast corner is preserved in good condition; it depicts the head of a clean-shaven youth, possibly the god Dionysos. Next to the reception areas is an antechamber (Room 14) that leads to a triclinium (Room 15). The antechamber is decorated with a circular mosaic composition bearing an inscription with the name of the owner and renovator of the house, along with the name of his wife (fig. 3). The inscription dates it to the end of the third or the beginning of the fourth century. The text of the inscription reads as follows:

Man(ios or -ilios) [son of] Aristoklias
May the fortune of the house be prosperous, and
prosperous too the restorer of the house,
Man(ios) Antoninos with his [wife] Theosegos

The mosaic floors of the house were showing alarming deterioration due to the decomposition of their substratum. In 1979 the local Ephorate of Antiquities requested the assistance of the then Directorate for the Conservation of Antiquities at the Ministry of Culture, and a specialized team of conservators

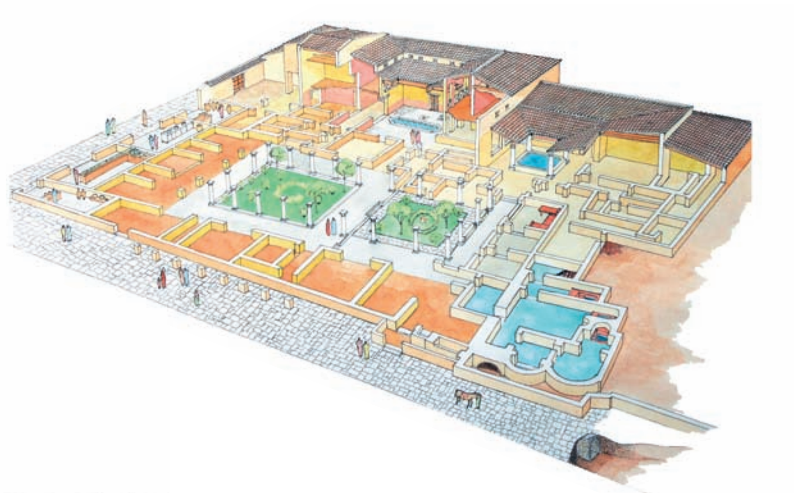


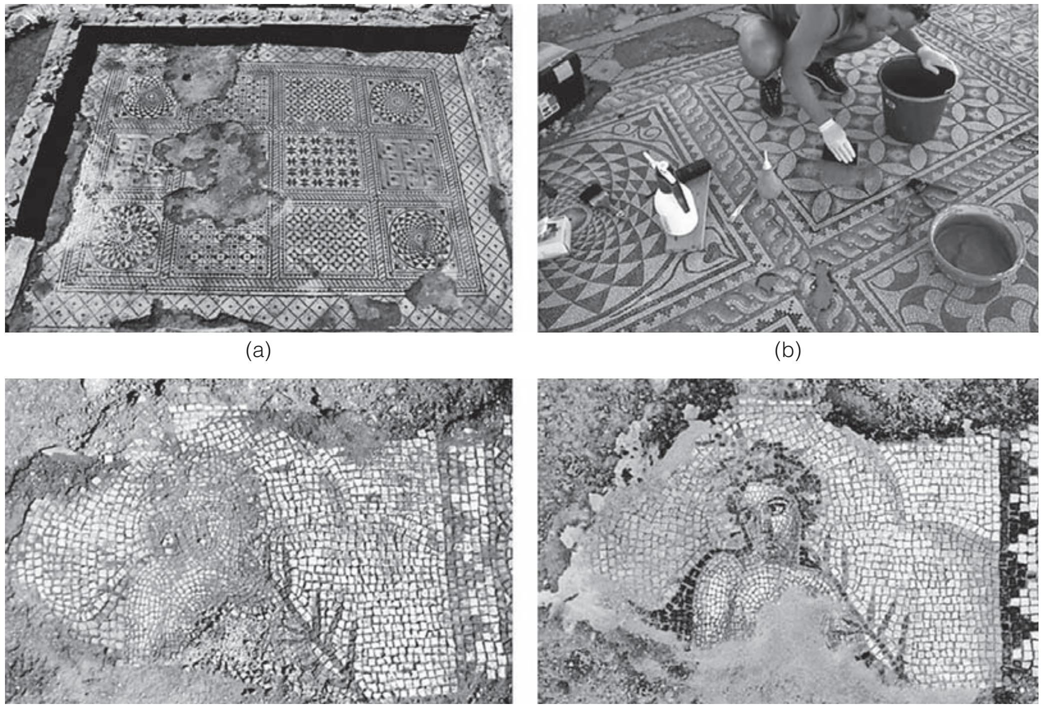
FIGURE 2 Plan and reconstructed view of the House of Manius Antoninus.

FIGURE 3 House of Manius Antoninus. Mosaic pavement with inscription in Room 14.

was sent from Athens. However, in accordance with the practice of that time, the team did not leave any detailed documentation of their work. In Room 11, for example, the mosaic floor was cut out in sections, framed on aluminum squares, and placed on a cement mortar. Following this, the unstable ancient substratum mortar was removed, and finally the square pieces were placed back on cement mortar and the missing parts were also filled with cement. The mosaics were then covered with plastic nets and metal sheets. In the long term such methods of restoration have proven unsuccessful, or, to put it more bluntly, disastrous. Today these mosaics are in poor condition; in many places the tesserae have come unstuck, and all the surfaces are covered with thin layers of cement. Painstaking mechanical cleaning may solve some of the problems. A mechanical test cleaning on the head of Dionysos gave promising results.

When excavation was renewed in August 1997, the various structures of the house were consolidated and the mosaic pavements, depending on their condition, were either conserved or restored, and then some units were covered in order to be protected. The area excavated so far is roughly 3500 square meters, across which the architectural complex (59 by 57.36 m) stretches, covering—it would seem—an entire *insula* of the urban grid of Nikopolis. Today the monument is open to the public. Visitors enter the house from its east side, step above the threshold of an ancillary door (the main entrance of the house is positioned on the south side), and pass four

FIGURE 4A–D House of Manius Antoninus. Mosaic in Room 6 (a) before conservation; (b) during cleaning and conservation; (c, d) before and after cleaning.



rooms facing onto the peristyle courtyard. Three of the rooms (1–3) probably related to the daily routine of the family and are paved with mosaic floors bearing geometric and vegetal motifs. The fourth room, a triclinium, is decorated with an elaborate composition and is in good condition. The central *emblema* of the pavement is dedicated to a scene from the life of Dionysos. To the left of the peristyle scant structural remains belong most probably to the garden of the house surrounded by a second peristyle. To the north, and near the ancillary door, are the remains of a small private bath complex (*balneum*), of which the hypocaust is in good condition.

Continuing toward the west, visitors pass another atrium with a square pool at its center. The atrium is surrounded by more functional rooms, including bedrooms, kitchen, lavatories, and service rooms. Room 6 is interpreted as a triclinium and is distinguished by its rich mosaic floor, which has an *emblema* depicting a scene (largely destroyed) from the life of Dionysos. Some remnants of the wall paintings with vegetal motifs are still in situ.

The mosaic floors of the house were composed primarily of limestone or terracotta tesserae. In the case of the central scenes, many different types of glass paste tesserae were also used. The colors vary and cover a wide spectrum (e.g., white, black, blue, ocher, gray, green, red), depending on the composition. Construction technique does not, however, follow the standard methods used by artisans of the Roman period. Usually there are small, sometimes rather large divergences in the substructure mortar used to support the pavements. It is only in Room 6 that the standard method has been followed. Otherwise, the lower layers are fused into one, while in quite a few instances these layers are forgone completely. In these cases the underlayer of mortar (*nucleus*) is laid directly on the ground, and a thin layer of lime is spread on top of the nucleus as the *supra nucleus* on which the tesserae are set.

A characteristic example of in situ conservation is that of the mosaic in Room 6 (fig. 4). The floor composition consists of eleven rectangular units with geometric motifs, such as triangular shields, back-to-back *peltas*, perspective meanders, lozenge-shaped stars with eight rhomboid petals, lotus blossoms, and ivy leaves. The central composition of the room is largely destroyed, and only the laurel-wreathed head of Dionysos, a part of his upper body, and parts of an unidentified figure are preserved.

The pathology of the mosaic is as follows:

a) fractures and breaks in the mosaic surface, frequently extending laterally to the substratum of the floor;

b) anomalies in the level of the floor and at some points subsidence or bulging, caused mainly by surface anomalies and geological changes;
c) disintegration of the materials of the substratum;
d) biological activity;
e) erosion of the surface of the tesserae, especially those made of limestone; and
f) lacunae in the surface of the mosaic.

In brief, conservation entailed the following activities:

a) uncovering the mosaic surface;
b) collecting scattered tesserae;
c) initial surface cleaning in order to document the pathology of the pavement;
d) documentation drawing (scale 1:1) to map losses from the surface of the mosaic, along with sketches of the motifs and other illustrations;
e) more detailed surface cleaning accompanied by wide-scale stabilization, including the replacement of eroded and loose tesserae in their original position;
f) stabilizing and consolidating the edges of the mosaic, either through edging repair (i.e., the edges of those sections with damaged perimeters are consolidated with lime mortar plaster placed a few millimeters below the level of the preserved mosaic surface) or by similar methods that aim at temporarily consolidating the surface until it can be permanently stabilized;
g) aesthetic restoration-presentation, done by filling both large and small gaps with new plaster and by replacing and setting all the tesserae that had been removed from their original positions; and
h) documentation, photography and drawings, through all stages of the work.

After conservation is completed and when it is determined that a respectable number of mosaics should be visible and accessible to the public (within the framework of the overall restoration of a building), a shelter is placed over the mosaics, as in the case of Room 6, which was covered over by a metal framed shelter that can be extended if needed in the future (fig. 5).

In cases in which the mosaic is in a fragmentary state, removal is chosen, so that conservation can take place in the laboratory. This was the method chosen for Room 3, on the east side of the villa, where a total of six mosaic sections, covering an area of some 17 square meters, were preserved from the border area of the composition, while the central scene had been entirely destroyed. The preserved mosaic surface of these sections displays three characteristic colors: white, blue, and rose. Apart from the loss of a large portion of the decoration, the tesserae themselves were frequently found broken or had their surfaces stripped off. In this case, the mosaic, with its total surface area of 10.06 square meters, was removed and transferred to the laboratory in fourteen pieces (fig. 6).

(a)

(b)

FIGURE 5A, B Mosaic protective shelters: (a) House of Manius Antoninus, completed 2000; (b) Basilica A, completed 2005.

The decision-making process in such interventions is as follows:

- First, the conservators propose and fully document the need to remove the mosaic, describing in detail all the stages of conservation that will ensue.
- Then, following approval by the Nikopolis Scientific Committee, the proposal is submitted to the Central

(a) (b) (c)

FIGURE 6A–C House of Manius Antoninus. Room 3 mosaic showing (a) stabilization, (b) drawing, and (c) lifting in process.

Archaeological Council, which ultimately issues a recommendation concerning the advisability or otherwise of removing the mosaic.
- Upon completion of the work, the conservation team submits a report to the Nikopolis Scientific Committee. The report is placed in the relevant archive, together with drawings and photographic material.

In the neighboring Room 4, where the central *emblema* represents a scene from Dionysos's youth, a different procedure was chosen. In accordance with the judgment proffered by the Central Archaeological Council, it was decided to conserve all the mosaic decoration in situ, except for the central *emblema*, which, by virtue of the rarity of its theme, was to be removed for conservation in the laboratory (fig. 7). The original is to be exhibited in the new Archaeological Museum of Nikopolis, with an exact replica placed in situ. A study concerning the procedure for removal of the mosaic has been prepared, just as a technical report will have to be prepared for submission following completion of the removal and conservation.

Finally, it should be noted that the villa's mosaics, like those of a number of other buildings at Nikopolis, were found at a shallow depth. This resulted in their sustaining a great deal of damage from agricultural activities, especially plowing, carried out on the site during earlier years. To avoid this type of destruction, the plot of land on which the remains of the villa are located was expropriated. But the greater portion of the archaeological site, although protected by relevant legislation, is owned by private individuals.

FIGURE 7 House of Manius Antoninus. Mosaic pavement in Room 4 depicting a scene from the life of Dionysos in the central *emblema*.

The Mosaics of the Early Christian Era

Mosaics from Basilicas A (known as the Basilica of the Bishop Dometios), B, and D are from early Christian Nikopolis. The oldest early Christian mosaic at Nikopolis, however, dates to the beginning of the fifth century and covers the floor of a secular building known as the Villa at Ftelia, located outside the walls of the city. These mosaics were excavated in the past, when some were conserved according to the methods of the time and others were covered with plastic sheeting and gravel, resulting in the complete destruction of some.

The entire collection of early Christian mosaics from the basilicas establishes Nikopolis as the most important mosaic production site in Old Epirus. In particular, the lavish decoration of the transept wings of Basilica A, interpreted as representing an allusion to earth and the terrestrial paradise (a Christian *mappa mundi*), has been considered a reference point in research on mosaic pavements of the late antique and early Byzantine periods (fig. 8). The "school" of Nikopolis was active for about two generations, from the late fifth century to the mid-sixth century. It is characterized by a high level of artistic quality and range of iconographic themes. The geographic expanse of the artisans associated with the Nikopolis workshop has not been ascertained. Echoes of their influence are seen in neighboring regions as far away as eastern Illyria (Kitzinger 1951; Sodini 1970; Chalkia 1997; Bowden 2003: 110–14).

FIGURE 8 Basilica A. The mosaic panel of the north wing of the transept with the dedicatory inscription mentioning Bishop Dometios.

Conservation projects in the past, as noted in reports from the 1960s, removed the mosaic floor in sections and then, after careful cleaning, reset them in cement mortar so as to fully restore their cohesion and horizontality. Gaps in the compositions were also filled with cement mortar. The large amount of cement, in relation to the aggregates, had serious consequences for the stability of the mosaics. Today the cement mortar is severely cracked and crumbling. In the areas of the transept wings of Basilica A, as well as the room north of the narthex and the chapel south of the narthex (*diakonikon*), sheet metal roofs were installed in the past, on raised modern walls built atop the ancient walls. In 1984, after various repairs, the entire construction was taken down because the metal sheets had rusted and because the shelters had an inappropriate aesthetic appearance. After a thorough cleaning, the mosaics were covered with plastic sheeting and gravel. Fortunately they did not remain covered by the plastic sheeting for long. After about twenty years of discussion and debate, new roofs were installed over these areas, and thus today the mosaics can be visited by the public (see fig. 5). According to the decision made by the Central Archaeological Council, the walls of the various architectural units to be roofed were built to a certain height using stones, bricks, and lime mortar like the ancient walls, together with lead sheets to distinguish the new construction from the original walls. They were topped with a wooden roof covered with bituminous shingles bearing a ceramic granule coating.

The method of sheltering was a topic of several meetings. In accordance with the governing legislation, several committees are involved in making such decisions, which is not always conducive to achieving a consistent approach. Because the site is extensive and ranges chronologically from Roman to early Christian, uniformity in sheltering could be confusing for the average visitor. In the case of the House of Manius Antoninus (see fig. 5a), it was decided to build a metal shelter that could be expanded should the entire villa one day be excavated. The method of sheltering the Basilica (fig. 5b) arose from the desire to re-create the volumes of the original structures for purposes of interpretation to visitors.

In the central aisle of Basilica A, where large cracks appeared in the previous interventions and the cement had come loose, a more drastic form of intervention was undertaken. The difficult and delicate work of cement removal was accomplished by mechanical means, and the cement mortar was replaced with traditional lime mortar.

The best-preserved mosaic from the older excavations in Basilica A is the wall mosaic on the base of the pulpit (*ambon*), originally the base for a statue from the age of Augustus. It bears a relief Amazonomachy that had been scraped off in order to lay the mosaic. This mosaic, which is indicative of the quality of the mosaics that probably covered the interior decor of some of Nikopolis's churches, was saved because the whole was transferred to the museum years ago, when the tesserae showed alarming signs of decomposition (Guidobaldi 1987).

Conclusion

This brief paper describes the issues that are of concern regarding Nikopolis as well as the procedures followed in the treatment of the mosaics, within the framework of a larger program to further explore and manage this extensive archaeological site. The most basic problem is the absence of specialist personnel (technicians-conservators) to undertake this large-scale and demanding project. A second problem is the conservation of those mosaics excavated in previous years that have already undergone conservation. A third problem is that of the construction, and types, of roofing that should be installed so as to satisfy all the parameters involving protection of the mosaics on the one hand and ensuring a consistent and aesthetic appearance of the site on the other. Finally, the storage of mosaics that have been removed will soon be a major problem, as the museum that has been built on the site does not have a great deal of storage space. For the first time we are attempting to address these problems within a comprehensive and holistic plan.

It would seem that most of the problems encountered at Nikopolis are common to the majority of sites throughout the Mediterranean. Therefore, I want to stress the necessity of disseminating knowledge concerning current views and perspectives, together with the technical know-how of mosaics preservation and restoration.

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Les mosaïques de Volubilis (Maroc) : Planification de la conservation et de la gestion

Hassan Limane et Gaetano Palumbo

Résumé : *Le site du patrimoine mondial de Volubilis comporte de nombreuses mosaïques* in situ. *Cette communication évoque l'élaboration d'un plan de gestion pour le site avec une importante composante conservation. L'état de conservation des mosaïques est documenté et un système de suivi comportant des visites répétées au site est mis en place. Les mosaïques sont nettoyées des effets de la prolifération de lichens et leur entretien assuré par le balayage de l'eau stagnante après les pluies ainsi que par un nettoyage régulier. Cela permet de maîtriser les lichens ainsi que d'autres formes de végétation. Si pour l'instant il a été décidé de ne pas recouvrir ni abriter les mosaïques, seulement un suivi permanent permettra de décider d'un recours éventuel à des interventions plus importantes afin d'assurer la conservation de ces chef-d'œuvres de l'art romain.*

Abstract: *The World Heritage site of Volubilis has a large number of mosaics in situ. This paper presents the development of a site management plan with a strong conservation component. The mosaics were documented for their state of conservation, and a monitoring system consisting in repeated visits to the site was established. The mosaics were thoroughly cleaned from the effects of lichen growth, and their maintenance ensured by sweeping the water that stagnates after major rain episodes and by regular cleaning. This controls the growth of lichen and other vegetation. Although the decision for the time being was not to backfill or shelter the mosaics, only constant monitoring will tell whether more substantial intervention will be needed to ensure the proper conservation of these masterpieces of Roman art.*

Introduction générale

La mosaïque est l'un des plus importants témoignages artistiques et elle reflète toute la finesse du savoir-faire des anciens. Sa conservation et sa présentation doivent être programmées dans le cadre d'un plan de gestion intégrée.

Le cas du site de Volubilis est un exemple qui mérite réflexion. L'ensemble des mosaïques visibles *in situ* est exposé toute l'année aux intempéries comme aux actes de vandalisme. L'entretien est limité à des actions simples comme le désherbage dans les fissures et autour du pavement, l'évacuation des eaux après des pluies abondantes et un balayage occasionnel. En fait, la conservation des mosaïques ne devrait pas se limiter à des interventions saisonnières ; elle exige au contraire une action continue portant sur l'ensemble des éléments d'un site archéologique comme Volubilis.

Un projet de conservation de la mosaïque donnant lieu à l'établissement d'une documentation riche et variée est une composante essentielle d'un plan de gestion bien structuré. Cela devient alors l'outil de travail, de suivi et d'observation qui assurera à la mosaïque un bon entretien et une surveillance adéquate.

1. L'importance de la mosaïque à Volubilis

Le site de Volubilis n'est pas simplement connu pour sa belle collection de statues en bronze et la richesse de son répertoire architectural privé, mais aussi pour la variété des pavements de mosaïque qui ornent les maisons et les thermes.

La plupart de ces pavements ont été mis au jour dans les années 1940 et 1950 (Thouvenot 1936 ; Chevalier 1960). Les mosaïques ont subi par la suite des interventions de conser-

FIGURE 1 Mosaïque d'Orphée. Reproduit avec la permission du Program INSAP-UCL Volubilis.

FIGURE 2 Mosaïque du Bain de Diane dans la Maison de Vénus. Reproduit avec la permission du Program INSAP-UCL Volubilis.

vation sans lesquelles elles n'auraient pu être sauvegardées. Pourtant, certaines de ces interventions sont à l'origine des problèmes que nous observons aujourd'hui.

Parmi les mosaïques majeures de Volubilis, citons celles de la maison d'Orphée (Thouvenot 1941), où le dieu est représenté charmant les animaux (fig. 1), la mosaïque des Néréides et celle de la maison de l'Éphèbe (Thouvenot 1945 ; Qninba 1998) qui, malheureusement, a perdu son éclat originel du fait de l'accumulation des lichens et de l'instabilité du terrain.

D'autres méritent aussi d'être signalées : la mosaïque des travaux d'Hercule (Thouvenot 1948), de Dionysos et des Quatre Saisons (Étienne 1951) et des Fauves (Étienne 1962). Celles qui ornent la maison du Cortège de Vénus sont sans conteste les plus belles de Volubilis, du point de vue esthétique comme par la variété des thèmes évoqués (Thouvenot 1958). Cette maison comporte plus de dix pavements entourés de cadres géométriques richement décorés ; les plus célèbres sont le Bain de Diane (fig. 2), l'enlèvement d'Hylas, le Cirque et l'Amour aux oiseaux.

On ne peut cependant préserver ce trésor pour le transmettre aux générations futures que par des mesures bien définies, dans le cadre d'une conservation et d'une mise en valeur de l'ensemble du site. Dans ce contexte, la formation d'un personnel qualifié chargé de toutes les opérations prévues aura une importance essentielle.

2. La place de la mosaïque dans le plan de gestion

L'élaboration d'un programme de gestion du site de Volubilis se fonde sur son étude et sa compréhension.

Depuis dix ans, il devient de plus en plus nécessaire de doter Volubilis d'un plan de gestion, et cela pour de multiples raisons, notamment l'afflux touristique grandissant. Le site attire en effet de nombreux visiteurs (plus de 150 000 par an), auxquels il faut ajouter les spectateurs du festival de Volubilis, inauguré en 2000, qui accueille jusqu'à 4 000 personnes lors des soirées d'affluence. Une situation budgétaire difficile, un manque de personnel spécialisé et une détérioration insidieuse et permanente des vestiges archéologiques qu'un simple entretien ne peut empêcher posent de nombreux problèmes de gestion. Qui plus est, le Ministère de la Culture et les communautés locales s'efforcent, non sans difficultés, de rendre le site encore plus attractif pour le tourisme culturel, en vue de développer la région de Meknès.

S'agissant de la conservation des structures, la situation est grave, voire catastrophique. De nombreux murs s'effondrent chaque année. Des mesures de sauvegarde et de nettoyage des mosaïques sont pourtant en place : les eaux de pluie, les mauvaises herbes, le sable et la terre sont régulièrement éliminés et les lichens, qui défigurent parfois totalement certaines mosaïques, sont systématiquement grattés. L'équipe de Volubilis a reconstruit plusieurs murs emportés par les pluies torrentielles de ces deux dernières années, mais beaucoup sont toujours en très mauvais état. De plus, de nombreux sondages anciens ont été laissés ouverts, surtout dans les zones peu fréquentées par les touristes. À ces endroits, les structures mises au jour sont souvent très dégradées et peuvent présenter de réels risques pour les visiteurs.

Présenter le site au public reste un problème majeur : les panneaux explicatifs sont tout à fait insuffisants et les guides sont incapables de fournir une explication satisfaisante du site et de son rôle dans l'histoire du Maroc.

Le projet de plan de gestion, mené par une équipe conjointe UCL-INSAP[1], vise donc à définir les valeurs du site pour les différents groupes d'intérêt présents à Volubilis et à vérifier les conditions administratives, de gestion et de conservation. L'objectif est d'établir un plan de conservation, de présentation et de développement du site afin de lui redonner l'importance qu'il mérite, en tant que bien du patrimoine mondial, et de favoriser un processus de développement culturel et économique au niveau local.

Ce plan accorde un rôle essentiel à la mosaïque. Le travail accompli va être renforcé par la mise au point d'un outil de travail structuré qui facilitera sans aucun doute les interventions et les opérations de conservation en dégageant les priorités de préservation, de conservation et de mise en valeur.

3. La stratégie de travail

L'analyse se fonde sur l'évaluation des mosaïques, la vérification de leur état, la documentation des interventions précédentes, la numérotation de base et la documentation écrite et photographique. Par ailleurs, il a été décidé d'effectuer un suivi de l'état de deux des cinq mosaïques précédemment réensevelies. C'est ainsi que des images digitales de plusieurs mosaïques font clairement apparaître le problème de la rétention d'eau.

Toutes les mosaïques ont été photographiées depuis un point de vue élevé (un escabeau de 4 mètres). Dans plusieurs cas, il a fallu prendre 4 à 6 photos pour couvrir toute la surface d'une mosaïque et pouvoir effectuer la rectification.

Des cibles ont été placées sur la mosaïque en utilisant un module de 1 × 1 m ou 2 × 2 m, pour faciliter le processus de transformation. Le logiciel de rectification d'images utilisé est Asrix, développé au Canada par Steve Nickerson et Stewart Wilson. Il donne une image rectifiée en noir et blanc qui peut être importée sur AutoCAD et mise à l'échelle 1:1. C'est ce qui a été utilisé pour la description des dommages et interventions pendant les activités de suivi et d'entretien.

L'équipe a mis au point une fiche permettant d'établir des conventions graphiques, pour représenter les conditions

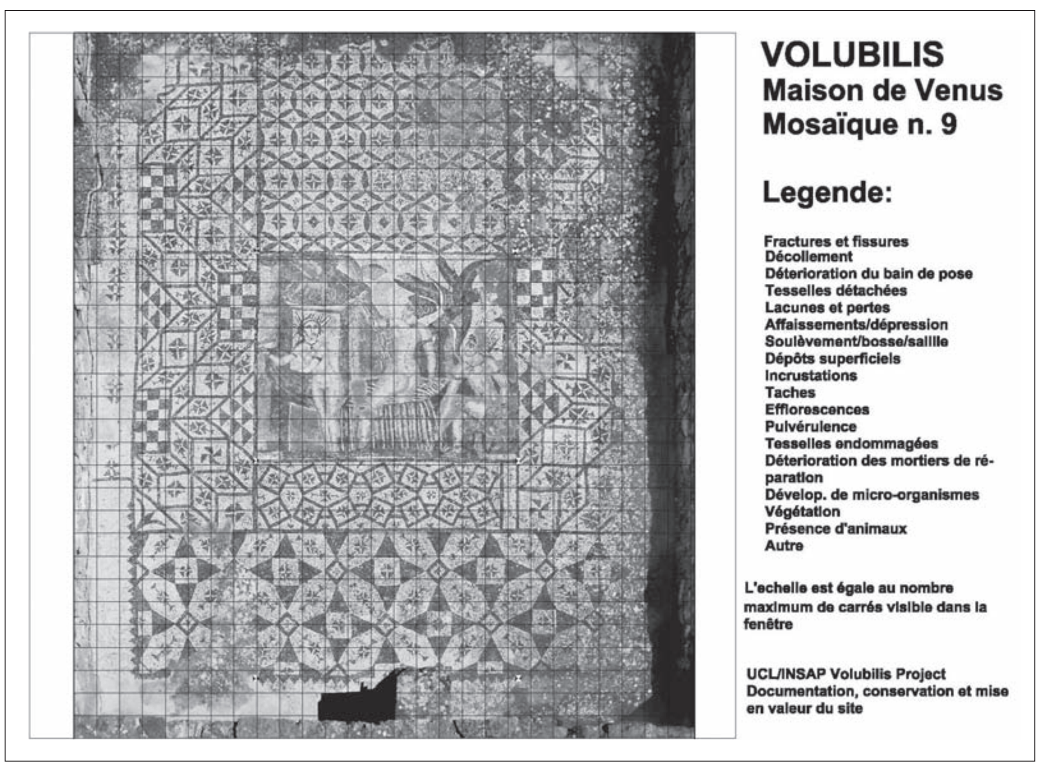

FIGURE 3 Une grille de 20 × 20 cm est utilisée pour marquer la condition des mosaïques sur des feuilles transparentes, avec des symboles agréés. Reproduit avec la permission du Program INSAP-UCL Volubilis.

FIGURE 4 Cette image du SIG montre les mosaïques du quartier nord-est (en violet), les huileries (en vert) et les parcours actuels des touristes (en bleu clair). Reproduit avec la permission du Program INSAP-UCL Volubilis.

observées sur des fiches transparentes (fig. 3), avant transfert dans des fichiers électroniques au format AutoCAD. La fiche a également été utilisée pour créer une échelle numérique représentant le degré de dégâts structurels, de surface et d'attaques biologiques (forme la plus connue de dommages observés sur le site). Cette échelle a fourni la base de la description des mosaïques à l'aide d'un système d'information géographique (SIG), développé pour l'ensemble du site (fig. 4). Le SIG, avec ses divers niveaux d'information, permet une observation intégrée et servira d'élément d'analyse et de gestion, surtout en matière de programmation des interventions d'entretien ordinaire et d'urgence.

Par ailleurs, l'analyse des tesselles et des mortiers faite en laboratoire a permis de reconnaître divers types de pierres, aux caractéristiques différentes, utilisées dans les mosaïques, ce qui a permis de mieux comprendre certains phénomènes de détérioration[2]. L'historique des interventions sur les mosaïques de Volubilis est très compliqué et l'on a essayé de le reconstituer à partir d'entretiens avec les conservateurs du site et de recherches dans les archives. Les premières étapes ont tout de suite montré que l'enregistrement des mosaïques comportait des lacunes. En parcourant les archives, on a retrouvé quelques dessins des mosaïques, mais aucune photographie aérienne, bien qu'il en ait existé de nombreuses dans le passé. Cette étude a permis d'établir que l'on a, jusqu'à maintenant, découvert à Volubilis soixante et onze pièces dotées d'un pavement en mosaïque.

Les conservateurs qui se sont succédé sur le site ont fourni des informations sur les projets de conservation et de restauration réalisés ces quinze dernières années. Nous les avons décrits et rapportés sur une carte, ce qui constitue un répertoire historique des différentes interventions menées sur chaque structure depuis les premières fouilles. Cette phase du projet exige naturellement une mise à jour régulière.

Tout en effectuant ces analyses, on a continué le suivi permanent des mosaïques et les mesures simples mais efficaces comme l'élimination des eaux de la surface des pavements après de fortes pluies. Les structures qui supportent les mosaïques sont aussi actuellement sous observation (fig. 5), ce qui nous a permis de repérer des phénomènes de glissement de terrain dans la zone du quartier nord-est.

Cette analyse intégrée de l'état des mosaïques de Volubilis, toujours en cours, permet de mieux comprendre l'évolution de certains facteurs liés à l'exposition et de trouver des réponses aux problèmes posés. Il est donc prioritaire d'équiper le site d'un outil de travail permettant de prendre toutes les composantes en considération.

4. Prévoir la conservation des mosaïques de Volubilis

Les observations effectuées à ce jour sur la totalité des mosaïques du site n'ont pas révélé de véritable urgence en matière de conservation. Les dégâts observés se classent dans la normalité des phénomènes de détérioration des pierres et des mortiers à ciel ouvert avec une seule exception, celle des mosaïques du quartier nord-ouest où l'on observe un glissement de terrain, notamment dans la maison de Vénus. Toutefois, ce phénomène n'évolue pas de manière constante et il est difficile de prévoir si le glissement va s'accélérer ou se ralentir.

La décision actuelle est de ne pas recouvrir les mosaïques d'abris ou de couches de sable (exception faite pour les cinq mosaïques déjà recouvertes).

Le suivi va continuer à intervalles réguliers (au moins deux fois par an) et l'entretien sera poursuivi avec des actions ponctuelles de nettoyage, trois ou quatre fois par an. Un drainage léger sera effectué après chaque pluie pour éliminer l'eau de surface. L'équipe du site se chargera également des petites réparations, comme le renforcement des bords et des lacunes, en utilisant des mortiers de chaux.

Pour ce qui est des mosaïques qui présentent, ou présenteront, des dégâts plus importants – comme des décollements

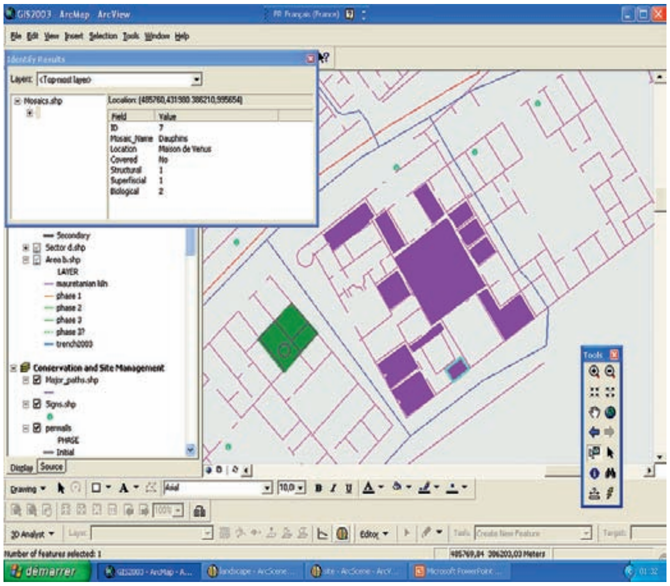

FIGURE 5 Cette image montre un détail du SIG, centré sur la Maison de Vénus et les attributs d'une des ses mosaïques (Dauphins), avec les conditions structurelles, d'attaques biologiques et les conditions de sa surface. Reproduit avec la permission du Program INSAP-UCL Volubilis.

ou des effondrements – un plan de conservation spécifique sera établi et soumis à la Division du Patrimoine pour approbation et financement.

