CONSERVATION ON ARCHAEOLOGICAL EXCAVATIONS

ICCROM

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With particular reference to the Mediterranean area

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FOREWORD

"Excavations should be carried out in accordance with scientific standards and the recommendation defining international principles to be applied in the case of archaeological excavation adopted by UNESCO in 1956."

The first paragraph of Article 15 of the International Charter for the Conservation and Restoration of Monuments and Sites, adopted at Venice in 1964 during the Second International Congress of the Architects and Technicians of Historic Monuments, constitutes strong approval of the UNESCO document. However, since it was first adopted, experience has shown clearly that there are still points to be revised and gaps to be filled. Several small meetings and individual publications have been of help, but within the particular field of archaeology, a significant example of active involvement in conservation was the conference organized by ICCROM, with the financial support of UNESCO and the co-operation of the Department of Antiquities of Cyprus, which took place in Cyprus from 23 to 26 August 1983.

There were two main aims of the conference: to review responsibilities for conservation, making particular reference to the 1956 UNESCO Recommendation on International Principles applicable to Archaeological Excavations; and to discuss the basic principles of conservation on excavations.

Fifty-six participants, including representatives of UNESCO, ICOM and ICOMOS, contributed to discussion of policies for conservation. The Departments of Antiquities of the following countries were represented: Cyprus, Egypt, Greece, Israel, Italy, Jordan, Libyan Arab Jamahiriya, Portugal and Spain.

The discussions revealed that there remains much to achieve in the way of co-ordination of different interests in archaeological conservation. It appeared that a number of initiatives were needed in this area: they would include the regular updating of the manual published following the conference, other similar meetings, new training schemes, the creation of lists of specialists and conservation laboratories, and research programmes. It is not surprising that these requests were addressed to ICCROM which, as part of its normal functions, will undertake to co-ordinate and implement these projects – some of them of a long-term nature – with the help of other organizations.

Other suggestions were made with a view to a possible future revision of the UNESCO Recommendation, acknowledging its evident influence on national legislations and policies regarding archaeological excavations.

This meeting has clarified where necessary certain doubts or omissions, in actively promoting archaeological conservation and emphasizing the responsibilities of professionals. It has defined principles to follow and moreover has established a new vocabulary for archaeologists of the Mediterranean and Middle Eastern region.

The need for such a contribution is evident from the concern expressed at several recent meetings about the conservation aspects of archaeology. For instance, the 12th Session of ICCROM's General Assembly in Rome on 10-12 May 1983 passed a Resolution to this effect, the text of which is reproduced opposite.

I take this occasion to thank all those who have helped to bring about this conference.

Cevat Erder

Director of ICCROM

[1984]

ICCROM
General Assembly
12th Session
Rome, 10, 11 and 12 May 1983

The 12th Session of ICCROM General Assembly,

Considering that archaeological finds from excavations may far exceed the existing possibilities for conservation, and that these researches undertaken may ignore or be in contradiction with the basic needs of conservation – a situation which can lead to serious damage to the historical and cultural heritage of each country and, consequently, of mankind,

Considering on the other hand, that many results of archaeological excavations are not published thus negatively contributing to scientific knowledge and mankind's history, since valuable information may be lost forever,

Taking into account that the "Recommendation on International Principles applicable to Archaeological Excavations" adopted by UNESCO General Conference at its Ninth Session, New Delhi, 5 December 1956, has already pointed this out,

Recommends that the Member States

a) take the necessary measures to prevent archaeological sites being opened up – except in special circumstances – without due consideration being given to the necessary requirements of conservation;

b) delay excavation if progress reports are not submitted in reasonable time;

c) see publication as an integral part of excavation and support it by adequate finance;

d) take the necessary measures for adequate, safe and secure storage facilities for archaeological finds to avoid the loss and deterioration of scientific and cultural evidence, thus causing possible illicit traffic.

Rome, May 1983

PREFACE TO THE SECOND EDITION

It is gratifying that the demand for this book has led to its being translated into Italian and Spanish, and that it is now being reprinted in English. The text of this reprint is unchanged from the original English edition, save for minor technical changes, a new layout and the addition of a bibliography with a selection of references that have appeared since 1984.

The role of conservation on archaeological excavations has received much greater attention since the first publication of this book. This is apparent from a growing number of publications on the theme, the holding of professional conferences devoted to the subject, and, particularly welcome, an increasing concern by excavators for the conservation of the finds and sites that they excavate.

The hopes expressed in the first edition for a revision of UNESCO's Recommendation on International Principles applicable to Archaeological Excavations (1956) have not yet been fulfilled. In the meantime, however, ICOMOS has created an International Committee on Archaeological Heritage Management; its Charter for the Protection and Management of the Archaeological Heritage (adopted in 1990) provides some new guidelines in this field. More influential has been the Australian ICOMOS Charter for the Conservation of Places of Cultural Significance (the "Burra Charter") adopted in 1979 (revised and provided with detailed guidelines in 1988). While developed for "places," the methodology outlined in the Charter for conservation policies based on significance assessment can be usefully applied also to the conservation of museum archaeological collections.

Nicholas Stanley Price
The Getty Conservation Institute

PREFACE TO THE FIRST EDITION

The papers in this volume are a result of the conference described in the foreword. The original proposal for this conference was made in 1979 by Dr Bernard Feilden, the then Director of ICCROM, and Dr Vassos Karageorghis, Director of Antiquities of Cyprus and at that time Vice-President of the Council of ICCROM.

Chapters 2 and 11 were written following the conference for inclusion in this volume. All the other papers had previously been commissioned by ICCROM, and were circulated as preprints before the meeting. The authors have since revised their contributions in the light of discussion at the conference and in response to editorial suggestions; they remain responsible for the opinions expressed in their papers.

Thanks are due to those who commented on earlier drafts of the papers, including a group of members of the Archaeology Section of the UKIC, to Mr Robert Organ for helpful last-minute suggestions, and especially Dr Giorgio Torraca for editorial supervision. Thanks are also due to June Taboroff (translation from German), to Susanne Peters (word processing), to Cynthia Rockwell and Monica Garcia for seeing this volume into print, and to Azar Soheil Jokilehto for the cover design.

Nicholas Stanley Price
Editor

EXCAVATION AND CONSERVATION

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> "The things he [the excavator] finds are not his own property, to treat as he pleases, or neglect as he chooses. They are a direct legacy from the past to the present age, he but the privileged intermediary through whose hands they come; and if, by carelessness, slackness or ignorance, he lessens the sum of knowledge that might have been obtained from them, he knows himself to be guilty of an archaeological crime of the first magnitude. Destruction of evidence is so painfully easy, and yet so hopelessly irreparable."
> (H. Carter and A. C. Mace, *The Tomb of Tutankhamun*, Vol. 1 (1924): 124)

The conservation of archaeological material must begin in the field; planning for conservation needs must therefore start when the excavation is first proposed. This obvious statement needs repeating; although excavation and other archaeological techniques have developed immensely in the past fifty years, the standards of conservation of excavated material have not generally improved to the same extent. The two must, of course, be considered together if the maximum information is to be retrieved and if the finds are to be preserved and accessible for future generations.

1. Archaeological conservation of sites and objects

It is taken as axiomatic here that the authority to excavate carries with it the responsibility to conserve and publish the results of the excavation. But the responsibility for conservation should not be delegated to specialist staff after the excavation is over for two reasons, one practical and the other technical. In practical terms, the supply of qualified conservators (especially those willing to work on excavated material) cannot meet the present demand; on a technical level, some of the remedial conservation work carried out after the excavation would be unnecessary if proper measures of preventive conservation were taken on site. For both excavation aims and conservation needs to be satisfied, the two must be reconciled in the field at the moment of excavation.

The actual moment of excavation is crucial on two counts: first, for the fullest possible observations by the excavator as to the context of the find and its associated material; and second, for the potentially disastrous consequences of the lack of environmental control over finds that are chemically or mechanically unstable. These two concepts, *archaeological context* and *environmental control*, are perhaps the very essence of sound excavation procedure; inadequate attention to either results in that idea of destruction which is often held to be characteristic of excavation. (Conservation too can be destructive, for instance in removing corrosion products from an object; as with excavation, the degree of control and documentation are all-important.) The raw material of archaeology is, almost by definition, non-renewable and only close attention to these two concepts – and the leaving of "witness" areas for control purposes – can make undeserved the label of "destruction."

Moreover, the ever-growing field of archaeometry (the application of chemical and physical analysis to archaeological material) depends for its best results on material with good archaeological context and in a state as similar to its excavated condition as possible.

The importance of "context" brings together two aspects of conservation on excavations which terminology and tradition have tended to separate. As to terminology, the products of excavation are either left on site or removed elsewhere, reflecting the distinction between immovable and movable cultural property. The term "archaeological remains" is useful for material still in context but not after its removal to a museum. The words "antiquities" and "monuments" are often inappropriate when applied universally. Instead "objects" can be used for portable items that are removed from a site and "the site" for remains left *in situ*.

The conservation of archaeological objects, on the one hand, and of archaeological sites, on the other, tend to be different specializations, each with its own practitioners, technical literature and methods of training. The term "archaeological conservation" should refer to both rather than, as often, only to objects.

Accepting the object/site terminology, it has to be recognized that many "immovable" remains (e.g., kilns, mosaics, stelae, temples) are in fact removed from a site for reasons perhaps of security, threatened destruction, "better" display or illegal sale. The loss of context caused by the removal of "immovable" objects, as with movable ones, represents a loss of information for which only the fullest possible documentation can compensate. It also leads to problems in the display of the objects in their new setting, usually requiring some form of re-creation of context. One of the purposes of archaeological conservation must surely be to minimize the loss of information suffered when the excavation process separates objects and the site from which they have come.

In summary, then, archaeological conservation is concerned with both sites and objects. In the event of excavation, its techniques are applied to excavated remains during and immediately following their exposure. This is field archaeological conservation, as distinct from laboratory archaeological conservation.

2. Conservation on excavations

The proper conservation of structures and objects during an excavation is best assured by having a professional conservator as a full-time member of the excavation team (see Chapter 2). This ideal is rarely achieved, however, for lack of qualified conservators.

The contributions in this volume, in recognizing this lack, describe some basic principles of conservation in the field with which archaeologists should be familiar. These basic principles should be relevant to the conduct of almost any excavation. For those carried out underwater the principles are similar but methods are often different. These have been fully described in a recent publication (UNESCO 1981).

The need for a single approach to all aspects of archaeological conservation has become increasingly apparent during the last fifteen years. During this period archaeology worldwide has been characterized by a remarkable increase in:

- the number of archaeological sites threatened with destruction;
- the number of survey and excavation programmes undertaken to meet this threat;
- the number of practising excavators;
- the exchange of field techniques and personnel across previously isolated period and area specialisms; and
- the quantity and sophistication of archaeometric analyses of excavated material.

These developments – which have also provoked important advances in archaeological theory – have resulted in a greater awareness of conservation issues in archaeology. As far as excavation is concerned, certain ideas remain basic – the uniqueness of each site, the need consequently to document every step of the investigation and the responsibility to conserve in some way the results of the excavation. Despite the use of systematic sampling techniques, there has been an enormous increase in the quantity of finds requiring conservation and also in the number of excavated sites to be preserved – those that escape destruction because of their obvious importance in addition to those excavated for research or display purposes where there is no immediate threat of destruction. In this connection, a further phenomenon of recent years in addition to those noted above is the marked increase in the number of visitors to archaeological sites.

In these circumstances, planning of conservation action is subject to the selection of priorities which in turn depend on national or local policies. Nevertheless, the reconciliation of excavation and conservation needs is a common objective, and the following principles are worth recalling.

2.1 Planning conservation before excavation

Three general principles can be stated under this heading:

(1) That the funds obtained for an excavation project are sufficient also for conservation and publication needs (staff, facilities, materials, printing, etc.). Some budgets and grants for excavation acknowledge that post-excavation analysis and publication costs may be higher than those of the fieldwork. But the recurrent costs of site-maintenance and storage of finds – responsibilities that are in practice often divided between two different agencies – also have to be calculated and budgeted for. In some cases, no facilities exist for post-excavation maintenance, a situation that should strongly influence policies in the field. For movable objects this means that the "first aid" treatment given them in the field may be the only conservation that they receive.

For remains *in situ* this should generally mean a policy of conservation by backfilling of the excavated area. In any case, the sum to be allocated to conservation cannot be forecast until arrangements for future maintenance of the excavated site and finds have been made.

(2) That sufficient is known of the local environment to plan for foreseeable conservation requirements at the site. There will always be the unexpected discovery that calls for emergency action, for instance the waterlogged deposit on an otherwise "dry" site. But, in general, preventive conservation can be planned in advance (see also Rose 1975) by studying the site's local environmental variables, for example its temperature and relative humidity (RH), extent of shade, predominant wind direction and frequency, frost occurrence, soil characteristics and groundwater level. These should be investigated during the reconnaissance visit to the site for planning excavation strategy, made ideally at the same time of year as that in which the excavation will take place. The data collected may well prove valuable also for ecological interpretation of the site and should be published anyway as an aid to future workers in the area.

(3) That sufficient is known of the site's cultural material to ensure its successful conservation. Although specific find circumstances cannot be predicted, all members of the team should be aware of the materials likely to be found. For example, for the excavation of an early church site the team should be prepared for preventive conservation of painted wall-plaster and/or mosaics. Flexibility in implementing conservation policies is also necessary; for instance the individual treatment and packing of sherds necessary under certain temperate conditions would not be feasible for the bulk quantities of sherds on a Middle Eastern tell-site. With the increasing mobility of excavators between climates and continents, familiarity with the local environment and cultural material is all the more important if "conservation disasters" are to be avoided.

The frequent necessity for emergency excavations at short notice does not make these principles irrelevant but, on the contrary, all the more important. An adequate fund for emergency excavations should be a standard budget entry, while accumulated experience of the local environment and cultural material reduces the impact of an emergency when it arises. It is precisely because conservators are unlikely to be available for such rescue operations that excavators should have a knowledge of preventive conservation measures.

2.2 Conservation during excavation

The moment of excavation can easily be disastrous for archaeological remains. Their deterioration since being abandoned will have almost ceased, leaving them in a near-equilibrium with their immediate environment. When exposed by excavation they are subjected to abrupt change in their ambient temperature and RH and in their access to light and oxygen. The excavator's aim must be to minimize environmental shock to the remains during their uncovering and recording, and, for movable objects, during their packing and transport to a store.

Rarely can the environment of a whole excavation or one trench be closely controlled during excavation. Rescue excavation of deposits in the cellars, basements or crypts of standing buildings may fortuitously be buffered from external climatic changes. If the RH inside a sealed tomb is measured, the time of its being opened can be chosen so as to minimize stress to the tomb contents. Attempts to control conditions on an open site have been made (e.g., Weaver 1973) but the costs of complete enclosure will usually be prohibitive. Otherwise climate control on site depends on selecting the optimum local conditions for exposing the find, using the environmental data previously collected and experience of the site's "environmental behaviour" (e.g., changing levels of RH in a trench as it deepens and the sun/shade ratio changes). The method and materials for packing sensitive and fragile objects will also vary according to the environment in which they were found. A description of this should be included with the standard details of context on their accompanying labels.

The moment of excavation can cause a conflict of priorities unless both conservator and excavator appreciate the other's concerns. Too rapid a removal of the object for preliminary stabilization may mean that its context is never fully understood; too long an exposure of the object in non-ideal conditions may affect its state of preservation for later analysis. Alternatively, the excavator may be under pressure to continue excavating sooner than allowed by the conservator's concern for the safe removal of an object. The finding of compromise solutions that fulfil both aims forms the basis of field archaeological conservation. Similar compromises are made when the lifting of larger objects has to be done without sacrificing intact deposits in their vicinity, and when protecting excavated remains from one season to the next.

The main methods of between-season site protection are:

- backfilling with earth of the whole excavated area or selected trenches;
- fencing the site to keep out livestock and the less determined sightseer;
- embankment and drainage systems to keep excess water runoff out of the excavated area;
- consolidation and capping of walls;
- covering of remains with protective sheeting of natural or synthetic materials; and
- erection of temporary roofs.

The choice of methods, either singly or in combination, will vary, of course, according to local requirements. Compromises need to be made when the recommended protective measures interfere with the future excavation strategy (e.g., consolidation of walls which are to be removed the following season; intrusion into unexcavated deposits of supports for protective roofs; additional costs in time and labour in re-clearing temporarily backfilled trenches). Although protective measures appear costly if not planned in advance, the alternative is quite unacceptable: the irretrievable loss of information about partially excavated features through leaving them exposed to destructive agencies from one season to the next.

Measures designed for site protection between seasons may in turn affect the preventive conservation of finds when work is resumed. Any protective covering of fragile remains will modify their environment for better or worse. The misuse of protective sheeting, for instance, can create conditions for the growth of micro-organisms, whereas a well-designed temporary roof over the excavated area is usually beneficial for controlled excavation work.

Protection by re-burial of remains requiring specialist treatment is generally to be recommended. However, even a short exposure may have accelerated the rate of deterioration, and the specialist intervention should be made as soon as possible.

Such protective measures as these should also improve site security – the safety of standing structures and trenches during work in them, the safe disposal of excavated soil and debris, and the security of the site and finds from vandalism and theft. In this last context, the employment of a guard may be as necessary during the excavation season as after it.

2.3 Conservation after excavation

For successful conservation action after excavation, good communication among archaeologists, conservators, curators, architects and site custodians is particularly important. Among them they must agree on a policy that ensures:

- the investigative cleaning, stabilization and safe storage of objects; and
- the consolidation, protection and guarding of the remains on the site.

In both cases, the conservation measures will be either preventive (active maintenance) or remedial (cleaning and treating to reduce the rate of deterioration). Rarely will restoration be carried out, and only for display purposes – the identifiable completion of lacunae on objects and the anastylosis of dismembered monuments on sites.

Whereas the objects from all excavations need continuing conservation, only some of the sites from which they come will be preserved. Some are unavoidably destroyed by construction works; others do not merit visible preservation and should be consolidated and backfilled. None at all deserve to be abandoned after excavation to inevitable destruction by natural and human agents.

For those sites that are selected for permanent exposure and presentation to the public, a conservation policy is needed that considers together the objects and the site. This is the easier if a single authority is responsible for both, and if the opportunity is taken to establish a site museum adjacent to the excavated site. The most important and valuable finds can, and perhaps should, still be displayed in a central museum; but the administrative and educational advantages of site museums are many. Conservation work for both objects and site is centralized under one roof, and the finds stored and displayed in the museum are more easily related by visitors to their original contexts.

The establishment of site museums (UNESCO 1978, 1982) should be considered seriously only if (a) the excavated remains merit presentation to the public; (b) the site is easily accessible by road; (c) the security of the collections is guaranteed; and (d) if laboratory facilities are adequate for basic conservation and research purposes. Security and facilities for monitoring the condition of the collections are also essential for any temporary storage building used during excavations. In fact, if planned in advance, conversion of a temporary store and dig-house used during the excavations into a site museum can be a very practical and low-cost undertaking.

The decentralization of many tasks from a central museum to local or site museums is all the more advisable as the quantities of excavated material increase. The pressure on storage space in a central museum sometimes results in the discarding of "surplus" material, most commonly sherds, bones and lithic implements. If there is insufficient storage space for all stratified material, then it should be identified and disposed of in such a way that it is retrievable. This material is as historically unique as the site from which it came, and future research may well require different questions to be asked of it. As more local and site museums are established, the need to dispose of carefully excavated material should be less frequent.

Centralized systems of inventorying can also be simplified. If the registration numbers given to finds by the excavator are treated as their unique identifying numbers, and duplicates of the excavation inventories are deposited in the site museum which stores the finds, there is no need for any museum to re-register them according to its own system. Alternatively, the district or site museum itself issues to the excavator before fieldwork a range of accession numbers (and even blank registration cards) to be assigned to objects as they are found during excavation. The same numbers should be used for reference by conservators who receive the objects for treatment.

Post-excavation maintenance is more than "passive conservation" because of the continuing need to make use of the resources being conserved. Total protection is incompatible with total use; if objects are to be handled for study and publication, and if the site is to be explored by visitors, maintenance will always be an active task, one that may itself contribute to research. For example, routine consolidation of a wall may provide new information about its construction and the context of associated finds made during excavation. Here again, an approach that treats together the conservation, study and display of both sites and objects offers considerable advantages.

3. Excavation and conservation: the problem of regulation

Effective conservation on excavations would seem to have three ingredients:

(1) *Attitude*, i.e., general recognition that excavation without conservation is destruction. This is a question of accepting the moral duty to conserve and publish the results of an excavation.

(2) *Training*, i.e., adequate instruction in the principles of preventive conservation. This is a question of including the deterioration of materials and its prevention in the training syllabus of archaeologists (and the principles of archaeology in the training of conservators).

(3) *Regulation*, i.e., sufficient control to ensure that conservation and excavation standards are maintained. This is a question of making formal or informal agreements which define the responsibilities of the various parties.

It is easier to control standards if excavations are regulated by some central body. If not, standards depend on the attitude and training of the excavator, and the only regulation of his work is through the approval or otherwise of the archaeological community.

In the majority of countries, however, an official archaeological service exists and is in a position to control standards by regulation. For its own projects, standards are under its own control; for other excavations that it must authorize, it usually makes a bilateral or multilateral agreement with other parties which define the conditions on which an excavation permit is granted.

The form of agreement used by national archaeological services varies in detail, but many are based to a greater or lesser extent on a single document: UNESCO's Recommendation on International Principles applicable to Archaeological Excavations, adopted by the General Conference in 1956. Many of the principles there laid down had their origin in turn in the Final Act of the International Conference on Excavations held in Cairo in 1937 (International Museums Office 1940). The force of a Recommendation lies in the fact that the principles are adopted, after detailed study, by the supreme organ (the General Conference) of an international organization to which the majority of states belongs. It is designed to influence national legislations by laying down a course of conduct that is internationally acceptable. A Recommendation is therefore persuasive, in inviting Member States to take any legislative or other steps necessary to apply its principles, whereas a Convention is coercive.

This form of regulation manages to retain the flexibility that is needed if national legislations are to take account of local conditions. However varied those conditions, the intention of the 1956 Recommendation is clear that the responsibilities for conservation on excavations must be defined and not left to chance (see in particular paragraph 21 of the Recommendation, Appendix 1). If there are now suggestions that the Recommendation is in need of revision, this principle is likely to receive all the more emphasis (Chapter 11).

Given an adequate degree of regulation according to internationally acceptable principles, sufficient attention to preventive conservation in archaeology training courses and regular achievement of the obligation to conserve and publish, excavation may continue to be an effective and responsible technique for the investigation of human history.

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THE ROLE OF THE OBJECTS CONSERVATOR IN FIELD ARCHAEOLOGY [1]

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There is a great need to clarify the role of the conservator in field archaeology. This became plain at the ICCROM Conference, and it was evident that any clarification must take account of the real needs of excavators, the existing provision for conservation, and the differing opinions about the temporary loan of objects from the country of origin. There are many conflicting views on the value and the need for field conservation; what follows therefore is an attempt to construct a rough map, identifying some of the principal features which already exist in a rather confusing area.

A basic definition of *conservation* is

> The preservation of cultural material for the foreseeable future in a way that allows the maximum information to be retrieved by further study and analysis.

This statement, however, must be qualified. What is the 'cultural material' which the conservator is bound to 'preserve'? Can we define 'preservation'?

Briefly, the object itself, with its corrosion or deterioration products as excavated, surrounded by its matrix of soil, is the 'material' and it may need to be kept unchanged. This would be a 'preventive' or 'passive' conservation process to be achieved by providing correct packaging and stable storage conditions.

More commonly, however, in order to provide scholars, scientists and the lay public with the maximum information about the object, a process of micro-excavation is undertaken; that is a careful removal of corrosion or decay products using the microscope and perhaps X-radiography as aids. Just as the destructive process of archaeological excavation must be meticulously recorded (Coles, Chapter 6), so micro-excavation must be accompanied by careful records, written, photographic and X-radiographic. In this case, part of the 'cultural material' being preserved will in fact exist only in the archive as a record, so the importance of intelligent recording cannot be over-estimated.

1 A discussion paper written following the ICCROM Conference on "Conservation on Archaeological Excavations," held in Nicosia, Cyprus in 1983.

Two points follow from this. First, good recording begins in the archaeological section and is an important field technique used by both archaeologist and conservator. The conservator needs contextual information but the archaeologist requires the data that a conservator can provide about the possible interaction of material with its post-excavation environment; plus an evaluation of its potential for yielding up more knowledge in the process of investigative conservation and other scientific or analytical techniques. Secondly, the majority of objects will only achieve their full potential of adding information to the archive if they are conserved in a laboratory where photographic, radiographic and microscopic techniques are used to explore and record them. This is the ideal for all excavated material, and although it is realised that in many places it must remain unattainable, some attempts must be made to see whether existing experience and resources could be better used to preserve artifacts for the future when they may be adequately investigated.

Restoration, a term which has often been used interchangeably with conservation, may be defined as

> The re-presentation of an object or structure in such a way that it can be more readily understood by both scholars and the general public.

This sparse definition implies that the aim of restoration is neither cosmetic nor intended to deceive, but to make the information contained in an incomplete and therefore visually enigmatic object or structure more readily accessible to those looking at it. This is fundamental to the ethics of archaeological conservation (see UKIC 1982 Guidelines on Ethics).

The papers of Stubbs (Chapter 7) and Mertens (Chapter 10) make it plain that structural restoration must be the product of full research and mature consideration, although planning for reconstruction may need to take place at an early stage in excavation. Similarly, although some pottery, for example, may need to be reconstructed on site to obtain a profile, restoration is usually a laboratory technique undertaken after all the relevant evidence is gained. Nevertheless, decisions may need to be taken in the field about the best way to retrieve, record and store material for future restoration – for example, the waterlogged wooden timbers of Viking York required the evolution of a methodical conservation strategy so that they could later be reassembled.

Working from these definitions, it may be possible to suggest some priorities for the preservation of excavated materials, a schema into which field conservation could fit in a flexible way, alterable when conditions and needs themselves alter. So, for example, when fragile, freshly excavated objects are not destined for the back-up laboratory, because none exists, it becomes doubly important that a conservator ensure that they are correctly packaged and stored. A system of priorities, arranged in chronological order of application rather than degree of importance, might be:

- planning for preservation (before, during and after excavation);
- supervision of material as excavated (including identification, preliminary recording, lifting as necessary, packaging and storage);

- good permanent storage; and
- a laboratory for investigative conservation.