Concernant la présentation des mosaïques, nous étudions actuellement des parcours pédagogiques. Objectif : faire comprendre aux visiteurs l'aspect technique de la mosaïque ancienne ou son évolution dans l'histoire du site et sa fonction à l'intérieur des grandes demeures et des espaces publics de Volubilis. Comme la plupart des visiteurs connaissent très peu la mythologie classique, il faudra prévoir dans ces parcours une présentation de ces mythes, en se référant peut-être aussi à d'autres représentations figurées sur des mosaïques du Maroc et d'Afrique du Nord. Les parcours pédagogiques pourront être suivis avec les guides, qui vont être formés pour transmettre ce savoir, et à travers des expositions qui seront organisées dans le Centre d'accueil des visiteurs, actuellement en construction. On va également étudier la possibilité de réaliser des brochures ou des audio-guides pour les touristes qui souhaitent visiter Volubilis à leur gré, sans guide local.

Grâce à ces mesures, nous espérons sensibiliser les visiteurs aux risques qui pèsent sur ces œuvres d'art, souvent par manque de compréhension de leur importance.

Notes

1 Ce projet s'inscrit dans le cadre de la coopération archéologique qui a débuté en 2000 entre l'UCL (University College London) et l'Institut National des Sciences, de l'Archéologie et du Patrimoine.

2 Voir le poster d'A. Dekayir et al. dans la présente publication.

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The Legacy of Nora, Sardinia: A Project for the Conservation, Restoration, and Maintenance of Mosaics

Chiara Zizola

Abstract: *This paper describes the project for conservation and maintenance of the floor mosaics of the site of Nora, Sardinia, that was designed in 2002 by the Centro di Conservazione Archeologica–Rome (CCA) for the Soprintendenza Archeologica di Cagliari. Because of the large number of visitors and the site's marine environment, extensive restorations and reburials were undertaken during the 1960s. The 2002 project was based on an analysis of the state of conservation of the mosaics and the performance of previous restorations and reburials. It produced a detailed technical program for treatment of the mosaics and a general plan for regular maintenance of the mosaics and the site. Today this project is the basis for the management plan of the Soprintendenza for Nora.*

Résumé : *Cette communication décrit le projet de conservation et entretien des pavements en mosaïques du site de Nora, Sardaigne, conçu en 2002 par le Centro di conservazione archeologica de Rome pour la Soprintendenza archeologica di Cagliari. Du fait de la fréquentation importante et de son environnement marin, des restaurations importantes et des réenfouissements ont été effectués dans les années 60. Le projet 2002 s'est basé sur l'analyse de l'état de conservation des mosaïques et des résultats des restaurations et réenfouissements précédents. Cela a débouché sur un programme technique détaillé pour le traitement des mosaïques et un plan pour leur entretien et celui du site. Ce projet constitue la base du plan de gestion de la Soprintendenza de Nora.*

In the current panorama of mosaic conservation at archaeological sites, a new problem has emerged that calls for active responses. This is the enormous number of mosaics exposed to the outdoors that were subjected to radical restoration treatments in the 1960s and 1970s, following a wave of enthusiasm for technical approaches. Mosaics were detached and reapplied on cement, as conservators were convinced that this would settle things once and for all. This was based on their faith in the modern materials developed for the building trade and adopted in the conservation of ancient monuments and the techniques used for removing surface features.

In Italy, which became a major center of study because of these treatments, it soon became apparent that they not only had limitations but also caused damage to the artifacts and their context. The situation is quite different in other places, where these treatment techniques were introduced some twenty years later and are still often practiced.

By the early 1980s protests were arising from various professional groups about the inadequacy of these treatments. Archaeologists, art historians, restorers, and scientists joined forces to point out the erroneous theoretical and ethical basis for such treatments, especially the serious and obviously damaging impact on the ancient materials and the sites in general, as well as the high cost of implementing and managing them afterward. They maintained that other solutions, apart from the purely technical ones, could be used to conserve the mosaic heritage. The critical review obtained in the large "laboratory" of all the archaeological sites with detached mosaics presented a strong case for a radical cultural change in the field of archaeological conservation. This led to a theoretical and methodological reversal in policy, whereby conservation in situ has now become the guiding principle for safeguarding archaeological areas with mosaics.

As a result of this new approach the practice of in situ conservation during the past ten years has led to the

FIGURE 1 The archaeological site of Nora. Courtesy Centro di Conservazione Archeologica–Rome (CCA).

formation of not only its own objectives but also, notably, the tools needed to achieve them. Among these—and quite apart from developing specific techniques for the direct and preventive conservation of surfaces—there is now a major emphasis on planning treatments as part of a global project of site management that includes not only the material conservation of the artifacts but also the relationships that exist among research, scholarship, presentation, and the dissemination of information.[1]

This paper discusses the project for the conservation and restoration of floor mosaics at the archaeological site of Nora, located in the province of Cagliari, Sardinia, Italy. In 2002 the Soprintendenza Archeologica di Cagliari (Archaeological Superintendency of Cagliari) commissioned the Centro di Conservazione Archeologica (CCA) to head a project to respond to the serious conservation problems posed by the mosaics. It was possible to analyze thirty-one pavements in detail, totaling 720 square meters of mosaics. About half had been detached and relaid on reinforced concrete in the 1970s, thus permitting a comparative study of their state of conservation under different display conditions in the same environmental and archaeological context. It also provided an opportunity to study the effect of contact coverings placed over some pavements in the early 1980s and to evaluate the benefits some twenty-five years after they had been placed on surfaces that had been first restored and laid on cement and on surfaces that were still in situ on original layers.

The Archaeological Site of Nora

Founded by the Phoenicians, Nora was colonized by the Carthaginians and conquered by the Romans in 238 B.C.E., becoming the capital of the Roman province under their dominion. It is located by the sea on the promontory of the Cape of Pula, which dominates the Gulf of Cagliari in the southeast of Sardinia (fig. 1). The gradual penetration of the sea and the arrival of the Vandals in the fifth century C.E. led to its slow decline and eventual abandonment in the eighth century (Tronchetti 1986). In the stratigraphic phases now open to the public, the city is characterized by a series of important mosaics, notable for the quality of their decorative compositions and extent. The site spreads over more than 3 hectares and is composed of fourteen monumental groups (720 square meters of mosaics), all belonging to the Roman phase of its life. It has public and private buildings, including a theater, a basilica, baths, temples and houses, streets and squares. With white beaches and crystal-clear sea nearby, the site draws tourists from all parts of the world, especially in spring and summer, and is a focus of regional development.

The conservation history of the mosaics and their display begins in the second half of the twentieth century with the first systematic excavations of the site. Although the city was known from the sixteenth century for its ruins emerging from the water, it was only extensively excavated in the period between 1952 and 1960 by Gennaro Pesce, then superintendent of antiquities of Sardinia. He brought to light most of the surface that is now on display. Further archaeological investigations were conducted in the late 1970s and early 1980s by Carlo Tronchetti of the Cagliari Superintendency, who uncovered the entire area of the baths near the sea. Research activities continue today under the direction of the Cagliari Superintendency, in collaboration with various Italian universities.

After the excavations in the 1960s an initial major restoration campaign was started in order to prepare the site for public display. Following the popular approach of the time, most of the pavements were detached, mounted on reinforced concrete panels, and relaid in situ, again on cement. By the end of the 1970s, some twenty years after treatment, the restored surfaces presented such serious deterioration that the Superintendency, in the person of Tronchetti, sought various solutions to protect the mosaics. The practice of detachment was abandoned, and newly excavated mosaics were left in situ. The treatments varied according to the seriousness of the condition of the surfaces, as did the decision as to whether or not to leave them on view. Eight pavements still on their original bedding layers and one restored pavement on reinforced concrete were given protective contact covering as follows: a layer of about 5 centimeters of river sand (or quarry sand, without salts), a layer of polyethylene, and a layer of lime-cement mortar of an average thickness of 5 centimeters. This completely isolated the surfaces from exposure to the environment (fig. 2). Treatment of the remaining, unrestored pavements was limited to reinforcing the edges and filling the lacunae with lime-cement mortar.

From 1988 to 1990, given a dangerous worsening in the condition of the still-exposed mosaics relaid on reinforced concrete, further treatments were performed to restore the restorations. Either the entire surface was detached again and the iron armature removed, or the tesserae were lifted and then replaced after the bars were removed. These treatments affected only those pavements restored in the 1960s; the pavements still on reinforced concrete are currently in desperate condition.

The Project for Conservation of the Mosaics

The objective of the project requested by the Cagliari Superintendency in 2002 was for the CCA of Rome to devise a global strategy for conserving the mosaics for both the short and the long term. The idea was to categorize and prioritize problems and to develop a plan for project implementation and the management and supervisory activities of the Superintendency. To formulate the project, the following phases were undertaken:

1. collecting information to determine the characteristics and conditions on the site;

FIGURE 2 The protective contact covering of lime-cement mortar completely isolates the surfaces from contact with the environment. Courtesy Centro di Conservazione Archeologica–Rome (CCA).

2. analyzing data, defining the site, and identifying problems and their types (condition, regional context, threats, human resources, users, managers, development of research and knowledge);
3. listing treatment priorities; and
4. defining a strategy for the site's conservation and management based on priorities and drafting a comprehensive action plan including operations and materials as well as necessary professional and financial resources.

1. Collecting Information

The first phase was dedicated to examining every component of the site. This included collecting all available information along with a technical analysis of the current situation in order to discover the physical characteristics of the mosaic surfaces; to quantify their exact extent; to reconstruct the conservation history from the time of excavation to the present; and to clarify the relationship between the current state of affairs, the environmental parameters, and the normal habits of life, use, and management of the site. The procedure was as follows:

- collecting archival photographs of the mosaics and all available written information, either published or in the form of internal reports;
- studying existing archaeological publications about the site;
- directing activity in the field to analyze and document all the pavements;
- producing base maps to record and describe the current condition (documentation); and
- visiting existing infrastructure (routes, visitor services, site museum) and interviewing personnel responsible for certain tasks, with particular attention to tour guides.

At the end of the study, it was possible to

- estimate the exact extent of the exposed surfaces;
- define and document their current condition;
- clearly identify the risk, deterioration factors, and deterioration processes under way;
- trace a picture of the relationship among the exposed mosaics, visitor routes, and current use.

The results of this first phase led to the drafting of a detailed report covering each mosaic analyzed: dimensions, compositional character, visible appearance of deterioration, conservation history (including the period of exposure and presence of preceding restoration treatments and their typology), the onset of deterioration and mechanisms at work, an evaluation of the gravity of the material condition found, and the degree of risk. A further element, studied individually for each monumental group, was presentation to the public in its current state. The evaluation process included the importance of the monument and its mosaic surfaces for understanding the site, the efficacy of any possible use, and the direct effect on its condition.

Three categories were identified among all the mosaics (fig. 3):

1. pavements laid on original bedding layers and never detached;
2. pavements detached and relaid on reinforced concrete and still on reinforced concrete;
3. pavements detached and relaid on reinforced concrete, with subsequent removal of the metal parts (1988–90).

This initial division corresponds to a substantial difference in the condition of the pavements. In fact, it became apparent that the greatest risk is to the pavements still on reinforced

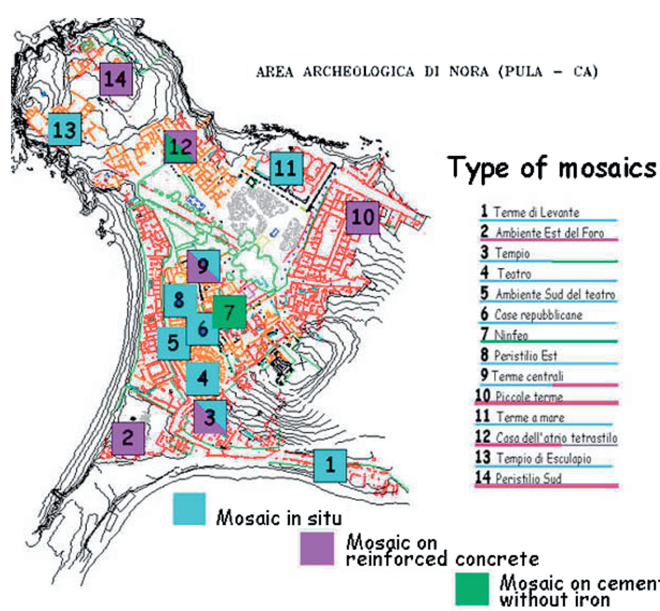

FIGURE 3 Three categories of the Nora mosaics. Courtesy Centro di Conservazione Archeologica–Rome (CCA).

FIGURE 4 Central baths, *frigidarium*. The pavement is on reinforced concrete with metal rods and suffers from such serious deterioration that the survival of the original material is at great risk. Courtesy Centro di Conservazione Archeologica–Rome (CCA).

concrete with metal rods (fig. 4). For some years now mosaic specialists have known the reasons for this situation: oxidation and consequent expansion of the iron, the excessive hardness and low porosity of cement, and solubilization and crystallization of soluble salts—all these factors take their toll on the ancient materials.

The mosaic pavements of Nora can be divided into three broad categories based on their condition:

(1) *Pavements on original setting beds:* Generally, the original preparatory mortars of these pavements have partially or totally disintegrated, with resultant detachment of the *tessellatum*, which is therefore often resting on the ground, as well as formation of lacunae. Where the mortars are still partially cohesive, there is cleavage between the original layers and infiltration of dirt and other organic material between the tesserae and the layers beneath, leading to the growth of weeds. The surface of the tesserae is covered with biological incrustations, lichen in particular.

In this category only two cases are serious. One is the pavement of the Temple of Aesculapius, which has been left exposed since excavation in an area that is especially unfavorable because it is close to the sea and far from the usual visitor routes. The other is the *apodyterium* of the central baths, which had been protected since excavation by a tile roof (perhaps because of its condition) and was then protected again in the 1980s with a contact covering. Almost all the other pavements that are still in their original position exhibit, to a similar degree, the same forms of deterioration. Seven of these can be defined as stable, thanks to the contact coverings that keep their microclimate in equilibrium and do not expose them to mechanical damage. In the four cases that have good general surface condition, this is due to their protected location and to the composition of the original layers. This is the case with the *opus signinum* and the *spicatum* of the Republican houses. Because they are situated lower than the adjacent spaces and because of the presence of *cocciopesto* (lime mortar with crushed brick) in the composition, their materials possess general compactness and resistance.

(2) *Pavements detached and reapplied on reinforced concrete in the 1960s:* The majority of these pavements suffer from such serious deterioration that the survival of the original materials is greatly at risk. Because of the total instability of the restoration materials on which the mosaics are bedded, entire portions of *tessellatum* are literally disappearing. On this type of pavement one generally finds explosions beneath the tesserae, with resulting detachment and raising of the *tessellatum*, cracks, subsidence, and progressive and exponential increase in lacunae, along with growth of roots under the tesserae.

Of the eleven pavements bedded on reinforced concrete, only one—Room L of the House of the Tetrastyle Atrium—can be defined as stable. This is due to the presence of the contact covering that sealed the pavement, impeding its interaction with the environment for more than twenty years. The two principal factors responsible for the current poor condition of the surfaces are exposure to the marine environment since excavation and the damaging restoration materials used in the 1960s.

(3) *Pavements detached from reinforced concrete support and relaid on cement alone:* These pavements are generally in good condition thanks to their restoration in the late 1980s, when iron elements in the bedding layers were removed. While this treatment eliminated the major element of instability, it was not without consequences, given the ample presence of patching along the cuts that were made while removing the sections of the mosaic. This patching indicates a high percentage of loss of original surface.

Although these pavements were exposed for twenty years after this treatment, they did not suffer rapid or dramatic deterioration. The three pavements that were re-restored are generally solid, except for occasional detachment of the *tessellatum* from the cement layer beneath and a slight loss of tesserae. Forms of decay are found principally on the tesserae surfaces and the interstitial spaces, with extensive accumulations of dirt and microflora.

2. Analyzing Data and Defining Treatment Priorities

Comparative analysis of the data led to defining and characterizing categories of problems, which in turn allowed for the planning of specific types of treatment to meet the various conservation needs of the pavements and the creation of a list of priorities. The chemical-physical processes acting on the artifact from the marine environment (i.e., rain, wind, strong and prolonged exposure to sun, frequent thermal fluctuations, and a significant presence of chlorides in the environment) were found to be the main factors responsible for the decline in the condition of the mosaics. These mosaics were already strongly compromised by the natural deterioration of their constituent materials, especially from the numerous imbalances introduced by past restorations. Moreover, some mosaics are directly exposed to erosion from the sea nearby.

The impact of poorly controlled tourism was also found to be among the principal causes of damage. The surfaces were subject to light and heavy damage from improper visitor behavior, such as walking on the mosaics or removing tesserae. This results from the lack of maintenance of paths, the illegibility of information panels, and insufficient control of the entire visitor access area, which receives peak numbers in summer without a corresponding increase in guards or additional ordinary maintenance.

In brief, the general picture regarding the state of the mosaics shows large surfaces where the mosaic fabric is detached from the support, the tesserae no longer adhere to each other, the original mortars are mostly crumbled or completely lost, and the materials used in previous restorations have activated the dangerous phenomenon of detachment of the *tessellatum*.

An encouraging fact that emerged from the comparative study was the efficacy of stabilization and protection of the surfaces through contact covering, which was carried out in the 1980s on nine pavements. In the case of those mosaics still on original layers and in the sole case of a mosaic on reinforced concrete, these coverings kept the mosaics' condition unaltered over the course of twenty years. The mosaics on original layers and those applied on cement without reinforcement are in serious but not alarming condition. In contrast, all those on reinforced concrete are in an advanced state of decay and urgently need treatment.

Starting from these objective considerations, the pavements were divided according to a hierarchy of treatment priority and a two-phase program devised (fig. 5):

- phase 1, treatment of pavements needing urgent and immediate attention;

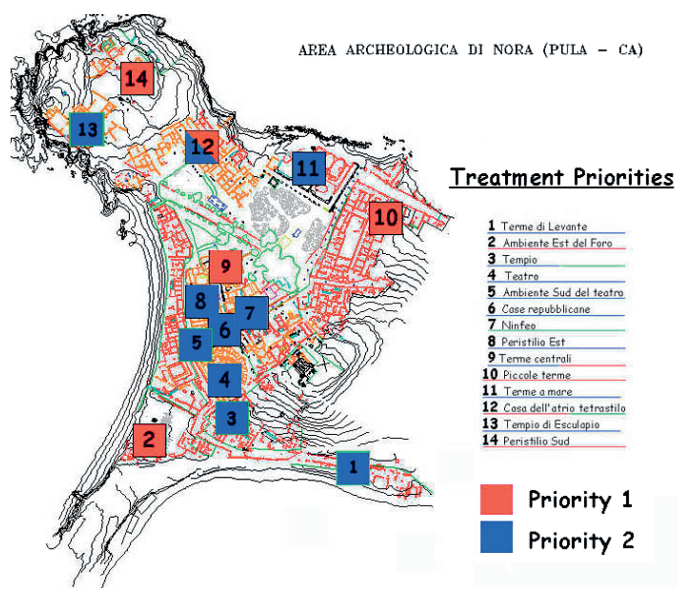

FIGURE 5 Treatment priorities determined for the mosaics. Courtesy Centro di Conservazione Archeologica–Rome (CCA).

- phase 2, pavements that can be treated later on—thanks to a medium to low level of deterioration or to contact protection that maintains the status quo.

3. Defining a Strategy and Drafting an Operational Plan
The main objective of the strategy was to create a long-term, sustainable conservation approach for Nora's mosaic heritage and to keep down the future management costs without diminishing the historical and archaeological interest of the monuments and the site as a whole. In other words, a compromise was sought between pure conservation needs and developing the site's tourism potential. It was felt that the greater the public appreciation and awareness of archaeological heritage and the benefits of economic and social development of the region, the greater the benefit to safeguarding the heritage itself—in a case in which presentation to the public is managed as part of a defined cultural program with all the structural and auxiliary support required.

Therefore, two treatment approaches were contemplated. One was a treatment aimed at conserving the surfaces, with a study of various specific treatments for each category of mosaic noted, including preventive conservation measures and maintenance plans. The other was the management and strengthening of the current visitor facilities for the site (which already has an archaeological museum in the nearby town of Pula), visitor routes, information panels, and other services such as a café, bookshop, guides who give free tours for the Superintendency, and shaded parking areas.

Restoration and conservation treatments

The following methodologies were given precedence when formulating the project:

- in situ maintenance and consolidation of the pavements not already detached;
- detachment, restoration, stabilization, and reapplication in situ of the pavements that are now on reinforced concrete;
- use of lime-based materials compatible with the original materials and structures;
- full documentation of the current state of affairs and of the operations to be performed.

Three types of treatment were identified for the various conservation needs of the pavements at Nora. The choice of one type or another was dictated by the condition of the original materials, by the presence of previous restorations carried out with unsuitable materials, by the condition of such restorations, and by the presence or absence of suitable environmental conditions for keeping the pavements in situ.

(1) *Conservation in situ through consolidation:* This treatment can be performed on pavements that have their original preparatory layers and on pavements that—although previously detached and relaid in situ—are basically in a solid and stable condition.

(2) *Detachment, restoration in the workshop, and replacement in situ:* This treatment is needed for all those pavements detached and relaid in situ on reinforced concrete during previous treatments that now show considerable deterioration due to the materials used in the restoration but also have environmental conditions that permit their replacement in the original position.

(3) *Detachment, restoration in the workshop, application on honeycomb panels, and display in the museum:* This treatment is needed for all those pavements detached and reapplied in situ on reinforced concrete during previous treatments that have major deterioration and almost total loss of the original *tessellatum* and do not have the environmental conditions necessary for being kept in situ for the long term.

The various typologies entail thorough documentation, including thematic base maps and photographs to register the current condition of the surfaces and all the treatments to be performed, such as cleaning of surfaces, consolidation of tesserae, repairing the interstitial mortar, and treatment of lacunae. An integral part of the treatment involves plans using indirect measures to prevent damage, managed presentation of the mosaics with periodic covering/exposure along the visitor routes, and implementing schedules for regular maintenance and long-term conservation. Each type of treatment has its related cost estimate, which clearly shows the high expense of treatment for those mosaics that are now on reinforced concrete.

Preventive conservation and maintenance

Long-term conservation of the mosaic heritage of Nora calls for the implementation of combined action plans to minimize the environmental impact on the surfaces, control deterioration factors, and maintain the positive benefits of the conservation work performed. Given that the mosaics are in an outdoor setting with unfavorable environmental factors (growth of weeds and lichen, proximity to the sea, wind, pronounced temperature changes) and are also subjected to heavy tourism during spring and summer, a plan was devised to respond in a balanced way to the needs of conservation and those of public enjoyment of the site. The plan involves a program of covering and exposure of the mosaics along the visitor route, combined with regular maintenance of the exposed mosaic surfaces.

The covering/exposure program will reduce the total surface area of mosaics exposed to the risks of environmental deterioration (and hence management costs) and will also limit the exposure time to periods of minor climatic risk. The regular maintenance program—through direct action performed on a consistent and continuous basis—will eliminate or limit the resurgence of alteration phenomena on the surfaces due to environmental decay factors that cannot be prevented. The combined action of these activities will ensure the enhancement of the site and its conserved monuments, increase visitor enjoyment, and drastically reduce the impact of decay factors on the original materials.

Program for covering or exposing the mosaics

The program for periodic or permanent covering of the mosaics was devised with the following factors in mind: condition, exposure to environmental risks, risk due to wear and small acts of vandalism by visitors, typology, geographic location along the visitor itinerary, and enhancing understanding of the monument and the site.

The pavements were classified on the basis of these factors and grouped according to different methods of display:

- always visible: a maintenance plan was foreseen for the mosaics on permanent view.
- seasonal visibility: implementing a schedule for seasonal covering with a temporary contact cover of geotextile bags filled with expanded clay granules, which will protect the surfaces from chemical, physical, and biological decay during the period of greatest climatic risk (winter) and lowest tourist presence.
- always covered: permanent contact covering was proposed for pavements far from the main visitor routes and/or those exposed to environmental and human risk factors such that they might not survive even with regular maintenance. Given the proven efficacy of the covering previously used, the mosaics will be protected using the same system.

Maintenance program

Maintenance must be performed on the mosaics that are always visible and those covered seasonally while also considering the paths and information panels. The maintenance program will involve cleaning the surfaces, manual and chemical weed removal, biocide treatments, inspection of materials, updating of information panels and replacement of damaged or illegible ones, and inspection of paths and routes with eventual modifications if they are not effective. These operations must be continuous and performed at regular intervals (table 1).

Conclusion

Fifty years after excavation Nora is one of the many archaeological sites with mosaics where conservation solutions were tested and became part of the history of archaeological restoration, from detachment and reapplication on reinforced concrete to temporary coverings to contact coverings and re-restoration. While strolling through the site, one can thus read the attempts made over half a century to reconcile the needs of conservation with those of heritage appreciation and knowledge. One can read the errors made and see the devastating impact of massive technical-type treatments and the sad outcome of the effects of natural forces and of human action or the lack thereof.

What clearly emerges is that so far the approach has been to adopt specific solutions one case at a time, without a broader perspective that sees the problems and the context as a whole. In other words, there is no global overview, not only of the risk factors, but also of the objectives set forth for future use of the archaeological area, including the complex relationship among conservation, management, and cultural use and the cost of operation. A critical examination of this situation allowed us to evaluate the material conservation of the works in real terms and to quantify the financial ramifications of the treatments that until recently were emblematic of our archaeological sites. We were also able to see more clearly the validity of the technical and methodological solutions offered by conservation in situ.

At Nora we have inherited mosaics that—precisely because they were restored—are now seriously damaged. Some have been irremediably transformed and will require substantial funds for conservation. We also inherit the certainty of a proven technical tool such as contact covering, which merits increasing consideration for the prevention of damage and for long-term conservation, together with regular maintenance. Moreover, we inherit the important signs of a cultural change in process. The Nora project is a key example of policy planning on the part of a local administration that intends to perform its duty of heritage protection, following a program that has examined the various current priorities and cultural objectives and attempts to acquire the tools that will permit the best autonomous, long-term management of the treatments and resources available.

Table 1 Program for the presentation of the mosaics and scheduled time for maintenance

Locale	Mosaic Surface (m²)	Presentation and Maintenance	Annual Frequency	Workdays per Year
Baths of Levante, room A	91	Seasonally covered, with ordinary maintenance	7	11
Forum	12	Displayed in the museum of Nora with ordinary maintenance	12	2
Temple	21	Exposed, with ordinary maintenance	12	9
Theater	14	Seasonally covered, with ordinary maintenance	8	4
Republican houses	25	Permanently covered; no maintenance required	0	0
Spaces south of theater	9.5	Permanently covered; no maintenance required	0	0
East peristyle portico	33	Exposed, with ordinary maintenance	12	4
East peristyle porticos	23.5	Permanently covered; no maintenance required	0	0
Nymphaeum	83	Exposed, with ordinary maintenance	12	12
Central baths, *apodyterium*	39	Seasonally covered, with ordinary maintenance	7	11
Central baths, *frigidarium*	101.5	Exposed, with ordinary maintenance	12	12
Small baths, corridor	25	Permanently covered; no maintenance required	0	0
Small baths, *frigidarium*	9	Exposed, with ordinary maintenance	12	4
Small baths, *apodyterium*	18	Seasonally covered, with ordinary maintenance	7	11
Baths on the sea	63	Exposed, with ordinary maintenance	12	9
House with Tetrastyle Atrium	78.5	Exposed, with ordinary maintenance	12	12
Temple of Aesculapius	70	Exposed, with ordinary maintenance	12	12
South peristyle	4	Displayed in the museum of Nora with ordinary maintenance	12	2
Total workdays per year				**115**

Acknowledgments

The author wishes to thank Cynthia Rockwell for her translation of this paper from Italian.

Notes

1 For an analysis of the theme of conservation in situ, the issues connected to its implementation, and the objectives involved, see Melucco Vaccaro 2003: 17–22.

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Discussion—Session 4: Managing Sites with Mosaics

Présidente/Chair: Martha Demas

Discussion following Amr Nawar Al Muayyad Al-Azm Presentation

KONSTANTINOS POLITIS: First, I want to make a quick comment related to the earlier paper given by our Turkish colleagues about documenting mosaics in the paper Dr. Kökten gave on a project funded by the European Center for Byzantine and Post-Byzantine Monuments. This is an ideal kind of situation where we can have regional cooperation, not just within Syria but also with this new entity. I hope to see the possibility for cooperation between more than one country in the region, in terms of documenting mosaics. Now for my question to Dr. Amr. The impression I got is that even though there are things being done in Syria to enhance the protection and documentation of mosaics, perhaps the administration might be the problem. You understand what the problems are; a number of people in Syria understand the problems, which are obvious from your lecture, but might the administration be inhibiting the protection of mosaics?

AMR NAWAR AL MUAYYAD AL-AZM: When you say "administration," we should be more exact in dealing with this particular point. It's not that the administration does not want to cooperate. I don't think that's the case; it's more a case that the administration, in many ways, is ignorant of what it needs to do. And quite often, while perhaps the conservators might be aware of what needs to be done, the curators who are responsible ultimately for looking after the mosaics once they have been conserved are not always aware of what needs to be done. And there are gaps in information. The administration as a whole is aware of what needs to be done, and it is supportive, as and when it can be. When you come up with a good project, the administration supports it and has been supportive of our work. So I think it's more a matter of a lower level, curators, conservators, archaeologists, working together, rather than the "administration."

JACQUES NEGUER: First of all, felicitations for your planning. Everybody here is dreaming of such a system with physical condition information online. But did you have some legal frame and time frame to implement this?

AMR NAWAR AL MUAYYAD AL-AZM: Well, as with all best-laid plans, we establish time frames, but whether we are able to stick to them or not is another matter. In a way, yes; I mean, our actual self-imposed time frame to come out with the first *tranche,* if you will, of information is about two years. And we are already, I'd say, three quarters through our first year. We have documented, at least in preliminary form, the mosaics from two major museums, which is no small undertaking when you consider that there are only eight students, myself, and a few of our colleagues working with us. The data have been input in the database, which is a major undertaking in its own right. But then presenting the data once they're in the database in a format that is readable by everybody is going to take a bit of work as well. So we hope that at least we can have something available by the end of 2006.

HOUDA MOUSSA: Ma question, docteur, n'est pas une question, c'est une remarque. Je le félicite pour avoir mis l'accent sur les mauvaises conditions de conservation dans les réserves et aussi pour le rôle constructif qu'il a tenu durant des années en qualité de chef du département de conservation et restauration au sein de la direction. Félicitation pour ses travaux dont on voit maintenant le fruit.

AMR NAWAR AL MUAYYAD AL-AZM: Thank you very much for your kind words, but I believe that we are really only at the beginning of a long road. And by the way, I'm no longer at the department. I resigned, and I am now at the university. But the team that was put in place is still there, and they are carrying on the work that we started, so the future credit goes to them rather than to me.

Ewa Parandowska: A couple of years ago I had the chance to visit the basement of the Damascus museum, and I was really impressed by seeing hundreds of mosaics resting on their facings and, let's say, neglected. I'm curious if, according to your present knowledge, they were stored like that because they belong to category B, which is a simple geometric design, and will never be treated and displayed because of lack of space, money, and so on, or maybe you can tell us that you're planning to do something with all these mosaics. I would say that our museum, the National Museum in Warsaw, would be very happy to have at least one of the category B mosaics in our exhibition.

Amr Nawar al Muayyad al-Azm: Very briefly, the mosaics that you are referring to are not just simple geometric designs. There are mosaics that appear to be more interesting and more important, but they're all part of this same corpus, and they're all important. But some of them are very important. And, unfortunately, in some cases we don't have a lot of documentation on them, and we have not yet been able to open the boxes; we just moved them and organized them in a safer place, but I hate to think what will happen when their turn comes and we start to work with them. All I can say is, we can hope for the best. But if you wish to come and take on one of those mosaics, please, I am sure the Department of Antiquities would be more than happy to accommodate you. And you know the team members there, so you can talk to them.

Discussion following Mervat Ma'moun Ha'obsh Presentation

Évelyne Chantriaux: My question is about the choice of glass for the walls of the shelter; you said it was because of transparency. Is it to see the mosaics from outside to inside or to see the archaeological context of the landscape from inside? Do you think that you have a system to reduce the effects of the sun? Because in Jordan, of course, during some months there is a lot of sun, and it can be very difficult to control the heat in the shelter. Did you plan for some flexible curtains or panels, something to provide protection? Because glass is a problem.

Mervat Ma'moun Ha'obsh: I would like to assure you that we have taken into consideration all the issues in environmental modeling, and we have measured everything. The environment inside the shelter will be just two degrees different from that outside the shelter, taking into consideration all the issues relating to visitors. Transparency here does not mean that it's all open, no, just for ventilation at the top and at the bottom so that you will have natural ventilation. Of course, we have taken into consideration the sheltering or covers on the windows and the glass. What we intend is that you can look through the glass from one side to another. The opening of the glass will be on the north and south, not on the east and west. It's a place in the desert, and we have to take into consideration all the issues regarding this.

Thomas Roby: I'm interested to know, considering the title of the conference, "Lessons Learned," whether while you were designing the shelters for Um Er-Rasas, you considered, or studied, other examples of preexisting shelters on mosaics. In particular, I'm aware of a shelter at the Petra church nearby.

Mervat Ma'moun Ha'obsh: Yes, we took into consideration other shelters. The design of the shelter is being studied by a consultant, a British company. And, of course, we asked the consultant to do a survey of different types of shelters. At the beginning, we were considering putting a tent over the shelter because we wanted it to be in a form that existed in the desert, but studies showed that there is a lot of wind in the area, more than 35 kilometers per second, and this is an issue that we have to take into consideration. So, yes, we looked at many examples.

Jacques Neguer: I'm interested in the decision-making process. Did you study the impact of the shelter on the environment, on the archaeological site, and the impact of the shelter on the mosaics, physically and visually? The shelter will change the landscape and the context of the churches. How is this shelter included in the site image, in the landscape?

Mervat Ma'moun Ha'obsh: If I understand the question correctly, yes, we studied all the issues—financial issues, physical and environmental issues—all around the site and inside the site. We looked into how this shelter would work with the whole environment, the outside, its shape, and how it looks. So we studied the elevations, and we also studied the height of this shelter, and we have diagrams that show all the different issues regarding the shelter itself.

Federico Guidobaldi: Only a very short question: You don't think that ventilation can be dangerous for the efflorescence of salts in the mosaic? It all has to be very well calibrated, because I think there is a real danger with ventilation.

Mervat Ma'moun Ha'obsh: You're right about this issue, but from what we found from the existing shelter, its natural ventilation was working well. The main problem was the water drainage under the mosaic.

AÏCHA BEN ABED: I'm going to ask a very naive question, I think. It seems that your project is very fancy and particularly expensive and using glass and all this material that needs a lot of maintenance. My question, my naive question, is why didn't you consider just rebuilding the walls according to the ancient techniques? It would be much simpler, less expensive, and easier to maintain.

MERVAT MA'MOUN HA'OBSH: We have considered this issue. We don't know exactly what type or what the architectural form of these churches is. So we were thinking that if we build a wall, we might give the wrong impression. We decided—of course, there is a committee that is responsible for advising the project—that a new structure would be better than re-creating the walls. First of all, it would differentiate between the old and new, and at the same time it would be sustainable for a long time. Yes, it cost a lot, but we considered the cost. We were trying to do all the mechanical work or the technical work in Jordan, so that local people can do the maintenance and it will be easier for us. And the main reason is that we don't know the exact shape of the churches, and we don't want to give an unrealistic form to them.

Discussion following Konstantinos L. Zachos Presentation

PAULA ARTAL-ISBRAND: When you talked about the Dionysos mosaic, you said that it was decided to remove the *emblema,* to place it in the Nikopolis museum, and, basically, a replica was made. I'm just curious about what you used to make the replica. What materials did you use?

KONSTANTINOS L. ZACHOS: We're going to use modern materials to make a replica to put back in situ where the original existed. Stone, glass, it depends. But we're going to follow what had existed before. We're using limestone, local stones for the pink, and also glass.

FEDERICO GUIDOBALDI: I remember there was a meeting perhaps fifteen years ago, and I presented a paper on the *opus sectile* of Nikopolis, which was in a terrible situation. I was surprised that you didn't speak about *opus sectile* floors too.

KONSTANTINOS L. ZACHOS: No, I did not speak about *sectile.* It was preserved in the late 1970s. It's covered, and we're planning to restore and reopen it again, and the church too.

JACQUES NEGUER: I'm impressed by the way you obtain approval for the removal of mosaics. Is this only for the Nikopolis area or for all of Greece?

KONSTANTINOS L. ZACHOS: No, this is only for Nikopolis, and there is a special committee for Nikopolis so it's easier to organize and decide than for the entire country of Greece. There is a scientific committee, of which I have the honor to be president, and the work is supported by the European Union. The scientific committee made the master plan for different issues, including mosaic preservation, and our decisions have to be approved by the central council, even after we start the actual work.

Discussion following Hassan Limane Presentation

ÉVELYNE CHANTRIAUX: Quand vous parlez de rendre à la nature, pour les deux cas les plus gravissimes, je n'ai pas très bien compris si cela voulait dire les réenfouir sous une couche de sable ou de terre ou les abandonner.

HASSAN LIMANE: Non, c'était les recouvrir, parce que vous ne pouvez pas les laisser comme ça. Oui, les rendre à la nature, c'est parce que normalement dans la vraie nature, ils étaient ensevelis, donc je crois que la meilleure manière de les protéger dans cet état-là, c'est de les recouvrir et les rendre à la nature. Car en tout cas une fois qu'ils sont en sous-sol, ils sont moins sujets à des dégradations. On a essayé, c'était aussi une expérience, on les avait recouverts avec du sable sec, c'était l'été, un plastique troué pour l'aération, bien sûr, et de la terre, et on les a recouverts pendant l'étude que nous avons opérée avec nos collègues anglais et ils étaient intacts, impeccables.

ÉVELYNE CHANTRIAUX: Sur quelle durée de temps le plastique a-t-il été utilisé ? Le plastique est plutôt déconseillé, c'est mieux d'utiliser du géotextile ou un Bidim.

HASSAN LIMANE: Sur deux ans. En tout cas, il n'y a eu aucune réaction. Vous savez, on travaille avec les moyens du bord.

ÉVELYNE CHANTRIAUX: Ce n'est pas très cher le géotextile, c'est utilisé pour faire les voiries publiques, ce n'est pas un matériau très cher.

HASSAN LIMANE: Mais en tout cas selon les analyses que nous avons effectuées, il n'y a eu aucune dégradation, ni au niveau des tesselles, ni au niveau du *tessellatum*, rien du tout. Il faut que j'ajoute qu'il y a aussi eu une étude de laboratoire, des analyses, pour les altérations. On a aussi établi une carte de risques, pas simplement une carte de risques pour les mosaïques, mais il y a aussi une carte de risques pour les structures et il y a une concordance. Ce que nous avons observé au niveau de l'ensemble du site, c'est qu'il y a un glissement de terrain qui agit sur les structures, que cela soient les structures verticales ou les structures horizontales.

ABDELILAH DEKAYIR: Je pense que ce n'est pas une bonne chose de recouvrir les mosaïques parce que si on les recouvre, de toutes les manières, toutes les couches de la mosaïque restent en contact avec l'eau, et c'est l'eau qui est l'agent dégradant des mosaïques. Je pense que si on ose recouvrir des mosaïques, il ne faut pas les recouvrir avec du sable parce qu'on sait que le sable, il est très poreux, il faut les couvrir avec des matériaux qui ne laissent pas passer l'eau, par exemple des argiles ou quelque chose comme ça. Je rappelle aussi qu'à Volubilis, on a entamé des recherches sur la minéralogie et la chimie des pavements et des tesselles. Ça aide beaucoup à comprendre comment fonctionne ce système, parce que je pense que les mosaïques, ce sont des systèmes qui sont très complexes, et on ne peut pas conserver des mosaïques sans connaître de quoi ces systèmes sont formés. Les mosaïques, pour nous en tant que géologues ou gens des sciences de la terre, c'est des systèmes qui sont avec plein de roches et donc c'est des systèmes qui sont très complexes. Et il faut aussi voir les mortiers, parce que le mortier fin, il est pratiquement de la même composition que les mortiers grossiers, mais c'est les caractéristiques qui sont différentes. Je pense que lorsqu'on veut parler de la conservation, je suis vraiment désolé de ne pas comprendre d'abord qu'est-ce que c'est qu'un système de mosaïque. Donc, j'aimerais, par exemple lors de la prochaine conférence, qu'il y ait des sessions sur l'art, des sessions sur la gestion et une session pour les scientifiques, pour parler des phénomènes de la dissolution, des attaques, de tout. Et donc, je pense que la place des scientifiques, elle est en plein là-dedans.

HASSAN LIMANE: Je répondrai seulement au niveau du recouvrement, sur le côté scientifique je te donne raison puisqu'on travaille toujours dans le même axe ensemble, mais au niveau du recouvrement de la mosaïque, je ne suis pas d'accord parce que c'est là où réside le problème. C'est une décision, qu'elle soit positive ou négative, mais en tout cas il faut la prendre. Doit-on laisser la mosaïque à l'air libre et qu'elle continue à se dégrader ou doit-on trouver une solution adéquate, même la plus simple des décisions, et arrêter, au moins momentanément, la dégradation ? Je crois, que soit du point de vue archéologique ou du point de vue de la conservation, la meilleure solution, c'est de recouvrir, parce qu'au moins on donne une longue vie à la mosaïque en attendant d'avoir les moyens et l'équipe nécessaire pour intervenir.

ABDELILAH DEKAYIR: La dégradation des mosaïques, comme on l'a vu, c'est des attaques qui se passent dans le bain de pose, et donc, si on couvre des mosaïques, c'est vrai qu'on ne va pas attaquer la surface des tesselles, mais il faut voir qu'il y a des drainages qui sont latéraux et qui attaquent le liant fin. Donc, j'imagine que ce n'est pas une solution.

HASSAN LIMANE: Non, je réponds encore et je maintiens mon idée. C'est là où réside notre problème de conservation. C'est la décision. Quelle décision doit-on prendre ? Lorsque tu es conservateur d'un gros site comme ça et tu vois un patrimoine qui est en voie de dégradation, mets-toi à ma place. Le système de drainage, oui, je suis d'accord pour l'installer, mais avant d'installer le système de drainage, il faut déposer. Avant de déposer, il faut avoir les moyens, et dans des cas comme ça, on n'a pas les moyens. A l'origine, la mosaïque, elle était enterrée, donc c'est l'exposition qui l'a rendue comme ça. Donc je crois que la meilleure solution, même si tu n'es pas d'accord, c'est de recouvrir.

CHIARA ZIZOLA: To respond to your critique, you have to remember that we found mosaics under the earth after two thousand years, so the degradation that you see is not related to the burial situation but the opposite, to the open air, to the drying of the mosaics, and to the interaction with the environment. The degradation of the mosaics after reburial is very slow, so slow that it's not a real problem.

Discussion following Chiara Zizola Presentation

JEAN-PIERRE DARMON: Je voudrais simplement dire que cet exposé concernant les mosaïqes de Nora était particulièrement remarquable et qu'il apporte une illustration parfaite à l'invitation qu'Évelyne Chantriaux nous faisait hier d'adapter les solutions à chaque cas et que chaque problème est un cas d'espèce. Vous avez très bien donné une illustration concrète de l'application de ce principe à un site à la fois très riche et qui fait l'objet d'une réflexion excellente. Le problème maintenant, c'est de passer à la pratique.

CHIARA ZIZOLA: Thank you. It's true that any archaeological site has its problems. We have to adopt specific solutions for each problem. So we are not against the lifting of mosaics, always and forever, but when it's necessary for conservation needs, we have to take into account these methodologies, always thinking that it's better to conserve in situ if conditions allow.

ZE'EV MARGALIT: Do you have any conclusion about the removal of the concrete backing and the return of the mosaic in situ? I was very interested in the seasonal reburying, but what is the impact of opening and covering every year? Can you say a few words about this?

CHIARA ZIZOLA: Seasonal covering will happen once a year, for the winter season. We feel that it is practical because we use filled bags of geotextile that you simply put on the floors with a sheet of geotextile underneath. So it's not a complicated method.

PART FIVE

Sheltering Mosaics

Rapid Assessment of Shelters over Mosaics: Methodology and Initial Results from England

John Stewart

Abstract: *The effectiveness of protective cover buildings, or shelters, over mosaics presented in situ is rarely assessed. In 2004 English Heritage, the Israel Antiquities Authority, and the Getty Conservation Institute agreed to collaborate on the development of a common methodology for rapid assessment of shelters in England and Israel. This was designed to collect data on a large number of shelters in order to determine if there is a relationship between mosaic condition and shelter design. Preliminary results from the survey in England are reported in this paper.*

Résumé : *L'efficacité des structures de protection, ou abris, couvrant les mosaïques exposées* in situ *est rarement évaluée. En 2004, English Heritage, l'Autorité Israélienne des Antiquités et l'Institut Getty de Conservation ont entamé une collaboration visant à élaborer une méthodologie commune pour effectuer une évaluation rapide des abris en Angleterre et en Israël. Il s'agissait de recueillir des données sur un grand nombre d'abris afin de déterminer s'il existe une relation entre l'état des mosaïques et la conception de l'abri. Les résultats préliminaires de cette étude en Angleterre font l'objet de cette communication.*

Protective cover buildings, or shelters, are one means to protect and present vulnerable archaeological features, such as mosaics, in situ. However, the effectiveness of the protection they confer in the long term is rarely assessed. It is clear that some shelters actually contribute to deterioration of the pavements they are meant to preserve.

English Heritage—the statutory agency for the protection of the historic environment in England—the Getty Conservation Institute (GCI), and the Israel Antiquities Authority all have research initiatives related to shelters over mosaics. Recognizing this shared interest, they agreed in 2004 to collaborate on a shelters evaluation project. This entailed developing a common methodology for rapid assessment, which was then applied to all sheltered mosaics in England (24 shelters over 70 mosaics) and in Israel (36 shelters over 105 mosaics).[1] In its evaluation of the Orpheus mosaic project in Cyprus, the GCI also assessed this sheltered mosaic using the same methodology.[2]

The objective of the evaluation was to better understand the relationship between the condition of a mosaic pavement and the environment created by the shelter covering it. Evaluation of the results of these surveys is expected to identify sites of further research interest for more intensive investigations and monitoring programs. Ultimately the aim is to define improved design and environmental criteria for shelters over mosaics in different climates.

In these assessments the term *shelter* has been applied very generally, to describe all forms of protective structures, whether fully enclosed or open on all sides. Subterranean sites were excluded from this project because of the very different constraints on the design of protective environments for mosaics below modern ground level.

Research Questions

The methodology developed for this rapid survey attempts to quantify

- the condition of the sheltered mosaic: is it relatively stable or actively deteriorating? (what data are needed to confirm active mosaic condition and its causes?)

- the influence of shelter design on the condition of the mosaic (what data are needed to prove a correlation between mosaic condition and the shelter design?)
- the best methods to efficiently describe all of these factors, in quantitative and qualitative terms.

Phenomena indicative of active deterioration of mosaics are listed in table 1, suggesting the possible role of shelter design in these deterioration processes.

Aspects of mosaic condition that are unrelated to environmental causes of deterioration have been excluded from this evaluation project, such as the impact of visitor walkways or damage due to visitors walking on the mosaic. These problems are understood and can clearly be addressed in a precise architectural brief for a new shelter and in a good management plan for any existing or new shelter.

Mosaics are composite structures made of a variety of porous inorganic materials—stone, ceramic, lime mortar, and sometimes glass—with varying susceptibility to deterioration processes. These processes are largely related to porosity and porosimetry of the material. Based on our current understanding, the most common direct causes of deterioration of mosaics

Table 1 Principal mosaic deterioration phenomena and the possible contributory role of a shelter design, open or enclosed

Mosaic Conditions Indicating Active Deterioration	Possible Relationship to Shelter Design
Salt florescence (on or below surface)	Shelter prevents rain from falling on the mosaic (no washing of salts) but allows or promotes water infiltration or seepage: • from lack of proper drainage (from and around shelter), leading to subsurface moisture (may be combined with topography that drains toward mosaic and/or footings that allow runoff toward mosaic) • from inadequate site drainage of high water table • from leaks in roof (design faults) • from condensation, cooling at night from lack of insulation • from inadequate lateral protection against rain or coastal aerosols • from limited shelter coverage (roof area) or excessive roof height, allowing rainwater to fall beyond the shelter to easily migrate below shelter and promotes wetting and drying cycles: • from direct sunlight • from heat buildup in shelter, lack of insulation • from passive ventilation (via open sides or fenestration pattern) or active mechanical ventilation with unstable internal climatic conditions.
Microbiological growth	Shelter allows • water infiltration (see salt florescence above) • condensation • insufficient ventilation/stagnant air • too little/too much light (dependent on species of microorganism)
Disaggregation, flaking, or fracturing of tesserae	Shelter promotes wetting/drying cycles (with presence of salts). Shelter does not protect mosaic from freezing (no or poor insulation).
Subsidence of mosaic	Drying out of subsoil below mosaic (contraction of subsurface with expansive clay), as a result of the construction of the shelter (may cause initial bulging).
Detachment or bulging of *tessellatum*	Swelling of subsoil below mosaic (expansion of subsurface with expansive clay), possibly as a result of removal of trees for shelter construction and access (increase in groundwater level). Shelter promotes wetting/drying cycles from subsurface moisture (with presence of salts), leading to detachment between layers. Shelter does not protect mosaic from freezing (no or poor insulation).
Bulging associated with loose tesserae or collapse of *tessellatum*	An indication of ongoing problem (continued expansion/contraction). Shelter allows concentrated direct thermal gain.
Rusting of iron reinforcement (relaid mosaic)	Shelter allows water infiltration (see salt florescence above).
Collapse of hypocaust supports	Shelter promotes salt florescence and/or microbiological growth (as above), which can result in decohesion of mortar joints.

Source: Martha Demas, adapted by John Stewart.

in sheltered environments are specific soluble salts, some types of microbiological growth, and thermal expansion-contraction and freeze-thaw events, causing, among other things, decohesion of mortar. Most of these processes are cyclical, and their severity is also associated with the concentration and relative strength of deteriogens as well as the frequency of cyclical events, which in turn is related to environmental conditions. All processes are progressively degenerative and are directly or indirectly dependent on the presence of moisture in its various forms.

Assessment Methodology

The methodology used for the site assessments distills the components of a conventional condition survey into a concise standardized template. This can be applied consistently to any mosaic or group of mosaics and associated shelter.

There are two components in the assessment process: preliminary research and site survey with evaluation. Preliminary research entails the compilation of existing written and graphic records relating to the discovery of the site, the history of the condition of and interventions to the mosaic, the construction and history of modifications to the shelter, and the site's environmental attributes. The site survey entails a very broad preliminary assessment of each site, undertaken over the course of one day, using the standardized template. In a hierarchy of description, it records, as visible:

characterization of the mosaic

- materials and structure of the mosaic
- deterioration phenomena within tesserae, the *tessellatum*, and its support, utilizing defined terminology[3]
- grading of each of these phenomena on a numerical scale by its physical extent (percentage of surface area) and an estimation of the degree of its severity (table 2)
- assessment of the loss of the *tessellatum* over time

Table 2 Sample pro-forma survey sheet for the rapid assessment project (Getty Conservation Institute, English Heritage, and Israel Antiquities Authority)

Mosaic: Observed Phenomena
Rate the extent and severity by circling the appropriate number. If the phenomenon is not present, circle 0.
Add further comments if necessary.

Extent refers to the percentage of surface area affected by the phenomena: **0** None, **1** (<10%), **2** (10–30%), **3** (30–60%), **4** (>60%)		Severity refers to the degree to which the phenomenon impacts the physical or aesthetic integrity of the mosaic. **1** low, **2** low–moderate, **3** moderate, **4** high
Surface Conditions		
(Salt) efflorescence or subflorescence	Extent 0 1 2 3 4 Severity 1 2 3 4	Briefly describe appearance, e.g., fluffy, needle shaped, thin veil, thick veil, and distribution.
Biological Growth		
Higher plants/vegetation or roots	Extent 0 1 2 3 4 Severity 1 2 3 4	Briefly describe appearance with type if known, and distribution.
Microbiological growth	Extent 0 1 2 3 4 Severity 1 2 3 4	Briefly describe appearance and distribution.
Deteriorated Tesserae		
Disaggregation	Extent 0 1 2 3 4 Severity 1 2 3 4	Tesserae displaying loss of surface cohesion, which have disintegrated into powder or small grains. Comments (including distribution):
Exfoliation/flaking	Extent 0 1 2 3 4 Severity 1 2 3 4	Tesserae displaying detachment or loss of layers, parallel or perpendicular to the mosaic surface. Comments (including distribution):
Fracturing	Extent 0 1 2 3 4 Severity 1 2 3 4	Tesserae displaying linear breaks or network of breaks through their matrix. Comments (including distribution):
Erosion	Extent 0 1 2 3 4 Severity 1 2 3 4	Tesserae displaying a worn or abraded surface. Comments:

- cumulative rating based on the numerical grading of each mosaic's condition
- summary classification of mosaic condition, described as "active deterioration," "nonactive/stable," or "cannot determine"

characterization of the shelter and environment
- construction materials, structure and its condition
- estimation of the shelter's efficiency in excluding or reducing all potential sources of moisture
- designed site drainage and its efficacy
- the site's ambient climate, hydrology, topography, and land use
- summary evaluation of the shelter's performance in protecting the mosaic(s) and mitigating environmental risks

Limitations of Assessment

There are clear limitations in any preliminary rapid survey, most obviously the time available to carry out detailed archival research. The extent of previous investigations, such as the amount of climatic and hydrological data available, will also vary greatly from site to site. However, rapid preliminary surveys are still the most logical means to characterize sites very generally and to identify those of greater potential for future research.

Good archival records are critical for understanding mosaic condition and particularly the rate of change over time. During this preliminary survey of sites in England, it proved difficult to locate archival records for many mosaics; photographic records are surprisingly poor or inadequate. However, it was possible to gather a reasonable number of illustrations of mosaics excavated in the nineteenth century, and most of these seem relatively accurate (figs. 1, 2). They provide at least some means of assessing the survival of the decorated *tessellatum*.

Importantly, where a mosaic has been lifted and relaid, the justification for this decision is almost always lacking. Lifting can have been prompted by one or a combination of the following factors:

- active degradation of the mosaic (e.g., bulging or collapse of the *tessellatum*, detaching tesserae, collapse of hypocaust structure)
- a subjective and incorrect assessment of the severity of a mosaic's condition and rate of change, influenced by the strength or lack of confidence in certain types of intervention (lifting and re-laying vs. consolidation in situ)
- the contemporary approach to treatment: conservation preferences, materials, and technology evolve over time; for example, re-laying was common in England during the 1960s and 1970s but is rare today

The relatively poor archives for the English sites excavated a century or more ago make their assessment much more difficult than for the sites in Israel, where the vast majority were excavated at the end of the twentieth century and sheltered in the 1990s. However, the numerous mosaics in England sheltered over a greater period of time are certainly of interest in this research.

Mosaic Sites in England

In England there are currently some fourteen sites with twenty-four shelters, which protect and present seventy Roman mosaics in situ.[4] Half of these sites were discovered in

FIGURE 1 Bignor Roman Villa. The Venus Room after its discovery in 1811 (Richard Smirke) and before construction of its shelter. Subsequent loss of the *tessellatum* in the center of the mosaic may have been a result of collapse of the hypocaust. The pavement was relaid in 1926. Reproduced with the kind permission of the Tupper family. Bignor Roman Villa, West Sussex, U.K.

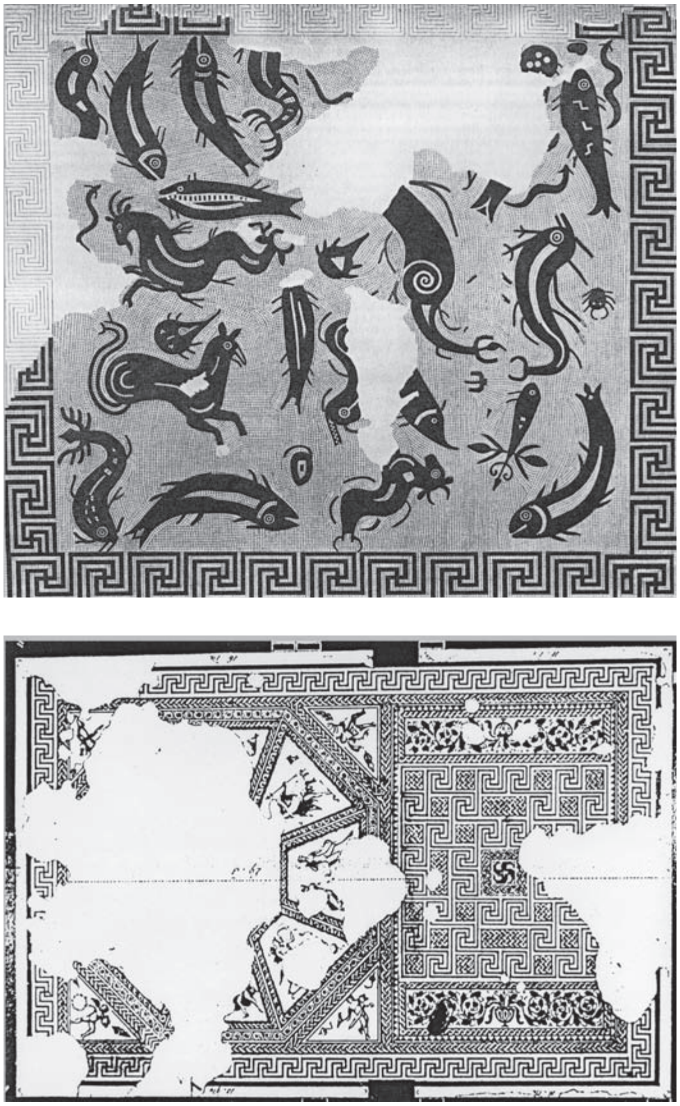

FIGURE 2 Examples of nineteenth-century illustrations of mosaics. Top: Great Witcombe Roman Villa, the pavement in Room 6 (ca. 1819, after Samuel Lysons); bottom: Chedworth Roman Villa, the triclinium mosaic (ca. 1869, George Fox). The latter drawing, executed shortly after the discovery and protection of the mosaic, shows that the *tessellatum* has changed very little when compared with its extent today. Courtesy Society of Antiquities of London.

the nineteenth century, and all but one are located in the south of England, which has a damp and temperate climate but is subject to winter frosts (table 3). Less than ten mosaics are on hypocausts, and just under half of all mosaics have been lifted and relaid. The shelters were erected between 1812 and 2004.[5] Several sites have had a sequence of structures, beginning with simple sheds and moving on to permanent buildings. The majority are vernacular buildings of masonry or timber-and-masonry walls supporting a timber roof covered with stone slates, thatch, or other materials (table 4). In the 1960s modern structures with large spans became common. A few shelters have mechanical heating to prevent freezing temperatures and mechanical ventilation to inhibit microbiological growth or reduce internal temperatures. A small number of sites benefit from real-time monitoring of environmental conditions, the only means to properly understand the dynamic role of environmental parameters.

Several additional issues make it difficult to compare the English sites with one another:

- the great range of dates of excavation and presentation (from 1812 to 1998)
- the great variety of shelter designs (affecting ventilation, solar gain, insulation)
- the evolution of shelter design, with two or three successive shelters over mosaics on some sites
- variations in seasonal opening times (affecting internal conditions)

Therefore, in England it is difficult to establish specific trends based on comparative analysis of shelter typologies.

Preliminary Assessment Results in England

The range of conservation issues encountered is best illustrated by a summary review of five English sites with different shelter designs. They can all be classified as relatively damp sites. As moisture is usually associated with the deterioration of mosaics, these sites are of greater interest than the few English sites that are apparently “drier,” where mosaics appear sound.

Fishbourne Roman Palace (West Sussex)

Fishbourne Roman Palace was discovered in 1960, just a few kilometers from the English Channel. It has the largest collection of in situ mosaics in the country; some twenty-five pavements of the palace are presented under the modern shelter, which opened in 1968. The entire south elevation of this structure was glazed, resulting in high solar gain and, in sunny conditions, intense sunlight falling directly on some mosaics (fig. 3). The roof had no insulation. In summer months internal conditions were very warm, so windows were kept open and electrical fans installed to assist ventilation for visitor comfort. The site has a high water table with aggressive soluble salts.

Table 3 Sites with shelters over mosaics in England

Date of Discovery of Site	Site	Shelter over Specific Mosaics	Date of Shelter Construction*	Number of Exposed Mosaics in Shelter	Number of Mosaics Relaid (date)	Condition of Mosaics on Original Supports*
1811–17	Bignor *Note:* museum and corridor mosaics were reburied, then reexcavated in the twentieth century.	Venus mosaic Ganymede and Geometric mosaic Winter, Dolphin, Four Seasons mosaics Medusa mosaic Museum mosaic Corridor mosaic	1812–13 1812–13 1815–16 1818 1959–60 c. 1974	1 2 3 1 1 1	1 (1926) 0 3 (1973) 1 (1973) 1 (1973?) 1 (1976)	A (salts and bulging)
1813–15	North Leigh	Room 1	c. 1823	1	1 (1929)	
1818–19	Great Witcombe	Rooms 5, 6 Room 10	c. 1820 c. 1820	2 1	2 (1906) 0	NA/S
1832 1848	Aldborough	Lion mosaic Star mosaic	c. 1830s c. 1840s	1 1	1 (1920?) 1 (1920?)	
1863	Wadfield		1895	1	1 (?)	
1864–67	Chedworth	Triclinium mosaic West Bath Suite Laconicum	c. 1867 c. 1867 1960s	1 4 1	¼ (1993) 1 (1978) 1 (1978)	NA/S
1880–82	Brading	Rooms 3–12	[c. 1882, 1907] 2003–4	5	1 (1982)	NA/S
1926	Newport	Rooms 1–9	1960s?	5	2?	NA/S
1933 ff.	St. Albans	Insula IV, Building 8	[1930s, 1950s] 2003–4	1	0	NA/S
1937–38	Dorchester Colliton Park *Note:* mosaics were reburied in 1938. Room 8 was reexcavated in 1957; others in 1998.	Room 8 Rooms 8–18	[1957] 1996–99	1 6	0 0	NA/S and A (algae and moss)
1948	Bristol Kings Weston *Note*: Room 6 mosaic is from another site	Rooms 3–7	1950s	3	2	NA/S
1949	Lullingstone	Rooms 12, 13	1961 1986–88	2	0	NA/S
1960	Fishbourne	Rooms 1–29	1968	25	14 (1960s) (1979–80) (1982) (1991)	A (salts and bulging)
1976	Littlecote *Note:* excavated 1727; subsequently lost until 1970s	Orpheus	1999	1	1 (1979)	

Note: Relaid mosaics, excluding those at Fishbourne, appear stable. Mosaics that remain reburied on some sites are not included on this list. Dates are as accurate as possible, within the time limitations of the survey. [ ] denotes shelters that have been demolished and replaced.

*Observed mosaic condition: A = active deterioration; NA/S = nonactive/stable.

Table 4 Structural typologies of shelters over mosaics on sites in England (with dates of construction*)

Vernacular Construction (traditional small windows or no windows)				**Modern Materials / Construction**					
Masonry enclosure(s)		Timber and masonry enclosure(s)		Corrugated iron and structural frame enclosure		Timber, glass, and masonry enclosure		Metal frame, open structure	
1812–18	Bignor	ca. 1823	North Leigh	[1907–2003]	Brading	1960s	Chedworth (Laconicum)	1996-99	Dorchester
ca. 1820	Gt Witcombe	ca. 1867	Chedworth	1986–88	Lullingstone	1968	Fishbourne	1999	Littlecote
ca. 1830s ca. 1840s	Aldborough	1950s	Bristol			ca. 1974	Bignor (corridor)		
1895	Wadfield	2003–4	Brading**						
1927 or ca. 1960	Newport								
[1950s–2003]	St Albans***								
1959–60	Bignor (museum)								

* Dates are as accurate as possible, within the time limitations of the survey.
** The new shelter at Brading contributes other new characteristics to this traditional design.
*** The new shelter at St Albans (2003–4) does not conform to any of these typologies (steel frame, precast concrete panels, and glass enclosure)
[ ] Denotes shelters that have been rebuilt.

Upon excavation nine mosaics were found to be in poor condition, so they were lifted and relaid in cement mortar. Another four mosaics on their original supports deteriorated in the new shelter, and these were relaid between 1978 and 1991, this time in lime mortar. The ten mosaics that have never been lifted currently exhibit active bulging of the *tessellatum* and disaggregation of tesserae, with clear presence of soluble salts. Two of the relaid mosaics, both located next to the south glazed elevation, now also show some limited bulging (Rudkin 2003). This appears to be due to thermal dilation from direct solar gain. The condition of these mosaics is the most serious encountered on any of the English sites. High internal temperatures, with mechanical ventilation and fluctuating relative humidity, have probably encouraged evaporation of groundwater and the mobilization of salts.

FIGURE 3 Fishbourne Roman Palace. Extensive glazing in the shelter's original design contributed to major solar gain on adjacent mosaics and high internal temperatures. Photo: John Stewart.

The structure is now being modified to create more stable environmental conditions, with the installation of roof insulation, double glazing with solar reflective glass, reduction of window area by approximately 50 percent, and improved ventilation.

Bignor Roman Villa (West Sussex)

The main interest of this site is the seven mosaics within four shelters erected between 1812 and 1818 (figs. 1, 4, 5). There are another two twentieth-century shelters built to protect two reexcavated mosaics. The earlier shelters are of stone or brick with thatch or slate roofs and small windows. Thatched roofs have no rainwater gutters or downpipes, so historically rainwater has been deposited around the perimeter of the buildings.