1. Planning

Clearly, an aceramic Neolithic site is unlikely to have a pressing need for a conservator. A Roman villa site, however, with a potentially rich yield of wall plaster, mosaics, glass, metal objects, including coins, etc., cannot be considered equipped for scientific excavation without some conservation input. This may vary, depending on the presence of indigenous conservation facilities and the accessibility of the site, but it will be implicit in the arguments below that, wherever feasible, an on-site conservation presence is of value. Stanley Price (Chapter 1) has already discussed in some detail the kind of geographical, environmental and practical questions that must be asked at the pre-excavation stage.

Two comments may be added. Just as it is never safe to plan an excavation without a contingency sum, so predictions of the potential cost of field excavation can become gross underestimates in the face of some extreme contingency. Nevertheless it is possible to make an informed guess at the cost of preserving the objects from a site, and the conservator should have a role in removing this particular headache from the director of excavations.

Also, over the years, side by side with some of the excellent indigenous conservation facilities that have grown up, a tradition has existed of giving students from foreign institutions the chance to work in the field in Mediterranean and Middle Eastern countries. The experience provided has been of unrivalled value for the students concerned, and most of the work done of excellent quality, so no-one would wish to see this arrangement of mutual benefit disrupted. Nevertheless, it must be stated that conservation aid is often invoked as a kind of afterthought if the funds come through, and I have seen students at very short notice expected to assemble a kind of 'magic kit' from which to meet all emergencies.

Let us recognize that if useful volunteer labour of this kind is to be mobilized, it cannot replace a methodology based on forward planning. This includes a collation of all the relevant local information and a courteous and proper consultation with those local colleagues in the same professional fields who may one day expect to receive an increment to their material archive and for which they too need to plan.

2. Supervision of materials: on-site conservation

2.1 The conservator's functions

What is it that the conservator can actually *do* for an excavator on site that cannot be as well done by any other competent member of the excavation team? This question is difficult to answer, and the difficulty is compounded unintentionally by the several handbooks in existence giving advice on how to handle delicate, freshly excavated material. These are the products of both compunction and honesty. They are written by conservators who fear for the health of the object in post-excavation shock; who know that the excavator may be unaware of the physico-chemical changes such an object may suffer; and who also quite rightly recognize that descriptions of methods of handling frail material must be available to archaeologists who may, in emergency, have to carry out such techniques.

Although there is definitely a place for handbooks of this kind, they should never be regarded as a substitute for the problem-solving approach of a person whose brief it is to understand materials. Sease (Chapter 4) emphasizes that most of the techniques she describes are best carried out by a conservator; indeed, the archaeologist who exercised the required control over the packaging, storing and lifting of finds would have little time available to implement his or her own programme.

What is needed is an on-site conservator to work in close conjunction with the finds staff, helping to implement agreed policy for the safe recovery and recording of finds, with a general supervision of packaging and storage, using only those tested materials and techniques which are compatible with the object's safety, and advising whenever a problem material in encountered (e.g., a composite object). In the long run this is the only approach that is economical as well as ethical.

Following on from this, another key activity for the field conservator is the use of that indispensable piece of equipment, the good binocular microscope. This can be used to identify all classes of denatured, degraded and corroded materials, both natural and artifactual. It can also provide technological clues, about, for instance, metal coatings, decorative inlays, or preserved, altered organic material, as for example traces of a sheepskin sheath lining, or fragments of a wooden handle. It also often helps to establish the presence of that large spectrum of frequently mis-identified materials associated with small-scale glassworking and metalworking – the fuel ash slags, crucible fragments, droplets, spills, dribbles and glassy wastes of all kinds.

The microscope may frequently be called upon by other members of the excavation team with questions to ask about, for example, pottery, stone or environmental material, and it should be without question the single most important item in the conservator's baggage.

It is also, and above all, the conservator's brief to plan and manage the lifting and transportation of finds. Problems can be as diverse as the recovery of a small, delicate scatter of metal or bone, or a whole burial, better excavated en bloc with micro-techniques in the laboratory. They can range from a waterlogged wattle well-lining (Jones 1980) to the siege platform of a kiln (Price 1975) but much discussion will be necessary, and many questions asked, before the co-operative venture of lifting can be begun. Are the proposed materials to be used strong enough for the job, or too strong to be compatible with a fragile object? Will the object remain unconserved for so long that certain materials applied become irremovable? Will any adverse effects be experienced by the object entombed in its new microclimate? Can it be got out safely? It is too much to ask the archaeologist who has other practical and academic problems to solve, to ask and answer these questions; better to leave it to the professional conservator.

Three functions, then, have been identified for the on-site conservator after the initial planning stage:

(i) co-operative supervision of finds which ensures that materials are identified as excavated, that the right questions are asked of the material and the strata from which it came; that the recording is of a standard to facilitate subsequent laboratory conservation and publication (Coles, Chapter 6; UKIC Archaeology Section Guidelines 4) and that correct packaging and storage ensure as far as possible the preservation of the material;

(ii) a vigilant use of the microscope for all kinds of diagnostic purposes; and

(iii) a presence to be called upon for conservation emergencies which may include some form of *in situ* treatment or lifting techniques.

2.2 Conservation and investigation

These activities, useful and time-consuming though they are, do not, however, cover what is often in the excavator's mind when an on-site conservator is employed. A fairly normal expectation is that as much on-site cleaning and stabilization of freshly excavated material as possible will be carried out by the conservator. This tacit assumption is based on the sad fact that often no further stage of investigative laboratory treatment has been arranged or is available. Alternatively, the excavator may be part of a visiting team and may therefore not be in a position to take advantage of what could be adduced from radiography and investigative handling. It should be given a thorough airing in the pre-excavation planning stage.

Obviously, some classes of material must have conservation processes carried out in order to be removed from the soil at all – wall plaster, mosaics, fragile assemblages of pottery or bone; while others, such as robust pottery, can perfectly well be cleaned and stuck on site, given that certain safeguards are observed; but how far is it possible or ethical for a conservator to clean metal objects, for example, without radiographic facilities? Copper alloy objects are, less often than iron objects, corroded to the point where information exists merely as a change of density on an X-ray plate. Nevertheless there are occasions when it is too risky to attempt to clean an object without using radiography.

Suppose the copper alloy object in question was a coin which the excavator needed to help unravel a particularly enigmatic chronology? This would obviously be an occasion for the fullest discussion between conservator and excavator. The experienced conservator knows when a particular coin can be cleaned without benefit from radiography and also those occasions when only radiography can establish whether or not any permanent detail is preserved in a mass of corrosion products. Although it may be both possible and helpful to clean copper alloy objects in the field, and perhaps to stabilize them (especially before consigning them to a period of unattended storage), *no conservation process should ever be carried on past the stage when another technique – e.g., radiography or some other form of analysis – could elicit more information.*

So far the arguments presented have been that a conservator is needed in the field precisely to carry out those techniques and exercise that supervision which Rose (1975) for example, is content to leave to the excavator. In order to substantiate the view that the care of freshly excavated material is not always a straightforward task, let us take iron, a material which is gravely at risk, but which is often the subject of simplistic advice. Recent work (Turgoose 1982) has demonstrated that the corrosion process is itself more complex than was thought. Although the Chloride ion has not been exculpated as the villain of the piece, the conservator now understands better its ancillary role in the breakdown of ironwork, and also appreciates that it cannot be wholly removed by any treatment. The most effective method of removing chlorides from an iron object, it is suggested, is by washing in alkaline sulphite (North and Pearson 1975) but it is found that its efficiency is diminished if the object has dried out. Yet the most unequivocal, theoretical research on the storage of iron (Turgoose 1982: 97) suggests that the only safe method of preventing corrosion in storage – apart from the removal of O_2 – is to dessicate to 15% RH.[2] On the grounds of cost and utility this is the method most often used by field archaeologists and recommended by conservators.

Improved radiographic techniques ensure that much information can be obtained from totally corroded objects. This can be complemented by micro-investigation by the conservator; and lately some very exciting new work by Scott (unpublished conference, Leeds, 1983) has indicated a real possibility of finding remnant metallurgical structures retained within the corrosion products.

Obviously, this material is full of potential but it is apparent that difficult decisions must be taken even before iron is stored. These should be the result of an exchange between the archaeologist who knows the cultural context and value of the objects, and the conservator whose task it is to keep abreast of current thought in conservation and technology. One cannot ever reduce the care of such materials to a recipe which can be applied safely in all cases.

Apart from the contradictions and difficulties inherent in the storage of iron and many other fragile materials, there are decisions that must be weighed and cannot be made on an *ad hoc* seasonal basis. For example, where is the material to be kept between seasons; who is to monitor it and, for example, perform the simple but necessary task of changing silica gel, or seeing that damp glass has not grown mould? What kind of treatment is envisaged for the material in the future, which must not be pre-empted on site? If there is no laboratory facility, may the material be temporarily exported; and if so, when returned to the country of origin how will it be permanently stored? For as well as grappling with problems posed by the nature of freshly excavated material, the conservator, excavator and the policy-making body of the country in which excavation is to take place have to do some hard thinking about the implications of increasing the indigenous material archive.

2 Some research by Knight (Ancient Monuments Laboratory, London) suggests that damp storage in earth could be effective; but this work is still in progress.

2.3 Minimum requirements for on-site conservation

For on-site conservation, some kind of enclosed space is needed so that excessive changes of temperature, RH and air currents can be at least approximately controlled; and sand, dust, rain, insects, etc., excluded. A good, natural light source and, if possible, an artificial light source which can be moved to bear on the problem in hand are important. Other necessities are a supply of clean water and deionized water for making up reagents; ample bench space; a good binocular microscope with a lamp and as flexible a head and as great a depth of field as possible; camera and film; a personal choice of hand tools; sufficient laboratory glassware and containers; lockable cupboards for finds and small quantities of reagents; the reagents themselves, and an outside lockable store for flammable solvents. Storage and packing materials will have been planned for at an early stage.

A fire extinguisher and some arrangement for the safe use of toxic chemicals is essential. This may simply be the use of respirator, goggles, gloves and a fan to direct vapours away; but it is important to consider the health of the people on site as well as the survival of the finds.

This minimum provision could be provided at relatively little cost. But it cannot be too strongly suggested that it is but a necessary half-way house to the permanent conservation laboratory which has the task of 'preserving the material archive for the foreseeable future.'

3. Conservation facilities

Planning and supervision have been discussed above under separate headings. Perhaps now it is necessary to make a value judgement and say that good permanent storage (see Scichilone, Chapter 5) must be considered as even more important than the establishment of investigative conservation facilities, if a hard choice has to be made.

Nevertheless, what models can be found for developing field conservation in an area where funding, terrain and human geography may vary very much from country to country? Building on indigenous strengths is always a useful approach. Where travel facilities are really good and a sound conservation infrastructure already exists, a 'flying conservator' service could suffice, providing that there were frequent enough visits to ensure a regular supervision of excavated material, and ready access in case of emergency.

In Britain, for example, it is usual to find a regional conservation laboratory with conservators appointed to exercise the supervision described. The system works fairly well when a laboratory exists within quick visiting distances of several urban sites (as at York and Lincoln, for example). Generally speaking, the greater the distance from the site to the laboratory, the more mishaps occur.

In Sweden (Nylén 1975, 213), the travelling laboratory has been developed, with the inestimable advantage that techniques are available to X-radiograph whole strata in the field, or when removed en bloc. The Swedes are also notable for their willingness to employ hitherto unusual solutions for excavating problem material, e.g., air or water brushes, or CO_2 for freezing and lifting scattered grave goods.

In some respects countries with few facilities of their own and a long tradition of playing host to visiting excavators are in a strong position if they are able to consider developing their own conservation infrastructure. They need not continue an outmoded concept of 'field conservation' taking place in a ramshackle hut on the fringes of the excavation. Instead, they can think flexibly about their own real needs, taking advantage of the 'minimal intervention' theories presently being propounded by archaeologists and conservators, as we ruefully contemplate how much information may have been lost by well-intentioned but misguided intervention in the past.

Three field conservation functions were outlined above. The key to the initial preservation of the material archive lies in these three functions being effectively carried out in the field; the key to the archive's continuance lies in the provision of good monitored storage facilities; and the key to its exploitation as a rich cultural resource can only be found in the establishment of permanent laboratory facilities with an investigative approach to conservation.

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OBJECT INTERRED, OBJECT DISINTERRED

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Introduction: object interred, object disinterred

When any object, whatever it may be, is put in the ground, it generally finds itself in a different environment to that for which it was made. The essential characteristics of this new environment are:

- absence of light
- frequent presence of mineral salts carried in water
- contact with more or less corrosive soils
- an extremely stable temperature
- an extremely stable relative humidity (RH)
- limited access of air (particularly oxygen)

When in contact with this new environment, the object will undergo a transformation regardless of whether it is of an organic material (wood, textile, skin, paper) or an inorganic material (stone, ceramic, glass, metal). This transformation can affect its colour, weight, material, or size. In most cases transformation will lead to the total destruction of the object. In certain cases, unfortunately very rare, the object will not be destroyed because transformation will have brought the object to a new stable state. One says the object has reached an equilibrium with its environment.

The discovery of the object will generally involve transferring it to a new environment, again different, characterized by:

- variable RH with values considerably higher or lower than those of the soil;
- air, containing O_2 (plus CO_2 , SO_2 and other acid gases); and
- light, which can activate oxidation processes.

This abrupt change can be quite traumatic for the object, setting in motion processes that can result in its complete disappearance, sometimes within a few hours of discovery.

To avoid this destruction it is essential to understand the condition of the object at the moment of its discovery and the changes that it has undergone while it has been in the ground.

1. Some physical characteristics of materials that affect their conservation

(a) *Organic.* These materials come from the animal and vegetable world:

- They usually burn if ignited.
- They are sensitive to light.
- When the RH is above 65% and there is poor ventilation and no light, micro-organisms can grow on organic materials at their expense and will disfigure and weaken them in the long run.
- Most of them are hygroscopic and absorb water readily, undergoing a change in dimension.
- They tend always to keep their water content in equilibrium with the ambient RH.
  Consequently, *if the air is drier than they are*, they will give up water vapour and dry out. They lose weight and shrink, and are in danger of cracking.
  If the air is more humid than they are, they will absorb water vapour and become damp until they again reach an equilibrium with the ambient RH. In the process they will increase in weight and volume.

(b) *Inorganic.* These materials come from the mineral world:

- They usually do not burn when heated.
- They are not usually sensitive to light.
- Micro-organisms do not generally grow on these materials, or, if they do, it is not at their expense.
- Stone and ceramics are porous. They transport water in liquid form by capillarity. When put into contact with water containing soluble salts (as can happen underground), they will take them up. Once the object is excavated, these salts, being often hygroscopic, will take up water vapour from damp air, or crystallize in dry air. Metal and glass are not porous but can undergo chemical change (corrosion) which will transform these materials into mineral salts (either soluble or insoluble, but always sensitive to humidity in the air).

2. The underground environment

Anyone who has been in the cellar of a house will recognize the characteristics of the underground environment:

- lack of light;
- frequent presence of soluble salts (commonly, but often mistakenly, called saltpetre);
- contact with a soil containing water, salts, acids (or bases), etc. (a metallic object on the ground will corrode very quickly);
- a stable temperature (required for keeping wine in temperate climates); and
- stable humidity in general.

Conditions underground can vary considerably depending on the local situation:

(a) In desert areas, humidity in an enclosed space underground will vary according to the soil and the depth of the water table. By way of example, the tomb of Queen Nefertari in the Valley of the Queens in Egypt has a stable RH of 30%, whereas the tomb of Nefer at Saqqara has an RH of 66% (Nasri Iskander, personal communication). Of course, over the centuries, exceptional cloudbursts have resulted in considerable quantities of water entering these tombs and temporarily raising the RH.

(b) In cavities of an unusual nature, such as the salt mines of Wieliczka near Cracow in Poland, the RH is perfectly stable at 76% (the RH of a saturated salt solution).

(c) In general, in non-desert areas, the RH reaches 100% at a certain depth in cavities in the ground – i.e., the air is saturated and no evaporation is possible. An example is the prehistoric site of Lascaux in France.

Moreover, temperature in the ground is the result of heat's being transmitted by the soil. Seasonal variations that can be found at the surface will be reduced and eliminated the deeper one digs into the ground. At a depth of 5-6 m, the air temperature becomes extremely stable and can vary annually by only 1°C.

3. Modification, transformation, reaction of an organic object during burial and exposure

3.1 Burial

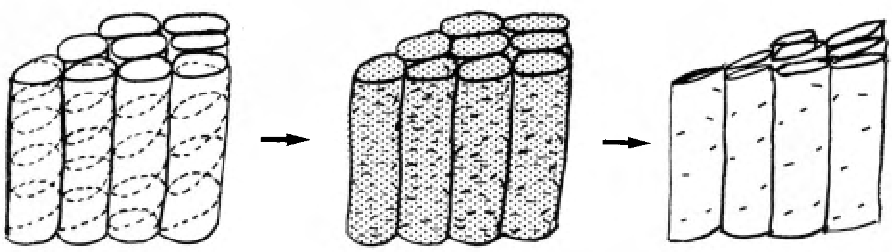
The absence of light and contact with more or less corrosive soils and with soluble salts are lesser factors in the deterioration of organic objects. A major factor is the level of the air's RH. It is this which will bring about deterioration.

If the RH is low, organic materials are in general well preserved. At worst, if the air in a cavity is too dry, cracks can appear. On the other hand, in a moist environment, organic materials have a very high probability of being attacked by micro-organisms (bacteria, fungus, mould). These will usually lead to the slow destruction of the object.

However, it is important to note the particular case of partial destruction when wood is immersed in water. Wood is composed of lignin and cellulose. Lignin (solid line in the drawing) forms kinds of empty tubes. Cellulose (dotted line in the drawing) forms spiral springs in the interiors of the tubes, preventing the tubes from collapsing inwards (fig. 1a).

During a long stay underwater, cellulose will gradually dissolve and disappear. The tubes of lignin do not collapse, however, because the water that has entered them plays the role formerly played by the cellulose. In this way, although it retains its appearance, the wood is transformed and is called 'waterlogged wood.' So long as it remains underwater, it will retain its shape and appearance perfectly well for hundreds of years (fig. 1b). The same is true of leather.

Figure 1.



a) Normal wood: lignin + cellulose

b) Waterlogged wood: lignin + deteriorated cellulose + water

c) Waterlogged wood exposed to the air: deteriorated lignin + cellulose

It is essential to understand that, whatever the humidity underground, certain organic objects are going to disappear and others will adapt to the prevailing humidity.

It will not be an object in wood that is going to be discovered but an object in wood that has been transformed into a new material which is stable only under certain humidity conditions. Therefore, any abrupt change of RH caused by its exposure can be fatal.

3.2 Exposure

Only by chance does the same humidity prevail below ground as above ground. Most of the time the air is drier above ground. Therefore, at the moment that a tomb is opened, drier air (not to be confused with warmer air) will penetrate the tomb and dry out the organic materials. The result will be a rapid transfer of water vapour from the object towards the air, causing a contraction of the surface of the material and pressure on its interior. From that moment on, there is a danger of surface splitting.

The same will happen when an organic object is excavated from the soil. In the case of waterlogged wood, this phenomenon is all the more impressive in that, with the evaporation of water from the object, the lignin no longer has interior support and collapses. The object can also irreversibly lose up to 90% of its weight and 80% of its volume within a few hours (fig. 1c).

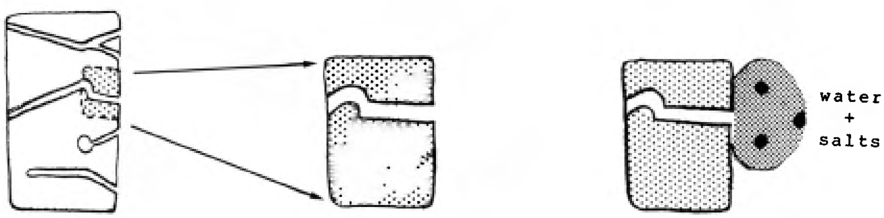
4. Modification, transformation, reaction of a porous inorganic object during burial and exposure

4.1 Burial

The absence of light and changing RH do not usually affect stone and ceramics, but the pH of the soil may do so. Moreover, the soluble salts and liquid water present in the soil, while not changing the external appearance of stone and ceramics, will penetrate into them, sometimes to the very core of the material.[1]

The process is simple. Stone and ceramics, being porous, contain an infinite number of minute pores. Through capillarity, these can absorb water and any salts previously dissolved in it right into the core of the material (fig. 2a-2c).

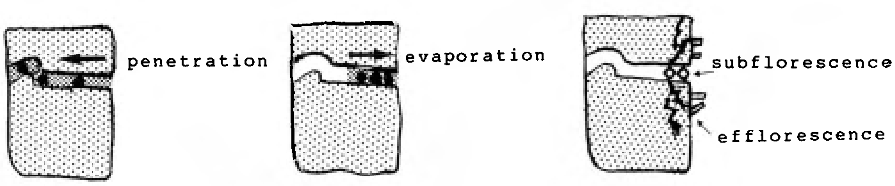
Figure 2.



2a) Section of a porous material

2b) Enlarged pore

2c) Put into contact with a drop of salty water



2d) The water has penetrated by capillarity, carrying the salt inside

2e) If the stone or brick dries out, the salts will concentrate towards the exit of the pore

and will crystallize with a mechanical effect that can cause fractures

1 All soils contain soluble salts in greater or lesser quantity. If the soil is near the sea, or is part of a former marine deposit, the quantity of sodium chloride is particularly high. Salts can also be introduced artificially through fertilizers and salt stores or through the de-icing of roads in cold countries, etc., by spreading mixtures of chlorides.

So for most of the time they are not merely stones or ceramics or mosaics that are discovered, but stone-with-salts, ceramics-with-salts or mosaics-with-salts.

4.2 Exposure

The discovery of a porous object either in a tomb or in the ground will generally put it into contact with drier air. The water filling the pores will then slowly evaporate and the water in the middle of the object will slowly migrate towards the surface, carrying soluble salts along with it. These arrive at the surface of the object, obviously cannot evaporate, and so they crystallize. This crystallization can sometimes happen beneath the impermeable surface of an object. All salts exert a pressure inside the pores at the moment of crystallization which may burst them, resulting in a surface flaking of the object to a greater or lesser extent (fig. 2d-2f). Crystallization can also occur on the surface of an object, which will be covered with a whitish deposit.

It is also essential to recall that insofar as a porous object contains soluble salts, these will move into the object according to the variations in the RH of the air. The process of dissolution, crystallization, re-dissolution and re-crystallization will result in microfissures on the object and an acceleration of its disintegration. One can easily see examples of this on archaeological ceramics on display or in reserve collections.

5. Modification, transformation, reaction of metals during burial and exposure

5.1 Burial

Apart from gold, metals are an unstable form of material. Minerals (salts or metallic oxides from which the metals were extracted) are the stable compounds of metals. The natural tendency of a metal is to regain its stable form and so to corrode, since the corrosion product is the salt or metallic oxide.

In the absence of water, corrosion affects, in general, only the surface of the metal and is seldom able to penetrate in depth (dry corrosion). When a film or water is formed on the surface, electrochemical corrosion (wet corrosion) takes place and it may cause a transformation in depth.

Absence of light will not damage a metallic object. On the other hand, the presence of oxygen and soluble mineral salts, contact with a more or less corrosive soil and a high RH will accelerate the transformation of the metal into a corrosion product (fig. 3).

This corrosion, which is due to the formation by chemical reaction of new products (sulphates, carbonates, chlorides, oxides, sulphur, etc.), will bring about an increase in volume of the object, a change in weight, a change in colour and a weakening of mechanical properties.

Thus a bronze object which was yellow might exceptionally remain yellow, but in most cases it will become red, black, blue, pale or dark green or layers of these colours depending on the environment(s) in which it is found.

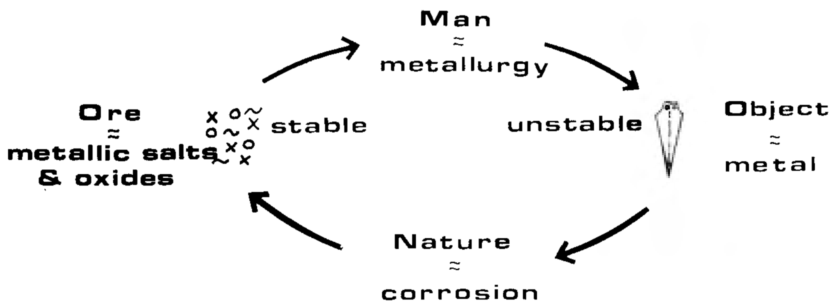


Figure 3. Corrosion is a natural destructive process which tends to re-form the salts and oxides from which the metal was extracted.

Since corrosion is due to a chemical transformation of the metal, it develops at the expense of the metallic object. So, also, it is not an object of bronze or silver that is discovered but an object of which a large part of the metal has been transformed.

5.2 Exposure

One might think that an excavated metallic object would not undergo further alteration because it has been removed from the corrosion stimulants; but there exist two types of corrosion:

- stable or passive corrosion which ceases its action the moment the object is removed from the soil in which it is found;
- unstable or active corrosion which continues its action at the expense of the remaining metal even if the object has been removed from the corrosive soil in which it was found. When the RH rises above 45%, the chlorides – or 'bronze disease' – are reactivated. This can happen within the space of an hour and can be very violent.

Active corrosion is frequently due to chlorides. It is especially common, therefore, on metallic objects found near the sea or in deserts. It appears in very bright green spots.

Consequently, if the bronze object has active corrosion, it will be essential to keep it in dry air, i.e., at 35% RH, if one does not want to run the risk of seeing it irreversibly transformed.

6. Modification of a glass object during burial and exposure

6.1 Burial

Glass is a composition of which the principal constituents are silica, lime and sodium oxides. It follows that, depending upon the proportions of the constituents, one will obtain not glass but various glasses. After burial in the ground, complex decomposition processes will transform the lime and sodium oxides into carbonates. This change often gives the object an iridescent appearance. If the alkali content of the glass is high, the corroded material is hygroscopic.

6.2 Exposure

At the moment of discovery, if the RH of the air is too high, the hygroscopic salts will absorb water vapour. At the other extreme, if the RH is low the hygroscopic salts will crystallize, with the risk that the glass will become even less transparent and may undergo mechanical damage. A suitable environment must be found for it, which is not an easy task.

7. Conclusion

Whatever the material of an object that has been buried in the ground – deliberately or accidentally – the burial will have brought about a profound physical, chemical or mechanical alteration:

- loss of weight, or sometimes a gain
- change of size
- change of colour
- change of chemical composition, etc.

This material was the material carrier of a message, either human, historical or technological, which the object brought to us. In order to let the object retain its message as intact as possible, it is essential from the moment of discovery to take a series of measures which will prevent the object, already mutilated by its stay underground, from being even more damaged by its being brought to light.