Of the mosaics in the earlier shelters, one was relaid in 1926 and four in 1973. This was possibly due to active

FIGURE 4 Bignor Roman Villa. The earliest surviving site shelters in England (1812–16), built of stone and timber and thatched roofs. Another shelter of brick (1818) is out of view. Photo: John Stewart.

deterioration and/or poorly controlled visitor access, as four of these pavements appear to have lost from 20 percent to 60 percent of their *tessellatum* between their initial excavation and re-laying. The two mosaics excavated in 1811–13 that have not been relaid show excellent survival of their *tessellatum*. However, the Geometric mosaic in Room 6 (fig. 5) began to deteriorate rapidly in the 1990s, with bulging of the *tessellatum* and the appearance of soluble salts. This decay has been related to an observed rise in the groundwater table. Drainage has since been improved, and the pavement is now being monitored.

Chedworth Roman Villa (Gloucestershire)

Chedworth Roman Villa was discovered in 1864. Within a few years two shelters had been constructed to present five mosaics (fig. 6). The shelters are of timber on low stone walls and have slate roofs. One of these has late-twentieth-century insulation, and both have winter heating. Four mosaics are on their original bedding, and compared with early records (see fig. 2), their *tessellatum* appear very well preserved. Their general condition is largely good with only small areas of instability. Algae and salt efflorescence are common, but the *tessellatum* of each mosaic has not been seriously affected.

Another mosaic shelter dates to the 1960s and has glazing on all four elevations. Consequently, it has very high levels of damaging microbiology, especially in the damp hypocaust. The small area of mosaic was relaid in 1978.

The environment of all shelters and the site has been monitored for the past eight years.[6]

Dorchester Roman Town House (Dorset)

Dorchester Roman Town House (Colliton Park) was excavated in 1937–38 and subsequently reburied. The mosaic of Room 8 was revealed again and presented under a wooden shed in 1957. Four decades later the rest of the house was fully reexcavated and a shelter constructed over it. The steel-framed structure has open gables above and fragmented glass panels below, creating a high degree of ventilation (fig. 7). The shelter offers negligible thermal insulation and allows direct sunlight to fall on at least one pavement. The roof of stone slate attempts to replicate the Roman design and therefore does not have gutters. Consequently, the roof feeds a large quantity of rainwater directly to the outer perimeter of the building. Site drainage was already poor, as a result of the depression created by the original excavation.

All six mosaics within the shelter are on their original bedding. They show variable degrees of dampness, algal growth,

FIGURE 5 Bignor Roman Villa. The *tessellatum* of the Geometric mosaic in 1815 (Samuel Lysons), which survives intact to this day. However, serious deterioration began in the 1990s with a rise in groundwater level. Reproduced with the kind permission of the Tupper family, Bignor Roman Villa, West Sussex, U.K.

FIGURE 6 Chedworth Roman Villa (ca. 1867). The Western Bath Suite, sheltering five mosaics. Photo: John Stewart.

FIGURE 7 Dorchester Roman Town House (1996–99). Steel structural frame with open gables and glass sheets below. Photo: John Stewart.

and salt efflorescence. The one mosaic that is most shaded has also been colonized by moss, which is tenacious and difficult to remove. The other mosaics currently appear relatively stable. Yet only seven years after their reexposure and conservation there is real concern about their long-term stability in such an open structure and unstable environment, particularly given the appearance of moss and soluble salts. In an attempt to mitigate these problems the gables are to be enclosed, gutters are to be added to the roofs, site drainage is to be improved, and environmental parameters are to be monitored.

FIGURE 8 Newport Roman Villa (1960s?). Window apertures have been blocked in to help reduce algal growth in the shelter. Photo: John Stewart.

Newport Roman Villa (Isle of Wight)

Newport Roman Villa was discovered in 1926. The current shelter is of concrete blocks and may date to the 1960s, but this still needs to be confirmed (fig. 8). In 1982 windows were filled in to improve presentation with new internal lighting. The shelter protects five mosaics, most of which appear to be on their original supports.

The site is certainly damp, as evidenced by algal growth, especially within the hypocausts. However, it has been reported that the blocking of window apertures reduced this problem. Supplementary mechanical ventilation has also been installed to inhibit algal growth, and heaters are triggered when internal temperatures fall to 10°C. The mosaics currently show limited algal growth but are otherwise in excellent condition eighty years after their excavation. There is no evidence of active soluble salts affecting any of the ancient remains.

Discussion

Mosaics Relaid on New Supports

Most sites have a combination of relaid mosaics and mosaics on their original supports. As a result, on these sites in England there is no clear pattern between re-laying mosaics and the design of the shelter over them.

As stated earlier, the justification for lifting and re-laying is obscure. Of the mosaics discovered in the nineteenth century, some were only relaid about 80 to 160 years later. Most re-laying can be dated to the 1960s and 1970s, when this treatment was common practice.[7] In one case, lifting of a mosaic at Bignor in 1926 may have been prompted by the collapse of the hypocaust beneath it (see fig. 1). However, the presence of a hypocaust under a mosaic does not seem to have consistently influenced lifting and re-laying, for of the nine mosaics over hypocausts on all sites, only four have been relaid.

Almost all the relaid mosaics appear to have been set in cement mortars. All but one of these (Littlecote) are inside full enclosures. These pavements are all now very solid and do not show any signs of deterioration, except at Fishbourne. Of course, cement is highly inappropriate for the conservation of mosaics as it is excessively strong and extremely difficult to remove safely, as well as aesthetically disfiguring. Fortunately, iron reinforcement does not appear common on relaid mosaics in England and is strictly only necessary as bridging on hypocaust structures. Its presence contributes to additional problems of iron corrosion with cracking of the cement matrix and mosaic. If iron is present on any of these pavements, the lack of cracking would infer that shelters are playing a protective role. Exceptionally, bulging and blistering have appeared on a few mosaics relaid at Fishbourne, both on new cement and on lime supports (of the 1960s and 1991, respectively).

Relaid mosaics are effectively of lesser interest in the survey in England. As almost all are currently stable and as the reason for re-laying has not been recorded, they contribute little to the understanding of the relationship between shelter design and environment. Even on damp sites relaid mosaics appear dry and sound and may be adjacent to mosaics on their original supports that are visibly damp and in variable condition (e.g., Bignor, Chedworth). This is undoubtedly due to the relatively impervious nature of cement to moisture from the ground and the possible inclusion of a damp-proof membrane under the relaid pavements. The problems with relaid mosaics at Fishbourne appear to be related specifically to the very unstable interior environment created in this modern structure.

Mosaics on Original Supports

On the sites surveyed there are eleven shelters with up to thirty-seven mosaics on their original supports (table 3). These shelters vary in design, all but one are enclosed, and most are traditional vernacular structures of masonry, or timber and masonry, with conventional small windows or no windows at all and with varied insulation properties (table 4). The sample number is small, but most of these shelters have provided reasonable protection in the English climate for their mosaics for at least fifty and as many as two hundred years.

In terms of recent observed deterioration phenomena, three sites are prominent.

At Bignor a traditional vernacular structure has not prevented damage from the recent change in site hydrology, with the presence of aggressive soluble salts. The role of the shelter is probably relatively benign, although the contribution of ventilation still needs to be quantified.

At Fishbourne substantial glazing and poor thermal insulation are suspected of accelerating the natural processes of deterioration from a high water table with aggressive soluble salts, causing blistering and detachment of the *tessellatum* of many mosaics. It was necessary to lift and re-lay four pavements within about fifteen to twenty-five years of excavation and presentation inside this shelter. Fortunately, it is a full enclosure, and its design is capable of being modified.

At Dorchester Roman Town House most of the mosaics have been exposed for only seven years. With poor site drainage, compounded by ineffective rainwater disposal from the building itself, aggressive microbiology has now colonized one mosaic, and salts are present throughout others. The environment in the shelter is very unstable, so the condition of the mosaics will have to be monitored very closely. With this shelter, stable internal environmental conditions could be created only at great expense, by extensive modifications to the rigid design concept.

All three of these sites have problems with inadequate shelter drainage and/or management of difficult site hydrology and unstable interior environments. Observed recent deterioration is all the more important given the poor archives for most sites. Other very specific events affecting site hydrology have also been recorded. A defective water main early in 2005 caused local damage to mosaics at Fishbourne. At Brading natural flooding inundated mosaics in 1990 and 1994, where there were inadequate flood defenses. The mosaics at Brading had previously been reasonably stable from their discovery in 1880.

Therefore, site drainage (from the building, from natural hydrology) and protection from acute water-related events are critical, particularly where aggressive soluble salts are also present. Problems of water management can certainly be exacerbated by shelter design, as for example by the high solar gain and unstable internal environment at Fishbourne, which has even affected robust relaid mosaics in addition to fragile ones on original supports.

Many of the more traditional vernacular shelters—of brick or stone with small external apertures—have the benefit of greater thermal mass (e.g., Great Witcombe, Bignor, Newport). However, thermal insulation does not necessarily seem to be the most important factor on sites with a mild winter climate. The shelter at Dorchester provides no thermal insulation, and some five years after its completion there is no clear evidence for frost damage, but this may still occur in time, with harsher winters. At Brading most mosaics survive on their original supports, although from 1907 until 2003 their shelter consisted of corrugated iron cladding on a structural frame, without any significant heating. However, the lack of thermal insulation in a shelter is more likely to affect mosaics in poor condition with high moisture content and where freezing temperatures are prevalent.

The role of ventilation or rates of air exchange may be significant, as it can mobilize soluble salts. However, this is extremely difficult to quantify and is certainly not possible to assess rapidly. All but two of the English shelters are fully enclosed, but most have conventional apertures that still allow for appreciable levels of ventilation.[8]

These issues of thermal insulation and ventilation illustrate that there is rarely one single contributing factor to the success or failure of a shelter; rather, several aspects of the design contribute in relation to the prevailing local environment—ambient as well as subsurface. These interact in a complex way with the structural condition of the protected mosaic.

Conclusion

The survey methodology developed for this project provided a useful and consistent tool for surveying a large number of mosaics and shelters in a relatively short time. The limitations of assessment of the complex English sites are evident in the significant gaps in knowledge of their postexcavation history, but meaningful case studies such as those presented above nevertheless have been identified.

In relation to specific risk factors, recurrent themes of concern in the designs of shelters have emerged from the survey in England:

- site drainage (from and around the shelter)
- area of glazing (direct and indirect solar gain and its influence on microbiology and mosaic dimensional change)
- thermal insulation (environmental stability)
- ventilation (influence on soluble salts and microbiology)

Of course, these general observations need to be corroborated by more thorough appraisal. From the inventory developed during this pilot study, a few sites with particular research potential can now be selected for additional study.

Acknowledgments

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Notes

1 See in this volume Jacques Neguer and Yael Alef, "Rapid Assessment of Shelters over Mosaics: Initial Results from Israel."

2 See in this volume Martha Demas, Thomas Roby, Neville Agnew, Giorgio Capriotti, Niki Savvides, and Demetrios Michaelides, "Evaluation of the Project to Conserve the Orpheus Mosaic at Paphos, Cyprus."

3 See the glossary developed by the Getty Conservation Institute and the Israel Antiquities Authority at www.getty.edu/conservation/publications/pdf_publications/mosaicglossary.pft.

4 There is also a long history of the protection of mosaics in England by means of reburial, recorded as early as the seventeenth century and still practiced today as a means of managing newly discovered mosaics that are not to be displayed.

5 Other mosaics excavated in the eighteenth and nineteenth centuries and protected under shelters have been lost through lack of effective maintenance and management (Stewart and Cosh 2005).

6 See in this volume Sibylla Tringham and John Stewart, "Protective Shelters over Archaeological Sites: A Review of Assessment Initiatives."

7 One company, Art Pavements, was active in lifting most, if not all, mosaics in this period.

8 Of interest in terms of ventilation is the Billingsgate Bath House beside the Thames in London. It is a subterranean site and

therefore was excluded from this survey. Partly excavated in 1848, it survived well in the cellar of the new Coal Exchange Building, with little or no ventilation. When this building was demolished in 1967, the replacement structure incorporated extensive mechanical ventilation, which resulted in major salt damage to the ancient walls and mosaics. All ventilation was subsequently terminated and more stable conditions were recorded (pers. comm., Brian Ridout, Ridout Associates).

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Rapid Assessment of Shelters over Mosaics: Initial Results from Israel

Jacques Neguer and Yael Alef

Abstract: *A risk assessment of 106 mosaics under 36 shelters undertaken by the Israel Antiquities Authority found that in half the cases the mosaics were deteriorating. These results made clear that shelters are not a simple solution for mitigating deterioration of mosaics; on the contrary, it seems that in some cases the shelters accelerated deterioration. This calls for rethinking shelters as a protective measure for mosaics and for systematic evaluation of their performance. Moreover, there are no clear criteria for their design, and very little information is available in Israel or elsewhere on the success of existing shelters either in mitigating deterioration or in the interpretation and presentation of the mosaics.*

Résumé : *Une rapide évaluation de 106 mosaïques sous 36 abris, entreprise par le Service des Antiquités d'Israël, a révélé une détérioration des mosaïques dans la moitié des cas. Ces résultats ont bien montré que les abris ne sont pas une solution simple permettant d'atténuer la détérioration des mosaïques ; au contraire, il semble que, dans certains cas, les abris aient accéléré la détérioration. Il convient donc de repenser les abris en tant que mesure de protection des mosaïques, et d'en évaluer systématiquement les performances. De plus, il n'existe pas de critères clairs pour leur conception et l'on ne trouve que peu d'informations, en Israël ou ailleurs, sur la manière dont les abris existants auraient pu atténuer la détérioration ou améliorer l'interprétation et la présentation des mosaïques.*

The Israel Antiquities Authority in collaboration with the Getty Conservation Institute (GCI) and English Heritage (EH) have been coordinating their individual efforts and developing a common methodology for assessing the protective function of shelters, which is being applied in Israel (and in England by EH).[1] The initial stage is a rapid assessment on a regional basis to discern broad patterns of preservation and deterioration. The assessment focuses on the microclimate a shelter creates and its effect on the condition of a mosaic, with the purpose of identifying evidence of active deterioration of the mosaic and linking this evidence with the design of the shelter. The outcome of this study will help to establish criteria and a methodology for evaluation of existing shelters that can then be used to improve design faults and maintenance of existing shelters and as a guide to the design of future shelters.

This paper presents the preliminary results of the mosaics and shelter surveys in Israel, starting with background information on shelters and the risk assessment of mosaics, which formed the basis for the rapid assessment of shelters over mosaics. It then describes the data collected and discusses preliminary observations that resulted from the survey, conclusions, and future directions for investigation.

Historical Overview of the Conservation of Mosaics in Israel

The continual discovery of archaeological sites with mosaics in Israel and the demand to open those sites for tourism pose serious problems regarding their conservation and presentation. In the past mosaics were commonly removed from their sites for display in museums. Today's historic sensibility requires that the authenticity of the ancient pavement be respected and the mosaic be interpreted in its archaeological context. This has led to favoring conservation and presentation of mosaics in situ. Until the early 1990s presentation of mosaics in situ entailed lifting them for treatment in the laboratory, where they were cast in cement bedding, and then re-laying them in the site. Since then new techniques for conservation in situ have been introduced in Israel that allow mosaics to be conserved on the site with traditional materials such as lime-based mortar. A belief that shelters can be a good in situ measure for the protection of the mosaic and at the same time provide an opportunity to present the mosaic to the public has resulted in the construction of 36 shelters covering 106 mosaics in Israel.

The first shelter over a mosaic was built at the Mount of Olives, Jerusalem, in 1873 to protect the beautiful Artaban mosaic. During the 1930s, shelters were built over the synagogue in Beit Alpha and the Lady Mary monastery in Beit She'an. The majority of the shelters, however, were constructed in the 1990s, at a time when the development of archaeological sites for tourism became a national priority, resulting in large-scale projects that included the erection of shelters in Caesarea (fig. 1), Zippori, Tiberias, and Beit She'an.

FIGURE 1 In 2001 two large shelters were built over the Domus and Bathhouse in Caesarea. The shelters in the marine environment protect the mosaics from rain but allow aerosol and dust accumulation on the mosaics. Photo by N. Davidov (2005) © IAA.

Risk Assessment of Mosaics in Israel

The risk assessment of mosaics, undertaken by the IAA Conservation Department in Israel between 1998 and 2000, evaluated mosaic conditions in order to identify and prioritize their conservation needs; this was followed by a survey in 2002 that focused on the presentation aspects of shelters (Alef 2002). This was the first time information about the condition of Israel's mosaics was compiled and assessed; approximately one hundred sites were studied, among them sites with shelters. The risk assessment contributed to the development of the rapid assessment methodology by the IAA, EH, and GCI; it is therefore useful to describe briefly its methodology.

The aim of the risk assessment was to quantify the level of risk to a mosaic. Higher percentage of risk means a poorer condition of the mosaic; for example, a mosaic with 90 percent risk is endangered, whereas a mosaic with 20 percent risk is in good condition (table 1). The first step identified ten principal risk factors for mosaics under shelters:

- Active decay or ongoing deterioration, whose mechanisms or causes have not been halted.
- Insufficient security and protection from vandalism and animals (mainly birds).
- Inadequate roofing, primarily partial cover of the mosaic, which does not protect the entire mosaic from rain and sun.
- Inadequate site drainage, referring mainly to water runoff.
- Inadequate roof drainage.
- Vegetation and microbiological growth.
- Lack of preservation treatment or inappropriate intervention in the past, for example, treatment with cement or re-laying of only one part of the mosaic where other parts are treated in situ.
- Lack of mosaic maintenance.
- Lack of regular monitoring.
- Lack of shelter maintenance.

Following this basic identification of risk factors, the condition of the mosaic was rated by assigning 10 percent for each factor, which was then calculated as a numerical grade.

The scores of the assessment were roughly broken down into four categories, which provide a general idea of the vulnerability of the mosaic and the severity and extent of deterioration (see table 1). A similar concept for creating a numerical grading of mosaic condition was elaborated in the rapid assessment methodology.

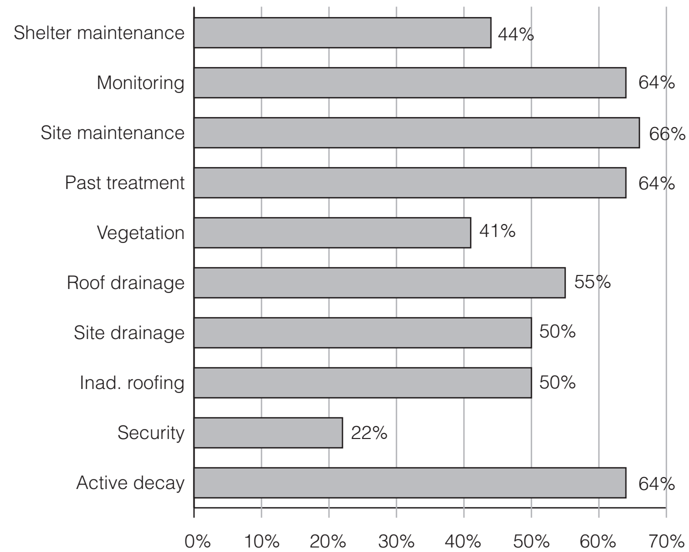
The results of the risk assessment show the condition distribution is as follows:

- 4 mosaics (10%) are in risk level "A," which means that they are endangered or have already been lost (at between 80% and 100% risk).
- 10 mosaics (28%) are in risk level "C," which indicates that they are in stable condition (at between 40% and 60% risk).

Table 1. Risk assessment, levels of risk categories

Levels of Risk	Description
A (80%–100%)	An endangered site, where total loss of the mosaic in the near future is imminent.
B (61%–79%)	The mosaic is in a state of active deterioration, which is likely to accelerate. In some cases partial loss may already be evident.
C (31%–60%)	The mosaic is in a stable condition. This may suggest that although no significant changes in its condition will be noticed, deterioration is still possible.
D (30% or less)	The mosaic is in good condition.

Table 2. Risk factor assessment



- 14 mosaics (40%) are in risk level "D," which indicates they they are in good condition (at less than 30% risk); these are usually cases in which the mosaics are protected and maintained and deterioration is under control.

When comparing the distribution of the condition of mosaics under shelters in each risk level and the distribution of mosaics exposed to the open air, we find that they are almost the same. Although deterioration of mosaics under shelters is a known phenomenon, its extent and similarity (in distribution) to that of mosaics exposed to the elements was not expected.

Along with the results of the risk assessment, an analysis of the risk factors was undertaken in order to begin to identify which of the ten risk factors (i.e., inadequate roof drainage, vegetation, etc.) are more prominent. The aim was to find out which are the principal factors that affect mosaics.

The risk factor analysis (table 2) gives an idea of the statistical weight of the studied factors that affect mosaics under shelters. It points out the following main causes for active decay:

- Lack of regular monitoring and maintenance of the mosaics and the shelter was found in 66 percent of the cases.
- Inadequate site drainage was found in 50 percent of the cases.
- Lack of conservation treatment of the mosaic or inappropriate intervention in the past was found in 64 percent of the cases.

The risk assessment proposes that the main factors affecting the condition of mosaics are monitoring and maintenance and conservation treatment. While the role of these factors in deterioration is quite well understood, the role of the environmental factors is less clear. These will be investigated further in the rapid assessment, to better identify the criteria for evaluation of the effect of shelters on the condition of the mosaic and to provide a better understanding of the weight of environmental factors in relation to other factors.

Initial Results of the Rapid Assessment

The evaluation of protective structures at archaeological sites consists of an analysis of the combination of the environmental and shelter characteristics and the mosaics' condition. To date we have collected existing information from previous surveys, including the risk assessment. At the same time we have surveyed most of the sites and collected information on the environment, shelter characteristics, and mosaic condition.

Table 3 provides basic information on the date of excavation of the mosaics and construction of the shelter and its typology. The typology is based on whether the shelter is enclosed or open and on its structural and material characteristics: lightweight metal structure, timber structure, reinforced concrete, tensile structure.[2]

The structural type of the shelter is defined by form, construction technology, and materials, which are characterized by strength and stability, durability, repairability, flexibility, ease of construction, and availability of materials and knowledge. The division between open shelters and enclosed shelters

Table 3. Rapid Assessment, sites and shelter data

#	Site	Location	History		Shelter Typology						No. and Area		Mosaic Treatment (support)					
													in situ (lime)		Relaid cement		Relaid epoxy	
			Excavation date	Shelter date of construction	Enclosed	Open shelter	Tensile	Metal frame	Timber frame	Concrete	Total no. of mosaics	Surface m²	No. of Mosaics	Surface m²	No. of Mosaics	Surface m²	No. of Mosaics	Surface m²
1	Beit Alpha National Park	Synagogue	1929	1931	X					X	1	80			1	80		
2	Beit Berl College	Mosaic from Tel Soho	1980s	1998		X					1	9					1	9
3	Beit She'an National Park	Sigma	1992–94	2000		X	X				8	148	8	148				
4	Beit She'an National Park	Lady Mary monastery	1930	1932	X			X		X	10	406	7[a]	335	3	71		
5	Caesarea National Park	Ibex mosaic	1990s	1997		X			X		1	110	1	110				
6	Caesarea National Park	Bathhouse	1990s	1995/ 2001[b]		X		X			10	410	10	410				
7	Caesarea National Park	Domus	1990s	1995/ 2001[b]		X		X			7	180	7	180				
8	Caesarea National Park	Experimental Shelter NN4	1990s	1998		X			X		1	10	1	10				
9	Ein Gedi National Park	Synagogue	1970–99[c]	1994–5		X	X				3	210	2	96	1	114		
10	Ramat Hanadive Park	Ein Tzur, Bathhouse	1991	1996		X		X			2	16	2	16				
11	Erez (Kibbutz)	The Hunter mosaic	1967	1967		X		X			1	4			1	4		
12	Hurvat Grarit	Church	1977	1980s		X		X			1	26	1	26				
13	Neot Kedumim Park	H. Hermeshit, Wine press	1988–97	1994		X			X		1	20	1	20				
14	Jerusalem, Ein Yael	Bathhouse	1986–7	1990		X		X			1	3	1	3				
15	Jerusalem, Ein Yael	Villa	1986–7	1990		X		X			2	25			2	25		
16	Jerusalem - Herodian Quarter	Residential quarter	1969–83	1990–1	X					X	10	90	4	44	6[d]	46		
17	Jerusalem, Mt. of Olives	Artaban mosaic	1872	1873	X					X[e]	2	45	2	45				
18	Jerusalem - Rockefeller Museum	Mosaic from Tel Hamam	1930s	1987		X		X			1	60			1	60		
19	Ma'ale Adumim - Martirius	Church and Monastery	1979–84	2002		X		X			2	440	2	440				
20	Maoz Haim	Synagogue	1974–7	1978	X			X			2	105	1	45	1	60		
21	Masada National Park	Bathhouse	1963–5	1965	X					X	1	2	1	2				
22	Masada National Park	Church	1963–5	1965		X			X		1	9	1	9				
23	Masada National Park	Western Palace	1963–5	1965		X		X			4	35	4	35				
24	Nahariya	Church	1972–6	1984	X				X		1	360	1	360				
25	Nir David Archaeology Museum	Tel Basul	1961–4	1970s		X		X			1	35			1	35		
26	Nirim - Ma'on Nirim	Synagogue	1957–8	1977		X				X	1	50			1	50		
27	Rishon Le Zion	Wine press	1991	1997–8		X			X		1	120	1	120				
28	Sussya	Synagogue	1970s	1980s		X			X		2	86	1	70	1	16		
29	Tel Aviv, Eretz Israel Museum	Mosaic from Ramla	1960	1995		X	X				1	18			1	18		
30	Tel Aviv, Eretz Israel Museum	Mosaic from Tiberias	1978-9	1995		X	X				1	6			1	6		
31	Tel Aviv, Eretz Israel Museum	Samaritan mosaic	1965	1995		X	X				1	13			1	13		
32	Tiberias (Archaeological Park)	Bathhouse	1954–6	1960		X		X			2	10	2	10				
33	Tiberias - Hamat National Park	Hamat Synagogue	1960s	1997		X			X		2	156	1	6	1	150		
34	Zippori National Park	Villa Dionysos	1987–8	1990–1	X					X	5	112	4	62			1	50[f]
35	Zippori National Park	Nile Festival Building	1991	1992/95–6[g]		X			X		13	270	12	265	1	5		
36	Zippori National Park	Synagogue	1993	1999–2002	X					X	1	60					1	60
				Total	9	27	5	14	9	8	106	3739	78	2867	25	753	3	119

a. Lady Mary: 7 mosaics are conserved in-situ with cement-based mortar

b. Caesarea Villa and Bath: 1995, temporary shelter erected; 1999, temporary shelter dismantled; 2001, permanent shelter erected

c. Ein Gedi: Several excavation campaigns

d. In the Herodian Quarter one of the mosaics is partly relaid on cement, and partly in situ

e. The enclosed shelter of the Mount of Olives is made of stone with repairs in cement

f. Zippori: Dionysos mosaic is partly relaid on epoxy, and partly in situ

g. Zippori Nile Festival shelter: 1991, temporary shelter erected; 1995–96, permanent shelter erected, combines metal and timber construction.

refers to the proportions between open and closed lateral surfaces of the structure, with no definitive distinctions. The types of shelters range from simple sheds, which provide only a horizontal roof, to open shelters with some lateral elements or completely enclosed structures, which allow additional facilities for protection and presentation. In some cases, lateral elements such as curtains or cladding are added or removed as needed (Alef 2002).

About 75 percent of the shelters in Israel are open. Open shelters provide a horizontal barrier to rain and direct sunlight, important considerations in the Mediterranean and desert climate of Israel, but they do not protect against wind-driven rain, dust and sand deposit, marine aerosol, temperature, and relative humidity, and they usually provide less security from animals and vandals.

Other data record number of sites and mosaics, surface area, and type of support. The survey found that 78 mosaics (74%) in an area of 2867 square meters are treated in situ; 25 mosaics (23%) in an area of 753 square meters are relaid on cement support; and 3 mosaics (3%) in an area of 119 square meters are relaid on epoxy and aluminum sandwich panels.

Discussion

The specific environmental factors pertinent to the protective function of a shelter are direct solar radiation (SRD), rain, wind-driven rain, relative humidity, moisture content, wind, pollution, marine aerosol, and deposits such as dust and sand. Other factors that are amenable to management solutions include drainage and protection from biological threats such as invasive flora and fauna and bird droppings.

Evaluation of the protective function of a shelter comes down to its effectiveness in mitigating the environmental and biological factors that cause physical deterioration of the mosaics. As can be seen in the following examples, a shelter can sometimes mitigate these factors, but it may also accelerate the deterioration process. Faults in shelter design are obviously among the main causes of deterioration, but identifying cause-and-effect is a difficult task. Mitigating mistakes that may be made in the future is one of the goals of this research, and the initial results advance the discussion on some of the phenomena that are found in shelters over mosaics, such as problems of accumulation of salts, condensation, and the effect of the type of shelter on the condition of the mosaics.

Shelters have been built in all regions of Israel and function under varied climatic conditions: Mediterranean climate in Zippori and Jerusalem; marine environment with high relative humidity in Nahariya, Caesarea, and Tel Aviv; semiarid climate in the area of Beit She'an; and desert climate with extreme temperature fluctuations in Ein Gedi and Massada. This distribution provides an interesting selection of case studies for examination.

Salts Accumulation in a Marine Environment

The in situ mosaics in Caesarea and the relaid mosaics in the courtyard of Eretz Israel museum, Tel Aviv, both situated on the Mediterranean coast, represent similar phenomena, where the exposed mosaics seem to have less dust deposit than the mosaics under the shelters in the same sites. In the survey, we noticed that this phenomenon is mainly found in sites in a marine environment.

The climate in Caesarea is humid subtropical (Mediterranean) with environmental conditions of 600 millimeters average annual rainfall. High relative humidity (average daily maximum ranges from 83 percent in January to 95 percent in June) makes it one of the most humid areas in Israel.[3] The Bathhouse and Domus were built in the fourth century C.E. and were in use during the Byzantine period. The interiors were decorated with marble fountains and paved with mosaics. The site was excavated during the early 1990s (Porat 1996). In 1995 a temporary wooden shelter was constructed, and in 2001, with the objective of preventing rain, two permanent shelters were constructed, one over the Domus and the other over the Bathhouse (see fig. 1).

The permanent shelters are large metal frame structures with hipped roofs—the bath shelter with an area of 646 square meters and 5.0 to 6.5 meters at the highest points and the Domus shelter with an area of 390 square meters and 3.0 to 5.0 meters at the highest points. Steel columns support an I-beam structural system. The roof cladding is made of metal sheets, and the ceiling is covered with aluminum sheathing. The roof is drained by gutters and pipes. The mosaics were conserved in situ with lime-based mortar. Their routine maintenance includes monthly dry and wet cleaning.

When comparing those mosaics to the exposed mosaics on the site, one finds greater amounts of dust and salt accumulation on the mosaics under the shelters. High relative humidity and moisture content together with the presence of aerosol and dust deposits in the marine environment can explain this phenomenon. The dust and its salt components, in the presence of water from relative humidity and aerosols, create an aggressive corrosion process. The open shelter provides horizontal protection from rain but does not prevent aerosols and dust from accumulating on the mosaic (fig. 2). On exposed mosaics these deposits are washed in the rain, but under the shelter their removal is controlled and depends on maintenance. A comparative exposure test conducted by the GCI and the IAA in Caesarea between 1999 and 2002 showed that once mosaics under shelter are not maintained they deteriorate at a much higher rate than do exposed mosaics.

The decision to shelter the remains in Caesarea was made primarily because of their location in deep excavation pits that did not allow for appropriate drainage of rainwater. The shelters did protect against rain, but they created a new problem: the accumulation of dust and salts from aerosols. This does not suggest that the decision to construct shelters over the mosaics was wrong,[4] but it highlights the need for routine maintenance in order to control accumulation of deposits.

The case of Caesarea (fig. 3) and the similar case of the shelters in the courtyard of Eretz Israel museum, Tel Aviv, demonstrate the function of the shelter as an ecosystem in which each parameter is related to other parameters. All the environmental factors in this case—rain, wet and dry cycles, aerosols, salt and dust accumulation—are active players in this ecosystem. For example, reducing rain results in increasing the dust and aerosol. The assessment of the effect of a shelter on the environment of the mosaic, therefore, involves the development of an ecosystem-based model.

Relative Humidity and Condensation

Condensation is one of the first indicators of design faults that can be observed in shelters in humid subtropical (Mediterranean) climates with high relative humidity. This problem has to do with inadequate control of the causes of condensation or, once condensation occurs, with the removal of the condensed water from the interior surface of the roofs. This phenomenon affects the mosaics in various ways, as seen in the Nile Festival mosaic in Zippori (fig. 4), the Bath in Ein Yael, Jerusalem, and the experimental shelter (NN4) in Caesarea (see fig. 3).