4

FIRST AID TREATMENT FOR EXCAVATED FINDS

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Impact of excavation

Any object buried in the ground for any length of time will have approached or reached virtual equilibrium with its surrounding environment. From the very moment the object is exposed to air, the processes of decay and corrosion can start. For organic materials this process can be very rapid; without treatment, they can disintegrate within hours while, at the other end of the scale, other materials – well-fired pottery or stone, for example – deteriorate little, if at all. With the majority of materials excavated, however, deterioration will inevitably occur unless positive preventive steps are taken. Such conservation steps are described in the following pages. It should be pointed out, however, that this can only serve as a guide. Every object must be treated individually as no two objects are exactly alike, even though they may be made of the same material and have been buried within inches of each other. If problems arise, do not hesitate to consult with a trained conservator. He or she can give invaluable help and advice, especially for a specific site.

In the following sections, reference is made to a variety of conservation materials. A list of suppliers can be found at the end of this chapter. These materials are cited specifically because they are of good quality and have withstood the test of time and, more important, of reversibility. A primary rule of conservation is that any process applied to an object must be reversible. For example, any consolidant or adhesive applied must be able to be removed whether the following day or within a year or more. It is important, therefore, that the materials cited be used. Do not use something else that looks or sounds the same as what is recommended here. If improper materials are used, even trained conservators may not be able to reverse the process if necessary. If in doubt about suitable material or replacement for something mentioned below, consult a trained conservator.

Pottery: lifting

Do not pry sherds out of the ground. Before lifting them, carefully remove all dirt surrounding them, especially if the dirt is dry and hard. Drops of water applied locally to hard dirt will help to soften it and facilitate the lifting procedure. Wooden spatulae are good for cleaning around sherds in the ground as metal tools or trowels can scratch and abrade pottery. Freshly uncovered pottery while still damp can be very soft and friable. Do not lift the sherd before ascertaining the condition of its surface. Make sure there is no paint layer or applied decoration that has become or will become detached from the sherd when it is lifted. If this is the case, remove the surrounding dirt so that the sherd sits on a pedestal, cut through the pedestal 2-3 cm below the sherd and lift it along with the sherd making sure that the two do not become dislodged from each other. Wrap them together carefully and firmly; pack the bundle so that it is well cushioned and take it to a conservator. See also the block lifting technique described in the section on bronze.

All sherds from the same pot, including the smallest, most insignificant-looking pieces, should be kept together after removal from the ground. When a large concentration of sherds is found, it is not always possible to tell immediately whether they all belong to the same pot. It is safer, therefore, to collect and keep together all sherds found together. Later, sherds can be returned to the pottery batch if they do not belong to the pot.

When sherds come out of the ground, avoid the temptation to clean them on the spot by scraping, brushing or rubbing. In this way, decoration can be removed (or added) and edges can be abraded, making for bad joins later on.

All sherds showing signs of fugitive paint, badly flaking surfaces or soft fabric should be separated out at this stage and marked for special treatment by a conservator.

When a pot is found intact, it can generally be lifted out after carefully removing all dirt around it. The contents of the pot should be excavated carefully, sieved and possibly sampled. Intact pots can contain the remains of their original contents or faunal remains that might give clues as to what the contents might have been. Objects and burials are also found inside pots.

If an intact pot has major cracks or breaks, leave the dirt inside to provide support, and bandage the pot firmly with strips of gauze or cloth to support it; with long strips of bandage, wrap the pot tightly in a gradual spiral being careful to overlap the strips (see figure 1a). Approximately ⅓ of the strip should overlap the preceding one and, in turn, be covered by the succeeding one. When one strip ends, fasten it securely with tape or a straight pin if it will not dig into the surface of the pot. Continue wrapping the pot in this manner until it is adequately supported. It may not be necessary to bandage the entire pot. If necessary, for added support, successive layers can be added on the opposite diagonal to the first layer of bandage and also vertically (1b, 1c).

If the pot is broken, but the sherds are still held in place, wrap the pot tightly in bandage leaving the contents inside. If the pot is large, this bandaging may have to be done piecemeal as the dirt is slowly removed from around the pot.

If bandaging is not sufficient, a more rigid support can be achieved by putting the pot into a bucket and surrounding it with dirt. It can also be wrapped further with a more rigid material such as plaster bandage. Bandage already impregnated with

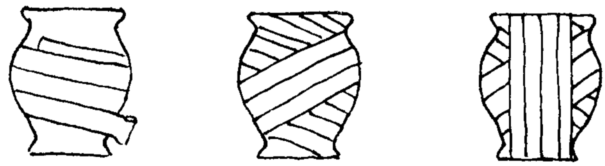

Figure 1

plaster can be obtained at a chemist's. Dip a long strip in water and then wrap it around the pot as outlined above following as tightly as possible the contours of the pot. Allow the plaster to dry thoroughly before lifting the pot.

If ready-made bandage is not available, plaster bandage can be made by mixing up a watery mixture of plaster of Paris, dipping the bandage strip into the plaster and then wrapping it around the pot. If plaster is not available, the same method can be employed using undiluted polyvinyl acetate (PVA) emulsion. Dip the bandage strip into the PVA and then wrap it around the pot. To prevent the surface of the pot from absorbing any of the plaster or PVA, make sure that impregnated bandage is not applied directly to the surface of the pot. Always apply a separating layer of foil or cling film first.

If it looks as though the sherds will move and rub against each other in spite of bandaging or that the pot will collapse, it is better carefully to take the pot apart, keeping the sherds together.

Pottery: consolidation

If a pot or sherd is too fragile to be lifted from the ground without damage, additional support is necessary. If simple bandaging is not sufficient, the pottery should be impregnated with a consolidant. The choice of consolidant depends on the condition of the pot. Whichever consolidant is used, allow it to dry thoroughly before lifting the sherd. A sherd still wet with consolidant is more fragile than it was before the consolidant was applied.

If the pottery is damp, a PVA emulsion should be used. Since the emulsion is water based, good penetration will be achieved easily. Clean the pottery to be consolidated as thoroughly as possible with a soft brush. Dilute the emulsion 1:1 with water and apply it sparingly with a brush allowing it to soak into the sherd. Keep applying more emulsion, waiting a few minutes between applications until it is no longer absorbed by the sherd, but try to avoid surface build-up. Allow the consolidant to dry completely before lifting the sherd.

When the pottery is dry, a solution of *Paraloid B-72* or PVA (resin, not emulsion) in toluene or acetone can be used. After cleaning the sherd, apply the solution by brush starting with a low (3-4%) concentration for the first two coats. Then increase the concentration, ending with a 7-10% solution. The method of application is the same as above. Allow the solvent to evaporate somewhat in between applications, but do not let it dry completely as this will impede penetration. In arid, hot climates it may be found that acetone is too volatile to be used effectively as a solvent. If available, methyl ethyl ketone or toluene can be used. If only acetone is available, the only alternative is to carry out the consolidation process at a time when the air and sherds are as cool as possible. Covering the pottery with a piece of plastic sheeting after applying the consolidant will also help to slow down the evaporation rate. Make sure, however, that the plastic material is not dissolved by the solvent in the consolidant.

If a large piece of pottery or pot is found badly crushed into a myriad of cracks, breaks, small chips and pieces, do not attempt to lift all the pieces individually. Rather, treat them as a whole and lift them together with the help of bandaging. Use the backing procedure or one of the block lifting techniques outlined in the section on bronze.

After lifting, pack the sherds carefully in well-padded containers. If cotton "wool" is used, keep a layer of tissue between it and the pot, especially if PVA is used as PVA softens when hot and the cotton fibres will stick to the pot. If possible, store consolidated sherds in a cool place.

Excess consolidant will have to be removed in the lab, possibly to the detriment of the pot, so apply the consolidant sparingly. There should never be a thick, glossy layer on the surface of the sherd. Make sure that the kind of consolidant used is recorded and that this information is given to the conservator.

Do not consolidate any sherds to be used for dating or analysis as this will contaminate the sample.

Pottery: cleaning

Not all sherds need to be washed. A gentle brushing is often sufficient to dislodge dirt.

Carefully inspect all sherds to be washed to make sure that they are in fact pottery fragments. It is easy to mistake fragments of tuyères, moulds and crucibles for pottery. This industrial material should not be washed as valuable information can be lost. Pack it carefully and take it to an expert.

The majority of well-fired sherds can be washed without special care. If there is any question as to the durability of the sherds, test an insignificant sherd in water first. Do not wash a sherd that needs consolidation or has already been consolidated. Friable pottery and pottery with fugitive paint or ink should go directly to a conservator without washing. If a brush is used, do not scrub too vigorously as edges can be abraded, making for bad joints later. Change the wash water frequently, if possible, as dirty water can be very abrasive. After washing, spread the sherds out and allow them to dry thoroughly before marking and bagging them.

Sherds are sometimes heavily encrusted with insoluble salts or a mixture of dirt and insoluble salts which will not come off in water and require treatment with acid. Before subjecting pottery to this treatment, test an insignificant sherd first to make sure the pottery fabric can withstand contact with acid. Not all pottery can be treated with acid; a calcareous or organic filler in the pottery will be attacked by acid which will drastically weaken the pottery, if not cause it to disintegrate altogether. If acid does not harm the fabric, soak the sherds for several hours in water to wet thoroughly the fabric. Then immerse them in dilute (5%) hydrochloric acid, checking them frequently, until the encrustation has been dissolved or loosened sufficiently to allow it to be removed mechanically. If the pottery shows any sign of deterioration, remove it immediately and rinse it thoroughly with water. After going through acid, all sherds must be thoroughly soaked in several changes of water, preferably distilled water, until a neutral pH is achieved, that is, until all traces of acid are gone. pH indicator strips can be used to determine when this stage has been reached. The sherds can then be dried. It should be emphasized that this rinsing process is extremely important. If all traces of the acid and the soluble salts it produces when dissolving insoluble salts are not removed from the pot, they can cause considerable damage later on.

It should be noted that acid can be extremely dangerous when handled by inexperienced people and should not be used unless absolutely necessary. Strict safety precautions must be observed at all times. Always add acid to water. Always wear thick rubber gloves when handling acid or sherds in acid. Use the acid in a well-ventilated area and be careful not to inhale fumes from it. Dispose of used acid in a safe place after diluting it with water.

Pottery: soluble salts

If, upon drying out, either from washing or after lifting, a white efflorescence appears on the surface of the pottery, it probably contains soluble salts. The removal of soluble salts from pottery is not generally undertaken in the field and requires considerable space, a plentiful supply of uncontaminated or distilled water and someone to monitor the treatment. It is also difficult in the field to determine which soluble salts are present and when they have been removed.

If pottery is known to contain soluble salts, it should not be allowed to dry out after washing. Wrap it in damp polyurethane, adding a small amount of 0.01% *Panacide* and place it in three well-sealed polyethylene bags and take it to a trained conservator as soon as possible. Do not allow the bags to dry out. If large quantities of pottery are involved, it might be feasible to set up an on-site salt removal treatment. Ask advice from a trained conservator who is familiar with the site, the soil conditions and the pottery.

Pottery: marking and piecing together

To prevent marking ink from soaking into the pottery fabric and becoming irremovable, first coat the area of the sherd/pot to be marked with a thick layer of lacquer. When it is dry, write the number on top of the lacquer and coat it with another layer of lacquer. A fairly viscous solution of PVA resin or *Paraloid B-72* can be used. Clear nail varnish works well and is generally readily available. If it becomes necessary to remove the number, acetone on swabs can be used.

The joining of pottery is best done by a trained conservator. If profiles are needed in the field, join only what is necessary. Joins made by inexperienced people in the field generally have to be taken down in the lab to the detriment of the pot. Do not join damp pottery. If the adhesive turns milky, the pottery is still too damp.

A re-dissoluble adhesive should be used. *HMG* and *UHU* are suitable and are both soluble in acetone. Avoid white glues as they can become insoluble over time. Also, it is best to avoid any local proprietary glues as they may contain substances harmful to the pottery or become insoluble over time. All pots joined with *UHU* should be kept away from extreme heat and sun or they will sag and/or collapse.

Before applying the adhesive, thoroughly clean the edges to be joined. Apply a sufficient amount of adhesive to achieve good contact, but not enough for excess to squeeze out along the joins. If this happens, do not wipe it off. Allow it to dry until it becomes rubbery and then gently rub it off with a finger or scrape it off with a knife. To facilitate piecing, sherds can be positioned in a tray filled with sand to hold them while the adhesive dries. If a sand tray is used, make sure that the join line is well above the sand to prevent sand from getting into the join. It is also important to make sure that joined pieces are properly aligned. Misalignments are generally cumulative and can completely throw off the assembly of the pot. If the surface of the pot is durable, sherds may be held in position with masking tape while the adhesive dries. Test first to make sure that the tape will not pull off pieces of the surface when removed. It must be stressed that taping joins should only be a temporary measure. As soon as the adhesive has dried, remove the tape. If left on for longer than 24 hours, tape can leave a stain on the sherds which can be difficult, if not impossible, to remove.

Keep a record of the adhesive used and make sure the conservator is given this information.

No restoration of missing areas should be attempted in the field without a conservator present.

Sherds can be packed in polyethylene or cloth bags, but make sure the bags are not too heavy when filled as sherds can be crushed by their own weight. If using polyethylene, make sure they are thoroughly dry first. Pack partially pieced pots in rigid containers using wadded paper if necessary to support them.

Pottery: unbaked clay

Objects made of unbaked clay range tremendously in strength depending on the nature of the clay, its density and to what extent it was sunbaked. Often unbaked clay objects are quite strong and can be handled easily. Do not wash them in water as they are likely to disintegrate. Dry brushing should be sufficient to clean them. If there are hard lumps of dirt or encrustation, they can be softened with drops of water or alcohol applied locally. If a brush does not then remove them, gently cut them off with a knife or scalpel, being careful not to damage the clay surface. If consolidation is necessary, follow the instructions for consolidating pottery. For joining, packing and storing, the normal procedures for pottery apply.

Pottery: glazed

Although glazed pottery is covered with a vitreous layer, it can generally be treated in the same manner as unglazed pottery. Glazed pottery only gives serious problems when the attachment of the glaze to the clay body is weak. The glaze layer is likely then to flake off in large pieces. Such pieces can be reattached with *HMG* or *UHU* after the pottery and the glaze have been thoroughly cleaned. The glaze, if sound, can be cleaned by gently swabbing it with water. If the glaze is still in place but loose, run a dilute solution of *Paraloid* along the edge of the glaze with a knife or fine brush. Only do this if the pottery is clean. If it is not possible to clean the pot, it is better to wrap it carefully to prevent any abrasion to the glazed surface and take it to a conservator.

The detachment of glaze can also be caused by the movement of soluble salts within the sherd. In such a case, small white crystals are generally evident on the clay body, on the glaze and in the cracks of the glaze. Reattaching the glaze with an adhesive in this instance can cause problems later on if it is not noted that the pot contains soluble salts. It is better not to reattach the pieces, but rather pack them carefully in tissue in a box and keep them with the sherds.

If the sherds are already dry, keep them as dry as possible and take them to a conservator. If the sherds are damp, keep them damp following the instructions given above for treating unglazed pottery with soluble salts.

Faience

Faience is a material similar to both glass and pottery. When fired, it becomes a porous, gritty material with a vitreous coating which is sometimes very thick and almost always coloured.

If found in good condition with its glaze intact, it can be treated like glazed pottery. Do not immerse it in water, but rather clean it with a swab of water. If the glaze surface is cracked or crizzled, avoid letting water seep down into the cracks.

More often, however, the outer vitreous layer is gone leaving only the porous inner core. Although this is difficult to clean as the pores are filled with dirt, do not attempt to wash it. Use only a dry brush to remove dirt, although drops of water can be used to soften hard lumps of dirt. Any further cleaning should be done only by a conservator.

Faience pieces can be joined with *HMG* or *UHU* following the general instructions for joining pottery. If the fabric is very gritty and powdery, it may be difficult to obtain a good bond. If this is the case, it is better to leave the joining to a conservator.

Glass

The condition of excavated Roman glass varies considerably depending on its composition, date and place of manufacture and burial conditions. Roman glass is generally very stable while medieval European glass is considerably less so.

If glass is found dry, keep it dry. A gentle brushing should be sufficient to clean it. Drops of alcohol or water applied locally can be used to soften hard lumps of dirt. If absolutely necessary, sound glass can be washed, using a soft brush to dislodge dirt, but generally it is wiser to clean without water. Allow the pieces to dry thoroughly before packing. Pack the pieces in layers separated by acid-free tissue, padding and supporting shaped pieces with tissue if necessary. Pad out the container to prevent the pieces from moving.

Do not remove or attempt to consolidate the thin skins on glass as they are the original surface. Pack such glass carefully in rigid containers and take it to a conservator.

If the glass is found extremely wet, it should probably be kept wet. Allow a small piece to dry out slowly. If it does not delaminate, crack or become opaque over a period of some weeks, it should be safe to dry the remainder. Allow it to dry slowly. If its condition worsens on drying, however, keep it as wet as when found. Pack the pieces in layers separated with damp polyurethane foam to which several drops of 0.01% *Panacide* have been added. Place the whole bundle in three well-sealed polyethylene bags and store them horizontally in a cool place until they can be taken to a conservator. If it is stored for any length of time, check it frequently to make sure that it does not dry out.

The storage of glass is a very complex problem; the kind of storage needed can depend on the composition of the glass in question. If large quantities of glass are being excavated, consult a trained conservator about the conditions appropriate to the type of glass found.

The joining of glass pieces is best done by a conservator as springing is frequently a problem and partially pieced glass can pose difficult packing problems. If joining in the field is absolutely necessary, *HMG* is a suitable adhesive. Follow the marking and joining procedures for pottery.

Stone

Most excavated stone is in good condition and requires no special handling. It can be cleaned with water and a soft brush. Alabaster, however, is soluble in water and should be cleaned by dry brushing only. Small pieces of sound stone can be joined with *HMG* or *UHU.* If stone objects are to be marked, follow the procedure for marking pottery.

If painted stone or ostraca are likely, examine the stone carefully for traces of paint or ink before washing it. If either is found, do not attempt to wash the stone. Take it to a conservator for treatment.

Stone, especially marble, is often found encrusted with insoluble salts which do not come off in water. Do not use acid as it will attack the stone as well as the encrustations. Gently cut off the encrustations with a scalpel or knife, being careful not to scratch or damage the stone surface. A drop of acetone can help to soften these salts. If the encrustation consists of more than sporadic, thin patches, do not attempt to remove it. Take it to a trained conservator for cleaning.

If a white crystalline efflorescence begins to appear on a drying stone, it probably contains soluble salts. Allow it to dry out slowly and then keep it as dry as possible and take it to a conservator noting the probable soluble salts. If the surface of the stone is painted and/or extremely friable and salts are present, it may be wiser to stop the drying process and keep the stone damp if a conservation lab is nearby. Place the stone in three well-sealed polyethylene bags and take it to a conservator as soon as possible. These salts may be all that is holding the stone together, so do not attempt to remove them without consulting the conservator.

Bronze, copper and copper alloys

Follow the same general lifting procedures as for pottery. If the object needs support before lifting, it should be backed with bandage. Carefully clean the surface of the object, being sure to expose the sides. With a brush, coat a strip of the object with a thick (15-20%) solution of *Paraloid B-72*. Place a strip of bandage slightly longer than the object on the *Paraloid* and gently tamp it down into the *Paraloid*. Add more *Paraloid*, if necessary, to ensure that the bandage is thoroughly saturated and in close contact with the bronze (see figure 2a). Apply additional strips in the same manner, overlapping at least 4 mm on each edge until the entire surface is covered. Be sure to include the sides of the object, pushing the bandage well down along the sides. Apply a second layer of bandage at right angles to the first (2b). Allow the *Paraloid* to dry thoroughly; it is dry when it has lost its milky colour. When it is dry, carefully excavate underneath the object (2c) and invert it so that the bandage is on the bottom. Store it inverted (2d), adding further support if necessary. Do not attempt to remove any adhering dirt or clean the object. Take it to a conservator.

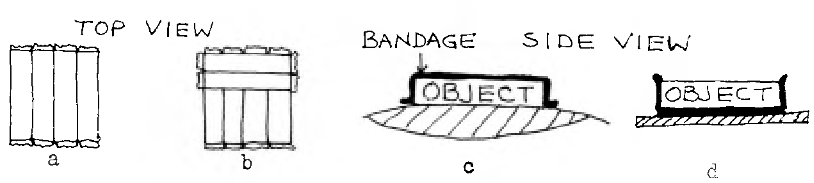

Figure 2

For very fragile objects, it is better to use a block lifting method if the surrounding soil is cohesive. Isolate a block of dirt containing the object with a 2-3 cm margin around the object and surround it tightly with a frame of wood or other rigid material (see figure 3a). Undercut the block and slide it on to a rigid piece of wood or metal (3b). Further support the block if necessary and take it to a conservator.

If the block method is not appropriate, an alternative method can be used. Remove all dirt around the object, leaving it sitting on a pedestal. Cover the object with foil or thin plastic sheeting to conform to the object's contours. Place a thin wooden frame around the object allowing a 2-3 cm margin all around (see figure 4a).

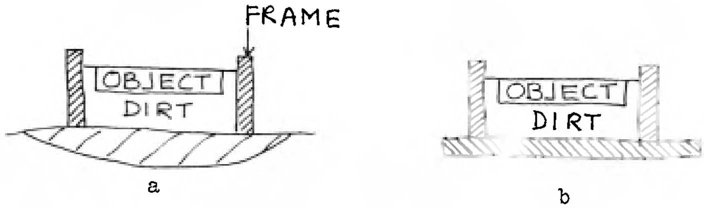

Figure 3

Cover the object and partially fill the surrounding space with plaster of Paris (4b). When it is set, place a layer of bandage or other strengthening material on top of the plaster and pour a final layer of plaster, filling the entire space and making the top as flat as possible (4c). Undercut the pedestal and invert the block and treat as above (4d). Polyurethane foam can also be used when large pieces are to be lifted and a lightweight material is needed (Jones 1980).

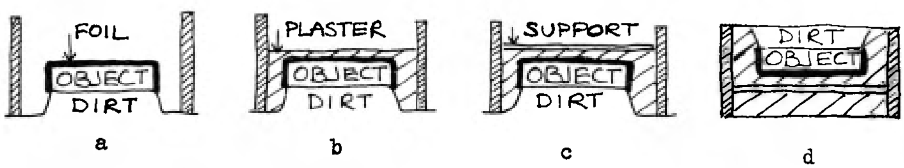

Figure 4

The corrosion of bronze can be extremely tricky and difficult to remove; therefore its removal should only be undertaken by a trained conservator. Injudicious cleaning can destroy not only decorative detail of the object within the corrosion layers, but also organic and environmental evidence preserved by the corrosion. Often this is the only way in which this kind of evidence is preserved. Undertake only superficial cleaning in the field. If the bronze is found wet, allow it to dry out slowly and gently brush off any dirt. If it is found dry, do not wash the object in water as this can initiate the corrosion process. This is especially true in areas where the water naturally contains large amounts of salt or where the water supply has been chlorinated.

Unnecessary handling can cause great damage as corrosion and dirt can hide cracks and splits in the bronze. Do not attempt to join any broken pieces.

Store bronze in the driest possible place and inspect it regularly. If possible, it is best to pack each object in a clear box of plastic padded with acid-free tissue or styrofoam. Place the object in a depression in wadded tissue and cover it with another wad of tissue to hold it firmly in place. Include some self-indicating silica gel in the bottom of the box if the storeroom is damp. It should be pointed out that silica gel is only effective if used in a sealed container. If boxes of plastic are not available, bronze objects can be stored in unsealed, polyethylene bags. If stored in a damp area, place those bags in a biscuit tin along with silica gel and seal the tin with tape or place them in a box and place the box in several thick polyethylene bags with silica gel and seal them tightly. A polyethylene food container with a snap lid can also be used. If the objects do not go directly to a conservator, check the bronzes frequently for the appearance of bright green spots. This is bronze disease and indicates active corrosion. Pack pieces with bronze disease in sealed containers with silica gel and see that they get to a conservator as soon as possible.

Self-indicating silica gel goes from dark blue to pink as it absorbs moisture. If it is used, it must be checked periodically and, when it becomes pink, regenerated by heating it in an oven until it becomes blue again.

Coins

Avoid the temptation to clean coins in the field. Injudicious cleaning by an inexperienced person can easily result in irreparable damage to the detail of the coin. Often a seemingly sound surface is really only a thin layer on top of a badly deteriorated, powdery bronze surface and can be easily destroyed with the least amount of pressure.

If a good, sound, original surface can be seen, some superficial cleaning can be attempted with a soft brush and alcohol or acetone, being careful not to scratch the surface. Do not attempt to remove any corrosion on the surface as the detail of the original surface may be contained in it.

Unless a good, sound silvery surface is evident, do not attempt to clean a silver coin. If sound, superficial dirt can be removed with a soft brush and alcohol or acetone. Such coins can then be treated like other silver objects.

Gold coins can be cleaned and treated like other gold objects.

Iron

Follow the same lifting procedures as for pottery and bronze.

If iron objects are found wet, it is preferable to dry them rather than store them wet even though some damage may result. Allow them to dry out slowly. If objects are found dry, keep them dry. Do not wash iron objects as water and oxygen cause corrosion. Gently brush the iron to remove dirt. Handle iron objects carefully and as little as possible. Often there is little sound metal present and the corrosion products can be extremely porous and fragile although they may look sound. No further cleaning should be attempted in the field nor should pieces be joined.

Pack iron in sealed containers with silica gel in the same manner as for bronze. Each container should have an approximately equal weight of silica gel and iron. Do not pack iron in sealed polyethylene bags without silica gel. If no silica gel is available, place the iron in perforated polyethylene bags and store them in as dry a place as possible.

Silver and gold

It can be difficult to recognize excavated silver. Often it is green and easily mistaken for bronze. It can also be a purplish grey or black. Excavated silver is usually extremely fragile and brittle and should be handled very carefully. Follow the general lifting procedures for pottery and bronze, but do not apply any consolidants to the silver. If support is needed before lifting, use one of the block lifting techniques outlined for bronze. Do not attempt to wash or clean the silver. Pack it carefully in well-padded boxes of plastic as for bronze, being careful not to put any undue pressure on the object.

Gold objects can also be difficult to recognize if there are impurities in the gold. Copper corrosion can completely cover a gold object and make it look like bronze. Make sure that the object really is made of gold. What at first may seem to be gold could be a fragile layer of gilding sitting on top of badly corroded bronze or iron. Injudicious rubbing or cleaning can damage or remove this gilding; therefore do not attempt to clean gilded objects. Pack them carefully as for bronze and take them to a conservator.

Gold objects need little treatment. A gentle brushing or washing is usually sufficient to clean them. If there are some light copper or silver corrosion products on the surface, they can be removed with swabs of very dilute nitric acid (ca. 1%). Do not immerse the piece in the acid. If gentle rubbing with a swab of acid is not sufficient to remove the corrosion, do not make further attempts to remove it. Rinse the object thoroughly in water before drying. Do not use the acid if it appears to damage the surface in any way. Also do not attempt to remove a thick covering of corrosion. Pack gold objects carefully as for bronze.