The Nile Festival building in Zippori was constructed in the fifth century C.E. It measures approximately 50 by 35 meters and has more than twenty rooms and corridors planned around a basilica hall and a courtyard (Netzer and Weiss 1992). The entire building was originally paved with polychrome mosaics; twelve mosaic floors in an area of 242 square meters have been discovered in various states of preservation. The site was excavated in 1991 and in situ conservation was undertaken during 1994–95.[5] At the same time, a permanent open-sided

(a)

(b)

FIGURE 2A, B The experimental shelter (NN4) in Caesarea is a low-pitched roof, built in 1998 (a). The photo of the interior taken in summer shows dampness on the mosaic caused by severe condensation (b). The problem is the outcome of insufficient ventilation in the humid climate. This mosaic also suffers from water runoff and wind-driven rain in winter and from inadequate protection from direct sun, which accelerates wet and dry cycles. Photos by Y. Alef (2006) © IAA.

(a)

(b)

FIGURE 3A, B The test panel (a) shows severe disaggregation caused by the aggressive environmental conditions (high relative humidity, condensation, dust, aerosols) under the experimental shelter (NN4) in Caesarea. These phenomena are also evident on the mosaic (b). Test panel photo by N. Davidov (2003), mosaic photo by Y. Alef (2006) © IAA.

FIGURE 4 The Nile Festival shelter is a complex system of pitched roofs made of fiberboard and copper that rest on a metal-and-timber frame structure. A series of faults in the design and during its construction impaired its protective efficacy. Photo by Y. Alef (2002) © IAA.

FIGURE 5 During the summer the Centaur panel in the Nile shelter suffers from water accumulating on its surface (under the right front leg of the Centaur). A difference in thermal conductivity of the copper and the wood in addition to lack of insulation in the roof construction causes condensation on the fiberboard, which then drops onto the mosaic. Photo by Y. Alef (2006) © IAA.

shelter was erected measuring 670 square meters.[6] The shelter combines metal and timber framing. The posts are steel covered with wood, set in concrete footings. Fiberboard covered with copper sheets, with no insulation, rests on the beams. The roof is composed of a complex system of pitched roofs in three levels that overlap. The smaller modules at the bottom are 3.5 meters high, and three large modules, one above the Nile Festival mosaic and two above the basilica hall, are nearly 6 meters high at the top (see fig. 4).

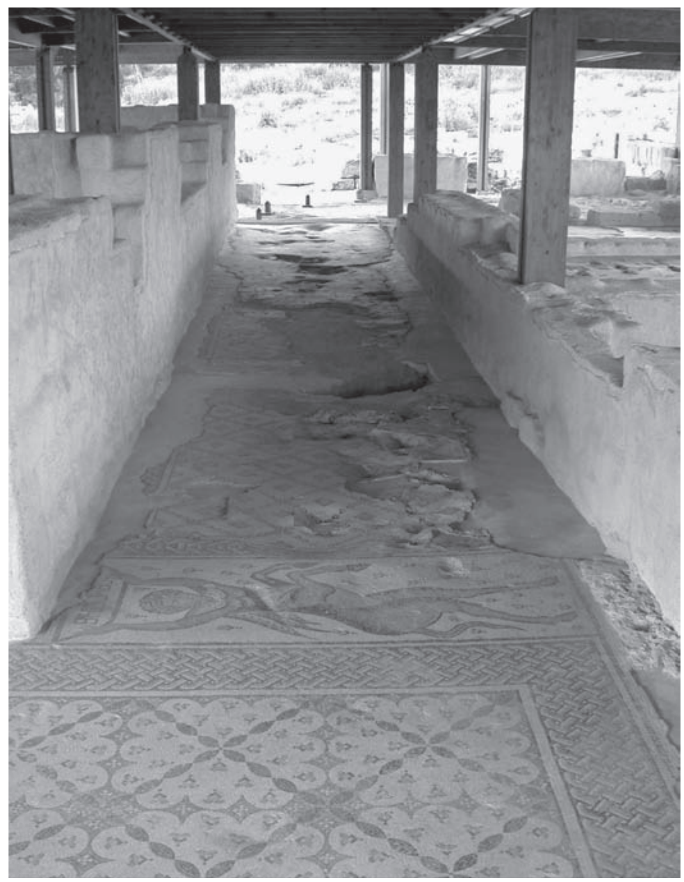
During the rapid assessment survey, the Centaur panel was found to be wet from water dropping from the roof (fig. 5).[7] This phenomenon was already recorded in 2000 during a site inspection. An explanation for the accumulation of water on the mosaic has to do with the condensation of water on the fiberboard that then falls directly on the mosaic. A difference in thermal conductivity of the copper and the wood, in addition to lack of insulation in the roof construction, is a cause of condensation on the fiberboard. It is not surprising, therefore, that the fiberboard all over the shelter shows signs of rot and needs to be replaced (fig. 6). However, most of the roof area has an angle sufficient to allow the water from condensation to leak along the slope. This is not the case above the Centaur panel, which rests at the end of a corridor, where a horizontal roof links two of the pitched roof modules (see fig. 6). The water that condenses on the fiberboard drops down on the mosaic. As a general note, soluble salts are not a major threat in Zippori, but the constant dry and wet cycles accelerated the damage to the mosaics, resulting in salt crystallization, bulging, and black-colored microorganisms on the mosaics.

Because the condensation problem of the Nile Festival shelter seems easy to manage, the question of how the design failed to address it arose. When we examined the planning and construction process of the shelter, we found that the original architectural details included roof insulation. During construction, however, unexpected expenses were incurred that originated from inadequate engineering planning. In order to stay within the budget, the decision was made to cut costs by leaving out the insulation (B. Shalev, pers. comm. 2002). The faults in the protective function, on the one hand, and the high costs of the shelter, on the other, raise questions regarding the choice of materials and design as well as on-site management decisions. It seems that architectural considerations were not balanced with other priorities of the site. This case illustrates a common problem in the decision-making process in Israel: not all the parameters of shelter design are integrated and balanced.

A similar phenomenon was also noticed in the Bathhouse of Ein Yael, Jerusalem, where the condensed water under the corrugated metal cladding ran along the metal construction and then dripped onto the mosaic. A stripe of rust stains on the mosaic traces the location of the metal beam above.

In a marine environment the consequence of condensation under open shelters is even more severe because of the corrosion of the materials such as stone and metal. The worst case of condensation was indeed observed in the experimental shelter of NN4 in Caesarea. This shelter was built in 1998 over a small mosaic as part of the comparative exposure testing project. The low-pitch roof rests on a wooden structure, with posts set in concrete footings. In the rapid assessment survey undertaken in summer 2006,[8] the mosaic was found wet. This was not surprising since it is a long-recorded phenomenon at this mosaic. During the comparative exposure testing, mosaic test

(a)



(b)

FIGURE 6A, B The fiberboard above the Centaur panel (a) shows signs of rot and needs to be replaced. Whereas in most of the roofed area there is sufficient slope, above the Centaur panel the roof is horizontal and water that condenses on the fiberboard drops onto the mosaic (b). Photo by Y. Alef (2006) © IAA.

panels under the shelter soon disintegrated into powder. The corrosion factors in these conditions are relative humidity, marine aerosols, surface deposits (very fine dust particles), and additional water from condensation, which activate and accelerate the deterioration processes that relate to multiple cycles of salt crystallization. This process in different variations, as shown so far, is a key to understanding corrosion under shelters.

Based on preliminary analysis, the key for reducing condensation in shelters lies in provision of proper ventilation, that is, sufficient height of the shelter and consideration of wind direction, sufficient angle of roof slope, proper selection of materials, including consideration of heat conductivity and insulation, and durability of materials that will ensure proper insulation. Finally, the importance of the cleaning of dust from mosaics under open shelters must be emphasized; this will eliminate one of the main corrosion factors, which is vital for their survival as well as for their aesthetic presentation.

FIGURE 7 The Artaban mosaic from the Mount of Olives was sheltered in 1873. The drawing on the left was made following the excavation (Clermont-Ganneau 1899). The photo on the right was taken in 2006 and shows the mosaic still in good condition. Photo by N. Davidov (2006) © IAA.

Condition of Mosaics in Enclosed versus Open Shelters

The survey results suggest that generally, as far as environmental factors are concerned, mosaics in enclosed shelters seem to be in better condition than mosaics in open-sided shelters. A preliminary observation for enclosed shelters, which will need further investigation as this research develops, is that deterioration seems to be associated mainly with management issues, namely, lack of site and shelter maintenance, rather than environmental factors.

Examples of mosaics in good condition can be found in enclosed shelters in Beit Alpha synagogue,[9] which was excavated 77 years ago, and the Mount of Olives mosaic in Jerusalem, which has remained in perfect condition for more than 135 years (fig. 7). The same could be said for the rather simple enclosed shelter over the mosaics of Lady Mary monastery, Beit She'an. The site was excavated in the 1930s, and two years later a metal frame structure with asbestos cladding and concrete walls was erected. This enclosed shelter performed well until the asbestos cladding reached its life span 15 to 20 years ago and broke. Since then, deterioration of the mosaics has accelerated, and today they are endangered. The enclosed shelter in Maoz Haim, not far from Beit She'an, was constructed in the late 1970s and provides sufficient protection for the relaid mosaics, but the in situ mosaic is disaggregating.

Each of the mosaics in these four examples was treated differently: the Mount of Olives mosaic was conserved in situ with lime-based mortar, the Beit Alpha mosaic was relaid on cement slabs, and the mosaics of Lady Mary were either conserved in situ with a cement-based mortar (the majority) or relaid on cement slabs. All but one of the Maoz Haim mosaics were relaid on cement slabs; the one exception was conserved in situ with cement-based mortar.

The examination of the condition of the different mosaics under enclosed shelters may indicate that these shelters provide sufficient protection for relaid mosaics. The condition of in situ mosaics in enclosed shelters depends also on drainage and groundwater insulation. In the case of Maoz Haim, for example, lack of drainage and groundwater insulation combined with the watering of fields adjacent to the shelter, high groundwater that originated from saltwater springs, and high soil salinity are the probable cause for the complete desegregation of the in situ mosaic.[10]

This observation is supported by a comparison of the mosaic under the open-sided shelter in Nir David and the mosaic in the enclosed shelter of Beit Alpha 3 kilometers to the west. The mosaic of Tel Bazul was lifted, set in cement bedding, and then relaid on a cement slab for display in the courtyard of the Museum for Regional and Mediterranean

Archaeology at Gan Ha-Shelosha (Nir David) during the 1960s.[11] The shelter is a simple shed constructed of metal posts set in concrete footings. The roof cladding is made of corrugated metal sheets. The mosaic rests in a concrete podium in the shape of a pool; no roof drainage was installed. Although the yearly average of rain is quite low (about 430 mm), wind-driven rain and wind-driven runoff from the roof accumulate in the pool-shaped foundation of the mosaic, which retains the humidity for long periods. This has resulted in disintegration of the cement support and may cause total loss of the mosaic. Both Nir David and Beit Alpha are relaid on cement slabs, but while the Beit Alpha mosaic is in stable condition, the Nir David mosaic is endangered.

Conclusion

The research presented in this paper is ongoing. To date, most sites have been surveyed, and a significant amount of information relating to the environmental data and the characteristics of the shelters and the condition of the mosaics has been collected but has yet to be fully analyzed. Nevertheless, some preliminary observations can be made. In all cases, the protective and preventive efficiency or the control of the process of deterioration is obtained only if a shelter is correctly planned, constructed, maintained, and used. If any of these elements is missing, the benefit of the shelter can be lost and its protective function transformed into an "accelerating aging machine" of the remains being sheltered (Accardo 2006: 21).

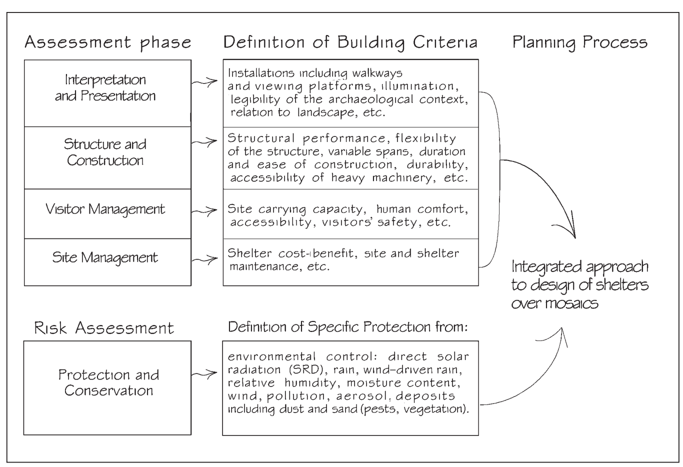
From the information collected so far, it appears that when shelters fail in their protective function it is because aesthetic design, visitor comfort, presentation, or other aspects were prioritized over the protective function, resulting in an unbalanced solution. The shelter over the Nile Festival at Zippori, for example, prevents rain, but the choice of materials and management generated a new problem, condensation. Integrated criteria, which form a common basis for communication among the participants in the process, are needed in order to prevent these mistakes.

Understanding the effect of shelters on the decay mechanism of mosaics (which is the focus of this research) is a first step in establishing common criteria for the evaluation of shelters. The protective criteria are only part of a broader context related to shelters and have to be considered in relationship to interpretation and presentation criteria, visitor and site management criteria, and structural and construction criteria (Alef 2002). With a common methodology for evaluation, an integrated planning process for the construction of new shelters, which responds to all the various concerns, can be developed.

Both the evaluation and the planning of shelters are based on understanding the shelter and mosaic as an ecosystem (table 4). An ecological evaluation or planning model for shelters as ecosystems needs to take into account not only the different criteria for each aspect independently (e.g., management, protection, presentation) but also the relations and interactions among those aspects. While the condensation problem in the Nile Festival mosaic is primarily a design fault due to the lack of an integrated approach, the shelters in Caesarea and Tel Aviv are good illustrations of the need for a balanced ecological system. Rain, wet and dry cycles, aerosols, and salts accumulation were factors that had to be addressed. Although the shelters prevented the entrance of rain, they created a new problem of salt accumulation from aerosols. Those problems created by the shelter require a maintenance routine different from that for the exposed mosaics in the same site. Understanding which environmental factor is most critical (e.g., rain, aerosols, condensation) guides the appropriate protection, treatment, and type of maintenance for the specific issues of each site.

At this stage it is too early to evaluate the validity of the methodology of the rapid assessment as a research tool and as a practical management tool for mosaic conservation. However, the development of a common methodology is already in itself an important outcome of the rapid assessment. A methodology for evaluation of the protective function of shelters based on defined criteria is a basis for common integrated criteria for evaluation of the overall shelter performance. In the case of evaluation of shelters, the answer to the question of whether a

Table 4. Integrated ecological approach to the design of shelters over mosaics



specific shelter fulfills its expectations depends on whom you ask. The architect may "like" it, while the site manager will criticize it for its expensive maintenance; the visitor may enjoy the shade, while the conservator may not be satisfied with how the shelter protects the mosaic from deterioration.

It is our hope that the results of the rapid assessment will assist in developing a planning model for shelters over mosaics with an integrated approach comprising all factors and based on ecological planning principles that considers the interaction of these factors.

Acknowledgments

The authors would like to thank Martha Demas from the GCI and John Stewart from EH for their insightful remarks, useful advice, and guidance in the writing of the paper.

Notes

1 The methodology of the rapid assessment is described more fully in Stewart, this volume.

2 Intended duration, i.e., temporary or permanent, can also form a category. Temporary shelters are erected for an excavation in progress or at the end of an excavation until a decision is made regarding permanent protection. These are usually simple low-cost structures that in many cases do not provide sufficient protection for the mosaic. Today a temporary seasonal shelter made of nylon sheets over metal frame arches is built over the mosaic in Megiddo, which was excavated in 2005 and is awaiting a decision about its future.

3 The environmental data are based on those of the meteorological station in Geva Carmel (Bitan and Rubin 2000).

4 Water accumulation would have undoubtedly accelerated the deterioration of the mosaics, plaster, and ceramic elements of the site.

5 Excavations were led by Netzer and Weiss on behalf of the Hebrew University. The conservation work was conducted by the Centro di Conservazione Archeologica–Rome (Costanzi Cobau and Nardi 1996).

6 The cost of the shelter ($500,000) was high, due in part to the choice of expensive materials (B. Shalev, pers. comm. 2002).

7 The survey took place on October 14, 2006, at 15:00; the relative humidity under the shelter was 48%, and the air temperature was 28^{0}C.

8 The mosaic was surveyed on July 18, 2006, in the afternoon when the relative humidity under the shelter was 71.5% and the temperature was 29^{0}C.

9 The mosaic floor of the synagogue was discovered accidentally in 1929. Excavations were directed by E. L. Sukenik, assisted by N. Avigad, on behalf of the Hebrew University of Jerusalem. Shortly after excavation an enclosed shelter was built over the site and then was replaced in the 1960s(?) with the current shelter.

10 The area is ranked as "medium rate of salinity" (rank 4 out of 7), that is, 10 to 20 percent of the soils in the area are affected with salinity throughout the cross section (Rabikovitch 1970).

11 The mosaic was unearthed in archaeological excavations headed by Nehemya Zory on behalf of the Antiquity Department between 1961 and 1964.

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Protective Shelters over Archaeological Sites: A Review of Assessment Initiatives

Sibylla Tringham and John Stewart

Abstract: *The primary purpose of a protective structure, or shelter, on an archaeological site should be to provide a beneficial environment for the preservation of an archaeological asset, such as a mosaic pavement. However, in reality shelters perform variably. This paper provides a review of initiatives that have been carried out to evaluate shelters, describing the range of methodologies and technical methods that have been employed. The collective experience of these evaluations can help to develop better means of understanding the performance of existing shelters and potentially inform the design and evaluation of new ones.*

Résumé : *L'objectif principal des structures de protection, ou abris, sur un site archéologique devrait être d'assurer un environnement propice à la préservation d'un bien archéologique, tel qu'un pavement en mosaïques. En réalité, cependant, la performance des abris est variable. Cette communication passe en revue les initiatives menées pour évaluer les abris, décrivant une série de méthodologies et de méthodes techniques employées. L'expérience collective de ces évaluations peut contribuer à mieux apprécier les performances des abris existants et à renseigner la conception et l'évaluation des nouvelles structures.*

In recent years the growing recognition of the need for better conservation and management of archaeological sites has been reflected in a heightened interest in shelters.[1] Shelters are built to protect significant archaeological assets, such as mosaic pavements. They also play a valuable role in presentation and access and can enhance the display and interpretation of archaeological remains. Of course, sheltering is not appropriate for all features on all sites; other conservation options, such as reburial, may be chosen as part of the conservation strategy for a site.

Despite the recent proliferation in shelter construction, sheltering has a long history, extending back almost 250 years in the United Kingdom, which attests to the long-perceived benefit of covering remains. Approaches to shelter design vary broadly: from temporary tents to open-sided roofed structures; from simple enclosed vernacular structures to buildings assembled from innovative materials with sophisticated provisions for internal climate control and visitor access.

While the principal function of a shelter—and the focus of this discussion—should be to reduce the rate of degradation of the remains, the notion that a shelter of any design will afford adequate protection is misguided. Deterioration of the archaeological features may well continue after the erection of a shelter. Indeed, a shelter may actually contribute to the degradation of covered remains, for example, by inadequate rainwater dispersal. Therefore, understanding the complex relationships between the vulnerability of the archaeological features and the conditions created by the shelter is critical to the longevity of the resource. Put simply, assessment of shelter performance serves to determine the overall effectiveness of the structure in preserving the archaeological remains from the main risks over time (Teutonico 2001: 89). For existing shelters, assessment can help to identify the need for remedial alterations; for proposed new shelters, evaluation can predict the performance of the design, to detect and resolve potential flaws before construction.

In the conservation field, literature on shelters has traditionally been descriptive, emphasizing aesthetic character and interpretive function, and critical reviews and evaluations of shelter performance are rare (Demas 2001). More recently, however, some evaluations have been reported in the literature, and there are others that remain unpublished. This review identifies and appraises these initiatives—their broad trends as well as their omissions—to develop better means of understanding existing structures and to potentially inform the design and evaluation of new ones.[2]

Shelter Performance Criteria

As it is at the interface of the buried and exposed environment, an excavated archaeological feature is susceptible to many types of deterioration, the causes and mechanisms of which are often complex and entangled. Mosaics, for example, are vulnerable to environmentally driven deterioration phenomena such as soluble salts and certain forms of biodeterioration that are activated by moisture in its different forms (as rainfall, dispersed or groundwater, or water vapor) (fig. 1). In general, a shelter needs to protect a mosaic or other cultural resource from climatic effects such as

- rainfall, through adequate roof cover, drainage, and water disposal
- insolation, through roof design and lateral wall cladding
- severe fluctuations in the internal climatic environment, preferably through passive means such as thermal insulation

The specific performance criteria of a shelter must of course be based on local climatic conditions and conservation requirements.

Shelters need to fulfill other utilitarian functions, including presentation and interpretation and security against unlawful entry (Stewart 2001). However, it is far easier to satisfy these requirements in a new design than it is to design a shelter that will create the best environment for the protection of archaeological resources.

Approaches to Assessing Shelters

Assessment of an existing or proposed shelter should be based on the understanding of the natural features of the site (including topography, hydrology, and soil structure/geology), the resources themselves (including their extent and condition), and the mechanisms of deterioration to which they are subject. A full understanding of these aspects of the site usually requires a number of investigations, including

- documentation of the archaeological feature and its postexcavation history

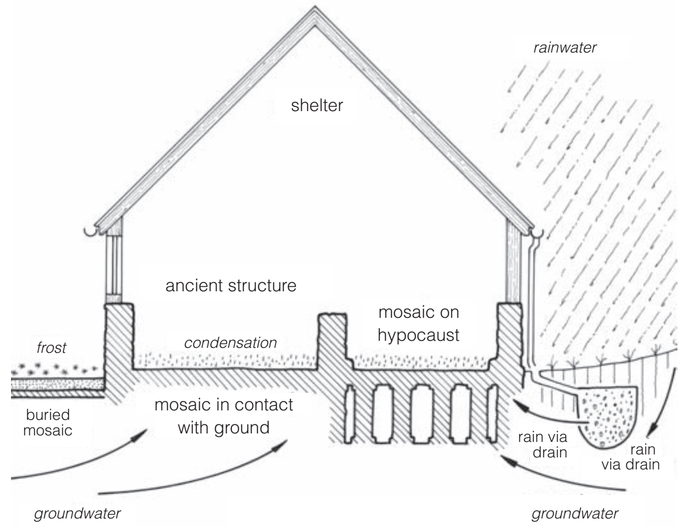


FIGURE 1 Schematic section through a shelter building with floor mosaics, showing typical sources of moisture activation mechanisms. Courtesy of Graham Reed.

- analytic investigations
- condition assessment
- subsurface investigations
- the collection of environmental data over time

Ranking the risks identified in these studies, in order of their severity and frequency, can help to define the specific performance criteria that the shelter needs to fulfill. These performance criteria should inform the design of a new shelter and function as a standard against which to test both its predicted performance during modeling and, ultimately, its actual performance as built.

The information gathered in these preliminary investigations can support monitoring strategies and data interpretation, in addition to providing a valuable baseline for further studies. More specific questions regarding the role of the shelter in the deterioration processes can then be addressed by assessing the main factors of deterioration and risk. Shelter evaluation needs to be a formal inquiry carried out with methodological rigor in which empirical observations are recorded systematically and corroborated with quantitative and qualitative data; as information is gathered it informs further investigations, feeding into a continual process of questioning and reinterpretation.

Source Material

For the purposes of this study, assessments of existing and proposed shelters were reviewed for a broad range of sites.[3] Over half the assessment initiatives have been undertaken at sites with mosaics; other sites have either stone or earthen architecture or wall paintings. This review aims to be as comprehensive as possible and includes both published and unpublished projects around the world. However, inevitable obstacles and omissions result from a range of issues, among them projects still in progress, material in preparation for publication, language limitations, and insufficient description in the published literature. Where possible, information was supported with personal communication. The data were collated in tabular form with sites, site typology, and assessment methods, which revealed trends in approaches to assessment (table 1).[4] With six project sites, Italy has the highest number of assessment initiatives. Other recent or ongoing projects are located in Cyprus (1), Czech Republic (1), El Salvador (1), England (3), Greece (1), Israel (1), Mexico (1), Norway (2), Switzerland (2), Thailand (1), Turkey (2), and the United States (3).

Methods of Assessing Shelters

Condition Survey and Monitoring

Condition survey or assessment, defined as a study that relates condition and deterioration phenomena, is a valuable and widely used tool in conservation. It has enhanced value for assessment when combined with monitoring change over time, in relation to an existing shelter or a proposed new one. The essential basis for the survey is a preliminary study of the physical history of the remains through previous documentation (written, graphic, and photographic). Photography plays an important part in both the initial survey and subsequent monitoring, as long as it is consistent, repeatable, and of sufficient resolution to capture a meaningful level of detail. Graphic representation of deterioration phenomena can be especially valuable because it emphasizes the distribution of the phenomena. However, the value of graphic documentation as a monitoring and evaluation tool is critically dependent on its objectives and design.[5] Furthermore, the terminology, relative accuracy, and consistency, as well as accessibility for future use, will affect its value. In most projects reviewed, a condition survey was undertaken in the initial investigations but rarely functioned as a comparative tool for longer-term monitoring. Few studies reported on the condition of the shelter during shelter evaluations, with the exception of the rapid assessments carried out by English Heritage, the Israel Antiquities Authority, and the Getty Conservation Institute.[6]

Investigations such as impulse radar and photogrammetric survey, which provide structural information on mosaics, have demonstrated value for mosaic condition assessment and diagnosis and potential for longer-term monitoring. However, these methods were reported only at the sites of Brading and Chedworth in England.

Analytic Investigations

Analytic investigations that provide information on original materials and deterioration phenomena are essential for developing conservation strategies. Most studies undertook materials characterization of the ancient fabric, although few carried out physical and chemical analysis to investigate the identified risks. For mosaics, salt analysis (quantity, composition, distribution, and hygroscopicity) was the most common investigation, providing a broad indication of the predicted risk from salts' presence.

More in-depth analytic investigations can serve to define risk parameters and aid specification of appropriate internal shelter conditions. This is amply demonstrated at the Roman site of Orbe-Boscéaz in Switzerland, where salts and blistering affected the *tessellatum* of one mosaic. Experiments characterized the critical range of relative humidity for the salt mixtures found underneath the mosaic as well as the role of thermal and hygric fluctuations in the formation of blisters. The actual behavior of materials in situ may vary significantly from that of materials in the laboratory environment and the internal conditions proposed. Therefore, the experiments were subsequently performed on-site, along with environmental and condition monitoring. These types of investigations have proven extremely valuable but unfortunately are unique among the shelter assessments reviewed.

Survey of Liquid Moisture Sources

Identification and characterization of all liquid water sources affecting the archaeological remains and the shelter may provide insight into their potential for activating or accelerating mechanisms of deterioration. Investigations into water movement through the site by hydrogeological, drainage, and/or geophysical surveys were a priority at Novy Kuks, Orbe-Boscéaz, Vallon, Brading, and Chedworth and resulted in the installation of appropriate drainage systems to manage the water sources. The availability of appropriate sampling locations that are not disruptive to surrounding undisturbed

Table 1. Shelter assessment initiative

Resource type		Mosaics/tiles										Stone			Earth						Misc.			Total
Site		**Chedworth (UK)**	**Brading (UK)**	**Vallon (Switzerland)**	**Orbe-Boscéaz (Switzerland)**	**Cleeve Abbey (UK)**	**Domus dei Coeidii (Italy)**	**Domus at Corfinio, Varignano, Arianna, Piazza Armerina (Italy)**	**Paphos (Cyprus)**	**Caesarea (Israel)**	**Ephesus (Turkey)**	**Novy Kuks (Czech Republic)**	**Apollo Epicurios (Greece)**	**Hamar Cathedral (Norway)**	**Casa Grande (USA)**	**Catalhöyük (Turkey)**	**Joya de Cerén (El Salvador)**	**Tell Mozan (Syria)**	**Cacaxtla (Mexico)**	**Fort Selden (USA)**	**Wat Sri Chum (Thailand)**	**Blackwater Draw (USA)**	**Trondheim (Norway)**	
Analytical investigations/ survey/ research	Analytical investigations			X	X	X		X	X			X	X		X	X	X		X				X	12
	Physical/ chemical properties				X			X				X	X		X	X	X						X	8
	Salt	X	X		X	X		X	X			X			X								X	9
	Hydrogeological	X	X	X	X				X			X											X	7
	Geophysical	X	X		X							X												4
	Drainage	X										X												2
	Condition survey of existing shelter		X													X		X				X		4
	Condition survey of resource	X	X		X				X	X		X			X	X	X		X			X	X	12
	Literary/ historical survey				X							X		X	X									4
	Comparison of current condition with historic photographs		X									X			X			X						4
Monitoring	Condition	X			X	X	X	X	X	X		X				X	X	X		X		X		13
	Internal environment	X	X		X	X	X	X	X		X	X	X	X		X	X		X	X	X	X		17
	External environment	X	X		X	X	X	X	X	X	X	X	X			X	X	X		X	X	X		17
	Pollution							X		X														2
	In situ soil moisture content/ temperature	X			X	X											X							4
	In situ masonry/ mosaic moisture content/temperature	X	X		X								X	X			X			X			X	8
	Mosaic/masonry dimensional change				X									X										2
	Indicator materials/ test samples/replica						X	X		X							X	X		X	X			7
Other	Protective indices							X									X			X				3
	Thermal simulation		X					X			X													3
Total		10	10	2	13	6	4	10	7	5	3	12	5	4	6	7	10	5	3	6	3	5	6	
References		Stewart et al. 2003 Stewart et al. 2004	Edwards et al. 2003 Gifford 2003 Knight 1994	Guex 2003	Fischbacher et al. 2003 Flatt et al. 1997 Weidmann 1987 Weidmann et al. 2003 Weidmann and Girardet 2005	Pers. Comm. Bill Martin	Laurenti 2001	Laurenti 2001	Stanley-Price 1991	Pers. Comm. Jacques Neguer	Krinzinger 2000	Kotlík and Heidigsfeld 2002	Theoulakis 1993	Ibenholt 2003 Statsbygg n.d.	Matero 1999	Catalhöyük archive reports	Maekawa 2006	Buccellati and Bonetti 2003	Pers. Comm. Diana Moletore	Agnew et al.1996	Nishiura et al. 2002	Jerome et al. 2001	Peacock and Turner-Walker 1998	

archaeology may limit the information generated from subsurface surveys.

Moisture Monitoring

Further investigations into the movement of moisture at a site by means of real-time monitoring of moisture variations in porous materials (e.g., mosaic, wall, or soil) can reflect potentially hazardous moisture fluctuations, including wetting and drying cycles. There are a number of techniques available commercially to monitor moisture content, including resistivity and capacitance probes, but they currently have drawbacks in accuracy, coverage, applicability, expense, and compatibility with datalogger technology (Dill 2000). Soluble salts and variations in soil composition may also affect results. Such technical challenges in moisture measurement may have resulted in its omission in many of the assessment projects. Where such monitoring of moisture in porous materials was carried out in the projects reviewed, it relied on custom-made equipment or adapted instruments intended for other purposes, with varying success.

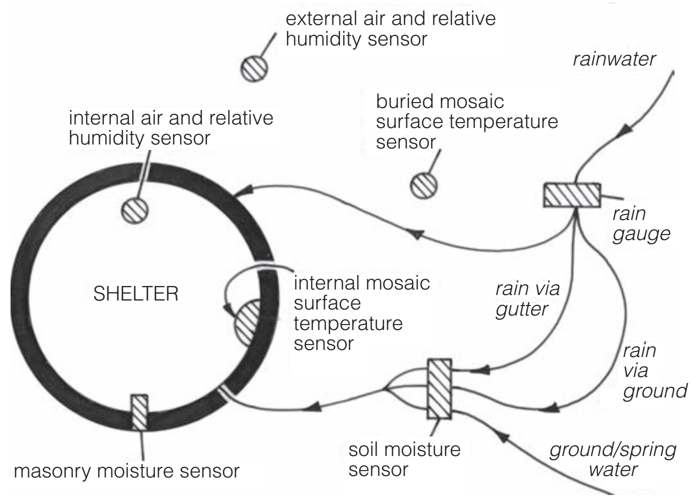


FIGURE 2 Schematic design of the integrated monitoring program at Chedworth Roman Villa. Courtesy of Graham Reed.

Environmental Monitoring

Environmental monitoring serves to measure the prevailing microclimate within the shelter and how it functions as an envelope with respect to the external macroclimate; it may also be used to assess empirical observations. In the studies reviewed, environmental monitoring was the most frequently employed method to assess shelter performance—typically with simultaneous monitoring of the conditions (at least temperature and relative humidity) both outside and inside the shelter. Monitoring several variables at the same time in an integrated strategy, such as surface temperature or moisture content of the archaeological features alongside climatic data, can help to characterize relationships among environmental factors, associated risks, and the condition of the remains.

Such combined strategies are less frequently undertaken, although at Chedworth, where mosaics are affected by salts and microorganisms, an integrated monitoring program over the past eight years has characterized the environments within several different types of shelters on the site. In addition to the more common parameters, surface temperature, masonry, and soil moisture content were also recorded to provide real-time data on the movement of moisture in relation to external events (fig. 2).