Do not attempt to unfold gold foil. It can be extremely brittle and will break along the folds if not unfolded properly.

Lead and pewter

Excavated lead is covered with greyish-white corrosion products and is generally quite stable. Although stable, it can be extremely weak and malleable, so handle it carefully and as little as possible.

Do not attempt to clean the object as lead is a soft metal and is easily scratched. Moreover, its corrosion products are generally harder than the metal itself. If inscriptions or decoration are present on the surface, they can be damaged inadvertently by brushing or scraping if cleaned.

The vapours from organic materials will cause lead to corrode, so pack lead objects only in polyethylene bags or boxes. Avoid paper, cardboard and wood, especially freshly cut wood. Only acid-free tissue should be used in packing lead. Follow the same packing procedures as for bronze, but it is not necessary to use silica gel. Cotton "wool" can be used for padding if it is sealed in polyethylene; or the padding can be made of synthetic fibres.

Do not attempt to unroll lead strips. This should be done only by a trained conservator.

Pewter is an alloy of lead and tin. Excavated pewter should be treated like lead.

Bone and ivory

For bone, follow the same lifting and consolidating procedures as outlined for pottery. If backing or block lifting is necessary, follow the instructions for the backing and lifting of bronze.

If sound, bone can generally be washed, but test a small piece first to see that it does not crack on drying. Use as little water as possible; do not soak the bone in water. A swab or soft brush can be used to dislodge dirt. Allow the bone to dry slowly and thoroughly before marking and packing, especially if it is to be packed in plastic. Do not wash bone that has been consolidated. If it is friable, attempt only superficial cleaning with a brush and pack it carefully in a well-padded, rigid container. If bone objects are marked, follow the same procedure as for marking pottery.

Bones and fossilized bones are often found cemented together with calcium carbonate. To remove such bones from this matrix and separate them from each other, the use of acid is necessary. Only apply this treatment to seemingly sound, robust bones. Remove as much of the soft, loose encrustation as possible with a scalpel or knife, being careful not to damage the surface of the bone. Then immerse the bone in 15% acetic acid. If only small, isolated amounts of matrix exist, the acid can be applied locally with a brush or dropper. A careful watch should be kept on the immersed bones at all times. Remove the bone after 10-15 minutes or when the fizzing has stopped and rinse it thoroughly in distilled water. Mechanically remove the softened carbonates with a scalpel or knife. As the surface of the bone is exposed, coat it with a layer of 10% polystyrene in toluene to protect it from subsequent immersion in acid. Allow the polystyrene to dry before re-immersing the bone in acid. If polystyrene is not available, a 10-15% solution of *Paraloid B-72* can be used. Alternate the acid treatment with mechanical cleaning until the bone is clean. After the final immersion in acid, thoroughly soak the bone in several changes of distilled water until a neutral pH is achieved. Be sure to follow the safety precautions for the use of acid as outlined in the pottery cleaning section.

If a soluble salt efflorescence appears on a drying bone object, follow the same procedure for this problem with stone. If it is absolutely necessary to keep the bone damp, a small amount of 0.01% *Panacide* should be included in the bag.

If sound, broken bone objects can be joined with *HMG* or *UHU*. Follow the procedure for joining pottery.

Ivory is often difficult to distinguish from bone when excavated. It is whiter, smoother and denser than bone and has a laminated structure. Often distinctive intersecting arcs can be seen on the end grain. Ivory is much more sensitive to moisture than bone and must be handled carefully. If it is found very wet, keep it as found. Do not attempt to clean or consolidate it. Wrap it carefully in damp acid-free tissue to which some 0.01% *Panacide* has been added, pack it in three well-sealed polyethylene bags and take it to a conservator as soon as possible. If found slightly damp, allow it to dry out slowly in the shade. If found dry, do not wash it; clean only by gentle dry brushing. Pack it carefully following the instructions for packing bronze, but do not use silica gel.

Shell

Shell is usually found in good condition. If sound, it can be washed in water with gentle brushing, if necessary, to dislodge dirt. If extremely friable, it can be consolidated by brushing on a dilute (2%) solution of *Paraloid* in acetone or toluene. If the shell is still damp, PVA emulsion should be used. Follow the procedure outlined for consolidating pottery.

On some sites, complete shells are found containing paint or that have themselves been painted. Do not wash these shells. Clean them only with gentle dry brushing. If the paint comes off to the touch, do not attempt any further cleaning or consolidation and take them to a conservator.

Cylinder seals are often made of shell. If at all doubtful about the condition of the shell, do not make a rolling as the entire surface can be pulled off if the shell is friable. The seal must be treated by a conservator first.

Leather

In general, leather does not survive unless unusual burial conditions exist. Although rare, it is possible for leather to be found dry. Never wash dry leather. Clean it only by dry brushing. If pieces are folded over or bent, do not attempt to relax or flatten them as this can result in cracking and tearing. Pack the leather in acid-free tissue and keep it in a dry place.

It is more common for leather to be found in a waterlogged state. Such leather has more than likely lost much of its internal strength so it should be handled extremely carefully and as little as possible. If waterlogged leather is allowed to dry out it will shrivel, warp and crack, possibly even disintegrate altogether. If it seems reasonably sound, it can be washed carefully in water using a soft brush to dislodge dirt. Often gentle streams of water can be useful in removing dirt. After cleaning, place the leather in three well-sealed polyethylene bags with some excess water to which 0.01% *Panacide* has been added. Store these bags, in turn, in a sealed container half-filled with water and some *Panacide*. Keep the container in a cool place until it can be treated by a conservator.

If the leather is extremely weak and cannot withstand even the gentlest cleaning, take it from the ground and put it directly into three well-sealed polyethylene bags along with some mud and *Panacide*; pack and store as above.

Wood

Wood is similar to leather in that it does not usually survive unless unusual burial conditions exist. Wood is rarely found dry. If it is found, however, keep it dry and clean it only with gentle dry brushing, making sure the brush does not damage the surface. If extremely fragile, it can be consolidated with *Paraloid* following the instructions for consolidating pottery. After applying the consolidant, be sure to cover the wood with a sheet of plastic to slow down the evaporation rate. This will serve to minimize stress on the structure of the wood as the resin dries, thereby preventing warping.

Waterlogged wood is not uncommon. Keep such wood wet. Drying out even for a few minutes can cause irreparable damage. If it cannot be taken out of the ground immediately after uncovering, keep it continuously wet by spraying and/or covering with damp cloth and/or plastic.

Some waterlogged objects are so degraded and fragile they require support before lifting. Due to the wet conditions, consolidation rarely proves successful, so it is generally better to attempt one of the two block-lifting techniques described under bronze. When the blocks are lifted, support them carefully and prevent them from drying out by wrapping them tightly in plastic. It is best to attempt such lifting procedures only when a conservation lab is near so that the block can be taken there immediately upon removal from the ground.

Sound waterlogged wood can be cleaned with water. Handle it carefully, however, as its soft, cheesy surface can be damaged easily. Pack it in three well-sealed polyethylene bags with excess water to which 0.01% *Panacide* has been added, then place the bags in a sealed container with more water and fungicide.

Any piece of wood to be used for dating should not be contaminated with fungicide or consolidant.

If large structural timbers are found waterlogged in quantity, it may not be feasible to try to save them all and a system of sampling may have to be worked out. Such a system is well explained by Keene (1977). Lifting such large waterlogged pieces is a difficult process and is described by Spriggs (1980).

Textiles

If a piece of textile is found dry, keep it dry. Since its fibres and threads are likely to be extremely brittle, do not attempt to clean or pick off adhering pieces of dirt. Pack it carefully in acid-free tissue or perforated polyethylene bags and store it flat.

If a textile is found waterlogged, keep it as found. Excavated wet textile is generally extremely fragile, so do not try to clean it, and handle it as little as possible. Keeping it with its surrounding mud, pack it in three well-sealed polyethylene bags with some 0.01% *Panacide*. Store it horizontally in a cool place until it can be taken to a conservator. If it cannot be taken immediately, check it frequently to make sure it does not dry out.

Composite Objects

Composite objects are often difficult to deal with as the two or more materials involved generally require opposite treatments. Often a decision has to be made as to which part of the object is most important and then treat the object accordingly. Composite objects should be taken to a conservator as soon as possible to ensure the optimum care for all the components.

Most combinations of materials can safely be kept dry, packed carefully using silica gel if iron is involved. If the object is found waterlogged and consists largely of an organic material, keep it wet, place it in three well-sealed polyethylene bags with 0.01% *Panacide* and take it to a conservator as soon as possible.

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SPRIGGS, J. 1980. The recovery and storage of materials from waterlogged deposits at York. *Conservator*, **4**: 12-24.

FURTHER READING

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LEIGH, D. 1978. *First Aid for Finds. A Practical Guide for Archaeologists*. Rescue Publication N° 1, 2nd ed., Hertford.

UKIC, Archaeology Section. 1983. *Packing and Storage of Freshly Excavated Artefacts from Archaeological Sites*. Conservation guidelines N° 2, (reproduced below).

SUPPLIERS AND MATERIALS

SUPPLIERS:

Conservation Materials, Ltd.
Box 2884
Sparks, Nevada 89431
U.S.A.

Conservation Resources Ltd.
Unit 1, Pony Road
Horspath Industrial Estate
Cowley, Oxfordshire
OX4 2RD, U.K.
Tel. (0865) 717-755

MATERIALS:

bandage, plaster bandage, swabs:	local chemist or medical supply firm
PVA emulsion:	supplier
PVA resin:	supplier
Paraloid B-72 (U.K. and Europe), **Acryloid B-72** (U.S.A.):	supplier
hydrochloric acid, nitric acid, acetic acid:	chemical supply house local chemist
pH indicator strips:	supplier
HMG adhesive:	supplier
UHU adhesive:	local stationers
acid-free tissue:	supplier
Panacide (or other all-purpose fungicide):	supplier
acetone, toluene, ethyl or isopropyl alcohol:	local chemist supplier chemical supply house
polystyrene:	chemical supply house
polyether foam:	do-it-yourself shops

ACKNOWLEDGEMENTS

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[Editor's note: recommendations for the packaging and storage of freshly excavated finds are also to be found in *Conservation Guidelines, N°2* prepared by the Archaeology Section of the United Kingdom Institute for Conservation. The text is reproduced on the following pages with the permission of the Archaeology Section.]

PACKAGING AND STORAGE OF FRESHLY EXCAVATED ARTEFACTS FROM ARCHAEOLOGICAL SITES

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INTRODUCTION

Archaeological materials are at their most vulnerable immediately after excavation, when they are to undergo drastic changes in their environment. Archaeologists, conservators and museum personnel will be familiar with the damage which may be caused to artefacts by improper storage, resulting both from incorrect environment and from insufficient physical protection. These guidelines are issued to help ensure the well-being of artefacts from the time of excavation, through the journey to the conservation laboratory, and finally to the recipient museum. They should be read in conjunction with Guidelines N°1, 'Excavated artefacts for publication: UK sites.'

1. ORGANISATION

1.1 Pre-excavation

Responsibility for correct packaging and storage rests with the Director of the excavation, who should obtain adequate amounts of packing materials before digging starts, bearing in mind the type of site and the types and quantities of material likely to be excavated. A pre-excavation meeting should be held with the conservation laboratory that will deal with the finds and with the museum that will be their ultimate destination. If the site is likely to produce waterlogged material, special preparations are necessary, for which see Guidelines N°4, 'Packaging and storage of waterlogged material from excavations' (forthcoming).

1.2 Excavation

The Director should appoint a Finds Supervisor to be responsible for recording and packaging the finds as they are excavated, and for their storage during the dig. The Finds Supervisor should maintain contact with the conservation laboratory and seek advice on lifting and packing fragile objects, and if necessary arranging for their immediate transfer to the laboratory. Artefacts should be placed in a controlled environment as soon as possible after the excavation, subject to the needs of recording and study, and not left unprotected until the end of the dig.

1.3 Post-excavation

The Director should ensure that the artefacts, suitably packed and accompanied by appropriate documentation, are taken to the conservation laboratory as soon as possible after the end of the excavation. Where the excavation extends over more than one season the artefacts should be despatched after each season.

2. PACKAGING AND STORAGE – GENERAL PRINCIPLES

2.1 The storage environments recommended here are based on the general principles that metal finds should be desiccated but that other vulnerable materials should be kept damp. To achieve this, sealable containers are required, and polyethylene boxes with self-seal (snap-on) lids are recommended. The contents can either be desiccated with pre-packed bags of silica gel or kept damp with pads of wet foam. Less vulnerable materials should be allowed to equilibrate with the ambient environment.

2.2 Reasonably robust small finds should be individually packaged in self-sealing polyethylene bags which are perforated near the top. The bags should have opaque bands for ease of labelling and be marked with a permanent spirit-based waterproof marker.

2.3 More delicate finds should be placed in individual clear polystyrene boxes with snap-shut lids, and padded with polyethylene foam, polyether foam, or expanded polystyrene. Acid-free tissue may also be used, but only when the item in question is to be desiccated. Objects should not be packed so loosely that they can rattle about, nor so tightly that any part is under pressure. The aim should be firm but gentle support.

2.4 In all cases the size of the bag or box must be commensurate with the size of the object inside, being neither too large nor too small.

2.5 The individually packaged finds should be packed into polyethylene containers with self-seal lids and any gaps should be filled with foam, to prevent the contents from moving in transit. Artefacts of different materials should be placed in separate boxes, the contents being desiccated or humidified as required. Boxes containing iron should also contain an RH indicator card. Once artefacts have been placed in sealed boxes they should not be removed unless absolutely necessary, in which case the lid should be replaced immediately and the item returned as soon as possible. Less vulnerable materials do not require to be placed in sealed containers, but nevertheless polyethylene boxes are more robust and durable than cardboard and are recommended.

2.6 While on site the sealed containers should be protected from extremes of temperature.

2.7 Boxes containing damp materials should be kept cool, preferably refrigerated (but not frozen) and dark, in order to prevent microbiological growth. If this is done fungicides should not be necessary. Paper padding must be avoided.

2.8 Waterlogged wood, leather and textiles present special problems which are dealt with in Guidelines N° 4 'Packaging and storage of waterlogged materials from excavations'.

3. DOCUMENTATION

3.1 Each item should be accompanied by a spun-bonded polyethylene label which should bear the name of the site in full and sufficient data (context number, small find number, etc.) for the item to be identified unambiguously. The label should also have sufficient space for post-excavation data (laboratory number, photo number, etc.) to be recorded.

3.2 Each container should be clearly marked and a list of its contents made so that any object can be found without searching every box.

3.3 A comprehensive finds list should also be sent which indicates those artefacts which are particularly fragile or liable to deteriorate and those which are of particular archaeological significance to the site. This will facilitate speedy conservation of those items most in need of it.

4. NOTES ON PACKAGING OF INDIVIDUAL MATERIALS

4.1 Vulnerable materials to be kept dry: iron, copper alloy, silver, gold, lead, pewter, tin

Iron

It is particularly important that iron finds should be rigorously desiccated after excavation to prevent corrosion. For efficient desiccation, each box should contain an approximately equal weight of iron objects and silica gel. Each box should also contain an RH indicator card which should be checked every day. If the RH is above 15% the silica gel packs should be replaced or regenerated.

Copper Alloy

Copper alloy objects should be stored in dry conditions. Enamelled copper alloy objects, or those having organic remains adhering to them, should not be allowed to dry out but should be packed damp and taken to a conservator immediately.

Silver and Gold

Objects made of silver and gold, or having a gilded surface, are often extremely fragile and should be stored in padded boxes. Care must be taken to avoid any pressure being exerted on silver or gilded objects as they may be totally mineralized below the surface.

Lead, Pewter and Tin

Objects made of these metals may be large and heavy but also brittle. If so they should be individually boxed and supported by foam or polystyrene blocks. Paper products should be avoided.

4.2 Vulnerable materials to be kept damp: glass, low-fired ceramics and those with flaking glaze, painted wall-plaster, painted stone, bone, ivory, amber, jet, shale

Glass

Glass should be packed in sealed polyethylene boxes between layers of damp foam. The glass must not be allowed to dry out because it may laminate and because any mud left on the surface becomes almost impossible to remove. Excavated glass should be referred to a conservator immediately.

Ceramics

Neolithic, Bronze Age or other low-fired pottery should be neither washed nor dried until a small fragment has been tested to see whether it will come to harm. Vulnerable ceramics of this type should be packed damp and referred to a conservator.

Bone, Ivory, Amber, Jet, Shale

These materials should be stored in self-seal polyethylene bags with damp polyether foam padding.

Painted Wall Plaster

Fallen painted wall plaster must not be allowed to dry out as this can result in a fine layer of silt attaching itself to the paint surface. The silt can be impossible to remove, especially if the paint is bound with tempera. The plaster should be kept damp, cool, and dark and a conservator consulted immediately. Treatment must be undertaken before micro-organisms can establish themselves on the surface.

Further copies of this and other publications in this series are available from the UKIC Archaeology Section, c/o York Archaeological Trust, Galmanhoe Lane, Marygate, York, YO3 7DZ, UK.

Other titles in these Guidelines series:

N°1. 1988 Excavated artefacts for publication.

N°3. 1984. Environmental standards for the permanent storage of excavated material from archaeological sites.

1990. Guidelines for the preparation of excavation archives for long-term storage.

ON-SITE STORAGE OF FINDS

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For storage of material at the site it is difficult to make any valid generalizations since conditions vary so much. Many long-term excavations have the help of a local museum with permanent equipment including storage facilities, providing, in theory at least, the possibility of better conditions of conservation. Probably more common, however, is the use of temporary stores which are established for several seasons in non-purpose-built buildings. In this respect we have all probably seen a great variety of types of building, ranging from the sound, old rural building, through the mediocre prefab in cement, to the corrugated iron shed (a real "torture chamber" for archaeological material!). In fact, the premises to be used for storage (whether temporary or not) should be chosen with the greatest of care, since it is generally recognized that their suitability for this purpose affects not only the correct conservation of finds but also, directly or indirectly, the whole life of the excavation and its related activities, from the first conservation measures to preliminary documentation work and so on.

The layout of the selected building should ideally allow an efficient separation of the following functions:

1. its function as *an entrance area* and for *preliminary treatment of finds*. These functions tend to generate higher levels of dust and/or humidity and a greater circulation of people, which result in unstable conditions for both conservation and security purposes. Particular care is needed when bio-archaeological samples collected on-site have to be processed with water, and large quantities of earth need to be immersed in even larger volumes of water. In such cases it would be better to have different premises far away from the store, with adequate drainage and drying facilities that prevented transfer of humidity to the subsequent storage area. Never should material be transferred from here to the permanent store until its humidity level is completely stabilized;
2. its function as a *centre for documentation and study.* These indispensable functions must be separated from the store so that finds already in store do not suffer any unnecessary "hygrometric shock." In practice, it is usually difficult to prevent the study area from being identified with the "living room" of the excavation, a situation which certainly encourages the circulation of ideas but tends to impede correct conservation practice;

3. its function as a *store*. Even in the case of a temporary store from which the finds will later go to a permanent store and/or a museum, this area must be considered an independent, self-sufficient unit, used solely for archaeological material. It should always be under the close supervision of personnel with adequate training in (and specific responsibility for) conservation of archaeological material. Any neglect of this principle can seriously compromise the usefulness and security of the premises.

The choice of building (or part of a building) to be used as a store must take into account various essential requirements. It must be isolated as far as possible from external climate and light, protected from possible infiltration of rainwater (from the roof or gutters or – in the case of underground stores – from outside) and must at the same time provide the maximum climatic stability for the material in store. If adequately adapted and consolidated, heavily-built structures such as rehabilitated old buildings often provide a natural protection against climatic fluctuations. Any risk that the premises will prove too damp must be carefully assessed beforehand using appropriate methods, for example by recording the premise's microclimatic variations with a standard thermohygrograph for a sufficiently long period *before* the store has begun to be used. Moreover, once it is being used, its climate must be constantly monitored and modified as necessary. Ideally, the premises in which the finds are actually stored should not be connected to or traversed by any water pipes (whether tap supply or for heating); these can, under certain circumstances, give rise to condensation phenomena and they always represent a flooding risk.

Wall plaster and wall paint *must* be adequately ventilated and properly seasoned before the premises may actually be used. There are, unfortunately, too many known instances of quite serious damage sustained by archaeological finds kept in recently constructed or re-painted premises in an atmosphere saturated with chemical vapours given off by plasters, paints, varnishes, bare cement surfaces, etc. (Thomson 1986: 133). Finally, the floor surface should be of an anti-dust material but it should *never* be treated or covered with substances to render it impermeable. These impede the natural transpiration of the floor and can result in capillary rise of water in the walls, with grave consequences for the conservation of the material.

Shelving has a crucial importance even in the simplest store. In choosing it, one must decide first of all to what extent the internal layout of the store should follow the layout of the excavation; that is, whether the sequence within the store of shelving (or stacks of shelving) should reflect the sequence of areas, squares and strata on the site. Secondly, and more debatable, one must decide whether objects of different material from the same context on site can conveniently be kept together in the store (as they obviously would be in a museum). In this case, compromises will have to be made, whether with regard to climate control (providing a climate acceptable for every single physical category of objects represented) or with regard to storage according to size (achieving a sufficiently compact arrangement of finds even though of very different dimensions). For this reason and others, the selected system should be as flexible as possible both horizontally (in plan) and vertically (in elevation). Horizontal flexibility allows the layout to be modified with regard to partitions and access points, and spaces for circulation to be adjusted (these being calculated allowing for ladders, trolleys, packing materials, and, obviously, the objects themselves). Vertical flexibility, in turn, allows a rational use of the height of the storage area according to the needs of the various kinds of material and the containers in which they are kept.

The ideal material for a system of shelving is without doubt metal sections of industrial type, available in a great variety of cross-sections, thicknesses and lengths for different purposes. They should preferably always be treated against rust, ideally with a superficial epoxy resin coating. The system should be worked out by simply assessing the intrinsic weight of the shelves and an estimated average weight of the objects, checking in good time that the whole installation falls with *absolute certainty* within the load limits of the store building. There are known cases, unfortunately, in which excess loading resulted in severe static problems and, ultimately, collapses even in stores situated on the ground floor.

High-density mobile units in metal, originally developed for storage of books and recently adopted for archaeological material, while very practical for the space they save, involve high initial investment and careful maintenance of several mechanical parts. Moreover they lead to an unnecessary degree of stress on the objects from vibration caused by moving the units to gain access to the stored material.

Shelves made of wood are on the whole inadvisable even though they may appear more economical. Compared to metal shelving, they are, first of all, much less flexible and much less easy to build in units; they do not allow precise weight calculations and, above all, they represent the most serious fire risk. Besides, wooden shelves are difficult to construct in a sufficiently 'open' format to allow easy inspection of material once it is in store.

In this connection it cannot be emphasized too strongly that every store should be systematically inspected at regular intervals to check conservation and security conditions. Ideally this is the responsibility of the "excavation conservator" or of a conservator specially appointed to monitor conservation conditions in the building. The lack of any inspection has often resulted in serious damage, sometimes irreversible, to particularly fragile material.

Containers and sub-containers have the functional task of allowing the best utilization of storage space. They can represent a physical barrier between the objects and the external environment, that is to say according to circumstances, they can be extremely beneficial or very dangerous. Furthermore they offer an indispensable, safe support for any label used to list the contents or to describe special treatments and/or warnings. For instance, self-adhesive coloured labels (usually circular, of different diameters) can be an effective, distinctive and low-cost method of 'coding' the contents of a container and, e.g., the dates on which they must be inspected.

In spite of their great importance, containers and sub-containers do not receive adequate attention. First of all, too commonly are "emergency" containers used;

wooden or cardboard boxes made for detergents or tins of sardines are often honoured with housing archaeological finds. These almost always, however, provide an unsuitable environment because of various physical and chemical properties of the material of which the container is made and the chemicals used in its manufacture. The risks are less, on the whole, but also less well-known with containers made of plastics, usually PVC (polyvinyl chloride). An essential first step is to know the effect of fire on these materials, and to avoid containers that are easily inflammable. If reliable data from the supplier are not available, an empirical test for inflammability and smoke-production on a sample should be made.

The most common form of container, and virtually indispensable, is of course *bags* of polythene (polyethylene) or other plastic material which are used for objects of all materials and sizes from the moment of excavation onwards. Used in the right way, they are a low-cost method of putting finds in order and separating them, and they can create suitable "microenvironments" for them when necessary. However they should not be used for this purpose unless one is well aware of the possible damage caused to finds when enclosed in an unsuitable microenvironment, whether because of the wrong level of relative humidity or because of the presence of noxious chemical products. Everyone knows of organic and inorganic material being damaged after being stored, for example, in polyethylene bags before being completely dry, resulting in growth of mould and other biological organisms; also metal objects with damp soil still adhering to them being sealed in polyethylene bags, with results that can easily be imagined.

Less well-known and less foreseeable is the damage caused by emulsifiers and plasticizers contained in the products used for making some types of bags. In this case too, the best strategy is not to leave the finds in bags of plastic but to consider them as *temporary* sub-containers unless it is absolutely certain that they are of inert material. The conservator in charge of the storage area should give all members of an excavation team basic information about choosing the containers or sub-containers most suitable for any class of material, so as to create particular microclimates when required. The conservator should also be personally responsible for selecting special containers (e.g., glass tubes) or special treatments (e.g., wet storage of waterlogged samples or deep-freeze storage).

Problems of *security* against fire and theft are a particularly urgent matter for excavation stores, whether temporary or permanent. Statistically speaking, protection against fire is easier. It is advisable, first of all, to inspect the electrical installations inside the store and in its vicinity and, if necessary, to replace any unreliable components. The fundamental requirement is that the electrical installations be calculated so as to support *all* the foreseen load (lights, industrial appliances, tools, etc.), and that it should have built-in safety mechanisms which can automatically cut it off from the grid in case of malfunctioning or overheating. Moreover the reliability of the power supply should be checked so as to avoid fluctuations that can damage sensitive equipment used for conservation work or security.

If there is no electricity supply in the store building, there should never be used a fuel-driven generator near the store, nor should gas-fired refrigerators, heaters, etc., be used because of the high risk of explosions and fires caused by gas cylinders. However, an efficient electrical installation is a considerable benefit for safe storage and is essential if sophisticated anti-fire and anti-theft devices are to be installed. If there is no electricity supply, the store should have at least a battery-powered walkie-talkie for purposes of communication.