Collecting environmental data on an archaeological site presents inherent difficulties, and integrated monitoring strategies are limited by the availability of appropriate technology, sound strategies, and expertise; therefore, the dissemination of innovative solutions is especially valuable. Other interesting approaches to integrated monitoring are illustrated at Orbe-Boscéaz, Fort Selden (a nineteenth-century military outpost in the United States), and Joya de Cerén (a Classic period Mesoamerican site in El Salvador).

When monitoring data (such as climatic data) is examined alongside condition monitoring data, significant correlations may be revealed, shedding light on deterioration mechanisms and the performance of the shelter (e.g., at Fort Selden and Orbe-Boscéaz).

Protective Indices

A tool for interpolating meaning from environmental data has been developed by the Getty Conservation Institute in the form of "protective indices." The protective index is a mathematical expression defined as the reduction in the variability of an environmental attribute brought about by sheltering (Agnew et al. 1996) and is intended to quantify the effectiveness of a shelter. For example, at Fort Selden the protective index demonstrated that the hexashelter significantly buffered various climatic effects. Provided that a control is present, as described below, protective indices can define the effect of the shelter on any environmental parameter and are of particular value when comparing several shelters at the same site.

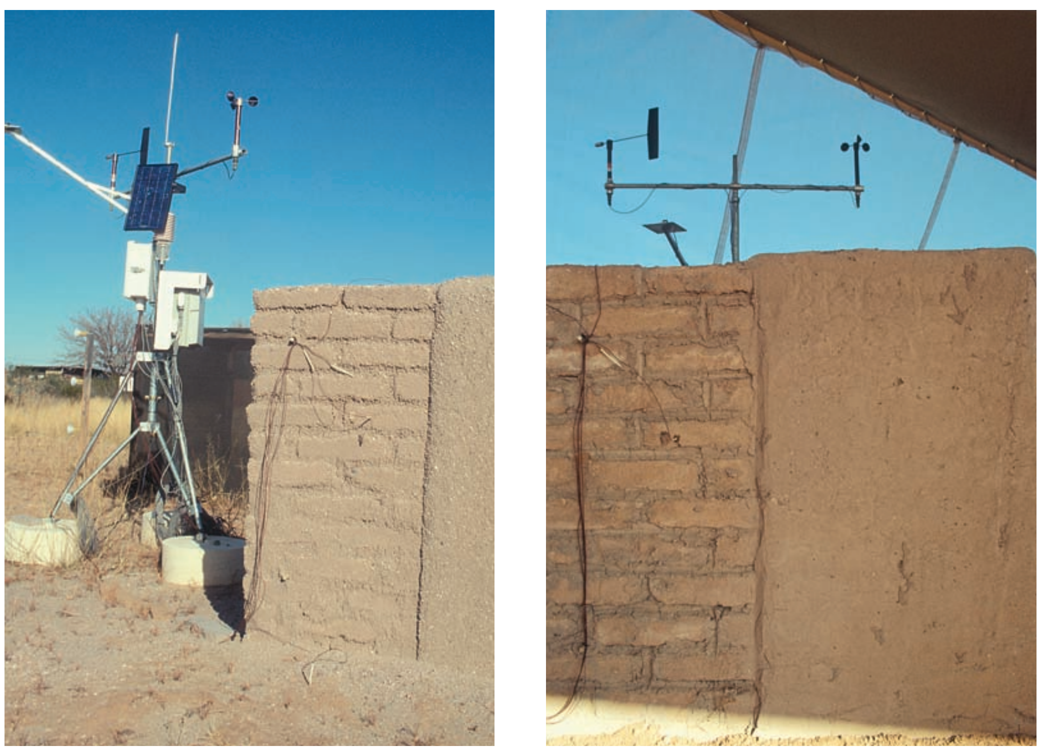
Controls, Replicas, and Test Materials

A potentially effective way to demonstrate the effectiveness of a shelter is to assess the effects of the shelter on controls or replicas placed within it. This is employed by an increasing number of initiatives; for example, at Fort Selden an exposed earthen test wall exhibited significant deterioration after nine months compared with the sheltered test wall (fig. 3). Monitoring the condition of replicas or other test materials eliminates risk to the original asset during testing; however, efficacy depends on a good understanding of the original and contaminant materials and the similarity of the analogue replica to those. Moreover, interpretation of results needs to take account of the likely differences in original and replica materials.

Computer Modeling and Test Structures for New Shelters

For predicting the performance of proposed shelters, computer modeling is demonstrating potential value as a design aid by characterizing the thermal response of the proposed building envelope to different conditions such as climate and anticipated usage. At Brading Roman Villa in England the new passive-design shelter is designed to provide conditions that mitigate environmentally driven deterioration. Thermal modeling demonstrated that a relatively stable internal climate could be achieved year-round without active mechanical climate control (fig. 4).[7]

However, the thermal model does not predict the influence of water vapor, a critical factor in deterioration. For example, moisture may enter the shelter envelope from the ground (especially during periods of heavy rain, increased temperature, or rising water table) or be contributed by the construction materials themselves, which can act as moisture reservoirs and desorb moisture into the shelter under certain conditions. These limitations emphasize the need for continued evaluation after shelter construction to identify long-term conditions that may be damaging. This is being carried out at Ephesus in Turkey and is part of the strategy for the new shelters proposed at megalithic temple sites in Malta.[8] Ideally, new designs for shelters should incorporate flexibility for modification in response to postconstruction review.



(a) (b)

FIGURE 3A, B Fort Selden, New Mexico. Adobe test walls outside the hexashelter (a) and beneath the hexashelter (b) after nine months of exposure. Photos: Neville Agnew. © J. Paul Getty Trust 1991.

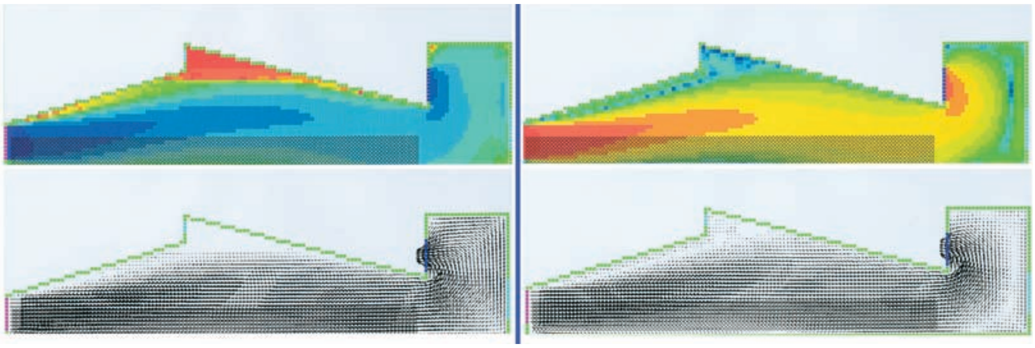


FIGURE 4 Brading Roman Villa. Winter (left) and summer (right) predictions of temperature (above) and airflow distribution (below) by means of computational fluid dynamics analysis. Courtesy of Gifford.

An alternative to computer modeling is the use of test structures to determine the optimal design properties for a permanent shelter. An adjustable tent structure has been erected at Cleeve Abbey in England, where the medieval tile pavement is vulnerable to thermal stresses.[9] The performance of this test shelter in varying configurations will be evaluated over a five-year period with some of the methods discussed above. This provides the opportunity to examine the benefits of a relatively simple cover in order to confirm that sheltering is an appropriate long-term conservation option. However, the inherent limitations of the simple cover mean that the environment created by a more complex design cannot be simulated.

Exemplary Assessment Projects

Several cases have emerged as models in shelter assessment. In these examples, the investigations and monitoring program were part of a larger conservation strategy and were based on coherent methodologies developed expressly to better understand the role of the shelter in the preservation of the archaeological resource.

The research at the Roman mosaic site of Orbe-Boscéaz stands out as a comprehensive and effective investigative program.[10] Laboratory experiments characterizing material behavior were supported by environmental monitoring (of both ambient climate and subterranean conditions) and condition monitoring. The results identified specific environmental parameters for the preservation of the mosaics, which prompted subsequent modifications of the shelter and a strategy for control of the shelter microclimate and subsurface conditions.

The program at Chedworth is notable for its integrated monitoring strategy and for the considerable research into multiple components of the site. Monitoring of various parameters using innovative as well as traditional quantitative and qualitative methods provided insight into the relationship between the shelters and condition of the mosaics (fig. 5). Also in England, Brading exemplifies a well-structured sheltering project with preliminary investigations into deterioration and definition of performance criteria before design, design testing with computer simulation, and the means of assessment after construction by environmental monitoring.

At Fort Selden an integrated monitoring program with replica earthen panels was employed to evaluate the performance of the modular hexashelter. The study also correlated condition with the prevailing environment, and protective indices quantified the degree to which the shelter reduced environmental variations. A similar approach was carried out at Joya de Cerén, where large earthen structures are protected by varying shelter types.

Although these cases employed a number of different methods in various combinations, they share some underlying approaches, which make them of interest:

- Clear articulation of the mechanisms of deterioration and of the real and potential risks to the features, by means of well-planned investigations undertaken by professionals.
- Consideration of the shelter as an intervention within the whole environment. Integrated monitoring strategies were developed relative to the identified risks while taking account of the variables of the resource, microclimate, and subsurface environment.
- Acknowledgment that research needs to be of a multidisciplinary nature and that only relevant specialists working in collaboration with conservators are able to choose the approaches and methods most appropriate to the specific needs of any one site.

(a)

(b)

FIGURE 5A, B Orbe-Boscéaz. The nineteenth-century shelter (a) and Roman mosaic (b). Courtesy of Archéologie Cantonale–Canton de Vaud–Switzerland.

Future Perspectives

Over the past decade the importance of evaluating shelter performance has been increasingly acknowledged. Other significant results are anticipated from assessment projects in progress, such as Piazza Armerina in Italy (Meli 2004), Brading in England, and Ephesus in Turkey, as well as of the proposed shelters at Dolmen de Dombate in Spain (*Dolmen de Dombate* 2005) and at Hagar Qim and Mnajdra in Malta (Lino Bianco and Associates 2004).

Most of the studies use familiar diagnostic methods of varying complexity; more novel methods were also occasionally encountered, such as tools for monitoring dimensional change. However, there are clearly technological gaps, for example, in masonry and soil moisture monitoring, that need to be addressed. Other conservation fields with parallel areas of investigation may provide some solutions. Many of the contributions to the two PARIS (Preservation of Archaeological Remains in Situ) conferences examine ways of monitoring the burial environment, and these could shed light on appropriate methodologies and instrumentation (Corfield et al. 1996; Nixon 2004). Further evaluations of indicator materials specifically for mosaics would be useful. There is also scope for investigating additional parameters, such as ventilation/air exchange or dust deposition, not encountered in any of the project descriptions. As instrumentation is always adapted from other industries, dissemination of methods, results, and evaluations is critical to advance the field.

Omissions in the approaches to shelter assessment are noticeable. Condition monitoring is rarely correlated with environmental data, and more in-depth investigations into the causes and processes of deterioration are often lacking. Integrated approaches using a variety of techniques are clearly beneficial, although they require careful planning and investment of time and money. Ultimately, there is a need to define a model methodology to guide the assessment of existing shelters, based on the experiences reported above. Shelters are an important investment for the future longevity of the resource as well as the presentation of the site to the public. They are also a major financial investment, including both the initial capital costs and permanent maintenance. Therefore, shelter assessment needs to be an integral component both in any new shelter design and in the long-term conservation plan for the site.

Notes

1 The term *shelter* is used to describe all protective structures that include a roof, from those that are fully enclosed to those that are open on all sides.

2 This review was commissioned by English Heritage. The research continued during Sibylla Tringham's internship at the Getty Conservation Institute (2004–5).

3 Subterranean environments and buildings attached to vertical faces (such as cliff structures) were omitted for the sake of simplicity in the review as these are in different environmental contexts, although they may yield valuable information in the future.

4 Please refer to table 1 for literature references to each site.

5 See in this volume M. Demas, T. Roby, N. Agnew, G. Capriotti, N. Savvides, and D. Michaelides, "Learning from Past Interventions: Evaluation of the Project to Conserve the Orpheus Mosaic at Paphos, Cyprus."

6 See in this volume J. Stewart, "Rapid Assessment of Shelters over Mosaics: Methodology and Initial Results from England"; and J. Neguer and Y. Alef, "Rapid Assessment of Shelters over Mosaics: Initial Results from Israel."

7 Computer simulation has also been used in the design of a shelter for Lot's Basilica, Jordan (more detailed information on the method is provided in Aslan 2001, 2003) and at Ephesus (see Krinzinger 2000).

8 Ephesus: pers. comm., Frederick Krinzinger; Hagar Qim and Mnajdra temples: Lino Bianco and Associates 2004.

9 Pers. comm., Bill Martin, English Heritage.

10 See in this volume D. Weidmann, "Orbe-Boscéaz (Canton de Vaud, Suisse) 1975–2005: 30 ans de réflexions sur la conservation d'anciennes et nouvelles mosaïques."

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Lessons Not Learned: The Shelters at Kourion, Cyprus

Demetrios Michaelides and Niki Savvides

Abstract: *This paper is a critical discussion of the protection of the in situ mosaics with shelters and the overall management plan and landscaping at the site of Kourion. An examination of previous interventions, shelters, and walkways at both Kourion and Paphos reveals the consequences of lessons not learned, as evidenced in the current situation at Kourion. Some of the main problems resulting from the lack of proper planning in conservation and site management are pointed out, in an attempt to use the present unsatisfactory situation as a lesson to be learned for future interventions at other sites on Cyprus.*

Résumé : *Cette communication ouvre un débat critique sur la protection des mosaïques* in situ *par des abris, ainsi que le plan global de gestion/aménagement du site de Kourion. En examinant les interventions du passé, les abris et les passerelles à Kourion, les auteurs évoquent les conséquences des leçons non retenues, telles qu'elles apparaissent sur le site de Kourion. Certains des principaux problèmes découlant du manque de planification adéquate en matière de conservation et gestion de site sont rappelés pour que l'on puisse tirer des enseignements de la situation insatisfaisante actuelle pour des interventions futures sur d'autres sites à Chypre.*

The city of Kourion, which traces its founding to a hero of the Trojan War, is one of the most important and spectacular archaeological sites on Cyprus. The surviving monuments of the area date from the thirteenth century B.C.E. to the seventh century C.E., while most of those located on the so-called Acropolis date to the Roman and early Christian periods. The monuments have been investigated since the 1930s, first by a team from the University of Pennsylvania and later by other excavators, both foreign and local (Swiny 1982; *Kourion* 1987; Soren and James 1988).

The site is famous primarily for the mosaics that decorate a number of buildings, such as the House of the Gladiators, the House of Achilles, the Episcopal Basilica, and, above all, the Annex of Eustolios, whose mosaics have acquired international significance. The Annex was excavated between 1935 and 1948, and its mosaics are dated, by coins found in the bedding layers, to the early fifth century C.E. The mosaics exhibit high technical and artistic quality, but their fame derives from the fact that they are among the rare artistic examples worldwide of the passage from paganism to Christianity. An inscription from the East Portico of the building mentions Apollo as the old patron of the city; another, preserved near the south end of the East Portico, mentions the "symbols of Christ" as the power that holds the building upright (Michaelides 1992: 85).

Because of its monuments and dramatic location, the site has always been one of the main tourist attractions of the island. Despite this, however, its monuments and, in particular, its mosaics have not been properly treated or protected over the years—something that has resulted in the loss of a considerable portion of them.

Previous Shelters at Kourion

Only one mosaic panel in the southeast corner of the portico of the Annex of Eustolios was treated differently. This panel is decorated with birds and fish and is accompanied by the previously mentioned inscription referring to the symbols of Christ, the importance of which was recognized on excavation. Thus, soon after its discovery in 1935, it was covered with a primitive shelter made of stone columns supporting a tiled roof. The other important mosaics of the Annex were lifted onto slabs of concrete reinforced with iron rods and relaid in their original location but left exposed, without the protection of a shelter (Daniel and McFadden 1938).

The shelter over the inscription panel provided protection for a few years until it was seen as ineffective and then removed. In 1966 two wooden bridges were constructed over the two most important floors in the Annex of Eustolios "so that visitors may move about without stepping on the mosaic floors" (*ARDAC* 1966: 7). These were the mosaic with the Christian inscription and the mosaic depicting the personification of Ktisis located in the *frigidarium* of the bath wing (Michaelides 1992: 86–87). Additional wooden bridges were constructed in 1967 (*ARDAC* 1967: 10), but they deteriorated so much that they had to be replaced in 1974 (*ARDAC* 1974: 16). In 1971 and 1974 some of the previously relaid floors were lifted again because of the corrosive effect of the iron bars (*ARDAC* 1971: 10; 1974: 16). The annual report states that these floors "were set on a new base of lime concrete" (*ARDAC* 1974: 16) (it provides no further information on the composition of the backing material used) and returned to their original position. But again they were not provided with a shelter. No further intervention in terms of protection at the Annex of Eustolios is documented until 1980, when "wooden bridges were constructed to facilitate the viewing of the mosaics and the baths" (*ARDAC* 1980: 15). The bridges were repaired in 1984 (*ARDAC* 1984: 19).

A shelter was added to the Annex to protect the mosaics in 1985, specifically over the mosaic of Ktisis (*ARDAC* 1985: 20) (fig. 1). This shelter was much larger than the one from the 1930s, as it covered most of the remains of the Annex of Eustolios. It consisted of a metal frame covered with translucent corrugated fiberglass sheets. This provided partial protection to the mosaics, most of which had been lifted and relaid on iron-reinforced "lime concrete" panels (*ARDAC* 1974: 16). An attempt was made to create a windshield by adding a skirting at the top, but this proved insufficient, as it failed to solve the major problem the site is facing: complete exposure to the strong, salty winds that come from the sea. Within a few years the shelter had become unsightly and unsafe, destroyed by the relentless sun and wind, a condition exacerbated by the lack of proper maintenance. New wooden walkways were provided for the Annex, but it is unspecified whether these were additions or replacements of the existing ones (*ARDAC* 1986: 20). Work began in 1987 on the construction of a shelter over the mosaics of the "Exedra" (southeast corner of the Annex) and was completed in 1988 (*ARDAC* 1987: 22; 1988: 23).

This shelter was replaced by a new one in 1990–91. It followed similar principles of design and construction as the previous one, but this time the metal structure was larger and roofed with corrugated iron sheets. A larger skirting was added at the top, but given the weather conditions and the lack of maintenance, this shelter deteriorated even faster than its predecessor. The metal parts oxidized severely, and drainage problems also occurred. Moreover, despite the skirting, dust and rain (carried by the wind), as well as sunlight, came into direct contact with the mosaics.

FIGURE 1 The shelter constructed over the Annex of Eustolios in 1985. Courtesy of Department of Antiquities, Nicosia, Cyprus.

In recent years the Department of Antiquities (Ministry of Communications and Works) decided that given the pressures from the tourism industry and the inadequacy and rapid deterioration of the shelter, the time was ripe for a new shelter—the fifth—over the Annex of Eustolios. The department also decided to landscape the entire site and to "protect" all its major monuments with additional shelters—a project that at the time of writing is well under way but not yet complete.

This brings us to the issue of lessons *not* learned. Apart from the lessons that should have been learned from the previous unsuccessful attempts to protect the mosaics of the Annex of Eustolios, there is also the sad story at the World Heritage Site of Nea Paphos, which provides important lessons that should have been taken into account. Looking at the history of sheltering and landscaping interventions at Paphos, one can see both positive and negative aspects. If these lessons had been taken into consideration when the master plan of Kourion was developed, major errors could have been avoided.

The Site of Paphos

One of the most important aspects of the Paphos master plan was the protection of the mosaic floors with shelters of a uniform design, some of which were going to replace the temporary shelters already on the site (Hadjisavvas 2003: 356). For this reason, some of the old "unsightly" shelters were removed, leaving the exposed mosaics to await new shelters. However, almost twenty years after the plan was drafted the new shelters have not yet been installed. The mosaics remain either exposed to the elements or protected by a series of old shelters, sometimes "temporary" ones, of different designs and variable efficiency.

What has also become evident in the case of the Paphos master plan, however, is its almost total lack of respect for the ancient structures and the way they functioned in antiquity. For example, the visitor is led to enter the Villa of Theseus, not through its original entrance on the east, which survives, but via a bridge over a ruined part of the facade and is taken directly to the spectacular mosaics that decorate the south wing—thus spoiling the logic of the architecture and the original, intended effect of a carefully planned "surprise," a constant element of Roman architecture and mentality.

This and other such issues, including the strain on the site that this landscaping has imposed, have been criticized by the uninitiated public, the local press, and, of course, many professionals, as evidenced in discussions at the 1996 ICCM meeting in Cyprus that followed the site visit and S. Hadjisavvas's presentation (2003: 357–61) and later in print (Stewart 1997).

Another failure of the Paphos project also not taken account of in the planning for the Kourion project was the fact that many of the problems of the newly landscaped archaeological park were the result of a near-total lack of maintenance. A project of such scale demands a relative increase in the number of employees to look after and maintain the new structures, as well as see to the safekeeping of the antiquities, an issue never seriously considered at Paphos.

One positive aspect of the Paphos plan was the location of the new parking lot away from the ticket office, where it had previously been located, thus removing the exhaust fumes, the noise of the air-conditioning systems, and the ice-cream vendors that had been a constant cause for complaints from people working at the site and from visitors.

Despite the lessons (both negative and positive) that should have been learned from the Paphos and the earlier Kourion experiences, nothing seems to have been taken into consideration when it came to designing the new shelters and the landscaping of the site of Kourion.

Current Shelters at Kourion

Beauty is in the eyes of the beholder, but to the eyes of the present writers, the beauty of some of the current shelters at Kourion is diminished or lost when one considers their visual impact on the site. Kourion was a beautiful site in the romantic sense of the word: well-preserved ruins in a beautiful landscape with the sea as a backdrop. Now, however, the site, both from within and from without, is marred by these shelters, which seem to have grown up like mushrooms. Those responsible seem to have been possessed by shelter mania; there are shelters everywhere, even where they were not needed, as in the case of the modern, stone-built ticket office (fig. 2).

How much thought has gone into the functionality of these structures, rather than their uniformity of appearance, is illustrated by the ticket office, the shelter of which was designed so that it covers only the back of the building. Thus the front, with its Perspex ticket windows, is left totally exposed to the strong sun during the first half of the day, making it an unbearable workplace, especially during the summer. Furthermore, this unnecessary shelter mars the wonderful view from the ancient theater across the site and down to the coast. A lack of similar functional considerations characterizes the shelter over the House of the Gladiators (fig. 3), which faces into the wind coming from the sea with what may be described as gaping jaws and draws wind, rain, and salty airborne water over the mosaics all the way to the back of the structure, from where the water has no easy escape.

FIGURE 2 The shelter over the ticket office. Photo by Demetrios Michaelides.

FIGURE 3 The shelter over the House of the Gladiators. Photo by Demetrios Michaelides.

Aside from the protective shelters, the site is now spoiled by what are described as visitor amenities. There is a proliferation of circular pavilions (fig. 4), professed to be resting and viewing points, scattered over the site, with a design alien to the character of the natural landscape. There are also several constructions that can only be described as gallows, set in sometimes very distant and isolated places, from where the adventurous visitor can admire the view over the bay of Kourion (fig. 5).

The Annex of Eustolios

The biggest part of the project is the protective shelter over the Annex of Eustolios (fig. 6). Its design is composed of a wooden arch-shaped frame consisting of heavy, curved beams topped by a membrane roof that covers an area of 30 to 35 square meters. The wooden beams are reinforced with metal bolts and connecting metal cables. The frame is secured to the ground with sixteen enormous cement blocks, whose foundations are 12 meters deep. Unfortunately, more details on the structure and its materials of construction are not yet available.

FIGURE 4 The circular pavilions. Photo by Demetrios Michaelides.

FIGURE 5 One of the site's resting points. Photo by Demetrios Michaelides.

FIGURE 6 The current shelter of the Annex of Eustolios. (Photo by X. Michael 2005)

Aesthetics

Although the shelter is not deprived of aesthetic qualities, it is very bulky and thus imposes on and dominates the landscape. From the outside, it is the sheer size and massiveness that disturbs, and on the inside it is the large and heavy wooden beams, in combination with the wooden walkways and the cement blocks of its foundations. Also, the shelter gives the impression of being too low for its size and seems to oppress the visitor—an impression accentuated during peak visiting hours and even more during the summer heat (fig. 7). There are also several unsightly incongruities, the most obvious of which is the difference in supports, which vary from the monumental for the shelter to the rudimentary for the walkways.

Conservation Effectiveness

It is too early to discuss the effectiveness of the shelter of the Annex of Eustolios in terms of the conservation of the mosaics, as it was only installed about two years ago, and no studies have been conducted to ascertain if the mosaics are faring better than before. Nevertheless, what can be stated is that this shelter, unlike its predecessors, covers the mosaic floors of the building more effectively, as it projects well beyond the edge of the mosaics. However, some pavements, for example, those near the southeast corner of the building, are partially outside the shelter, and others nearby are not well protected since that side of the shelter is open and allows wind and rain to enter.

Furthermore, this shelter is a prime example of the lack of coordination between archaeologists and architects. After one of the training courses organized by the Getty Conservation Institute, in collaboration with the Cyprus Department of Antiquities, in 1993, the latter decided to rebury a Hellenistic pebble mosaic belonging to an earlier building on this spot, which was suffering from erosion. This is one of the most important mosaics on the island, and the decision to rebury it in a scientific manner for protection—the first time ever in Cyprus—is certainly to be admired and commended. Unfortunately, it seems that it was reburied too well, as it was apparently "forgotten" by the archaeologists—and the architects. Hence, it is now left buried just outside the edge of the

FIGURE 7 The low ceilings inside the shelter seem to oppress visitors. Photo by Demetrios Michaelides.

Table 1 The main documented interventions at the Annex of Eustolios, 1935–2004

Date	History and Types of Interventions	Total Cost in CY £	Source
1935–38	A small shelter was constructed over the mosaic panel in the SE corner of the portico.	Not known	Archives of the Cyprus Department of Antiquities
1965	The mosaic pavements were repaired, but it is not known how.	Not known	*ARDAC* 1965
1966	Two wooden bridges were constructed over the Ktisis mosaic and the mosaic with the early Christian inscriptions.	527	*ARDAC* 1966
1967	Three wooden bridges were added at the Annex of Eustolios.	168	*ARDAC* 1967
1969	The mosaic floors of the baths of the Annex were repaired during November–December, and work began on the consolidation and restoration of all the floors of the area.	427	*ARDAC* 1969
1970	The floor of the baths was lifted and relaid on a new foundation and restored.	664	*ARDAC* 1970
1971	The pavement of the entrance hall was lifted and reset in its original position. Conservation began on the mosaic with inscriptions in the large room.	1,351	*ARDAC* 1971
1974	Parts of the wooden bridges were replaced due to advanced deterioration.	437	*ARDAC* 1974
	The mosaic pavement that was lifted before 1939 and reset on a concrete base was lifted again and reset on a new base of "lime concrete."	1,019	
1978	Repairs were carried out on the mosaics in the Annex, but it is not known how. The Hellenistic and Roman remains of the Acropolis were pointed and grouted; some mosaics were lifted and reset, but it is not known which ones.	3,027	*ARDAC* 1978
1979	Parts of the mosaics in the Annex were treated. Some mosaics were also treated in the Basilica and other buildings of the site.	2,966	*ARDAC* 1979
1980	Wooden bridges were constructed to facilitate the viewing of the mosaics and the baths. Mosaic sections were lifted and reset on a new foundation. Conservation work was carried out on the Basilica remains.	2,480	*ARDAC* 1980
1983	The mosaic pavement of the exedra was detached due to the corrosion of the iron bars inside the concrete. The mosaic was removed and cleaned and laid on a new bed of stones and two layers of "lime concrete." Repairs were carried out on the Basilica.	6,789	*ARDAC* 1983
1984	The wooden walkways were repaired.	2,053	*ARDAC* 1984
1985	A shed was constructed above the Ktisis mosaic in the baths, consisting of a metal frame with translucent corrugated fiberglass sheets.	5,901	*ARDAC* 1985
1986	New wooden walkways were constructed. Conservation began on the mosaics of the Nymphaeum.	1,424	*ARDAC* 1986
1987	Work was begun on a shed over the mosaics of the exedra at the Annex.	2,032	*ARDAC* 1987
1988	The shed, begun in December 1987, was finally finished.	8,600	*ARDAC* 1988
1991	A larger shelter was installed, made of a metal structure and roofed with corrugated iron sheets.	8,390	Archives of the Department of Antiquities
1995	Restoration was carried out on the mosaics of the whole site.	14,928	*ARDAC* 1995
2004	The current shelter was constructed.	Not known	

new shelter, on the edge of the precipice, condemned to lie hidden there, as uncovering it now would leave it completely exposed to the elements and lead to its rapid destruction.

Materials: Costs and Maintenance

The shelter and the pathways of the Annex of Eustolios indicate another lesson not learned in terms of conservation and maintenance: the use of materials compatible with the climatic conditions and with low-cost maintenance. The designers of the new shelter and pathways at Kourion have not taken into consideration the previous wooden pathways at the Annex of Eustolios, which deteriorated rapidly and required repeated and costly replacement (table 1). Inevitably, the new shelter and pathways at Kourion will have to withstand the same weather conditions as the previous ones and will eventually deteriorate due to humidity and climate fluctuations. Without frequent and regular maintenance, they will need to be replaced very soon once again.

Damage to the Archaeological Remains

Another disastrous effect of the shelter is the damage it has caused to the ancient remains. The deep foundations have been dug mechanically, with heavy machinery that should not have been allowed on the site, while ignoring the earlier archaeological levels lying under these late structures. When something similar happened in Paphos in the 1990s there was a public outcry, and when work began at Kourion in 2003 there were even stronger protests, to the point that some demonstrators blocked the machinery while others tied themselves to the railings of the Cyprus Museum (Department of Antiquities) in Nicosia. The authorities were not deterred, however. After a brief interruption, the excavation work continued. These foundations, while the deepest, are only the latest set dug for shelters or for the many walkways built over the years at Kourion.

FIGURE 8 The entrance for the disabled to the Annex of Eustolios. This is the entrance used by most visitors, thus turning the main entrance to the shelter—seen in the background to the right—into the exit from the Annex. Photo by Demetrios Michaelides.

Interpretation of Archaeological Remains

The arrangement of the visitor itineraries to and through the Annex of Eustolios marks two more lessons not learned from the Paphos experience: the need to present the ruins correctly within the spatial organization of the site; and the lack of understanding or the misinterpretation of how the building functioned when it was in use. Itineraries should enable the visitor to understand the role and function of the mosaics in their original context and to be able to relate the mosaics to the overall architectural structure of which they are a part. This, after all, is one of the main reasons for preserving mosaics in situ. The construction of the recent walkways ignores the original layout of the building in a number of ways, only the most serious of which are mentioned here.

One enters the site through the Information Center, which has a wooden floor and a glass southern side—materials that are not at all suitable to the dust and local climatic conditions. On exiting the Information Center, one comes across the northern side of the Annex of Eustolios and a secondary entrance to it for the disabled (fig. 8). The main entrance to the Annex is about 100 meters down the hill (seen in fig. 8 in the background behind the sign) and corresponds to the original entrance to the ancient building, but hardly any visitor (not even tourist guides) will walk this distance in the scorching sun. Thus most visitors enter the shelter through the entrance for the disabled, and the first thing they see is the mosaic of Ktisis, which should have been the highlight, reserved for later on in their visit, as was the case in antiquity. Unless they make a special detour, they cannot really appreciate the mosaic, since entering from this side means that they see the panel upside down.

The walkway near the panel of Ktisis is provided with a bench for resting and an exedra for getting a closer view of the mosaic. Both features are a good idea, but the bench is behind the exedra, and consequently those sitting on the bench see nothing but the backs of the visitors who crowd the balcony for a better view of the mosaics.

The pathways that guide visitors through the building do not pay due respect to its original organization, making it difficult to understand how the building functioned. For example, the square atrium with its rectangular pool, "the main architectural focus of the lower complex" (Rupp 1982: 133), cannot now be appreciated (or even easily recognized), since one of the main pathways cuts through it in the most incongruous way. Worst of all, the last thing visitors see when exiting the shelter is a room with the mosaic inscription "Welcome with good health to this house," which, of course, forms the original entrance to the Annex of Eustolios.

Landscaping and Relocation of the Parking Area

The positive lesson that could have been learned from the relocation of the parking area at the site of Paphos outside the archaeological area was unfortunately ignored at Kourion. Thus a new and large car park has been constructed right next to the Annex of Eustolios, which not only is incongruous but also prevents any further archaeological investigation of a large part of one of the most significant areas of the ancient city. Furthermore, the area in front of the Information Center, which is the main entrance to the site, is now designated as the parking space for coaches! The consequences of such an intervention in terms of noise, air pollution, and heat from the exhaust fumes and air-conditioning systems of the coaches seem to have been completely ignored. Instead, the convenience of the drivers and the coach-loads of visitors intent on a quick and "easy" visit seem to have been the primary concern in the landscaping of the site.

Conclusion

It is evident that all the mistakes pointed out could have been avoided if lessons had been learned from the past. Lack of money—a widely used, common excuse—cannot be blamed. Money was not lacking for either the Paphos or the Kourion project. The exact costs for Kourion have not yet been officially reported, but it appears that to date nearly 3.000.000 Cypriot pounds have been spent (at the time of writing, 1.6 Euros = 1 Cypriot pound).

Furthermore, such a huge project should have been the result of a multidisciplinary effort, involving people who have experience in what they are asked to produce. A good architect, for example, is not necessarily an architect who knows how to build shelters over archaeological remains.

Another issue that arises from this discussion is that of reversibility. Even a well-functioning shelter should not be built as a permanent construction. Just as the conservation treatments of artifacts and ruins should be retreatable, the same principle should basically hold true for the construction of a shelter.

Undoubtedly, such a large project should have been accompanied by an equally large increase in the number of staff, whose duty would be to conserve and maintain the antiquities and the shelters, as well as to guard the site. But so far there is no movement in that direction.

The involvement of the various stakeholders in the decision-making process of a site management plan is vital, but this did not happen at Kourion. Despite innumerable articles in the press and demonstrations as have never been seen before in Cyprus, the authorities decided they knew better. Clearly, the Department of Antiquities cannot bear all the blame. After all, many final decisions in large-scale, very costly projects are usually made by institutions other than those directly involved with antiquities.

One may well ask, why the criticism of the Kourion shelters after they have been built? The answer is simple. There have been protests all along, and many articles in the press, some by eminent professionals (e.g., Karageorghis 2005, 2006), criticizing the work that was being carried out on the site. But these were ignored, and the project has continued, albeit with some modifications. Even so, one remains optimistic that since the project is not yet complete some of the errors can be corrected before they become final.

In many ways, however, it is too late for Kourion. But perhaps Kourion can serve as a model to be avoided in the future. Even more important, we hope that with this criticism, some lessons will be learned and similar occurrences can be prevented at other sites, such as Amathous, another beautiful and unspoiled archaeological site, which is next in line for landscaping and roofing in the service of tourism once the Kourion project is completed.

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Une nouvelle approche pour la préservation *in situ* des mosaïques et vestiges archéologiques au Liban : La crypte de l'église Saint-Georges à Beyrouth

Isabelle Skaf et Yasmine Makaroun Bou Assaf

Résumé : *Entre 1994 et 2001, la restauration de la Cathédrale Saint Georges des Grecs orthodoxes de Beyrouth a permis des fouilles menées par le Musée de l'Université américaine de Beyrouth. Une surface de 250 m² sera ouverte au public sous un plancher en béton armé percé d'une paroi vitrée. Cette approche innovante pour le Liban a été le fruit d'une longue concertation. La crypte, accessible par l'extérieur, est un espace confiné sous contrôle climatique complet. Nous présentons les difficultés de conservation des mosaïques et des structures ainsi que les conditions de présentation des mosaïques. Un projet de mise en valeur des vestiges est en cours de réalisation.*

Abstract: *Between 1994 and 2001 the restoration of the Greek Orthodox Saint George's Cathedral provided the opportunity for excavations carried out by the American University of Beirut museum. A surface area of 250 square meters will be opened to the public under a reinforced concrete floor with a glass floor section. This innovative approach for Lebanon was the result of long consultations. The crypt, accessible from outside, is a confined space with permanent climate control. This paper discusses the difficulties with respect to the conservation of mosaics and structures as well as the presentation of mosaics. A presentation and interpretation project for the remains is in progress.*

Dans le cadre de la reconstruction du centre-ville de Beyrouth[1], l'évêché grec orthodoxe a entrepris en 1994 un long processus de restauration de la cathédrale Saint-Georges, située dans le quartier des églises[2], en bordure de la place des Étoiles.

Des recherches pluridisciplinaires

Dans une perspective globale de connaissance du monument et de son contexte, des recherches pluridisciplinaires ont été menées :

- à travers les sources historiques (Davie 1998) et les archives de l'évêché[3] car : « la cathédrale Saint-Georges est le dernier vestige d'un ensemble urbain complet, le centre épiscopal de la communauté grecque orthodoxe de Beyrouth, dont l'origine remonte à la période mamelouke, au moins ».

- à travers une lecture détaillée des phases chronologiques de l'évolution du monument conduite sur les structures du bâti[4] : cette approche a permis de dégager au moins quatre phases constructives du XVIII^e^ à la fin du XIX^e^ siècle.

- par le biais de fouilles archéologiques.

Les fouilles archéologiques[5]

Le projet a débuté par une étape incontournable de dégagements des déblais. Les fouilles en cours dans le secteur immédiat de la cathédrale auguraient des résultats prometteurs, confirmés par les premiers sondages intérieurs réalisés dans la nef centrale. Ces derniers ont livrés des indices qui témoignent de l'occupation ininterrompue du site et des origines anciennes de la cathédrale. Six niveaux d'occupation ont pu être identifiés (fig. 1). Les niveaux les plus anciens remontent à la période hellénistique (entre le III^{e} et le I^{er} siècle av. J.-C.) et se limitent dans un sondage étroit à quelques murs, des canalisations et du matériel (anses rhodiennes estampillées, lampes, anses figurées de braseros) ; la période romano-byzantine (entre le I^{er} et le VI^{e} siècle apr. J.-C.) est largement représentée, surtout par un tronçon du *cardo maximus*, des mosaïques variées, des bases de colonnes, un collecteur d'égout.

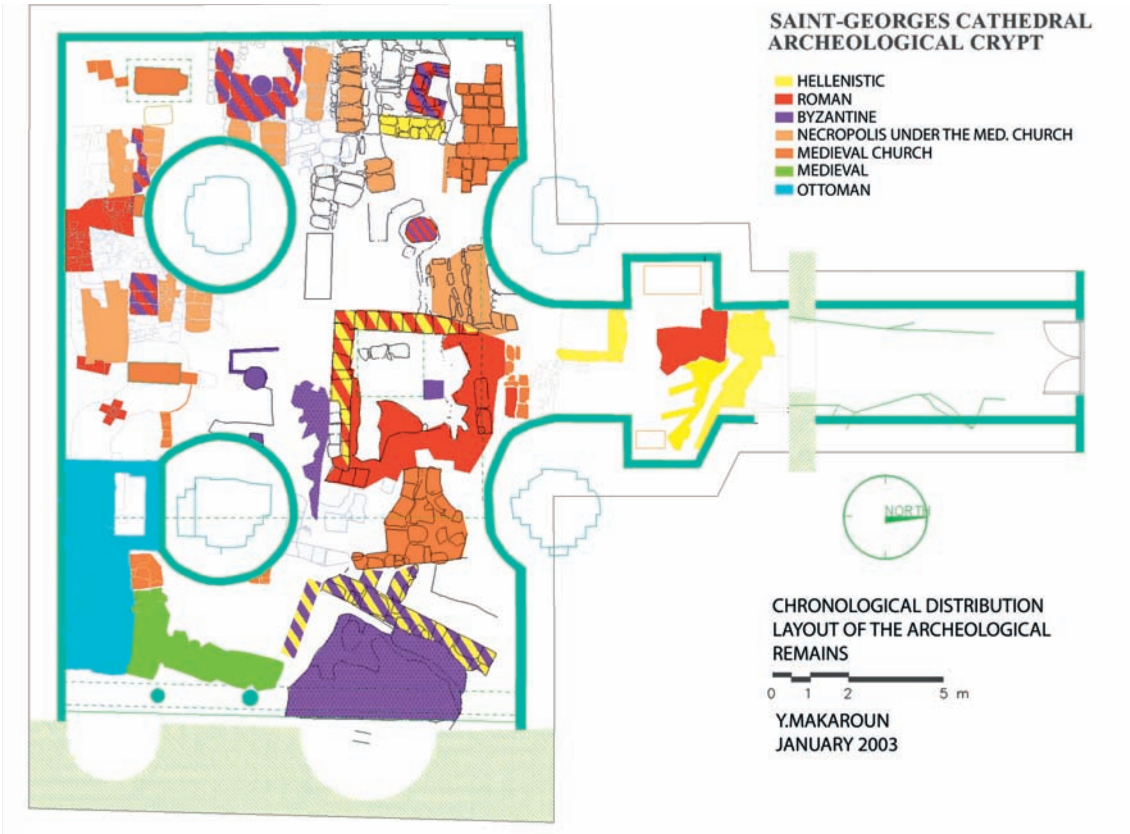

FIGURE 1 Plan des vestiges archéologiques. Reproduit avec la permission de Yasmine Macaroun Bou Assaf.

Les vestiges imposants d'une église marquent l'époque médiévale : piliers enduits peints, dallage en pierre, abside, couvrent une première nécropole. Cette dernière a livré plus de 20 tombes contenant un matériel de qualité (casque en bronze, flèches, croix).

A la période mamelouke, un cimetière se développe autour de l'église, avant sa destruction par un tremblement de terre, en 1759.

Des caveaux funéraires sont construits à la période ottomane contre les vestiges de l'église médiévale. En 1764, la communauté orthodoxe décide de démolir l'ancienne église pour en construire une plus grande, elle-même détruite et reconstruite après maintes transformations. Cette superposition continue d'églises devient le trait marquant du site.

Au regard de ces découvertes agrémentées par un matériel de qualité, le Comité de restauration de la cathédrale a été confronté à la question de la poursuite des fouilles face aux demandes pressantes de réhabilitation du monument au culte. Un délai de réflexion a été nécessaire avant que le Comité ne décide de la poursuite des travaux de fouilles.

Ces derniers étaient conditionnés par des mesures de confortations préliminaires des structures portantes. En effet, un agrandissement inconsidéré des sondages risquait de mettre en péril la stabilité de l'édifice. Des études géotechniques, étayées par des carottages, préconisaient la mise en place de micro-pieux[6].

Dans le cas similaire de réalisation de fouilles archéologiques sous la cathédrale Saint-Pierre de Genève, le prolongement des fondations par des micro-pieux a permis la confortation des structures instables et la possibilité de réaliser des fouilles extensives avant les travaux de restructuration du plancher. Malgré de nombreuses similitudes, le cas de la cathédrale Saint-Georges des Orthodoxes de Beyrouth, présentait des conditions différentes : des contraintes budgétaires et surtout de délais relatifs à la reprise des travaux de restauration ont conduit le Comité à renoncer à fouiller l'ensemble du monument et à se restreindre à la moitié de la surface.

Un projet d'extension des annexes de la cathédrale (salons, services, locaux techniques et autres) a conduit à la fouille du parvis nord, ce qui a permis de découvrir les vestiges d'un quartier hellénistique et d'imposants éléments de l'urbanisme romain, dont un tronçon du *cardo maximus*. Les éléments majeurs du stylobate et deux bases moulurées ont été réintégrés dans le plancher du salon de la paroisse (fig. 2).

FIGURE 2 Insertion des éléments du *cardo-maximus* dans le plancher du salon. Photo I. Skaf.

Le projet de crypte archéologique

Ce projet a vu le jour progressivement, à la lumière des résultats obtenus et de l'ancrage historique qu'ils fournissaient au monument. Cette opportunité unique de présenter ces vestiges *in situ* au public s'est cristallisée dans un concept de plancher-dalle isolant le sous-sol archéologique du lieu de culte. Des travaux préalables de consolidation et de protection des vestiges n'ont pas permis d'enrayer tous les risques de dégradations engendrés par les travaux des structures[7].

Ce nouvel espace confiné a pu être mis en relation visuelle et verticale ponctuelle avec le public à l'aide d'une plaque vitrée, aménagée dans l'axe de la nef centrale.

L'accès de la crypte est limité à une cage d'escalier indépendante et externe, accessible du parvis qui mène par un sas à une brèche percée dans les fondations du monument. Un parcours, prévu pour un public réduit, guidera le visiteur dans les 250 m² de la crypte, le long des vestiges et des vitrines, après une première introduction à l'histoire du monument.

Les problèmes de contrôle climatique

L'atmosphère est régulée par des moyens artificiels et des contrôles réguliers. La relative stabilité hygrothermique des lieux passe par une complète dépendance à un système d'air conditionné – une rupture de cet équilibre s'ajoutant à des paramètres extérieurs pouvant augmenter l'humidité ambiante.

Sans climatisation et sans apport d'air frais, l'humidité relative dans la crypte peut atteindre les 90 % en été, avec des températures atteignant 25 à 30°. À la suite de pannes d'électricité ou d'erreurs de manipulation du système de climatisation (commun avec la cathédrale) nous avons eu à traiter à plusieurs reprises la prolifération de micro-organismes, notamment de champignons (*aspergillus*) et de bactéries. De plus, les bouches d'aération étant mal réparties, certaines parties de la crypte sont plus ventilées que d'autres, d'où un développement plus important de micro-organismes dans les parties les moins aérées.

Le traitement a été effectué par une société spécialisée dans le traitement de plantations agricoles, à l'aide de deux produits Bayer – *Flint 50 WG* (2,5 g / 20 litres d'eau) et *Hygienist CD601* (1 % dans de l'eau) appliqués avec un atomiseur automatique et par aspersion directe à l'aide de pompes manuelles selon les recommandations de la société Bayer. Ces produits avaient été testés avant leur utilisation par application directe sur des fragments de pierre calcaire provenant du site.

Les mosaïques

Des pavements de mosaïques ont été découverts lors des fouilles du parvis nord et déposés dans le but d'une réintégration future dans les annexes de la cathédrale. D'autres pavements ont été mis au jour lors des fouilles à l'intérieur de l'église et ont pu être préservés *in situ* dans le périmètre actuel de la crypte.

Deux pavements à motifs géométriques (fig. 3) sont superposés et situés contre le mur Est de la crypte. La mosaïque supérieure d'une surface d'environ 5 m² se compose d'un motif d'écailles oblongues adjacentes monochromes avec apex chargé d'un bouton de rose (Balmelle et al. 2002 : 340). Le second niveau, qui n'est que très partiellement visible, présente un motif linéaire de méandres de svastikas.

Le pavement supérieur présente des problèmes de conservation principalement liés à l'humidité. Le parvis Est à l'extérieur de la crypte n'est pas dallé et un drainage insuffisant favorise les infiltrations d'eau de pluie. Le mur accolé à

FIGURE 3 Mosaïque à double niveau (Est). Photo I. Skaf.

FIGURE 4 Mosaïque centrale. Photo I. Skaf.

la mosaïque en sous-sol absorbe et emmagasine ainsi beaucoup d'humidité, ce qui favorise le développement de micro-organismes, surtout au point de contact entre le mur et les tesselles ainsi que dans les parties lacunaires du pavement. La bordure qui longe la berme archéologique est très fragile et sa consolidation devra se faire en fonction du traitement de la berme. Dans l'ensemble, la cohésion des tesselles est bonne et le mortier est en bon état.

La mosaïque centrale (fig. 4), d'une surface d'environ 3 m², présente une composition linéaire formée de bandes monochromes et gemmées, d'une tresse et d'un motif de rinceau de lierre. Elle est plus fragile que les pavements précédents car le mortier de base est endommagé et certaines tesselles sont disloquées.

La surface des deux mosaïques est recouverte d'une fine couche de concrétions calcaires. Le développement de micro-organismes et les traitements de désinfection ont été suivis d'opérations de nettoyage répétées avec scalpels, brosses, éponges et un aspirateur.

Les travaux de consolidation de certaines structures en maçonnerie et des bordures des pavements fragilisées par la fouille sont en cours à l'aide d'enduits de chaux. La suite des interventions consistera en une consolidation des substrats et des tesselles avec des mortiers de chaux hydraulique. Le traitement des lacunes ainsi que la poursuite du nettoyage de surface des pavements se poursuivront une fois que le climat de la crypte sera stabilisé.

Impact des mosaïques de la crypte

Il est intéressant de constater que les mosaïques découvertes lors de la fouille archéologique ont eu un certain impact sur la réhabilitation de la cathédrale puisque les motifs de rinceau de lierre et de bandes gemmées de la mosaïque centrale

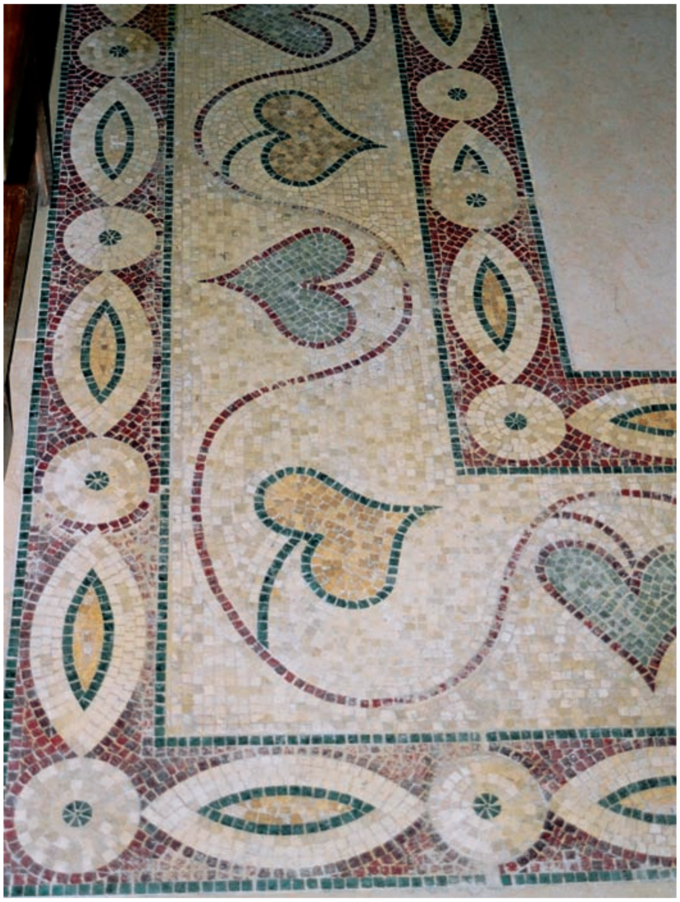

FIGURE 5 Exemple de reproduction du motif de la mosaïque centrale dans les revêtements de sol modernes. Photo I. Skaf.

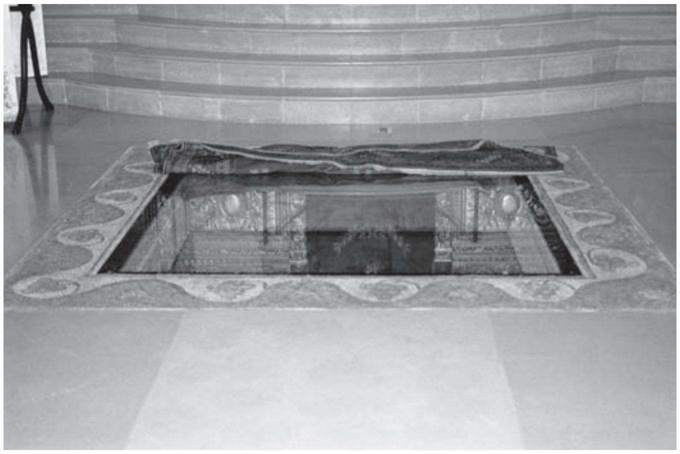

FIGURE 6 Relation verticale crypte/cathédrale. Photo I. Skaf.

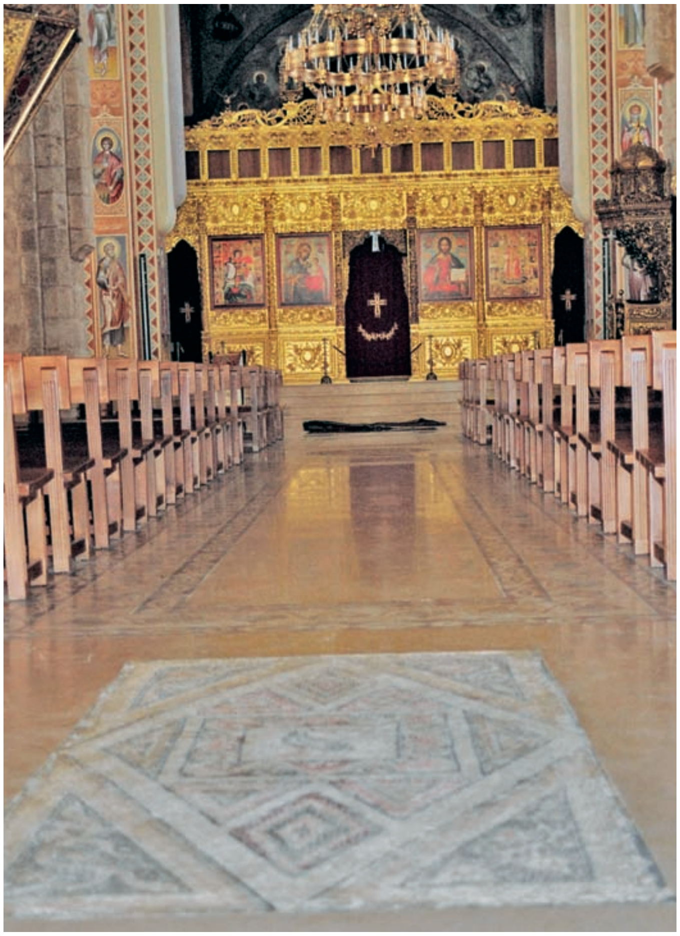

FIGURE 7 Une des nouvelles mosaïques acquises sur le marché des antiquités, placée à l'entrée de l'église. Photo I. Skaf.

ont été reproduits dans les revêtements de sol modernes (fig. 5). Cette mosaïque est également visible à travers la plaque vitrée dans l'axe de la nef centrale (fig. 6) de la cathédrale et constitue (avec les vestiges archéologiques qui l'entourent) une attraction pour les visiteurs alors que la crypte est encore fermée au public.

De plus, cinq nouveaux pavements remontés sur dalle de ciment – acquis sur le marché des antiquités et offerts à la paroisse par un mécène – ont été intégrés dans le sol des allées principales de la cathédrale afin de décorer l'édifice et d'attirer un nombre plus important de visiteurs lors des tours archéologiques du centre-ville de Beyrouth (fig. 7).

Il est regrettable qu'aucune mesure ne soit prise pour protéger ces pavements piétinés chaque jour par de nombreux fidèles et visiteurs lors des offices religieux et des visites touristiques, alors qu'un budget important est déjà engagé pour

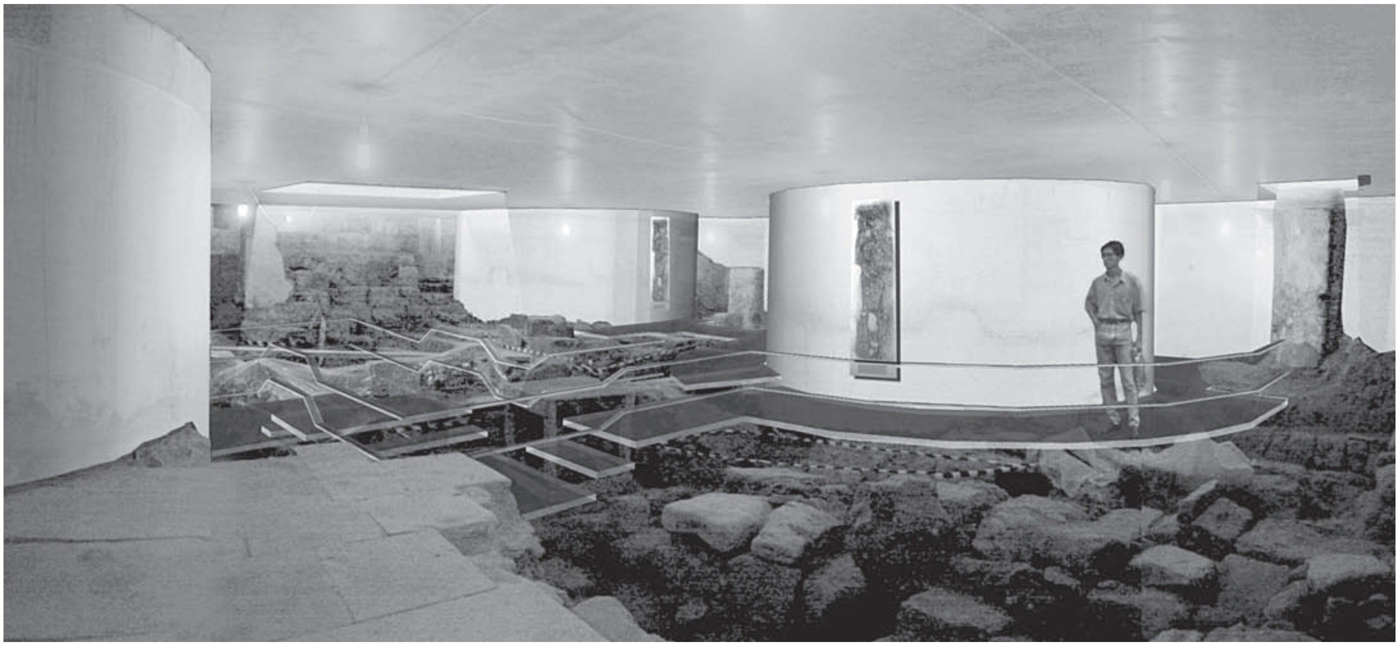

FIGURE 8 Perspective du projet de crypte. Reproduit avec la permission de Yasmine Macaroun Bou Assaf.

la conservation des mosaïques et autres vestiges archéologiques situés dans le sous-sol de cette même cathédrale.

Contrairement à d'autres projets de fouilles dans le centre-ville de Beyrouth qui ont vu des centaines de mètres carrés de pavements déposés et stockés sans lendemain, la volonté dans ce projet, unique au Liban, consiste clairement à préserver les vestiges de la crypte archéologique *in situ* et à les présenter au public (fig. 8).

Certains obstacles financiers et techniques persistent, notamment au niveau du contrôle climatique de la crypte. Il faudra résoudre ces problèmes avant de pouvoir passer à une mise en valeur et à l'ouverture de la crypte au public.

Notes

1 Après les longues années de guerre civile au Liban.

2 Trois églises parmi les plus anciennes de Beyrouth partagent ce secteur : Saint-Georges des Orthodoxes, Saint-Élie des Grecs catholiques et Saint-Georges des Maronites.

3 Slim Souad, Université de Balamand.

4 Dr Samir Rubeiz, Dr Yasmine Makaroun Bou-Assaf, Antoine Fishfish : études historiques du monument non publiées.

5 Dr Leila Badre, Université américaine de Beyrouth : « Rapport préliminaire ». Voir www.stgeorgebeirut.org

6 Certains micro-pieux ont atteint une profondeur de plus de 8 m.

7 Coulures de laitance de béton et déstabilisation de certaines structures.

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140 Years of Mosaic Conservation at Chedworth Roman Villa, United Kingdom

Philip Bethell

Abstract: *Chedworth Roman Villa is one of the most important Roman sites on public display in the United Kingdom. Many features survive, including fragments of at least thirteen mosaic pavements. The treatments that mosaics have undergone since their original excavation in 1864 represent the checkered history of mosaic conservation practice. The site presents the opportunity to examine the treatment of mosaics over a period of 140 years and should be useful for planning future conservation elsewhere. A comprehensive development plan is in progress that we hope will lead to new site shelters with greatly improved conservation performance, ensuring the safety of the mosaics for the next 140 years.*

Résumé : *La villa romaine de Chedworth est un des sites romains majeurs ouverts au public au Royaume-Uni. Plusieurs vestiges ont survécu, y compris des fragments d'au moins treize pavements en mosaïques. Fouillé pour la première fois en 1864, par le traitement de ses mosaïques depuis lors, il illustre l'histoire de la pratique de la conservation des mosaïques. Du fait que ce site permet d'étudier le traitement des mosaïques sur une période de 140 ans, il constitue une référence pour tout projet de conservation à l'avenir. L'élaboration d'un plan global de mise en valeur est en cours qui devrait aboutir à de nouveaux abris présentant des performances améliorées en matière de conservation, assurant ainsi la protection des mosaïques pour encore 140 ans.*

Chedworth Roman Villa is one of the most important Roman sites on public display in the United Kingdom (fig. 1). It has been open to the public for more than 140 years, and more than three million people have visited it. Current visitor levels are at 55,000 to 60,000 per year, surpassed by those of only one other Roman-period domestic site in the United Kingdom. Chedworth is the only Roman villa site open to the public that is owned by the National Trust. Although not to be compared with some of the astonishing treasures of the Mediterranean provinces of Rome, in the British context Chedworth is of the highest significance. Many features of the villa survive, including fragments of at least thirteen mosaic pavements in situ. Other elements, such as 2 kilometers of walls, two bathhouses, several hypocaust systems of varying types, at least one triclinium (dining room), and a water shrine with a running spring, provide evidence of a luxurious fourth-century house. With its long history of preservation and display, it presents an unusual opportunity to study a site where mosaic treatments have been carried out over many years. The conservation activities that began in the 1860s represent a checkered history of mosaic preservation and reflect changes in conservation philosophy and practice over time.

Discovery

The villa was originally excavated in 1864, but no primary records exist of that initial activity. Apart from one short published report (Farrer 1866), the excavators have left us nothing except the exposed ruins. Much later there is a newspaper interview (*Gloucestershire Echo* 1930) with Frederick Norman, who worked on the excavation when he was a boy. According to Norman, the triclinium mosaic was almost complete when first uncovered, but much of it disintegrated on being exposed. He described how thousands of visitors came to the site to marvel at the new discovery and had to be stopped from poking at the mosaics with their umbrellas and sticks. Crucially, none of the mosaics were lifted—the most common practice at the time. A number of other descriptions of the villa were pub-

FIGURE 1 Aerial view of the Chedworth Roman Villa site. The extent of the ruins, the nineteenth-century house, and the site shelters are clearly visible.

lished in the nineteenth century (Scarth 1869; Marshall 1887), but the exact extent of the original investigations remains unknown. One can conclude from modern excavation that the early diggers exposed the walls of the villa and cleared the interiors of the rooms and corridors. They stopped at the fourth century C.E. levels, whether or not there was a mosaic pavement present. Although it is possible to extrapolate the physical intervention carried out on-site, there is no written record of the conservation philosophy behind the initial decision to protect and preserve the site, a decision that was extremely significant for its modern history.

However, it is possible to say something about the social background that prompted the discovery and subsequent display of the villa. Interest in the Roman period at that time was a product of the educational system of the British aristocracy in the nineteenth century. The teaching of classics, including Latin and Greek texts, made Victorian gentlemen well versed in descriptions of life in the luxurious ancient villas of Italy. The discovery of something so "Roman" as a mosaic supported their belief that Roman gentlemen—in their eyes, the direct equivalent of the nineteenth-century British gentleman—had arrived with the invading army and built fine residences in order to rule wisely and civilize the barbarian inhabitants. The aristocracy saw many parallels between the British and Roman empires and between the role of the Roman elite and their own role as the cultural and political elite. Thus to some extent the Roman villa reflected and legitimized their position, as it was the direct forerunner of their own large country houses (Roach Smith 1865; Baddeley 1924)

Conservation History

The owner of the site, Lord Eldon, was determined to present his discovery to the world. Shelters were built over some of the surviving mosaics on-site (fig. 2); other fragments were reburied. The room interiors left unsheltered were covered in earth and allowed to grass over, and the surviving walls were leveled and capped using original stone from the building's collapse. A dedicated site museum was also built, and a house for a resident custodian was added soon after the initial excavation. It is clear that a plan to preserve and display the villa was made from the outset, but what can never be known is the thinking behind the selective reburial of the mosaics. Why were some left exposed and others not? The reasons could vary from the condition of the mosaics (only the least fragile were left uncovered?) to aesthetic considerations (only the most interesting/beautiful were not reburied?) to economic constraints (too costly to shelter and display the whole site?).

FIGURE 2 Late-nineteenth- or early-twentieth-century postcard showing the original site shelters and the wall capping using Roman roof tiles.

FIGURE 3 Early-twentieth-century postcard of the interior of the west bathhouse shelter. The wood-burning stove used for protection from winter frost can be seen to the right.

The site shelters, which still stand today, were essentially contemporary agricultural buildings, of timber frame and stone tile roof construction. The fourth-century masonry was consolidated and repointed with a hard lime mortar to provide a stable base for the shelter superstructure. This major intervention into the historic fabric that compromised the archaeological integrity of the surviving walls is perhaps not something that would be done today. It does, however, bring into focus the fact that one cannot construct shelter buildings without having some impact on the intact archaeology of a site. The decision to construct a shelter always involves some form of balance, with the aim currently being minimal disturbance of in situ archaeology. The nineteenth-century "conservators" did not worry about this too much but concentrated on creating a strong and durable structure to protect what they saw as the real archaeology: the mosaic pavements. It can be said that their work was very good in many ways, in particular, in terms of conservation, as it has preserved the remains that we can still see today, although much of the aboveground masonry has been altered since excavation (Cotswold Archaeology 2005). The three surviving shelters from the 1860s cover the triclinium, the bathhouse in the west range, and part of the north bathhouse (originally interpreted as a *fullonica*) (Fox 1905) (fig. 3).

Early conservation measures inside the newly constructed shelters included the use of wood-burning stoves to prevent frost. Lacunae in the mosaics were filled with a hard cement alone, without using tesserae to attempt to reconstruct patterns, despite their availability. The major changes to the site in the late nineteenth and early twentieth century were the landscaping and planting of the gardens around the villa. The consolidation work done during the 1860s was repaired and renewed, but little else changed. The site was in private ownership until 1924, and there was no consistent management plan. Early photographs show the site sometimes overgrown with trees and weeds, sometimes carefully trimmed and mown, and at various stages in between. There were very few visitors initially, and access to the sheltered mosaics was simply through the doors. Although there were windows in the shelter buildings, they were not opened regularly, so one can suppose that the shelters functioned reasonably well to protect the mosaics by ensuring relatively stable temperatures and humidity.