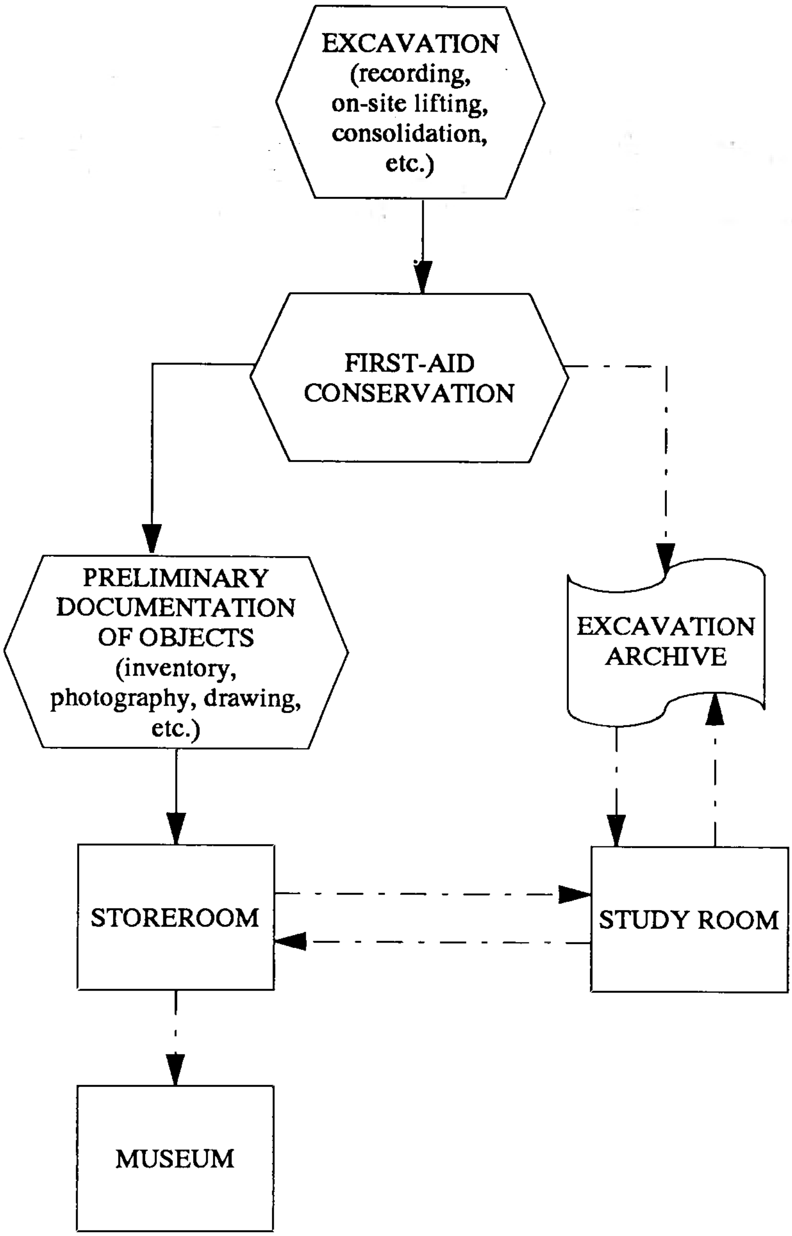
An adequate supply of fire-extinguishers must be available in every room or bay of the storage area and they must be maintained and serviced regularly as prescribed by the supplier. Given the constant evolution of new techniques in fire control, the best approach is to consult a specialist who can recommend appropriate systems for the country and specific situation in which you operate. Nevertheless – needless to say – much the best protection against the risk of fire is to avoid having within or in the vicinity of the storage area any combustible materials that are not essential there, whether furniture, packing materials, containers, partitions, paints, chemical products or whatever.

Protection against theft, however, is more difficult. Fairly often, even the most elementary precautions regarding the passive security of the building are neglected when choosing a store: walls of sufficient thickness; roofs, ceilings and floors that are structurally sound; strong doors and windows, fastened with adequate bolts and locks and possibly reinforced with grilles and bars, etc.; absence of places of concealment near the store and, above all, constant surveillance. Rare are the cases in which efficient technical protection systems are used; frequently the fact that the store is not usually visited by outsiders gives rise to an unjustifiable "sense of security." This false security often leads to dangerous neglect, especially when the excavation or storage team includes technical staff such as archaeologists, draughtsmen and photographers who are not always familiar with security matters and may not respect basic preventive measures. It is upon such basic measures that the security of the material when excavated and stored must depend, so they must be clearly defined and observed by *everyone.*

Statistics indicate that the following steps in post-excavation work are particularly open to risk:

- transport of the excavated finds from the site to the store (including packing and unpacking stages);
- preliminary conservation treatment in the laboratory, graphic and photographic documentation, identification; and
- deposit of material in the store, repeated removal of samples for study, repeated despatch of material to other institutions.

It is impossible here to discuss technical specifications for protection in specific circumstances but there are some general principles which are usually applicable also in museums. Most important, (1) an object should never enter the store without a preliminary identification (preliminary inventorying, excavation catalogue or similar); (2) after that, an object or group of objects should not leave the store for any other place



(even within the same building) without one or more people being responsible for its safety; (3) finally, an object should never be in any place without at least two written records, kept by different people in different places. For example the transfer of an object from the store to the photographic laboratory should be recorded in two distinct records, that of the store and that of the photographic laboratory. All records of the finds are as precious as the finds themselves and, moreover, they can be duplicated and kept in different places. In case of theft, then, at least the data about the object can be salvaged (Note 1).

Fireproof cabinets, often reasonable in price, provide an indispensable protection for vulnerable records and materials, against fire and also against theft. In using these – and, indeed, any safe or "quasi-airtight" container – it must be kept in mind, however, that they behave as closed microenvironments, and so must be "conditioned" under the care of the conservator.

As for active prevention, all members of the excavation team should keep in mind the risks inherent in any public announcement, formal or informal, about the value (commercial, historic or aesthetic) of the objects that have been found, particularly when the levels of passive and active security are not high. When objects of potential interest to a hypothetical thief are shown in public (for instance, on a television programme), no indication should be given of where the object is being kept.

Furthermore, information about the whereabouts of important objects should be extremely restricted even in the case of internal security, so as to protect them from threats posed by the excavation and post-excavation staff. The precise provenance of the object should also never be publicized since it has often happened that an excavation has been devastated by illegal digging in search of other "treasures." Many of these acts of devastation, unfortunately, are the result – directly or indirectly – of the vanity, excessive "optimism" or unnecessary desire for precision on the part of people who would certainly have wanted anything but to endanger the security of their excavation!

* * * * *

Note 1. In addition to the finds themselves, the excavation archive includes their accompanying documentation– labels, notebooks, registration cards, drawings, photographs and so on. These too must make use of appropriate materials if they are to be preserved in the long term. Certain types of labels and markers can be recommended (see Coles, Chapter 6) but they should always be tested for local conditions before use. The adhesive of many self-adhesive labels and of *Dymo* tape will deteriorate within months, leaving a mark that is difficult to remove; they should *never* be applied directly to objects. Paper labels and record cards intended for permanent archives should be acid-free; other documents can be stored in acid-free boxes or folders (e.g., *Permalife*) which absorb acid pollutants while also buffering RH variations and protecting from light. Only stainless steel or brass staples should be employed. If mass de-acidification of an existing archaeological archive is contemplated, prior testing of *all* design materials used in the documents must of course be carried out.

For drawings, tracing paper is highly acidic and has very bad ageing properties, becoming brittle and opaque quite rapidly. Of the modern plastic films, polyester (e.g., *Melinex, Mylar, Permatrace*) is to be preferred to those of plasticized synthetic resins (e.g., polyvinyl chloride) if safe long-term storage is desired. The same is true for envelopes and mounts made of plastics designed for storage of photographic negatives, prints and transparencies; these should be kept at as low a temperature and as constant an RH as feasible [note added by editor].

FURTHER READING

Although there is no specific and/or detailed treatment available on storage of archaeological materials at excavation sites, applicable principles and information will be found in the ICOM Working Document, October 1976 (76-STOR.2), for the International Conference on Museum Storage, Washington, DC, 13-17 December 1976 (with an extensive bibliographical Annex, pp. 9-14) and in relevant papers (by R. B. Burke, E. V. Johnson, K. Kawasaki, J. Schneider, N. Stolow *et al.)* delivered at that conference. The Working Document and texts of the papers have never been published but are available at major documentation centres. See also:

JOHNSON, E. V. & HORGAN, J. C. 1979. *Museum Collection Storage.* [Technical Handbooks for Museums and Monuments, 2]. Paris: UNESCO. (Many practical suggestions, with excellent illustrations. Existe aussi en version française.)

PARTINGTON-OMAR, A. & WHITE, A. J. (eds.) 1981. *Archaeological Storage.* Lincoln: Society for Museum Archaeologists. (Collection of papers providing up-to-date reviews of many problems inherent in storage; available from A. J. White, Lincolnshire Museums, Aquis House, Clasketgate, Lincoln, U.K.)

REMPEL, S. 1980. *The Care of Black-and-white Photographic Collections: Cleaning and Stabilization.* Technical Bulletin. Ottawa: Canadian Conservation Institute (existe aussi en version française).

THOMSON, G. 1986. *The Museum Environment.* 2nd ed. London: Butterworths. (especially pp. 120-24 on improvisation and RH control; 133 on contamination in new concrete buildings; 154-56 on contamination from containers; and *passim*, with extensive references).

TILLOTSON, R. G., & MENKES, D. D. 1977. *Museum Security.* Paris: ICOM. (especially pp. 32-40 on inventory control; 44-68 on protection against fire; 164-76 on planning for security; and *passim*) (texte en anglais/français).

6

THE SITE RECORD AND PUBLICATION

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> "The unpardonable crime in archaeology is destroying evidence which can never be recovered; and every discovery does destroy evidence unless it is intelligently recorded" (Petrie 1904: 48).

The importance of making good records of archaeological excavations hardly needs to be stated. No archaeological site is exactly like any other, and therefore every excavation is an experiment into unknown conditions. Unlike many scientific experiments, however, an excavation cannot be repeated. Excavation equals destruction and the only parts of this evidence that survive for future use are those recorded, as drawings, notes, samples or artifacts. The problem then is not whether to record, but what to record and how to record.

Recording archaeological context

Although no standardization in recording procedures exists at present, any site system must include the following records to be made as work proceeds:

- site name (and abbreviation to be used on finds, etc.);
- area and grid numbers (for location of all features);
- contexts and relationships (of features and finds);
- descriptions, measurements, character and condition of all materials;
- illustrations (contexts, features, finds, by drawings and photographs); and
- interpretations (identification of function, context and role of features and finds on site).

For every excavation, this is the *minimum record*, the least amount of information required; all are vital, but none more so than context.

Context implies a knowledge of the layer in which artifacts may occur, of the feature associated, and of the relationship between these and other features and finds stratigraphically above and below. It involves an understanding of the soil and other geological, chemical and biological agencies at work on the site; these form the direct environment of most finds on site, and a knowledge of these environments (soils, peats, rocks, etc.) is essential for any excavator. They form the basis for understanding the site stratigraphy. Stratification consists of variable *units* defined by the archaeologist through the recognition of different soils, colours, textures and other characteristics.

The term *stratigraphy* encompasses layers of material, and features and finds within them.

Layers are laid down in successive deposits.

Features can be *negative*, cutting away or through the layers (pits), or *positive*, with layers deposited around them (walls).

Finds will occur within layers which may fill negative features or be related to positive features.

Contexts are the associations and relationships of finds, features and layers.

The principle of stratification is fundamental to excavation. On a stratified site, the orderly removal of layers allows complicated negative and positive features within the layers to be observed in their relative time sequence, and recorded in a matrix. The matrix is diagrammatic and serves as a guide to the sequence of deposits, thus allowing the contexts of finds and features to be recorded (fig. 1). The development of the matrix method is best described in Harris (1979), and it is not a substitute for observation or interpretation; "it is more an instrument for aiding clear thinking and coherent publication than for primary interpretation" (Barker 1977: 199).

The fundamentals of recording a site, its layers, features, and finds, are based on the need for order, for a series of fixed points to which every measurement can be related. The following comments about certain essentials do not replace the need for fuller explanations (Barker 1977; Coles 1972; Hogg 1980). The normal procedure for preparing a site plan is the establishment of a fixed base line; this allows the development of a grid system into which any point on a site can be measured by offset or triangulation (fig. 2; plates 1a, 1b). Plans can be constructed on site, on transparent paper mounted over metric gridded hard paper base. Polyester films (e.g., *Melinex, Mylar, Permatrace*) are recommended as they do not distort as does linen or tracing paper; in addition, pencil work can continue in wet weather. Soft pencils (HB or F) are suggested as these give a darker and more flexible line than hard pencils. Coloured pencils for field plans are highly recommended (e.g., *Mars-Lumochrom*), but a colour code must be agreed and clearly marked on the plans. For complex and overlapping features it is best to use several separate transparent overlays.

Photographs of all important features, from various angles, should be made as an integral part of the plans (Conlon 1973). If these are available to compare with the drawn plans, then later ambiguities can be avoided.

Section drawings are basically the same as horizontal plans, except that they are vertical. The section base line must be measured in by level or theodolite to a fixed datum point on the site. Such a point will be used to provide the start for a general

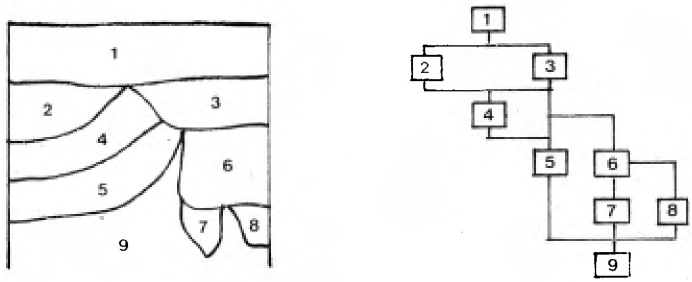

Figure 1. The matrix is designed to set out the degree of relationship of contexts and stratigraphical units to one another. The matrix is built up *as work proceeds*. In this simple example, layer 4 lies beneath 2 and 3; pits 7 and 8 cannot be related to one another except that they are sealed by 6 and lie above part of 9, i.e., they are cut into 9. The matrix provides a ready guide to all contexts of finds and features, as each will have its context number recorded on its sheet.

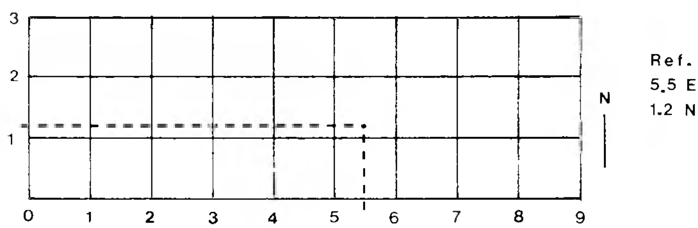

Figure 2. A simple grid for a site, with carefully surveyed lines forming a frame. The grid should ideally be laid out with zero point for both Northing and Easting measurements set well outside the projected excavated area. (If the grid cannot be set to true E and N, then adaptations must be carefully recorded.) Any find or feature can be recorded by measurements E and N along the grid lines, and the detail recorded on the find sheet (5.5/1.2), e.g., the spot is 5.5 m E and 1.2 m N; this is a unique reference. Note however that this is for horizontal planning only, and without context the measurements are valueless.

contour of the site and its features, and levelling of finds; for the latter, however, a bare level will not say much in a stratified site where context and associations are the vital record.

These few comments in no way replace the need for careful study of the variety of excellent guides to recording techniques (e.g., Barker 1977: 142-156).

Recording small finds

For sites likely to yield numerous and variable small finds, the requirements for accurate and workable recording techniques are essential, as without them no proper evaluation will be possible. The term *small find* generally refers to any object that can be lifted from the site; such objects may therefore be minute beads or a collapsed building block, a single potsherd or an interwoven wooden hurdle. Each find has an importance to an understanding of the site in precise ratio to its stratified position within the site; this is a basic and fundamental law. An object, however precious, unusual and exotic, which cannot be recorded in relation to a part of the site is reduced in value to that of a stray find, because that is what it is. An object, however ordinary and common, which has a precision of position within the site is important to that site and to its comprehension. Every such find is important and never more so than at the moment of its recognition when its precise relationship with other finds and with its containing deposit can be seen. This is the *context* of the find and is more important than its level, or its horizontal location; its context provides the archaeologist with its association and relationship with all other features and finds on the site. The contextual recording of finds is therefore a matter of great importance (figure 3).

CONTEXT SHEET *

Site:		Area:	Unit N°
Location:			
Feature/Layer:			
Description:	Composition:		
	Colour: (soil colour chart to be used)		
	Texture: (sand, silt, clay, etc.)		
	Structure: (friable, compact, sticky, etc.)		
	Clarity of horizon: (between layers)		
Extent:			
Thickness:		Levels:	
Record:	Planned:	Photo:	Section:
Association:			
	Layers above:	Layers below:	Adjacent:
	Feature fills:	Feature seals:	Cut by:
Interpretation:			
Finds:	General finds:		
	Recorded finds:		
		Position within context:	
Recorder:		Date:	

* Spacing and other entries may be devised on the basis of the particular site and its unique character.

FINDS SHEET *

Site:				N°:
Context:	Layer:		Feature:	
Other finds:				
Location:	Grid Peg:	Distance:	Direction:	
	Grid Peg:	Distance:	Direction:	
	Grid Peg:	Distance:	Direction:	
Object:	Identification:			
	Material:	Quantity:		
	Description:			
Record:	Planned:	Photo:	Recorder:	Date:
Condition:				
	Special instructions:			
Treatment:	In situ:		Conservator:	
	Off site:			
	Containing deposit:			
Analysis and evaluation:			Analyst:	
Final identification:				
Final record:		Photo:	Drawing:	
Storage:				

* These entries may be changed to suit particular site requirements, but basically they represent the minimum record, for any find.

Figure 3. The Context and Finds sheets provide a guide to the details essential for any stratigraphic unit, layer, feature or find. A find will have a Find sheet, numbered, and its context will be noted down at the time of discovery. A unit, layer or feature will have a numbered Context sheet, with any associated finds noted thereon. The orderly conduct of this dual recording will permit the site to be reconstituted in its vertical and horizontal elements.

There is no general agreement about the actual numbering system most suited to archaeological excavations, and various proposals for standardization have not met with success. A simple system uses a single set of numbers for layers and features, and these form the matrix presentation; a second set of numbers is assigned to the finds associated with the layers and features. Thus a site with a shortened designation of e.g., SW83, with several areas under excavation (A,B,C) in one of which a layer (e.g., 4) contains a find (e.g., 23), would result in that artifact having a unique label SW83 A4/23. Another find (16) in a particular fill (b) of a negative feature such as a pit (6), would have a label SW83 A6b/16. This system has some merit although it may sound cumbersome; its basis lies in the stratigraphical matrix sequence, and in the importance of context (Hirst 1976).

Although it may not sound necessary, it is advisable for any group of artifacts with an abbreviated site designation (e.g., SW83) to contain a small proportion which *also* bear the full site name (e.g., Sweet 1983). This will allow museum identification in years to come, and will prevent loss, however caused, of the site identification should records go astray.

An alternative scheme for finds produces a running numbered sequence for the whole site and makes labelling more simple, although here the context is detached from the unique number. The stratigraphical sequence is recorded as before but finds receive a simple number in a system totally separate from the stratigraphical units. A find labelled SW83/7 refers only to the Finds Book where all contexts and relationships are recorded. On sites where finds are numerous, this system can be streamlined and effective. Two labels, plasticized and marked in ink, are prepared; one is attached to the find which can be removed from the site, and one is pinned in its position in the layer or feature from which the find came. The find sheet records context (essential to be noted at once), and locations on the grid system can be done later, when a group of such finds have accumulated. The context *must* be recorded at once, as further excavation may remove the evidence. Such find sheet records will be duplicated as necessary, particularly so that any laboratory treatment of the artifact will have the benefit of information about context directly accompanying the artifact during its processing.

If an object is still embedded in the deposit, it can still be labelled and recorded for context and position, and removed later; if it requires immediate conservation or protection, it should be covered by polyethylene and/or reburied, or treated appropriately. Only in exceptional circumstances should it be dug out; to do so will damage units of stratigraphy beneath, and contexts may be destroyed or rendered indistinct. The archaeologist must decide if the find is so important as an object that its context can be tampered with. If so, collaboration with a conservator would be useful for on-site discussion and joint responsibility.

The excavation of small finds should pose few problems if adequate preparations are made and techniques are established. Finds that have decayed to fragments or stains pose the greatest difficulty, and here recording is of the utmost importance. Sketches, notes, scale drawings and photographs must be made at once, and the finds carefully observed in case drying, even for a few minutes, brings out new evidence or indeed accelerates decay. Rotted finds, reduced in some cases to mere stains, can only be lifted in a block of the soil in which they lie. This is fraught with difficulties, as the archaeologist is cutting into deposits unknown. Contexts are potentially lost, and all stratification and associations, as well as planning and levelling, must be done as part of the operation to avoid unnecessary loss.

In any cases where some decay has occurred, where precise details of the find are obscured by the soil, where the soil is stained in contact with the object, where the object may have had organic parts believed to be lost, the lifting of the artifact must include the surrounding soil still *in situ* if at all possible. Without this, much information may be lost. The conservator, or failing that the archaeologist, can often identify and record barely visible features when working under laboratory conditions, and conservators must have samples of the deposits from which artifacts came.

The use of photography in the recording of finds for conservation is important. Photographs of the object upon discovery, during lifting, immediately prior to bagging or boxing, upon entering the laboratory, during treatment, and following treatment, with a subsequent monitoring of stabilization, are not optional. Only in this way can the success or otherwise of the recovery and conservation be assessed, and a record of the artifact in its different conditions be made. Photographs do not replace drawing, but supplement them. Polaroid films allow pictures to be annotated at once, and mounted by tape onto the finds sheet or finds book. A record of all photographs, all plans and sections, and all drawings of finds must be made in a graphics book. This allows drawings to be numbered for ease of storage and retrieval, and photographs including colour slides to be identified.

The safety and security of small finds can be assured by the use of suitable markers, labels and bags (Leigh 1978). Care should be exercised in the selection of these. Bags of various grades can be marked on the outside with the find number, using a marker pen; ballpoint pens, water soluble felt-tips, pencils and wax crayons are not suitable, and only black, waterproof, spirit-based marking pens will produce marks that will survive storage in airless, cool, warm, damp, or dry conditions, and sometimes in fungicide solutions (e.g., *Artline 70, Edding*; test for site and storage conditions *before* use). Labels of spun-bonded polyethylene, or waterproof plasticized labels, which can be cut or punched, will accept such marker pens and should be placed within the bag as an insurance against the outer label's loss or blurring; the inner label (50 x 30 mm) can be used to accompany the artifact from its bag onto the site or laboratory bench for recording or treatment. If both bag mark and inner label are by some misadventure separated from the artifact, recourse must be made to either the *in situ* photographs and sketch, in the graphics book, or the finds card which will bear description, dimensions and the number of the object.

The finds sheet should be in duplicate, or if not, then a finds card should be prepared to accompany the object for conservation. This record must provide adequate notes on the condition and appearance of the find, with warnings and recommendations for the conservator. The details of cleaning and treatment should be added to the record as work proceeds, and assessments of success noted both by the conservator and the archaeologist who is responsible for the site report and archive; one man's success may not be the other's, and consultations about degree of cleaning in particular must be held between the two. Many new details about an artifact may be revealed during its conservation, and consultation is essential in order to avoid loss of information, for instance when corrosion layers are to be removed.

Finds that are conserved will in due time become available for study, either for the first time if lifted immediately and decayed, or for the second time if originally described fully on site. In either case, the completion of conservation will generally allow the find to be handled more freely, scale drawings to be made accurately, and photographs to be taken from all suitable angles. The record sheet should be annotated accordingly.

Publication of excavations

All excavations must by definition be destruction. The precision taken in records and in conservation are not the end of the archaeological work, but are only steps along the way towards the interpretation of the site and its publication. Just as to dig blindly for information of any sort, or for finds alone, is a negation of the principles of archaeological endeavour, so too the failure to preserve the records, maintain the finds and publish the report is a denigration of archaeology as a science and a humanity. Publication is not an option, it is an obligation. Much discussion and argument has gone into the question of publication of excavations – the degree of detail, the quality of illustrations, the separation of observations from interpretations – but most would agree that the following are essential:

1. The site records, plans and sections, photographs, find sheets and cards, which form the site archive, should be housed in a public institution, normally a museum. Duplicate or security copies of all original records should be produced and stored in another secure institution.
2. The finds themselves, conserved and labelled permanently, with finds lists, should be deposited in a museum for storage and display.
3. The full written report, with descriptions and interpretations of all features and finds, contexts explained, prepared final drawings of site and finds, selected photographs, specialist analyses, classified lists of finds, should be deposited in a public institution. All or part of this may be published.
4. The published report, which may consist of all of the items listed in 3, but more likely will be reduced to a briefer report which provides a synthesis of the site description and interpretation, with appropriate drawings and photographs, with drawings of selected finds, and analyses, should appear in a journal or monograph. The use of microfiche may well allow a greater proportion of the prepared report to be published. The preparation of camera-ready copy will often permit an excavator to publish more cheaply, as type-setting is eliminated and proof-reading is done at source. Sloppy and uneven typing can be avoided by word-processing, but the content of the report must remain unimpaired for clarity.
5. The reluctant publisher: some excavators resolutely refuse to submit to public scrutiny, by never publishing their sites. There are various courses of action to be taken in such cases, but these do not solve the problem of lost information:
   - After a certain interval, perhaps five years, following the completion of the excavation, non-publishing excavators should be refused permits for further work, and should not receive grants for fieldwork; or

- No excavator should be allowed to embark upon other field programmes if he has more than one report on a previous excavation still unpublished or in press.

The conservation record of finds will appear on the finds sheets in 1, in 2 (abbreviated lists), in 3 (specialist conservation reports), and in 4 (shortened comment). The record cannot be omitted from any of these if archaeology is to benefit from the discoveries made on the site and in the laboratory. Conservators should therefore publish their results in the final excavation report so that others may benefit from the discussion of problems and solutions.

The use of computer facilities allows the production of computer-generated drawings, features and finds lists in any association or order, and presentation of these data via tape or disc, or on microfiche, is a simple matter. Nonetheless, these are mechanical aids for the archaeological excavator and are no substitute for an adequate recording system capable of dealing with contextual information which alone can offer the opportunities for interpretation of the site as part of our past cultural heritage.

The progress of an excavation (figure 4)

The organization of research leading to publication is not complicated, but plans must be formulated at an early stage. It is assumed that the archaeologist undertaking the excavation has allocated sufficient time following the excavation to analyse, study, interpret and prepare the archive and report. Collaborators and specialists involved in the work must be engaged at an early stage, granted opportunities on site, and given time and support afterwards to allow the analyses and reports to be prepared.

Conservators and museum officials who will be concerned with the finds will also be informed well in advance of the likelihood of work and artifacts from the site. Full information must be made available to these specialists to allow them to work as effectively as possible. The availability of conserved finds for drawing and study will depend upon adequate conservation facilities. The archaeologist is responsible for

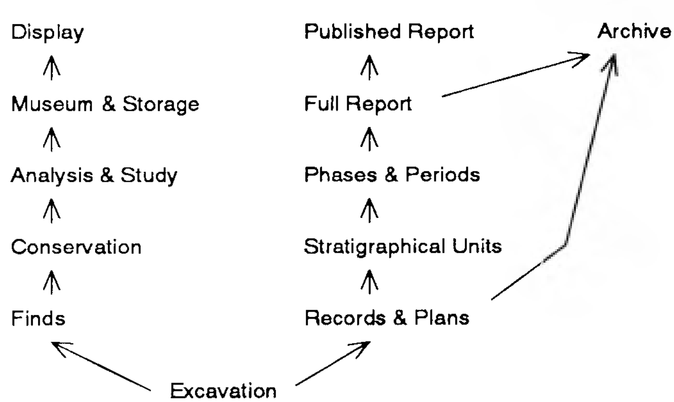

Figure 4. Excavation progress

overseeing all of these projects through to the submission of reports and finds for publication and storage (Grinsell, Rahtz and Price Williams 1974).

The progress of an excavation should be logical, from the physical assault on the site itself through its recording, sampling and extraction of finds, to the development of stratigraphical units and phases, the conservation and analysis of finds, and to the eventual written report, museum storage and the deposition of the full archive. Without such a design and strategy, excavation will revert to its former position as an exercise designed to recover objects rather than evidence, finds rather than facts.

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PETRIE, F. 1904. *Methods and Aims in Archaeology.* London.

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The Publication of Archaeological Excavations. 1983. Report of a joint working party of the Council for British Archaeology and the Department of the Environment (UK).

Excavated Artefacts for Publication: UK Sites. 1988. Archaeological Artefacts Conservation Guidelines N° 1. Archaeology Section, United Kingdom Institute for Conservation.

Selection and retention of environmental and artefactual materials from excavations. 1982. A report by a working party of the British Museum.

Editor's note: the references and reports listed above are self-explanatory and together provide a selective reading-list for this topic. The following publications are also recommended:

CARADINI, A. 1981. *Storie dalla terra. Manuale dello scavo archeologico.* Bari, Italy.

DEVER, W. G., LANCE, H. D., eds. 1978. *A Manual of Field Excavation – Handbook for Field Archaeologists.* Jerusalem.
(with particular reference to Middle Eastern conditions)

ROBINSON, W. S. 1981. *First Aid for Marine Finds.* Handbooks in Maritime Archaeology, N° 2. London: National Maritime Museum.

SCHNAPP, A., ed. 1980. *L'archéologie aujourd'hui.* Paris.
(notamment: N.-C. Berducou. La conservation archéologique, pp. 149-70, et H. Galinié. De la stratigraphie à la chronologie, pp. 63-85)

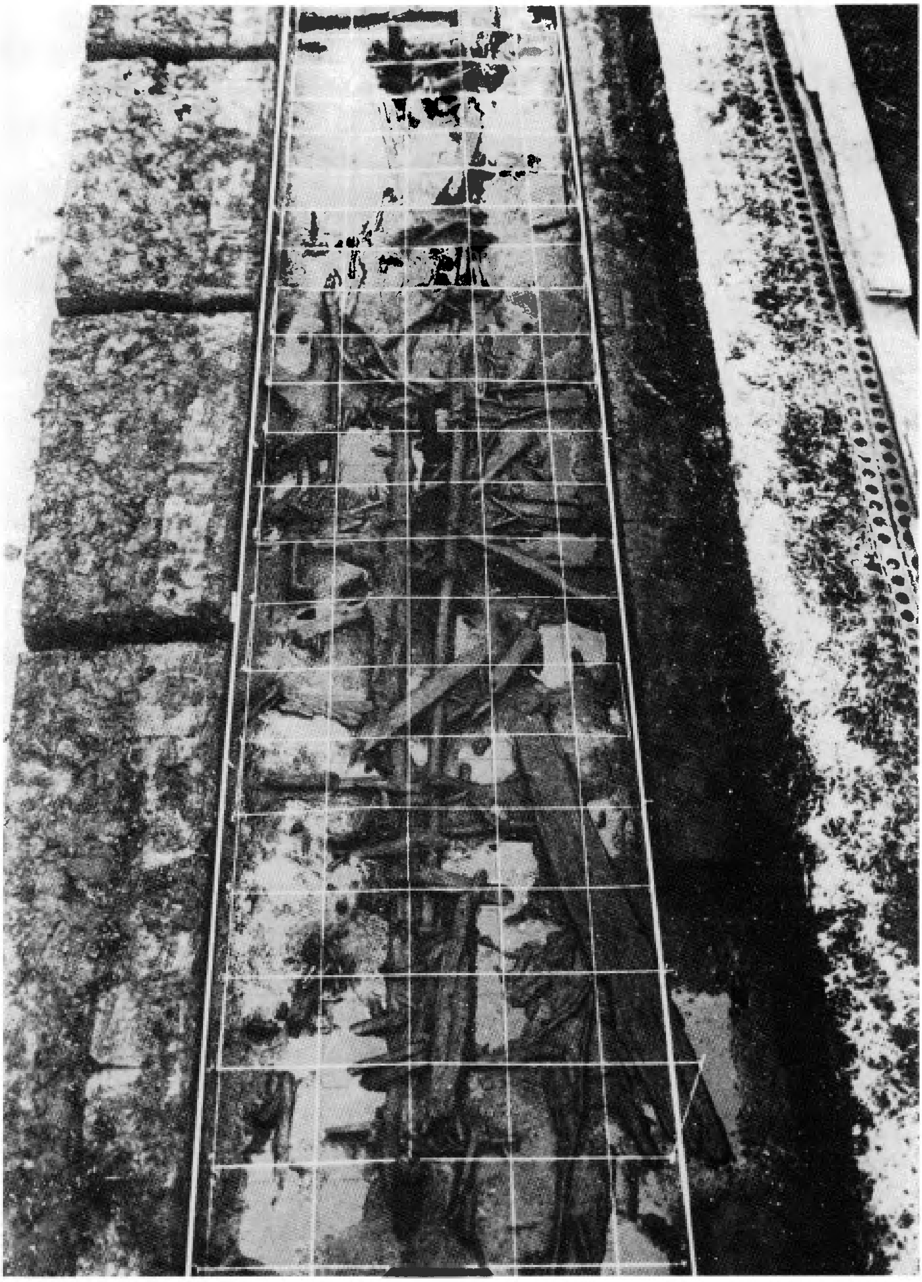

Plate 1a. A string grid for an excavated surface with multiple features, in preparation for drawing with a minimal use of direct measurements and a maximal use of drawing-by-eye. The grid is in 40 cm sections. Site: Sweet track, Somerset, England, date 3200 BC.

Plate 1b. Recording on site with the use of portable grid frames moved along an established line. The grid is in 20 cm sections. In the background, protection from rain and wind during excavation and recording is provided by plastic sheeting and an iron frame. Not generally suitable in hot weather because a greenhouse effect is created. High winds necessitate firm anchorage of the frame. Entire shelter weighs about 150 kg and is easily moved by four persons. Site: Abbot's Way, Somerset, England, date 2000 BC.

Both of these grids can allow a very rapid record to be made of structures and features which are fragile and which cannot therefore survive many hours of exposure to drying. The same procedure is entirely appropriate for other sites where soil discolorations and other features are fugitive.

7

PROTECTION AND PRESENTATION OF EXCAVATED STRUCTURES

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The problems of preserving and presenting *in situ* archaeological and architectural remains are among the most difficult faced today by archaeologists and architectural conservationists. The basic difficulties are that structures in a ruinous state are no longer suited for exposure to the elements and that all man-built structures are in a dynamic state of change towards an equilibrium with the forces of nature.

Ruins are structures which are in an advanced state of deterioration. Various preservation interventions can be made in an attempt to arrest the deterioration process through structural stabilization, reconstruction, restoration and sheltering from the effects of weathering. A large quantity and variety of open archaeological excavations and architectural ruins exists throughout the world, each with a separate history, physical context and conservation potential. In many cases similar treatments for preservation can be used to extend the life of building remains; however, the problems of any two sites are never exactly alike. Climatic situation alone, whether in hot arid, temperate, tropical or frigid areas, radically affects the preservation and presentation interventions which can be used at a given site. Despite the large number of variables, some basic approaches to archaeological site conservation problems can be applied. Concerned individuals and organizations can now more than at any previous time learn from a variety of site conservation efforts which have been tried in the past.

Planning

Planning for at least the contingency of site preservation and presentation should begin in the formulation phase of any archaeological programme. This can present a difficult task since one rarely knows what will be discovered in the excavation process. A series of both short- and long-term objectives for preserving and presenting a site should be developed and updated throughout the planning process. An example would be the early programmatic decision made at some excavations to erect a field house for use by the excavation team, which can be later adapted to become an interpretive centre and museum for the site. Or, perhaps the decision can be made at the start to erect a permanent shelter so as to protect a site both during excavation and later when the site is presented. This approach was used by the U.S. National Park Service at Dinosaur

National Monument in Utah where excavation of palaeontological remains continued while also being on display within a permanent shelter.

After excavation, an objective and comprehensive evaluation of the site should be made. On assessing all the problems and potentials, an initial question might be "should the site be presented at all?". Given the technical difficulties and costs that can be encountered in preserving and presenting sites, it may well be that the best solution is to backfill carefully the excavation and let its description be by secondary means such as publications, exhibitions, models or perhaps a facsimile (for backfilling and temporary protection of excavations, see also Mora, Chapter 8, and Alva & Chiari, Chapter 9).

A second question might be "to what level should one intervene in preserving a site and its structures?". Should an undermined foundation or a leaning wall in precarious condition be structurally consolidated? Most would agree that it should be. But on intervening, at what point should one stop restoring? Perhaps the most practical and theoretically defensible policy is that of the Ancient Monuments Board of the Department of the Environment in England which attempts simply to arrest the process of decay at the time when a monument falls under the stewardship of the Department. This usually involves attempts to structurally consolidate and weatherproof a monument in its 'as found' condition, and to present the remains to their best advantage within the context of the site.

Preliminary objectives for preserving, presenting and maintaining a site should be agreed upon and budgeted as early in the archaeological process as possible. A principal reason for this is that the excavation can then be carried out with site preservation and presentation in mind. Depending on the nature and condition of a site, archaeologists should consider that only a minimum of occupation periods can be effectively presented lest there be confusion on the part of visitors in their interpretative efforts. The decision whether to present the archaeological evidence of a site as it might have been in its heyday or all its successive occupations is largely a question for the archaeologist and historian. At this stage the opinions of other specialists including conservators, architects, museologists and site planners should be consulted. The team approach involving appropriately experienced personnel is critical to effective archaeological site preservation and presentation. Such an approach may result in important programmatic decisions, for instance that the site should be presented essentially as one 'period,' with the more complicated issues of its historical and morphological development being explained in a nearby interpretive centre and museum.

Methodology

A thorough knowledge of all aspects of an archaeological site and its remaining structure is prerequisite to any decision-making for site conservation and interpretation. It is of vital importance to understand the design intent and construction methods of the original builders.

Planning for the preservation of archaeological remains and their interpretation is largely an issue of site planning. Visitor circulation and its control should, where possible, be guided by inherent circulation provisions within a site. For instance, site access for the modern visitor should be from the same direction as that of an original inhabitant (for instance, access to the Parthenon via the Propylaea, and to Mycenae through the Lion Gate). The key features of a site should be readily discernible to the scholar, to the inquiring visitor and to the recreational visitor. At sites where successive occupations existed, as far as possible one period of occupation should be primarily featured, with other periods given a secondary presentation. For example, where above-grade walls are situated on older foundations, these walls can be featured with inspection pits for viewing the earlier wall-footings.

Although one period of a site may be emphasized, by no means should a site be cleared of all subsequent archaeological evidence. Experience has proven that this is not a wise attitude if an honest interpretation of a site's history is ultimately desired. Excavation is in any case a destructive process, so the careful retention of control strata for reference and eventual display is important.

A fundamental fact in archaeological site conservation is that reburial of exposed archaeological remains is the nearly optimum preservation solution. The many lessons learned at Pompeii, a virtual laboratory for archaeological and preservation methods for more than 200 years, has proven that no matter which preservation methods were used, nothing remains better preserved than the unexcavated portions of the site! All perishable archaeological remains survive longer in the constant environment provided by surrounding earth, sand and water, than if subjected to atmospheric exposure. Therefore, so far as conservation is concerned, the more a site is buried or unexcavated, the better it is preserved.

Quality control of field work during the restoration process is extremely important. The lack of a comprehensive plan can often lead to work being done in a piecemeal fashion or on an "as needed" basis which in the long term has often proven to be more costly and more difficult to manage. Effectively consolidating *in situ* ruins requires skilled craftsmen under able direction. Where possible, structural interventions should be discreet, as when reinforcing masonry walls using grout injections and stainless steel reinforcing rods buried within the wall core. The joining of old and new fabric and detailing should usually be discernible at close range and not noticeable from a distance.

It is essential that all physical changes to a site during excavation and conservation be thoroughly and accurately recorded. The documentation should include details of any previous repairs and the performance of materials then used.

Materials conservation

Consolidating exposed brick and stone masonry structures should be done in most instances using traditional masonry construction techniques with perhaps some minor modifications. In consolidating and restoring ruinous walls, special attention must be given to protecting the inner wall core and all joints from moisture penetration. An effective solution for weatherproofing wall tops is to add either stone capping or metal cap flashing with drips which direct moisture away from the walls. Though efficient, this type of solution can have unacceptable aesthetic consequences except, perhaps, when used on high walls. In most cases where ruinous masonry wall tops of varying heights are to be consolidated,the best approach is to re-set the top three or four courses in a visually compatible mortar setting-bed, with slightly recessed joints which are pointed so as to shed water away from the wall centre. In some cases the new mortar can be more durable than that which exists. However, mortars used in the repair and consolidation of historic masonry should never be significantly more dense or with greater bonding capacity than the softest masonry component which is being repaired. There is no need to flatten all wall tops of an exposed wall, with the possible exception of cases involving mudbrick masonry consolidation. The levelling of wall heights compromises the visual integrity of a structure in ruin.

Many attempts have been made to reinforce and waterproof ruined structures using chemical solutions and additives. Included among those solutions used for masonry consolidation are silicates, acrylic polymers, polyurethane resins, vinyls, waxes, silanes, asphalt emulsions and epoxies. Chemical additives include portland cement, hydrated lime, concrete hardeners and glues. Although apparently successful in some instances, the majority of such interventions have proven to be failures. Applications can be expensive and on several occasions have been known to cause irreversible damage – a most lamentable situation where irreplaceable cultural resources are involved. Failures are generally due to new and old materials having different strengths, coefficients of expansion, porosities, colours and durability. Incorrect product mixing and inexpert applications pose sizable problems in themselves. Where one may care to experiment, chemical solutions and additives should be thoroughly and scientifically tested at the site over a period of at least one year. Many promising possibilities exist for the successful use of chemical consolidants and waterproofing substances for exposed archaeological materials but as of yet no cure-all formulae have been developed. Until they are, more "organic" traditional methods of building repair should be relied upon and a healthy skepticism of new products should be maintained.

Exposed ruins after excavation may also be protected by roofs and sheds of different types and materials. In designing these, it is important – as in other engineering and construction projects – that the materials be specified. The roof must, first of all, be able to protect itself and the specifications must take account of, for instance, the need for rust-proofing and fire resistance. Clear specifications are no less necessary for temporary protective roofs, bearing in mind the tendency of the temporary to become permanent.

Landscape restoration

Restoring landscape features based on archaeological evidence can be highly effective in site presentations. Restored horticultural elements such as trees, gardens and parterres can offer the practical advantages of shade and windbreaks while also directing visitor flow through a site. Only plant and tree species native to the area should be used; they should be carefully placed, with preservation of the site the main objective. Large-rooted trees and clinging ivy should not be placed in close proximity to old masonry walls. If vines are to be allowed on a ruin, they should be planted in specially built pockets, and be of the twining or running variety.

Grass lawns over either unexcavated or backfilled areas of the site can often define a floor plan as well as, if not better than, the original flooring. In high-traffic or shaded areas, gravel walking surfaces offer the same advantage with less maintenance. Vegetation growth beneath gravel areas can be prevented with the help of recommended herbicides.

Restored water features can also contribute greatly to the effectiveness of a site presentation. Reactivating dormant water displays such as fountains and restoring water bodies and edge conditions, as has been done for some European castle moats, can add a pleasant vitality to the stillness frequently found at uninhabited sites. In some cases original water collection and distribution systems can be rehabilitated for continued service (for example, in an urban setting, the Roman bath building at Bath, England).

The presentation of some sites is primarily a question of landscape restoration, as in cases where original landscape elements, and occasionally complete gardens, remain. A less horticultural example would be the restoration of a battlefield consisting mainly of earthworks. This sort of presentation usually requires practical revisions to what would otherwise be an authentic restoration. Timber revetments should be treated with chemical preservatives and embankment slopes should both resist erosion and be more easily maintained than the original builder would have intended.

Building reconstruction

The use of restraint in architectural design for ruins preservation is of great importance. The history of archaeology and architectural restoration contains many instances where both architects and archaeologists have been over-zealous in reconstructing vanished structures. The only conceivable situation where complete reconstruction might be undertaken is when there is complete or very nearly complete archival or archaeological evidence, for example where accurate pictorial records exist or perhaps where a natural catastrophe preserved a structure *in situ*, such as the mud slide inundation of Herculaneum and the volcanic explosion of Santorini in Greece. Otherwise reconstruction should be limited to anastylosis (see Mertens, Chapter 10).

Hypothetical reconstructions using identical materials often cause more confusion than anticipated. Complete reconstruction does, however, offer the advantage of enclosing a structure again, and thereby offers more efficient protection, for example the reconstruction of the Stoa of Attalus in Athens (plate 3a) and parts of the Palace of Minos at Knossos, Crete (plate 3b). Given the practical and philosophical issues raised by this practice, an approach involving more understated suggestions of a structure's size and shape would now generally be preferred. If the condition of a site requires sheltering systems as well, then sensitively designed shelter structures should probably be used that do not detract significantly from the natural qualities of a site and its building remains. Or, as an English architect once put it, "a properly presented site should be made as photogenic as possible."

Examples of site protection

There are many examples of sheltering and protecting *in situ* archaeological ruins, most of which date from the last 100 years. A range of possibilities exists which can be placed on a scale of intervention ranging from the simplest, most practical approach to those which are more technically and theoretically complex (figure 1).

The method used for presenting mosaics at an imperial Roman villa discovered at Woodchester in Gloucester, England, may be the most practical, cost-effective and preservation-conscious of all solutions. An area of 256 m^2 of mosaic flooring is uncovered for public display during the summer months on a regular basis every tenth year. When on display, a walkway bridges the mosaic, one of the largest and most elaborate in Northern Europe. Interested visitors are only able to visit a few times in their lives and there is something rather special about the local tradition centred around the excavation and reburial events.

Figure 1. A SELECTION OF ARCHAEOLOGICAL SITES REPRESENTING A POSSIBLE SCALE OF PHYSICAL INTERVENTION

1. Discovered sites that remain unexcavated:
    - Unexcavated portion of Pompeii
    - Photo-mapped sites in Turkey
    - Second Funeral Barge Pit at Cheops Pyramid,Giza, Egypt
    - Etruscan tumuli at Cerveteri and Tarquinia, Italy
2. Backfilled sites which are periodically presented:
    - Mosaics at Woodcester, Gloucester, England
3. Above-ground ruins left "as found":
    - Plaza of the Seven Temples, Tikal, Guatemala
    - Rosewell Plantation, Whitemarsh, Virginia, U.S.A.
4. "Abstract" presentations which preserve archaeological fabric:
    - Ben Franklin House, Philadelphia, Pennsylvania, U.S.A.
    - Facsimile of below-grade ruins, Nara, Japan
    - Wolstenholme at Carter's Grove, near Williamsburg, Virginia, U.S.A.
5. Temporarily protected excavations:
    - Regia in Roman Forum (under shed roof)
    - Can Hasan, Turkey (excavated beneath pneumatic shelter)
    - Lawson Indian Site, Ontario, Canada (use of tent structures in inclement weather)
6. Stabilized and/or partial ruins *in situ*:
    - Fountains Abbey, Yorkshire, England
    - Colosseum, Rome, Italy

- Nalanda temples and monasteries, Rajgir, India
- Windsor Plantation, Port Gibson, Mississippi, U.S.A.
- Hadrian's Wall, North England
- Macchu Picchu, Peru
- Mycenae, Greece
- Pyramid Complex, Mexico City, Mexico
- Persepolis, Iran

7. Stabilized ruins with an adjacent site museum:
   - Paestum, Italy
   - Tarquinia, Italy
   - Tintern Abbey, near Monmouth, Wales
8. Ruins protected beneath or within shelters:
   - Tomb of Chin Shih Huan, Shen Si Province, China
   - Piazza Armerina, Sicily, Italy
   - Fishbourne, Sussex, England
   - Roselle, Italy
   - Casa Grande, Arizona, U.S.A.
   - Kara Tepe, Turkey
   - Dinosaur National Monument, Utah, U.S.A.
   - Lullingstone Villa, Kent, England
   - Akrotiri, Thera, Greece
   - House of Dionysos, Paphos, Cyprus
9. Ruins incorporated into other structures:
   - Theatre of Marcellus, Rome, Italy
   - Dome of the Rock (Second Temple platform), Jerusalem
   - Lord Byron's Home, Nottingham, England
   - Baths of Diocletian, Rome, Italy
   - Sugar Mill Conversion, National Park of Culture and Rest, Havana, Cuba
   - Roman Baths and Museum, Bath, England
10. Completely restored ruins:
    - Curia, Rome, Italy
    - Temple of Hatshepsut, Deir el Bahari, Egypt
    - Arch of Titus, Rome, Italy
    - Gymnasium and Synagogue, Sardis, Turkey
    - Queen's Megaron, Knossos, Greece
    - Colonia Ulpia Traiana, Xanten, Germany
    - Cardiff Castle, Wales
11. Relocated archaeological monuments:
    - Abu Simbel, Eyptu
    - Philae Temples, Egypt
    - Ramesses II Obelisk, Place de la Concorde, Paris, France
    - Temple of Dendur, Metropolitan Museum of Art, New York, U.S.A.
12. Archaeological reconstructions:
    - Stoa of Attalus, Athenian Agora, Greece
    - Colonial Williamsburg, Virginia, U.S.A.

Sites under excavation and open for exhibition for short periods can be easily and economically enclosed in any of several types of temporary structures (plate 4a). Protective shelters can range from pneumatic structures to more durable prefabricated metal-clad structures. Pneumatic structures are practical at sites where ongoing excavation requires short-term protection. A pre-formed continuous membrane of plastic sealed around its base with air-locked entrances can be kept inflated over an extended period of time by small gasoline or electrically powered fans. With balanced ventilation, such a structure can actually serve to provide a more or less air-conditioned space and both the excavation and its excavators can be protected from direct sunlight (Weaver 1973).

Fibre-reinforced membranes can also be stretched over lightweight structural frames which can span over 20 metres. Among the choices of structural systems for such spans are space-frame trusswork and tensegrity-type structures which support tent-like forms.

The excavated site of Roselle, a 7th-century BC Etruscan hilltown site in central Tuscany, has a simple shelter over its most significant area (plate 1a). The structural system consists of round steel columns placed at approximately eight-metre intervals and a roof structure made largely of a grid system of steel angles. Green corrugated fibreglass panels form the roof sheathing. Gutters and directional rain leaders divert water away from excavated portions of the site. Ruined wall tops are consolidated, with some serving as pathways for visitors, and a modern cast-concrete footbridge spans one portion of the exposed ruins. This strictly functional sheltering system effectively protects the excavated areas from direct sunlight and rain, and its colour and low height are sufficiently neutral and visually recessive so as not to detract significantly from the natural character of the site.

More durable features at the site such as a polygonal stone roadway and standing stone walls have been reconstructed, and throughout the site restoration work is discernible on close inspection. The date of restoration work was occasionally stamped into the new mortar work.

A more permanent form of open-air shelter was erected over historically important bilingual inscriptions at Kara Tepe in Turkey (plate 4b). The structural system and roof, of reinforced concrete, should require less maintenance than a metal and fibreglass structure, for example; however, there is a risk that the shelter appears monumental in relation to the site.

The discovery of important mosaic floors during excavation of an imperial Roman palace at Fishbourne near Chicester, England, was an important archaeological discovery which merited complete presentation. It was enclosed in a new shelter which also accommodated an interpretive display. The complex dated from AD 75 when it was destroyed by fire. The most significant mosaics at the site and other archaeological remains were consolidated and are presented within the modern enclosure; outside it is an archaeological park. The well-kept grounds have restored landscape features such as trellises and topiary. In addition subterranean foundations in other areas of the site are "lined out" at grade level with pre-cast concrete pavers. Mounted bronze information plaques offer interpretations of the few archaeological features which are exposed to the weather (plates 1b, 2a).

The protective shelter at Fishbourne is a clear-span structure with window walls. Inside, an elevated walkway with carefully located footings allows visitor viewing from above (plate 2b). From the design and interpretation point of view, the complex is highly effective. Some problems, however, due to groundwater conditions are evident in parts of the sheltered remains. Rising damp is present in some of the most fragile archaeological fabric. The wooden thresholds and plasterwork were not re-set in impervious setting beds, as were the mosaics, leaving them vulnerable to rising damp. Moisture in these elements is evident from the tell-tale presence of biological growth. In this case, lowering the groundwater table through the installation of dry wells or similar means may not be the preferred solution because of the differential settlement potential for the foundations of the new structures. The present moisture problem at Fishbourne is relatively minor compared to the many successes, though it does underscore the issue that archaeological ruins, even if presented in carefully controlled interior environments, are not always exempt from deterioration problems.

The shelter system used to cover important mosaics at Piazza Armerina in southern Sicily represents an enclosed protective structure which abstractly reconstructs volumes of major portions of the 3rd-century AD villa (plates 5a, 5b). The modern structure encloses a complex of rooms which surrounds a central courtyard. Restored mosaics and consolidated walls which are no higher than two metres can be viewed from within the enclosure from a meandering, elevated metal walkway centred over ancient walls. In the place of the original walls and roofs are translucent panels of plastic attached to lightweight metal framing. Much of the wall area consists of panels of fixed louvres for ventilation. Suspended panels of plastic create flat ceilings in certain areas, reduce heat transmission and glare, and also create a ventilated attic space.