In 1924 the site came into the ownership of a conservation charity, the National Trust (Waterson 1995), and was marketed and brought to the attention of a wider public from that date. The National Trust had little in the way of resources, and certainly no expertise in the conservation of Roman mosaics at that time.

For the next forty to fifty years the routine maintenance of the mosaics on display consisted primarily of dry-brushing and mopping with spring water (Irvine 2001). A trial cleaning of the triclinium mosaic with diesel fuel sometime in the 1950s was not repeated, though it "gave the mosaic a lovely shine" (Irvine 2001). There was nothing that one would regard today as systematic conservation, but the constant attention paid by the very conscientious resident caretaker was most valuable. His conservation activities were both reactive and preventive. He ensured that the walls and roofs were repaired and that any problems were reported to specialist curators. The value of untrained but sensitive and intelligent caretakers in preserving many archaeological features should not be underestimated. However, this low-level preventive and reactive conservation work was not systematically recorded, so we do not know exactly what regimes were employed for cleaning and repair work until relatively modern times.

In the 1950s and 1960s new archaeological investigations showed the presence of several phases of building during the Roman period (Rutter 1957; Richmond 1959, 1965; Goodburn 1979). The north bathhouse was fully excavated and an additional shelter constructed over its western end, with some small fragments of mosaic preserved in situ. There was still, however, no systematic recording or analysis of the mosaics. As a result it is remarkable that the mosaics have not suffered more deterioration. Some pavements were vulnerable to visitor traffic, but fortunately the visitor levels were relatively low until the 1960s and the diffusion of private automobiles. Since the mid-1960s visitors have averaged 63,000 per year (Bethell 2005).

The conservation methods employed for the first one hundred years of the villa's life as a public monument can be summarized as follows:

- an initial investment in durable, functional shelters;
- repair of lacunae and resetting of loose tesserae;
- irregular mechanical cleaning;
- selective reburial with no subsequent monitoring; and
- limited excavation and new shelter construction (in the 1960s).

The numerous developments in the theory and practice of conservation since the late 1960s has led to more varied treatments and interventions on the mosaics at Chedworth. It was during the late 1960s that the current overhead electric heating system, controlled thermostatically, replaced the wood-burning stoves (Irvine 2001). It was installed specifically to eliminate dewpoint events and freezing episodes on the mosaic surfaces. In the 1970s and 1980s an archaeologist was employed at the site who began some recording of the mosaics. This included nonrectified vertical photography to make a base record but was not accompanied by systematic monitoring, so its only value today is as a point-in-time reference. As the nineteenth-century shelters aged, some damage to the mosaic floors was noted both from faults in the buildings themselves and from erosion due to increasing visitation. Mitigation strategies were put in place to reduce the effects of visitor traffic on the pavements. Direct public access to the triclinium was stopped, and an external walkway was built. This required replacing the fixed windows in the side of the historic structure with windows that can be opened. The largest lacuna was excavated, revealing the fine, channeled hypocaust below (fig. 4). This also helped to ventilate the mosaic, as it allowed moisture to escape. It also revealed more of the floor's substructure, showing the silted-up hypocaust channels and providing better understanding of the whole structure. Some protective cloth scrim was glued with PVA along the face of the mosaic and mortar support laid along its collapsing edges. At some point water ingress to the shelter building and the action of frost began to damage the northern ends of the triclinium mosaic, and several sections were lifted, pending discussions on their re-laying (Irvine 2001).

A metal frame was erected in the west bathhouse to prevent visitors from stepping directly on the sensitive section of the *frigidarium* floor, and access was restricted to the *apodyterium* because the floor had begun to collapse. There has never been public access inside the new north bathhouse shelter, but it was built with clear glazing on all four sides to allow viewing from the outside (Irvine 2001).

Around 1980 the *apodyterium* mosaic of the west bathhouse was lifted and the hypocaust excavated and rebuilt. The floor was relaid on a hard cement base with a damp-proof plastic membrane. While this arrested the collapse of the pavement, it has had the effect of making the floor look very artificial. It is completely flat, and the colors of the tesserae are dull as there is no capillary moisture in them. The treatment does prevent salt efflorescence and algal growth, however, and therefore has both advantages and disadvantages. This mosaic happens to have the most complex history of ancient repair and re-laying of all those on the site, and it is feared that such archaeological subtleties can be lost as a result of such a drastic intervention (Irvine 2001; Chedworth Site Records n.d.).

In the 1980s limited investigation was initiated to establish the full extent of mosaics still buried on-site. Those in the west wing, between the triclinium and the bathhouse, were exposed and recorded photographically. However, recording was not done in a systematic way, so again it is useful now only as a snapshot in time. The photographs remain the most useful records from this investigation due to the lack of condition recording using modern systems (Chedworth Site Records n.d.).

Further work was carried out in the triclinium, with much discussion on the correct methodology to be used in the re-laying of the pavement fragments that had been lifted for safekeeping around 1980. The debate was a reflection of what was (and is still) going on in the wider world of mosaic conservation regarding the aesthetics of presentation, the need to preserve original bedding material, and so on. Before any re-laying was carried out, a French drain was dug across the back of the building to reduce the flow of water downslope

FIGURE 4 Excavation of the major lacuna in the triclinium mosaic, ca. 1980. The metal barriers were removed and visitor access to the triclinium halted from this date.

into the ground below the hypocaust and consequently into the mosaic through capillary rise (fig. 5). Different re-laying methods were tried, and one small area was treated, like the *apodyterium,* with an impermeable plastic membrane and cement base. Another area was relaid on lime mortar, resulting in a flat surface. Experiments were also carried out to try to reintroduce lime into the leached Roman mortar by dripping a lime solution into the in situ beds, but this has proven largely unsuccessful.

It was only in the early 1990s that the removed sections of the triclinium mosaic were relaid. In the end a decision was made to preserve as much of the surviving fourth-century mortar substrate as possible and to rebuild the mortar beds with materials matching the original. The surface contours were re-created as close as possible to those recorded at the time of lifting, the idea being to blend the appearance of the relaid area with the surviving in situ historic ruin.

FIGURE 5 Re-laying of part of the triclinium mosaic in the early 1990s. As much of the original mortar as possible was retained, and the new mortars were based on particle-size analysis of the Roman material. Photo by Philip Bethell.

Recent Conservation Activities

In the early 1990s a change in management resulted in the appointment of a single manager to control all aspects of the site's management, including conservation, finance, visitor services, and education (National Trust 1993). The desire to redevelop the site was also stated at that time, and long-term plans to create new shelter buildings and display more of the historic features of the villa began to take shape. This required a program of investigation and survey, which continues today.

An early survey undertaken as part of this program was a radar survey of the type used by structural engineers. This enabled the hypocaust tunnels to be mapped, and it also identified areas where adhesion to the mortar substrate was poor. In addition, cracks and other damage to the large flat hypocaust capping stones were recorded. This was very useful evidence for laying down a stricter access regime for the mosaic to carry out periodic cleaning of the surface. Now that the structural delicacy had been revealed by radar it was possible to map those areas of the mosaic that should not have any load placed on them and also to specify the use of foam pads and matching wooden boards to spread the load when cleaning or carrying out conservation of the mosaic (GB Geotechnics 1994).

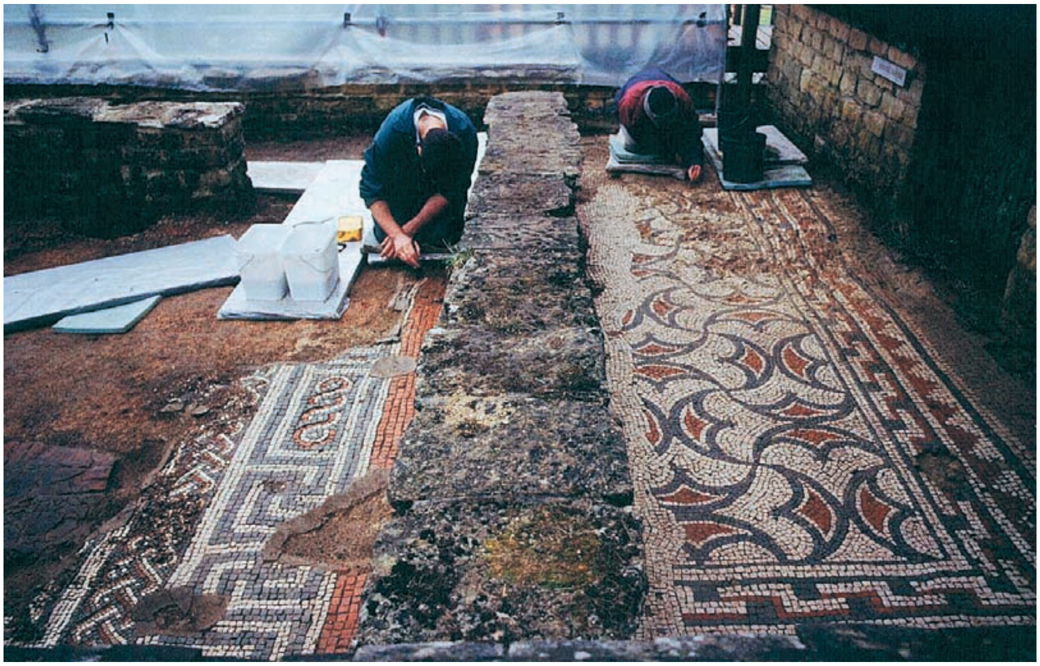

FIGURE 6 Uncovering of mosaics reburied after the 1864 excavation during a sitewide survey in 2000. These mosaics and others were recorded and reburied. Photo by Philip Bethell.

FIGURE 7 Mosaic in the west bathhouse, with subsurface moisture-temperature probe and ambient RH-temperature probes in place. These are part of the continuing environmental monitoring system, using remote radio signaling equipment to transmit data to a logger. Photo by Philip Bethell.

Other surveys have been conducted in recent years. The most exciting, perhaps, was the Buried Mosaic Survey in 2000 (Cotswold Archaeological Trust 2000). This involved test excavations all over the villa to ascertain the full extent of any surviving in situ mosaics (fig. 6). Although there were records of the 1980s intervention, these were not complete, and the intervention was not extensive. Therefore, it was necessary to uncover the three fragmentary floors in the west wing. What was surprising was the presence of an intact pavement with geometric designs under the portico of the west wing, just 5 centimeters below the feet of thousands of visitors. This mosaic was exposed in three small sample areas and found to be intact but in poor condition, as most of the interstitial mortar had disappeared and the bedding mortar was decayed (Stewart 1997).

Other small fragments of mosaic were found in the rooms and corridors of the villa, indicating that it had originally been far more opulent than was previously thought. What is important is that the location, as well as the current condition, of all the surviving mosaics is now known, and plans for their systematic monitoring and long-term conservation can be developed and implemented.

One major project that has been undertaken as part of improving the understanding of the optimum conditions needed for the mosaics and the conservation performance of the shelters is the wireless environmental monitoring program. This ongoing project (Stewart 2004) was instigated in 1997 and uses a number of probes to measure surface temperature, ambient temperature, relative humidity, and even the fabric moisture content inside the various shelter buildings. The readings are relayed via radio signal to a logger and compared with the ambient readings (fig 7). In this way the varying performances of the different shelters can be compared and the effects of introducing changes to the heating and insulation regimes monitored. For example, an analysis of the data from the triclinium led to the decision to switch the heating system to humidistatic control. This has resulted in a marked reduction in condensation on the mosaic surface, almost eliminating surface algal growth. However, this system has created a problem with increased salt efflorescence, as there is more evaporation of capillary moisture from the mosaic surface (Ahmon 2005). Clearly there needs to be a subtler control and heating system.

In addition to the above interventions, there has been a photogrammetric survey of all the exposed mosaics that provides an excellent base record for comparison in the future (Chedworth Site Records n.d.). A comprehensive investigation of the biological growth associated with the Chedworth mosaics has also been undertaken (Wakefield 2001). In 2004 a base record of the entire exposed historic fabric was completed, enabling a fuller understanding of the context in which the mosaics are located (Cotswold Archaeology 2005). Study of the wider site environment has included a hydrological survey (Hunting Technical Services 1999).

The emphasis in recent years has been to develop a better understanding of the mosaics by surveying and recording their condition, their archaeological context, and their environment. It is clear that remarkably little active intervention has taken place, in the sense of lifting or repairs since the site was excavated, and this adds both to the value of the mosaics and to their conservation problems. In order to widen the involvement of partners in planning the future of the mosaics, a collaborative agreement with University College London's Institute of Archaeology currently enables archaeological conservation students to carry out thorough cleaning and condition recording of the mosaics during an annual fieldwork session. In addition, a new post is being created to provide a permanent conservation assistant on-site so that regular surface cleaning and condition monitoring can be carried out throughout the year. However, the dangers of spending too much time debating what to do while the ancient remains gradually decline are clear.

Conservation work currently under way and carried out in the past five years consists of the following:

- maintenance of historic shelters (including quinquennial structural survey, roof replacement, timber repairs, painting of exterior with wood preserver) (fig. 8);
- monitoring the internal environment of historic shelters and modifications to improve it;
- regular mechanical cleaning, with a defined protocol (including precleaning salt and algae survey, use of deionized water with separate buckets for salt-containing rinse water, use of foam padding to avoid pressure, supervision by a qualified conservator);
- monitoring of reburied mosaics via selective reexcavation and recording and surface temperature monitoring with buried sensors;
- excavation to understand the full extent of surviving archaeology and the hydrology of the site;
- base record production and regular monitoring of exposed historic fabric; and
- long-term conservation planning based on the best practice to date.

FIGURE 8 The triclinium shelter today. The original roof has been repaired and insulated and the timber cleaned and treated, but otherwise the structure is essentially as it was built in the nineteenth century. Photo by Philip Bethell.

Many of the findings from the recent investigations have been summarized in a Conservation Plan (Bethell 2005), which has helped to direct subsequent management of the site. A comprehensive development plan is being worked on. It is hoped that this plan will lead to new site shelters with greatly improved conservation performance, ensuring the preservation of the mosaics for the next 140 years. The much-improved knowledge of the entire site will ensure that the mosaics are not only better conserved but also displayed and understood in the context of the Roman house in which they still sit after nearly seventeen hundred years.

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Discussion—Session 5: Sheltering Mosaics

Présidente/Chair: Évelyne Chantriaux

Discussion following John Stewart, Jacques Neguer, and Sibylla Tringham Presentations

GAËL DE GUICHEN: C'est un commentaire général sur les trois communications. Je crois qu'on ne devrait pas faire une session sur l'évaluation des abris, ce que l'on devrait faire c'est l'évaluation des mosaïques qui sont sous abri. Parce que finalement on est en train de se dire, on a un bel abri, on n'a pas un bel abri, il s'intègre, il ne s'intègre pas, il protège ou il ne protège pas, mais on n'est pas en train de dire ce qui est en train de se passer en-dessous et ça, c'est beaucoup plus difficile. Les deux premières interventions ont parlé de la mosaïque, la troisième a plutôt évalué l'abri en lui-même. Je crois qu'il ne faudrait pas oublier l'objectif de l'abri, l'abri est fait pour protéger la mosaïque et à ce moment là on doit bien étudier comment la mosaïque se modifie ou ne se modifie pas, et pour ceci, je devrais dire que John Stewart a bien cherché à évaluer—justement, il a la chance d'avoir des abris en Angleterre qui datent quelques fois de deux cents ans—et John Stewart s'est bien occupé de la mosaïque. Et le résultat est très intéressant.

ZE'EV MARGALIT: I have a question for the three of you. Do you make a distinction between roof and shelter, which is a complete building? Because when you compare a roof with open walls to the roof of a house with a completely closed environment, the situation of the mosaic is completely different. So, in your assessment, have you, each one of you, differentiated between roofing and shelter?

JOHN STEWART: Well, as I said at the beginning of my presentation, we use the term *shelter* very generally to include all types, but of course, in our own assessments we define what the specific types of designs are. In the case of England, all but one of these structures are enclosures, for obvious reasons—because there is certainly a more severe winter climate. There's one mosaic that is within an open building; it's a mosaic that was lifted and relaid and very heavily restored on a cement bed in the 1970s and, in fact, is very sound, and it's given winter thermal protection. All the structures in England are enclosures, but, of course, in Israel this situation is very different.

JACQUES NEGUER: Yes, we looked at the relationship between shelters—open shelters and enclosures—and the relationship between the state of conservation and the shelter. I presented this. In general, enclosures are protecting the mosaics better, but this is related to the high cost of conservation and building, and at the same time, it's mainly affecting the site and the environment. Open shelters are very different in Israel. We have five identical shelters at two sites, but everything else is different, including the conditions. If we talk about mosaics conserved in situ, everything depends on the maintenance of the mosaics and the shelter together.

JAROSŁAW DOBROWOLSKI: I would like to ask John Stewart for just a bit of clarification. At the beginning, you talked about the shelter, an early-nineteenth-century shelter over a mosaic in Brading, and then you talked about a modern 2004 shelter, also in Brading. Does this mean that the early-nineteenth-century shelter was removed, or is it a different site?

JOHN STEWART: That's a different site. The first site was Bignor; the other site referred to was Brading.

MARTHA DEMAS: I would just like to address Gaël's comments, because I don't see how you can begin to understand what's happening with a mosaic and begin to put forth criteria for building shelters that are going to protect mosaics without undertaking assessment of the environment of the shelter. I think it is extremely important, and the two are totally interconnected. So, maybe, Gaël, you meant something else, but I did not really understand the objection to the monitoring of shelters. I think it's a very important thing to do.

jacques neguer: In addition, the microclimate around the shelter itself is extremely important, and the change in the microclimate under the shelter is affecting the mosaics too.

hassan limane: Je tiens d'abord à remercier les trois orateurs de leurs sujets, de leurs présentations, bien documentés sur un sujet qui est très délicat. Ce sujet des abris, effectivement, ça pose un gros problème de couvrir les mosaïques. Lorsqu'on est devant un site isolé, c'est simple, mais lorsqu'on a le cas d'un grand site, comme on en a vu des exemples, est-ce que ça ne pose pas un problème du côté paysagiste ? C'est à dire est-ce que ça ne déforme pas le paysage archéologique ? Bien sûr, on est tenté de couvrir l'ensemble des mosaïques, mais la multiplicité de ces abris, est-ce que ça ne déforme pas le paysage du site ? D'un autre côté, on a vu avec vos expériences que même avec les abris, ça réduit tout simplement la dégradation, c'est à dire que devant ce phénomène, devant la mosaïque, je crois qu'il n'y a pas de solution pour arrêter la dégradation, même avec l'abri.

john stewart: Well, first of all, I would just like to address the first half of your question. Any conservation solution that's chosen for a site obviously needs to be subject to a rigorous process, a methodical process, based on decision making, and that, of course, includes significance, condition of the resource, and the risks to which that resource is exposed. Now, shelters may be one solution or a solution for one site or part of a site but not necessarily the universal solution for an entire site, and of course, it's a combination of options, shelters, reburial, and so on. This morning Chiara Zizola showed us the site in Sardinia where three different types of options were used to present, or in the case of reburial, not to present, part of the site. The shelters are really only one part of the palette of choices that we have to present mosaics in situ, but, of course, there are other methods to protect mosaics in situ, such as reburial or seasonal reburial.

jacques neguer: Sometimes the shelters are built oversized, protecting not only mosaics but more vulnerable artifacts too, and the choice should be made from the beginning. Do you really need to build a shelter? Do you really want to spend a large amount of money, and not spend this money over time, maintaining the site? This is a big question, and it needs to be answered before the beginning of every construction project. A shelter is not a solution like every conservation operation. This all relates to management and maintenance over time. One solution for everything doesn't exist.

jeanne marie teutonico: This is just a quick comment regarding Martha's and Gaël's comments. I don't think you're really disagreeing with each other. I think what was being said is that it is important to understand the environment underneath the shelter, but it's also important to understand the effect that that environment has on the condition of the mosaics. I think that's what you're all trying to show. Maybe it was emphasized a little bit differently in each presentation, but I think that's the critical point. So, in fact, both are important. You can't understand the environment in the abstract; we have to understand how the environment affects the condition of the mosaic. What you were trying to do, Sibylla, was to show different ways of perhaps assessing that change over time in places where there weren't very good records on how the shelter was designed at the beginning and according to what criteria. So I don't really think there's an essential disagreement.

gaël de guichen: L'abri est là pour nous protéger contre sept types d'agresseurs, ce sera le vandalisme, le vent, la poussière, la pluie, les changements de température, les changements d'humidité relative et les microorganismes. Je crois qu'on a fait le tour, là. Le vandalisme, on n'en a pas trop parlé. Le vent et la poussière, ce sera entièrement du si l'abri est ouvert ou fermé, et les trois autres éléments essentiels sont changement de température, changement d'humidité relative et microorganismes. On sait qu'un abri, il réduit les changements de température, ça on le sait, il n'y a pas besoin d'avoir des mosaïques en dessous et au-dessus, il réduit les changements d'humidité relative, on le sait, les microorganismes, on le sait pas. Alors, c'est important, c'est intéressant dans l'approche de John, parce que sont des approches différentes, c'est qu'il a d'abord cherché à voir s'il y avait une amélioration au niveau de la mosaïque du fait de la stabilisation de la température, du fait de la stabilisation de l'humidité. Je crois aussi que ce qu'il y a d'intéressant, c'est qu'il a pu faire des comparaisons, sous le même abri, entre des mosaïques qui avaient été détachées et des mosaïques qui n'avaient pas été détachées. Là, je crois que la méthodologie qu'il a appliquée est très intéressante et devrait être poursuivie.

denis weidmann: Je pense que nous ne sommes qu'au début de ces analyses de situation, c'est un domaine très particulier.

On a là les premiers résultats des analyses et c'est très intéressant d'établir, comme le propose Sibylla Tringham, d'unifier un peu les critères, parce que c'est encore ça qui manque. Il faudra intensifier les échanges entre les personnes concernées et je pense qu'il faut multiplier les instruments. Pour répondre à Gaël, c'est les instruments qu'on dispose sous les abris qui vont donner des réponses, la mosaïque, elle répondra beaucoup plus tard aux effets. J'ajouterais un critère de plus peut-être, non pas aux calamités qui nous menacent mais, un phénomène qu'on voit se développer dans le domaine des abris, c'est celui de la prise de possession par les architectes. Certains abris deviennent des créations architecturales qui échappent, peut-être pas au créateur, mais aux archéologues et aux conservateurs. Souvent des projets deviennent des œuvres de pèlerinage d'architecture, on voit ça dans plusieurs musées qui protègent des sites, et là, il y a un autre facteur de difficulté auquel il faudrait prendre attention, peut-être l'illustrer dans certains cas d'analyse.

JACQUES NEGUER: Ce n'était pas une question je pense, mais disons qu'on sait pas toujours ce qu'on cherche. Nous sommes en train d'établir des facteurs à analyser pour comprendre ce qui se passe sous les toitures.

ÉVELYNE CHANTRIAUX: Les architectes sont quand même utiles.

JACQUES NEGUER: L'architecte n'est pas là.

KHALED KARAOUI: Mon intervention essaie de voir et de comprendre l'abri qu'on conçoit. Est-ce qu'il protège la mosaïque ou il protège autre chose ? Est-ce qu'il vise la protection de la mosaïque ou des structures qui sont autour de la mosaïque ? Si la protection est double, de quelle manière l'abri deviendra un élément didactique pour la compréhension peut-être même de l'architecture qui est autour ?

JACQUES NEGUER: Parfois, l'abri ne se protège pas lui-même, il est fait de matériaux qui ne résistent pas à l'environnement. Les matériaux de base de l'abri même se détruisent beaucoup plus vite que les mosaïques. Ensuite, avec la destruction, la corrosion des matériaux de la toiture, nous avons les problèmes sur les mosaïques. Alors, on doit seulement penser avant de construire.

ÉVELYNE CHANTRIAUX: Je pense que la réponse des architectes est déterminée par le cahier des charges qui est établi par les archéologues, les conservateurs, restaurateurs, les manageurs du site, et donc la réponse architecturale, elle sera d'autant meilleure qu'il y a une collaboration avec les différents acteurs qui interviennent sur un site et sur les mosaïques. Vous parliez de mise en valeur, si le cahier des charges met l'accent sur la protection, ça va être une réponse avant tout fonctionnelle, si le cahier des charges met l'accent sur la protection et la mise en valeur du contexte archéologique et avec une intention pédagogique, donc c'est des éléments qui vont influer sur la réponse formelle apportée par les architectes. Après la question de l'appropriation, c'est une question peut-être de rapport de force, c'est à dire si l'architecte est plus fort que les autres, c'est une question, je crois, d'équilibre à trouver entre les différents intervenants.

Discussion following Demetrios Michaelides Presentation

AÏCHA BEN ABED: Ma question est à propos des abris de Kourion. Je voudrais savoir si tu as une idée de ce que ça représentait dans l'esprit des planificateurs, de ceux qui ont fait ces projets d'abri. Est-ce que c'est vraiment un problème de mise en valeur ? Ou est-ce que c'est pour eux réellement, c'est un problème d'abri pour les mosaïques, de conservation pour les mosaïques ? Et qui prend la décision ? Est-ce que ce sont des archéologues, est-ce que ce sont des aménageurs, est-ce que c'est l'Institut du patrimoine ? Quels sont vraiment les décideurs pour ce genre de choix qui me semblent un peu, je sais pas, dépassés, et puis tuer le site que j'ai vu et que je trouve très, très changé depuis.

DEMETRIOS MICHAELIDES: Well, it is a difficult question to answer, in the sense that it's a very complicated process and a lot of it seems to be happening in isolation. The Department of Antiquities, for various reasons, decides that something needs to happen to the site. The proposal has to go to the Programming Office of the government. The Programming Office has to approve it; then they have to find the architect. The architect needs to be briefed. But frequently the architect is not briefed; also, the architect is not necessarily knowledgeable about ancient sites. So the architect is allowed to create, which is his right to do because nobody told him to do otherwise. When he arrives with a finished result, it goes to the Department of Antiquities. The Department of Antiquities says, "I don't like this, I don't like that." The architect says, "But it's going to cost much more." The plan goes back to the Programming Office, which says, "No more money," and then you start losing control over what happens, and either nothing happens, as in Paphos for twenty years, or something like this happens. And at the end, you can't blame anybody. It's the lack of working together and programming everything well ahead. You can't find the mistakes of the shelter once it's built or once you sign an agreement that it's going to be built. You have to find them before. But if you don't ask for advice, you don't get it. The original thinking is that the shelters are to protect the mosaics, to make them accessible, and to guide the thousands of tourists that walk through the site in the summer in a manageable way. But they don't work like that, and we can't tell yet whether they are actually protecting the mosaics that are under them. We know the shelters don't protect the ones on the edge, because they're outside them.

federico guidobaldi: This morning we heard about educating archaeologists in conservation. I think it's time to talk about educating architects in conservation because it's usually a great problem. I have lots of friends, splendid architects who understand conservation, but there's a large percentage of architects who think that it's very important to be creative, so they have to make something shocking that usually, like the things in Kourion, is not appropriate for us. Really, I think it's a great problem that we have to consider.

demetrios michaelides: Well, to a certain extent, yes, and there are architects who are educated in this way. The problem is higher up—the people who really make the decisions. Often, this is neither the architects nor the archaeologists, and this is a major problem in monuments that are controlled by the government. It is a governmental, political decision, and that affects antiquities, and that's where we need enlightenment and education. High up, not the archaeologists and the architects—that we can do among ourselves.

federico guidobaldi: I was speaking for my country too. In my country the case is quite different: the architects decide; they have the final decision.

agnieszka dobrowolska: I'm an architect, by the way. But I have a completely different and practical question. You mentioned that there are winds, salty winds, affecting the mosaics. Have you got any examples of any sheltering, or shielding from winds, that give positive results to the monuments, in terms of conservation?

demetrios michaelides: No, I cannot. But it is not my field. What I can see there is that all the shelters are open to where the wind comes from. And I think you only need to stand in the shelter to get the wind coming from the sea, so I know that doesn't work without being an architect. But I don't have a solution myself.

Discussion following Isabelle Skaf Presentation

patrick blanc: Oui, ma question à Isabelle, c'est au sujet des gens qui ont repris les motifs et je crois qu'on en a tous rencontrés, des personnes qui font des copies pour la vente au grand public, pour les touristes, et qui sont parfois aussi appelées à faire de la restauration. Parce qu'il y a une contrainte, on est pour refaire à l'identique sur les sites entre autres on aime bien que les mosaïques brillent. C'est une question que je me pose qui n'a pas abordé lors de communications propres sur ce sujet. Je pense qu'il faut avoir une réaction vraiment ferme vis-à-vis de ces personnes qui font des copies et qui finissent par glisser vers la restauration, donc, qui ne sont pas vraiment contrôlées.

isabelle skaf: Les mosaïques de la cathédrale ne sont pas des copies, ce sont des originaux. Ils ont été offerts à l'église, au comité, comme étant des originaux, sauf peut-être pour la petite bordure autour de la fenêtre que je pense être une reconstitution avec des tesselles anciennes. Pour les autres maintenant, je ne sais pas quelle partie de ces pavements est originale et combien est reconstitué, mais les mosaïques ont été offertes comme étant des originaux. Attention, il n'est pas question ici de refaire des nouvelles choses, eux sont convaincus qu'ils ont accepté une donation de cinq pavements anciens pour embellir l'église et augmenter le nombre de visiteurs. Mais ce ne sont pas des nouvelles mosaïques, enfin, ce sont peut-être des nouvelles mosaïques mais l'intention n'était pas celle-là.

patrick blanc: Non, je parlais de celles qui étaient dans l'église, des motifs qui avaient été refaits, inspirés à partir de motifs antiques, le sol. Je voulais dire, c'est qu'il peut y avoir un glissement, donc, les personnes qui ont fait ça, les mosaïstes qui ont fait ce décor en tesselles, c'est une véritable mosaïque.

isabelle skaf: Oui, mais ça, c'est un dallage normal, ce n'est pas des tesselles anciennes, c'est moderne, c'est des carreaux polis. Je ne pense pas qu'il y ait un quelconque désir de faire passer ça pour de l'ancien, non, c'est comme un carrelage normal, ils ont fait ça comme ça avec des petites mosaïques, avec des petits carreaux modernes. Donc, en reprenant le dessin parce qu'ils ont trouvé que c'était bien.

aïcha ben abed: Je voulais savoir, ces pavements qui seraient des originaux, est-ce qu'on sait d'où ça vient, quelle est leur provenance? Est-ce qu'ils viennent du Liban, d'un monument connu, comment ils sont arrivés là ?

ISABELLE SKAF: C'est un problème qui est très peu abordé au Liban parce qu'il y a quand même tout un aspect politique à ce trafic d'antiquités et les gens, en général, font très attention. Ce que je sais, ce qu'on me dit, c'est que les pavements viennent des pays avoisinants, ils ne viennent pas nécessairement du Liban, je pense qu'on peut le dire. À des personnes de Syrie, on dit que les pavements viennent de Syrie, à des personnes de Turquie, on dit que les pavements viennent de Turquie. Je le dis clairement, c'est ce que j'entends, c'est ce qu'on me dit. Il y a un trafic de pavements de mosaïques important au Liban. Maintenant, comment ça rentre, c'est quand même des grands pavements, je ne sais pas comment ça rentre. Je pense qu'il y a une partie qui est fausse, qui est reconstituée avec des tesselles anciennes, vendues comme étant des originaux. C'est très difficile, enfin, on connaît les marchands, mais il n'y a pas de volonté politique d'arrêter ce trafic actuellement.

AÏCHA BEN ABED: Mais là, c'est quand même une cathédrale, c'est quand même, je ne sais pas, ça me semble un peu …

ISABELLE SKAF: Oui, c'est assez étonnant, je dois dire, mais comme c'était une donation, ils n'ont pas voulu fâcher le mécène. Vous savez, c'est aussi des politesses, le mécène a dû donner de l'argent pour la cathédrale, il a dit « Voilà, j'ai cinq pavements que j'ai achetés sur le marché et je vous les offre, vous ne les voulez pas ? Comment ? » Donc ils les ont pris et ils les ont installés sans état d'âme. Je pensais que l'archéologue en charge de la crypte, qui est un membre éminent du comité, aurait quand même dit quelque chose—rien.

AÏCHA BEN ABED: Le Liban est un pays libre.

ISABELLE SKAF: Oui, enfin, plein de contradictions.

Discussion following Philip Bethell Presentation

JACQUES NEGUER: Did you try to prevent microbiological growth using UV light during non-working hours in the monument? The same question for Isabelle.

ISABELLE SKAF: UV light inside the crypt? No.

PHILIP BETHELL: We haven't tried that yet, but it's one of the plans we'd like to build into our new shelter design—that wonderful, perfect shelter we're going to build with all your advice.

JOHN STEWART: If I can answer your question, there was actually a proposal for Chedworth in 1999 or 2000 to modify the building by the elimination of fenestration on three elevations to introduce better ventilation and, during blackout periods, to introduce UV light and to test the results. But, as Philip said, it's still to be fully implemented.