Built in the 1950s, the structure was the first of its kind to enclose *in situ* archaeological remains using contemporary materials to recreate the geometry of a vanished building form. The shelter functions well in protecting the exhibition of mosaics and was installed with a minimum of intrusion to the original building fabric. The prefabricated structure can also be easily dismantled. There has, however, been material failure in the exterior sheathing as sunlight has discoloured the plastic of the panels. During the summer months visitors have also complained of uncomfortably high temperatures despite what would seem to be adequate ventilation designs (Fitch 1982).

Another unusual approach towards preserving and presenting archaeological remains was used in 1975 at the Benjamin Franklin House in Philadelphia, Pennsylvania. Architects Venturi and Rauch, retained by the U.S. National Park Service, constructed an abstraction or a "ghost" of Franklin's long-since demolished home and carriage house in their original locations (plates 6a, 6b). Although archaeologists and archivists yielded a wealth of artifacts and written descriptions concerning the building and its ground, there was insufficient archaeological or pictorial evidence to reconstruct the two buildings accurately. This lack of information was the basis of a decision to construct only an outline of the two structures in a framework of square steel sections. Entrances, rooflines, gables and chimneys are represented in their supposed size and shape. The ground level walls and the first floor rooms are defined in a pattern of bluestone and granite pavement, with either grass lawns or brick paving used at other areas of the site. The actual foundation walls of the house and cellar remains can be viewed immediately below grade by looking into several periscope-type inspection pits.

The plan of each ground floor room is clearly delineated by different colours and textures of paving. Adding to its interest are excepts from Franklin's correspondence pertaining to each room inscribed in the bluestone paving. A typical example reads, " '... in the front room which I designed for guests I have the bed you sent from England, a chamber mahogany table and stand.' Deborah Franklin to Ben, Paris, Fall, 1765." Such a device adds a valuable human element to the site. In addition to this open-air presentation, an interpretive museum describing aspects of Franklin's life and accomplishments is located in an adjacent underground facility. The unique presentation used at the Franklin house attracts an average of one million visitors a year and serves as one of the nation's major exhibitions of American history.

Summary

As the fields of archaeology and architectural conservation have matured, there has been a certain development in attitudes about preserving and presenting *in situ* archaeological remains. Attitudes towards site conservation have evolved from a general "laissez-faire" approach, through an interest in scholarly reconstructions, to preserving and presenting ruins, in a practical manner, with the aid of improved conservation and interpretation techniques.

There is a continued role for discreet interventions where there is a high appreciation for historical authenticity. This is not to say that bold interventions are not sometimes warranted – all possibilities should be considered, so long as in each case preservation is the main objective.

Experience at preserved and presented sites has proven that stabilization and restoration efforts can never be permanent measures in themselves since deterioration is a never-ending dynamic process. At exposed sites, a long-range commitment is needed, not so much to keep the resource unchanged as to mitigate the effects of time. Realizing this, it must be accepted that maintenance is an essential part of preservation. New developments in science and preservation practice must always be involved in the efforts to conserve sites.

The many potential aspects which each site poses require detailed planning for satisfactory solutions – the principal reason for using a multi-disciplinary approach. As knowledge and experience continue to accumulate, the success rate for archaeological site preservation and presentation efforts will only improve.

ACKNOWLEDGEMENTS

Figure 1 is based on the "Scale of Intervention Concept in Historic Preservation" originally developed by J. M. Fitch. The following kindly supplied photos: C. Erder (plates 3b and 4b), R. M. Organ (plate 4a), D. Mertens (plate 5a), and J. M. Fitch (plates 5b and 6b); remainder by the author.

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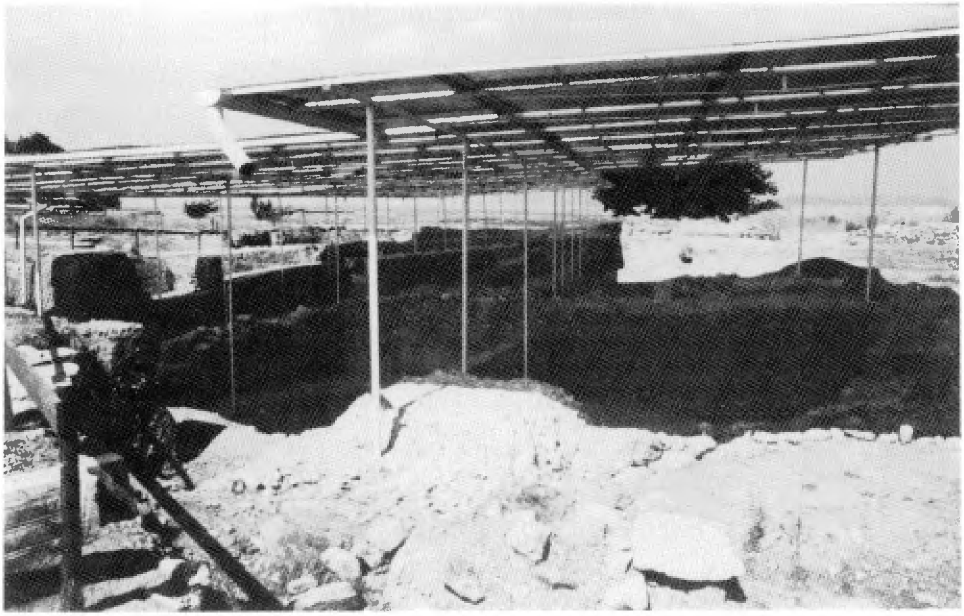


Plate 1a. Simple shed covering at Roselle, Tuscany, Italy.

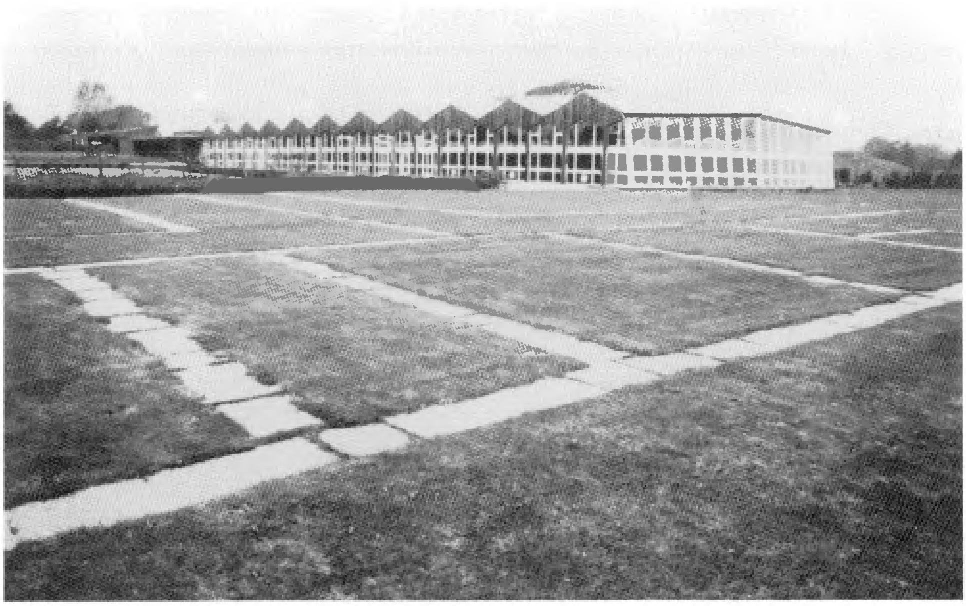


Plate 1b. Fishbourne Palace Museum, Sussex, England, showing "lined-out" subterranean structures.

Plate 2a.

Consolidated archaeological remains at Fishbourne.

Plate 2b.

Clear span structure sheltering mosaic flooring and wall remains, Fishbourne.

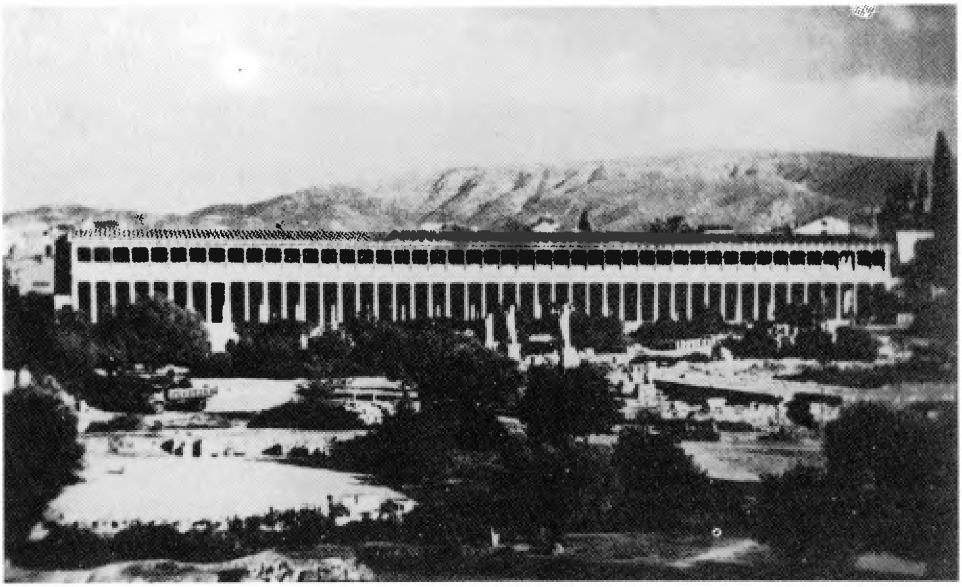


Plate 3a. Reconstruction of the Stoa of Attalus, Athens.

Plate 3b. Knossos, Crete. Reconstruction of royal apartments, Palace of Minos.

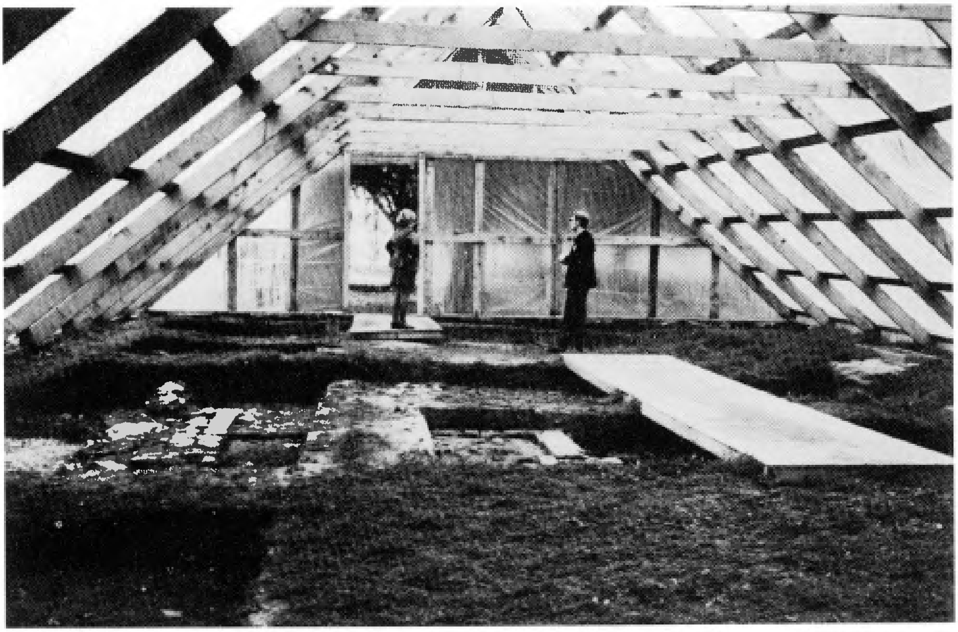


Plate 4a. St. Mary's site, Maryland, U.S.A. Temporary roof of polythene and wooden framework over excavation.

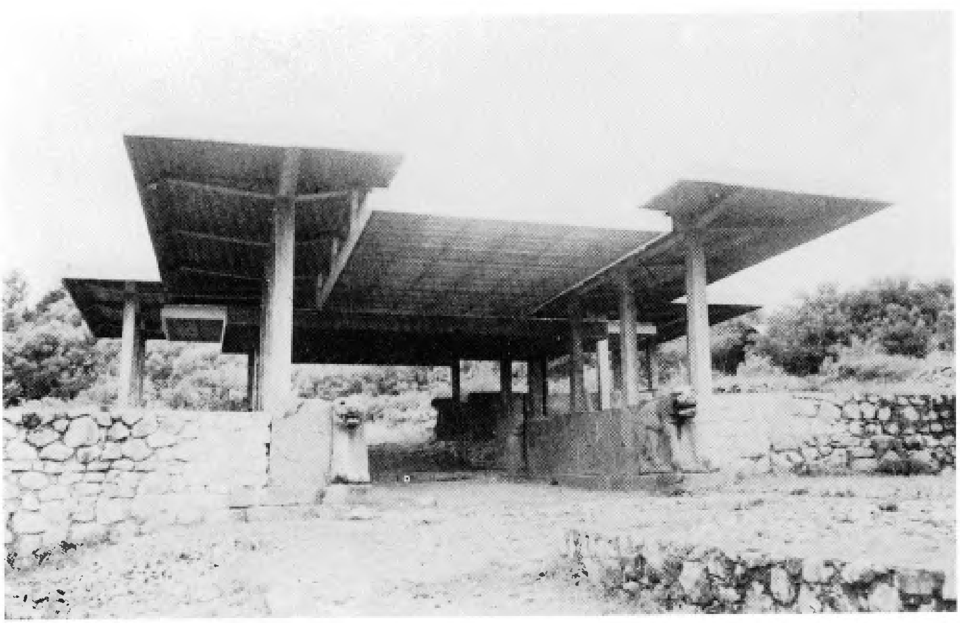


Plate 4b. Kara Tepe, Turkey. Concrete roof over ruins.

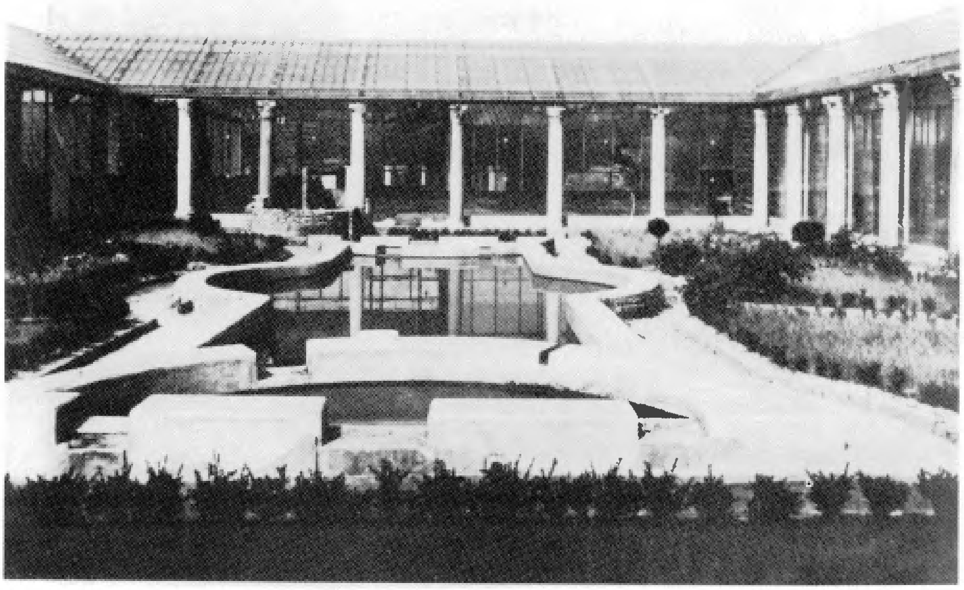
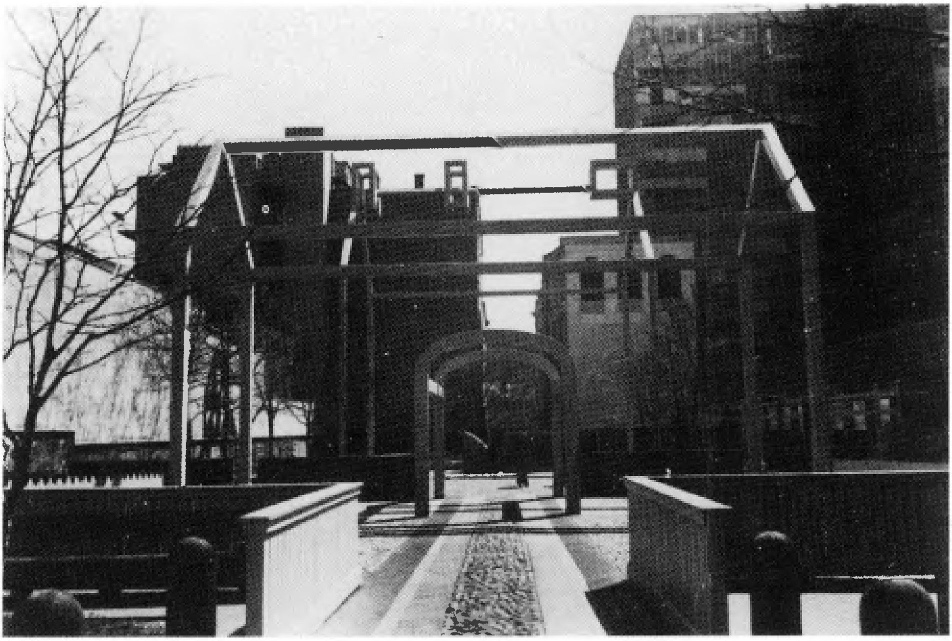
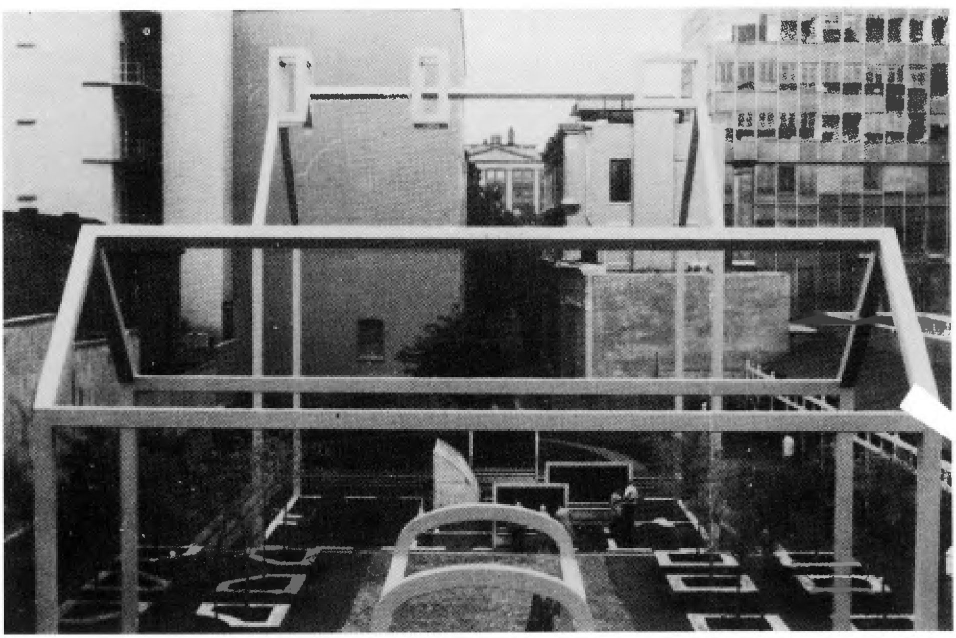


Plate 5a. Piazza Armerina, Sicily. Form of Roman villa recreated using Plexiglass.

Plate 5b. Piazza Armerina. Protective shelter abstractly recreating spatial volumes.





Plates 6a, 6b. Abstract reconstruction of Benjamin Franklin home and carriage house, Philadelphia, Pennsylvania.

CONSERVATION OF EXCAVATED INTONACO, STUCCO AND MOSAICS

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1. Introduction

The preservation of architectural surfaces decorated with paintings, stucco and mosaics which come to light in the course of excavation presents particularly serious conservation problems unlike those of movable objects. This is because their long-term survival depends above all on their local environment and, being themselves an integral part of an unmovable architectural whole, they are always difficult to protect from the effects of deterioration caused by external agents.

In fact, while it is already complicated to keep in good condition architecture that has always been exposed to the air, it is still more difficult not to subject it to deterioration when it has come to light in a good state of repair.

Structures when buried in the ground or submerged in water or ice can be preserved unaltered over the centuries so long as they remain in stable conditions of humidity or temperature. Indeed, the state in which an object or a structure appears at the moment of its excavation would probably be no different if it was uncovered only many centuries later.

Therefore the treatment of these surfaces at the moment of exposure is of vital importance since it is at the very moment in which they are freed from their surrounding deposit that they undergo a trauma caused by the negative effect of a new environment and thermo-hygrometric variations. Everyone has heard stories about objects and decorated intonacos which are found almost intact but which deteriorate, or are sometimes actually destroyed, in a very short time.

Given that deterioration is initiated primarily by the change from a damp to a dry environment and given that according to the type of material – whether organic or inorganic – different mechanisms of destruction are put into operation, the difficulty of the intervention will depend mainly on the climate and type of terrain. In fact, while variations between one state and the other in desert areas may be very little or none, in other areas the change will be much accentuated. If this in turn is not gradual, rapid drying will inevitably provoke an irreversible deterioration which can be avoided only if the change from the static condition to a new one is slow and controlled.

Knowing that deterioration of the artifact begins from the first moment of discovery, it is therefore necessary to make sure at the planning phase that conservators are present. With an immediate intervention they can stabilize it in its state as found, but they cannot preserve it in the long term unless adequate definitive protection measures are considered at the same time.

2. Deterioration

Deterioration is a product of physical, chemical and biological agents which enter into contact with the object from the moment of its burial and thereafter exert their effects. Nevertheless, they allow the object while remaining buried to reach a general equilibrium that is interrupted only when it is brought to light, whereupon they initiate their mechanisms causing disintegration. All these agents operate solely in the presence of water which impregnates the artifact, dissolves and re-deposits salts, forms superficial concretions and, depending on the type and pH of the soil, corrodes the surfaces and at the same time encourages both plant and animal life.

Built structures that have been buried for centuries in good condition below the ground surface start to dry out immediately following their discovery and exposure. This favours a process of disintegration due principally to the concentration of soluble salts towards the surface and to their subsequent crystallization. This mechanism of deterioration resulting from their stay below ground occurs especially on decorated surfaces (paintings, stuccos, mosaics), being the part in direct contact with the external environment and therefore the most sensitive and vulnerable part of the artifact. Unfortunately, one cannot prevent this mechanism but one can slow down the speed of evaporation of water in the drying phase, thereby reducing the disintegrative action.

At the same time, from the moment artifacts recommence life in the open air, they will be again exposed to the activity of the usual agents of deterioration: variations in humidity, temperature and light, to which should be added disasters, vandalism, flora, fauna, etc. Only a prompt and correct conservation intervention on the object and its environment can reduce, if not remove, all destructive effects.

3. Intervention

Although one is led to believe that urgent intervention is necessary only for organic materials from excavations (such as wood, textiles, or leather) because they are more easily perishable, it is evident that inorganic materials, i.e., built structures and their decorated surfaces, are also sensitive to immediate attack by all agents of deterioration. An indication of conservation measures to take depends in large part on several factors: the long-term future of the excavation, its geographical and topographical position, extent of the buildings, climate, possibility of surveillance, the time available for work and other factors dependent on local circumstances. The description here of intervention operations will concern only the treatment of artifacts destined to remain *in situ*, since it is now well known that, except in special cases, everything that involves *transfer* as a single method of conservation no longer corresponds to current criteria of protection since it destroys the unity of the remains that have survived. Only when further technical or historical information is essential or when the remains are threatened with immediate destruction can the transfer of an excavated decorated surface be justified.

3.1 Initial intervention

In order to be efficient, the intervention on mural paintings, stuccos and mosaics should follow a logical sequence of operations. Taking for granted the indispensability of the usual documentation with drawings and photography and of laboratory investigations, the first intervention must be concerned with the safeguard and protection of the *site*, with particular attention to the problem of protection from water by diverting and draining it. At the same time all the fragments of decorated intonaco should be collected with the usual precautions of documentation and recording in three dimensions.

The fragments must be collected with great care so as not to damage their edges, which absolutely must be in good condition for later reassembly. Sometimes fragments are found still adhering to one another; in this case, in order to avoid breaks and losses, it is advisable to protect them by means of light cleaning and gluing a gauze over them, even in several layers if required for mechanical stability. The recommended adhesive is an acrylic resin in solution (note 1).

If the fragments are too large, it will be necessary to make a support that fits their shape. According to need and availability, this could be made of expanded polyurethane, possibly reinforced with ribs of fibre-reinforced silicon rubber, of wood or, as a last resort, of plaster.

3.2 Treatment of the decorated surfaces

The second phase consists of the treatment of the decorated surfaces, *in situ*, still attached to the structure. The operations to follow are (1) initial cleaning, (2) partial extraction of soluble salts, and finally (3) consolidation of the parts that have lost cohesion and become detached.

3.2.1 Initial cleaning

The initial cleaning involves the removal of earth, light concretions and plant growth. This should be done with plastic spatulas, with brushes selected according to the resistance of the original surface, and with scalpels for the more resistant areas, taking great care not to cause the slightest damage to the surface, which often is more delicate than the material to be removed.

If the condition of the object allows, the cleaning should be carried out by washing with water using nebulization, so as to wash away superficial salts, taking care to direct the water runoff well away from the structure.

3.2.2. Extraction of soluble salts

Again if the object's condition allows, it is useful to follow with the immediate extraction of soluble salts so that they do not continue to exert their disintegrating action during the drying phase and successive variations in the ambient RH. The complete extraction of soluble salts from a built structure which has long remained below ground is virtually impossible; one can only reduce their concentration in the superficial layers.

The method of extraction is by means of a wet compress of cellulose pulp. The paste is obtained by adding deionized water to the cellulose until the necessary consistency is reached for it to remain adhering to a vertical surface. The compress should be several centimetres thick and should remain in contact with the surface until it dries out.

The process of extraction works because the water of the paste becomes absorbed by the intonaco and dissolves the soluble salts contained in it. This water, enriched in salts, migrates once again towards the surface and, in evaporating, it deposits the salts in the paste.

The operation can be repeated as needed. The quantity of salts extracted can be controlled by measuring the concentration of salts deposited in the compress.

In the case of surfaces that have lost much of their cohesion, it is convenient, simultaneously with the extraction of the salts, to carry out a light fixing with consolidants in very low percentages (from 15%), so as to allow the water of the compress still to exercise its function.

3.2.3 Consolidation

The third operation consists of consolidation which attempts to reestablish cohesion between the particles of disintegrated material and adhesion of the various layers between each other and to the structural support. This is achieved by applying consolidant materials (note 1) which, by penetrating to the right level, will improve the mechanical characteristics of the rendering.

For re-establishing cohesion the consolidant should be able to penetrate in depth; therefore it should be applied in solution with adequate solvents so that, having a good power of penetration, it can reach even the deeper layers. The solvent or mixture of solvents must have the right evaporation rate, not too high or else it would evaporate before its action takes effect, not too low or else it would make the surface sticky for some time and would favour the deposit of atmospheric dust upon it. In the case of structures saturated with water, as is usual in excavated walls, a solvent not miscible with water should be used, such as, for example, trichloroethane (*Chlorothene*) or *Xylene* (note 2).

The consolidant can be applied with a spray, by brush or through percolation. In all cases, given the toxicity of solvents, the operators should observe the necessary precautions for use. The concentration of the solution can vary from 2-10%, according to the state of deterioration; the more the material has deteriorated, the more concentrated the solution should be.

Even so, it is preferable to keep to low concentrations, repeating the operation several times, rather than to apply the solution in a high concentration, which tends to form a superficial film that is damaging from the point of view of conservation and displeasing to the eye.

To restore adhesion one uses the same synthetic materials but in an emulsion since, being itself a dispersion in water with high surface tension and with particles relatively large compared with the solution, it does not have good penetration and therefore tends to form the superficial film which allows the two parts to re-adhere.

When there are cavities and detached areas that cannot be rejoined, the same emulsions are used with the addition of inert fillers such as marble dust or calcium carbonate, or, better, of a fluid mortar with a hydraulic set (note 3). Later reinforcement or filling of gaps will be done with the same type of mortar but with a higher content of filler and with a lower mechanical resistance.

In the case of a particularly fragile decorated surface, but only for temporary protection for not longer than two years, one might affix to the surface a very light cloth, glued with the same resin but in a greater concentration (from 15-25%).

The choice of materials to be used in the treatment of excavated structures, if the excavation is due to be backfilled, must be done with great care, keeping in mind that the materials must be able to resist particular conditions (high humidity and biological attack).

4. Protection after excavation

After conservation treatment, depending on the future fate of the excavation, one might consider the following possibilities:

(1) for an excavation in progress needing to be protected from one season to the next:

(a) temporary protection with shelters

(b) temporary protection with backfilling of earth.

(2) for an excavation completed or indefinitely suspended:

(a) definitive protection with permanent shelters

(b) definitive protection with backfilling of earth.

Since points 1a and 2a are discussed in Chapters 7 and 9, attention will focus on temporary or final protection by backfilling.

There are certain principles to follow if the long-term protection of an excavated decorated surface by backfilling is to be successful. At the bottom of the trench, adjacent to the decorated surface, a backfill material must be insulating, and it must be impermeable to liquid water while remaining permeable to water moisture. Never should a sheet of plastic be laid directly on the surface since this encourages moisture condensation under it and thus microbiological activity. Clay or clean, salt-free sand are acceptable, although they tend to become compacted and heavy when wet, and therefore difficult to remove, if need be. Pozzolana, in the form of large lumps, performs better in this respect.

Positive results have been obtained with clinkerized expanded clay in small pellets. However, this material is suitable only for re-covering pavements and mosaics, since it is too hard to be in contact with more delicate surfaces such as painted intonaco and stuccos. For contact with these surfaces, the use of vermiculite (expanded mica) may be recommended, as it fulfils most of the qualities demanded of the materials to use.

These materials can be utilized in two ways: in small bags or loose. Normally they are to be preferred loose, because bags leave spaces between them, preventing a homogeneous protection of the surface.

The top of the backfilled trench must be stabilized, while remaining permeable to water moisture, so as to be protective and to prevent the backfill material from being blown away. Selected plants that are shallow-rooted and native to the area should be used. If the area before excavation is under grass, the turf should be carefully cut and stacked, grass-face to grass-face, and kept damp until it can be replaced on the backfilled area. For excavations in denuded areas, the possibility of transporting turf from elsewhere should be considered.

One possible sequence of backfill materials for an excavated built structure is proposed below (see figure l); experiments to check its efficacy are in progress:

(1) *plastic net,* with fairly close mesh (e.g., of the type used for protection against hail), spread over the pavement and applied liberally over all the vertical surfaces to be protected,

(2) *an upright partition* to contain vermiculite, placed upright on the pavement parallel to the surfaces to protect,

(3) *expanded clay* 15-20 cm deep, in a horizontal stratum,

(4) *plastic net*, laid down over the expanded clay outside the upright partition,

(5) *vermiculite* to fill the spaces between the decorated surfaces and the partition,

(6) *earth* to fill in partially the excavation, treated with adequate biocides,

(7) *bentonite* (clay) in horizontal layers, to prevent direct penetration of rainwater,

(8) *earth*, for final filling in of the trench to higher than the surrounding ground level (depth of trench plus 5-10%),

(9) *selected planting* of shallow-rooted plants.

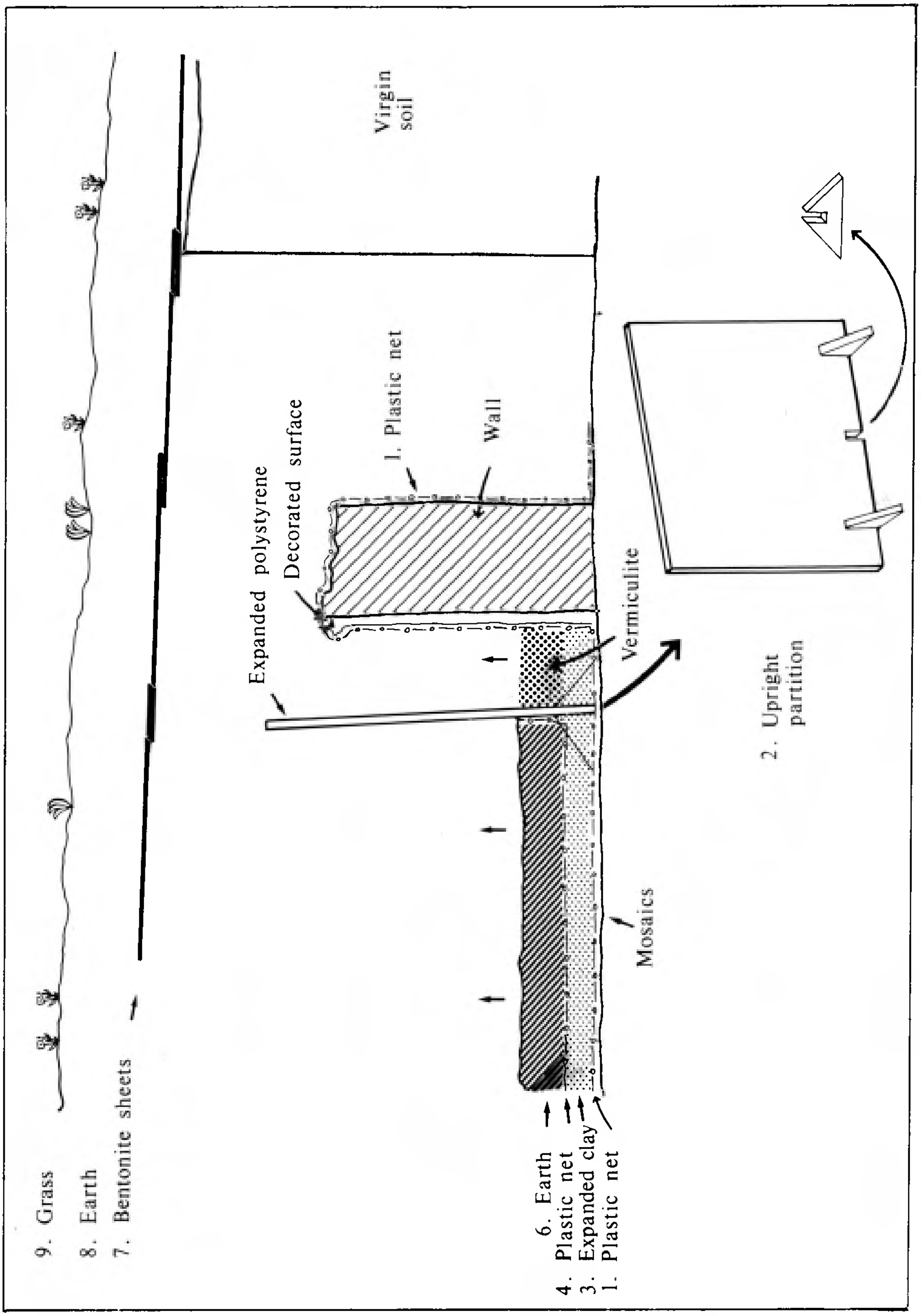

Figure 1. Proposed sequence of backfilling

The plastic nets (levels 1 and 4) are designed to make it easier to remove the backfill material; these can be omitted if the excavation is to be filled in for ever.

Before spreading the expanded clay (level 3), upright partitions to contain the vermiculite should be provided, at 20 cm distance from the vertical surfaces. The partitions can be made of expanded polystyrene sheets about 2 cm thick, with support footings of the same material. Expanded polystyrene, even in the long term, will never have a negative effect on the decorated surface.

After spreading the stratum of expanded clay over the entire pavement, including the part of the pavement within the partitions, a second plastic net (level 4) will be put down. Then the space between the partition and the wall will be filled with vermiculite (level 5) while the rest will be filled with earth (level 6).

At this point, naturally, care should be taken that the space within the partition be filled at a similar rate as the rest of the area being filled with earth. In this way the process of filling continues until the vertical sides are completely covered with earth, and the space within the partitions filled entirely with vermiculite.

The conservation intervention on the object and the protective backfill will not be sufficient for preservation unless future inspections are planned. This is because after a certain time, the natural animal and plant life of the earth will begin to establish itself as before, with results that cannot be foreseen but that will be similar to those that occurred before the excavation.

NOTES

Note 1. The materials used as consolidants can be organic or inorganic. Some of these do not have any counter-indications from the point of view of ageing or of the formation of damaging secondary products, while others, which should respond better in being homogenous with the materials to be consolidated, give rise to some reservations on a theoretical level.

To resolve these uncertainties, comparative tests are in progress to define the efficacy of inorganic consolidants such as lime water, silicate esters, barium hydrate or potassium aluminate, since there remain some reservations about either their difficulty of application or their being certainly and totally irreversible.

So-called "reversibility" which, in the case of intonaco would seem to be a secondary property, is on the contrary indispensable, so as to allow the materials to be changed if they prove to have negative effects.

Among the organic consolidants, on the basis of long practical experience to date, selected tests and the existing literature, the use of acrylic resin (copolymer of acrylates and methacrylates of methyl and ethyl) is recommended, being found commercially under the name of *Paraloid B-72*.

Note 2.

Characteristics of the solvents

	Trichloroethane	Xylene
Boiling point (°C) at 760 mm Hg	74.1	138-144
Coefficient of Evaporation(ether=1)	12.6	13.5
Flash point (°C)	non-flammable	29.5
Toxicity TLV (ppm)	350	100
Miscibility with water – water at 20°C	0	0

Note 3. By *hydraulic mortars* one means mixtures based on cement, hydraulic lime or lime-pozzolana which have the property of setting through chemical reaction with water even if not in contact with the air. In contrast, air-setting mortars based on hydrated lime need carbon dioxide contained in the air in order to set.

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PROTECTION AND CONSERVATION OF EXCAVATED STRUCTURES OF MUDBRICK

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1. Introduction

Five meetings on the conservation of mudbrick and other raw earth materials have recommended measures for the protection and preservation of excavated mudbrick structures.

These meetings were:

- The First International Conference on the Conservation of Mudbrick Monuments (Iran/ICOMOS), Yazd, Iran, 25-30 November 1972;
- The Second International Symposium on the Conservation of Monuments in Mudbrick (Iran/ICOMOS), Yazd, Iran, 6-11 March 1976;
- The Adobe Preservation Working Session (US-ICOMOS/ICCROM), Santa Fe, New Mexico, USA, 37 October 1977;
- The Third International Symposium of Mudbrick (adobe) Preservation (Turkey/ICOMOS/ICOM/ICCROM), Ankara, Turkey, 29 September-4 October 1980;
- International Symposium and Training Workshop on the Conservation of Adobe (ICCROM/Regional Cultural Heritage Project (UNDP/UNESCO) in Latin America), Lima, Cusco, Trujillo, Peru, 10-22 September 1983.

Despite the existence of the guidelines proposed at these meetings, these recommendations are frequently overlooked by those responsible for conducting archaeological excavations on sites likely to contain remains of structures built of raw earth materials. There is a direct relationship between this attitude and the irreparable damage and loss of mudbrick archaeological structures.

This paper calls attention to internationally accepted principles for the preservation of those structures.

2. Archaeological sites, conservation policy

A first and fundamental consideration in planning archaeological excavations is preventing the decay of cultural material recovered through these works. Such material also includes the structures of the site. In accordance with this viewpoint, the resolutions of Yazd (1976) recommended that no archaeological excavations of sites likely to contain the remains of structures in mudbrick should be undertaken unless a provisional conservation policy had been established and had been included in the excavation budget agreed upon by the archaeologists and the competent authorities.

Furthermore, for the cases in which a conservation policy has not been established, the resolutions of Ankara (1980) include the following recommendation: newly excavated mudbrick material must immediately be given temporary protection until such time as its importance is defined and a definite conservation plan is established.

The above resolutions stress the importance of the definition of a conservation policy as a fundamental step in preventing the decay of archaeological sites due to exposure to environmental agents.

3. Causes of deterioration of mudbrick material

Clay particles (by definition, smaller than 2 microns) and to a certain extent silt are the binding element in mudbrick. Clay minerals in contact with increasing amounts of water first increase their volume, then become looser (higher plasticity) and eventually are dispersed in a water suspension.

For these reasons, by far the largest amount of damage to mudbrick structures (with the obvious exception of that caused by earthquakes in seismic regions) is attributable to water, especially when it is abundant and in liquid form (rain, water pools). Wet clay becomes impermeable to water and excess rain runs over the surface, carrying suspended matter and digging preferential channels which are eroded even faster because they are subjected to a larger water concentration.

Moisture content can decrease the tensile and compressive strength of mudbrick by up to 200 per cent (Clifton and Davis 1979). Therefore the bases of walls, in particular, which have to support all the weight, tend to collapse once they are impregnated with water.

Upon drying, clay tends to contract causing cracks and the formation of crusts.

The water movement (in liquid form) from the interior part to the surface of walls due to evaporation can transport dissolved salts. Depending on the speed of evaporation, these may crystallize on the surface (efflorescence, often hygroscopic) or, even more dangerously, immediately underneath it (subflorescence), with their increase of volume causing detachment of the crust.

Rain alone, with its macroscopic effects, accounts for most damage in mudbrick structures.

Other causes of alteration are:

- Rising damp: limited to 40-60 cm since capillarity is not a major effect in mudbrick due to the large size of the pores. It does, however, affect a part of the wall which is particularly weak.
- Surface condensation: with cyclical contraction and expansion, it may cause microcracks and crusts or help the detachment of previously formed crusts.
- Sun: it acts in an indirect way, combined with water, to produce cracks. Crust detachment can be caused by differential thermal expansion between the surface and internal layers.
- Wind: it can cause detachment of loose parts or be responsible for abrasion, especially if carrying suspended sand. It can transport hygroscopic salts when in proximity to the sea. It can increase surface evaporation speed on a damp wall to such an extent that a liquid water film cannot be formed on the surface. Evaporation then takes place immediately below the surface, in the pores; the disruptive effect of salt crystallization is at a maximum, creating alveoles by loss of material (alveolar or aeolic erosion; Torraca 1982: 33-35).
- Biodegradation: plants and animals. Algae, lichens, grass, even trees, birds with their excrement and nest building, wasps and other animals all contribute to the damage of mudbrick monuments.
- Man: direct human intervention is often responsible for the loss of archaeological remains. We should not forget that the act of digging itself causes the rupture of an achieved equilibrium, and therefore puts the monuments in a precarious condition. Moreover wars, modern urbanization, dams flooding entire regions, acts of vandalism, or the mere presence of a great number of visitors can be very damaging. Finally, the lack of maintenance has been proven to be deleterious.

4. Possible interventions for conservation purposes

Interventions tend to reduce the speed of deterioration processes either by removing the causes of alteration and/or repairing small defects in the structure which act as catalysts of disruption. The fact that no "final solution" has been or will be found for the mudbrick conservation problem is never stressed enough. This is true for all materials but particularly so for mudbrick, whose weak characteristics have always been counteracted with regular maintenance and extensive rebuilding. The fact that modern conservators obviously cannot act with the same freedom in rebuilding damaged parts of monuments simply means that, in the long term, the buildings are condemned.

All we can hope for is to enhance their life expectancy. For this purpose some techniques have been proposed.

4.1 Archaeological monuments which, after excavation, are to remain below ground level

4.1.1 Backfilling

If the presence of water due to rain or a rising water table is expected, the only possible measure – a rather drastic one – is complete immediate reburial. This operation should be done with some care if concrete evidence of the excavation is to be preserved for the future. One special technique useful in the case of mosaics or mural paintings is described by Mora in this volume (Chapter 8). For less important and/or delicate remains, perhaps a simpler way of proceeding can be accepted. A shallow layer of salt-free sand can be laid with the purpose of facilitating future excavation; then the same earth taken from the excavation should be used to backfill the trench. This should be done with care and never using mechanical equipment.

A lot of damage can be caused to incompletely excavated sites during the periods between excavation campaigns. This is a very serious matter since the partially excavated parts that are damaged are not yet documented. Therefore temporary shelters should always be put in place.

4.1.2 Shelters and temporary protection

The extremely variable characteristics of earthen archaeological structures seem to be a limitation for specific and detailed recommendations concerning shelters. The resolutions of Ankara (1980) proposed the following lines of research on the subject: first, that a study for the construction of low-cost protective shelters (either full or partial enclosure) be undertaken; second, that shelter design concepts should be developed by professionals from different disciplines (i.e., architecture, archaeology, conservation) and tested jointly in the field.

Whereas these proposals are concerned with the design and construction of permanent shelters, the requirements for temporary protection have been specified as follows (Ankara, 1980):

- it should rely primarily upon the materials and techniques available locally;
- it should provide adequate protection against direct erosion by rain or melting snow;
- it should afford sufficient thermal insulation to avoid condensation or a "green-house effect" and, preferably, be permeable to water vapour;
- it should be easy to remove and put back in place when study and/or inspection is necessary;
- it should have a minimum useful life of five years, with periodic maintenance, if required (it should be kept in mind that "temporary" shelters have a tendency to become permanent);
- it should include provisions to drain rainwater and avoid erosion at the base of walls; and
- it could include the use of straw mats, reeds or other vegetable matter covered with soil or mud plaster, and of capping with sufficient projection beyond the

top edges of the walls so as to avoid the flow of rainwater over their vertical surfaces.

The implementation of such requirements for temporary protection should allow the necessary time for the archaeologists responsible for the excavations to complete the archaeological study of the structure, the materials and the environmental conditions, and to reach a decision about future treatment. In addition, this protection would provide necessary shelter to structures that should *never* be left exposed to the environment from one archaeological campaign to another.

4.2 Archaeological monuments which, after excavation, are to remain above ground level

Provided that they are protected as soon as they are discovered, and that a good drainage system can be created, there is a chance of slowing down the deterioration processes with a combination of protection techniques.

4.2.1 Protective roofs

Sheds and roofing systems have been used on many sites. These are described by Stubbs in this volume (Chapter 7) and are not considered here.

4.2.2 Capping

In general mudbrick structures brought to light by archaeological excavations are incomplete: they are lacking the roof, which was originally an essential protection; the walls are preserved only as crosssections, when not simply foundations. They can withstand the action of rain only if they present a complete surface reinforcement, without any weak, unprotected parts.

One way of obtaining this is by protecting the top part of the walls with one course of new, reinforced mudbricks. This is possible if the walls present a rather regular cross-section.

In the case of very irregular upper surfaces, a capping can be performed with, for example, soil cement. (By soil cement we mean a mixture of soil with the minimum amount of portland cement needed to confer water resistance. In any case this amount should not exceed 10%.) Experiments done in Seleucia in Iraq in 1969 showed good results (Torraca *et al.* 1972).

4.2.3 Chemical treatment

The vertical surfaces of walls can be treated effectively by spraying ethyl silicate (about 1 litre per square metre). Synthetic resins (i.e., acrylics, epoxies and polyurethanes) have been extensively proven to be ineffective, since they tend to form a film on the surface that presents physico-chemical characteristics too different from the untreated parts. With the exfoliation of this film and the detachment of the treated part, more damage is done to the surface to be protected than if it had not been treated at all.

Chemical products such as silica esters, on the other hand, react with the clay particles, forming a three-dimensional network of silica bridges which increase the water resistance of the material. The fact that what remains in the mudbrick is of a mineral nature should ensure that the treatment has a long-lasting effect.

The surface maintains its original porosity with the advantage that the internal moisture can evaporate, and that further treatments of any kind can be performed in the future. This partially overcomes the fact that the treatment is irreversible in nature. (On the other hand, products which are normally considered to be reversible have proven to be very difficult to extract from mudbrick.)

Silica esters do not have gluing properties, and if pieces of mudbrick are already detached from one another, they cannot be held together. This means that the treatment, to be effective, should be performed as soon as possible after excavation, when the surfaces have not yet deteriorated. In the case of intervention on a deteriorated wall, injections of synthetic resin emulsions (acrylics, PVA) inside the wall can be performed with sufficient confidence, since there is no problem of film formation and the deterioration of the organic polymer itself is reduced since it is not exposed to the effects of light.

Friezes and painted surfaces have been treated in this way with very satisfactory results (Chiari 1980, Schwartzbaum *et al.* 1980). No changes in colour and texture of the surface were noted.

In the case of very valuable finds, such as friezes and mural paintings, the protection offered by surface treatments should by no means be considered sufficient, and in all cases a complete, permanent shelter, designed in the best possible way, should be put in place.

Such works of art should be isolated completely from the external environment in order to exclude the action of rain, condensation and marine aerosols and to minimize temperature excursions on their surfaces. They should also be isolated as far as possible from the surrounding soil in order to exclude or minimize migration of soluble salts into them.

5. Maintenance

It should be stressed once again that the key point in the conservation of a fragile material like mudbrick has always been maintenance. Without maintenance there is no hope of preserving monuments in mudbrick, whatever treatment is performed. On the other hand, good, careful maintenance may sometimes give better results than the most sophisticated and expensive treatments.

Unfortunately, the end of an archaeological campaign often means the abandonment of entire structures to the effects of exposure to the environment. Such an irresponsible attitude frequently results in total loss or irreparable damage to mudbrick structures. This problem was addressed in the resolutions of Ankara (1980), which state:

The sites left exposed to the environment (which have suffered from lack of conservation planning) should be analyzed by experts and a policy should be determined in relation to the condition of the structures and the importance of the site.

6. Closing remarks

Given the difficulties of preserving mudbrick remains, perhaps not all the excavated sites with mudbrick should be protected to the point of being exhibited to visitors or scholars. This does not mean that they should be simply abandoned to total destruction. Backfilling would allow future archaeologists to be able to study the excavated evidence with whatever techniques will be available at that time.

For those cases that are considered important enough to be conserved and displayed, the techniques described here may be able to slow down the processes of deterioration.

We have decided to emphasize these established principles and tested techniques in the hope that they will reach those who lack knowledge of them, and also to call attention to the need to undertake concrete steps for their implementation, in order to prevent further loss of a significant part of the world's heritage.

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Plate 1.

Kalavasos Tenta (Cyprus). Prehistoric site ca. 6500 BC, excavated 1976-80. Mudbrick treated with PVA emulsion; shed roof of reinforced fibreglass corrugated sheets on iron supports (1980). Mudbrick in good condition in centre where protected from rain; at sides strong wind-driven rain has reached treated surfaces and caused exfoliation of synthetic resin film on mudbricks (1983).

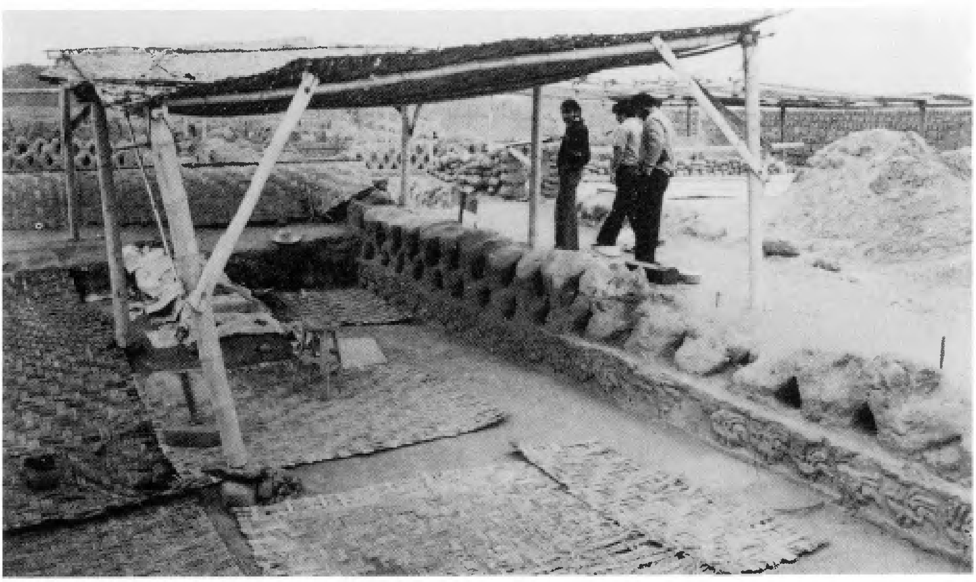

Plate 2. Chan Chan (Peru). Chimù Period, AD 900-1450. Temporary protection with wooden poles and straw mats; note also experimental capping. Mud friezes treated with ethyl silicate with good results despite torrential rain in spring 1983. Many lower parts of friezes at Chan Chan were backfilled, thereby shifting to upper part of wall the evaporation surface and hence the area of salt crystallization. Most therefore not damaged by the 1983 floods (photo: autumn 1983).

Plate 3.

Tell Umar (Iraq). Sassanian fortress. Protection of wall cross-sections with one course of new, reinforced mudbricks (containing 8% portland cement in volume) on upper parts, and a 5 cm thick capping of soil cement (same proportion) on lower, more irregular surfaces (photo: 1969, during conservation work).

Plate 4. Similar view of Tell Umar in August 1983 after being completely abandoned for 14 years; note overwhelming growth of vegetation. Capping provided only partial protection, though an unprotected portion disappeared completely within two-year period. New mudbricks seem to provide better protection, but at cost of hiding completely the original work (photo, Centro Scavi, Torino).

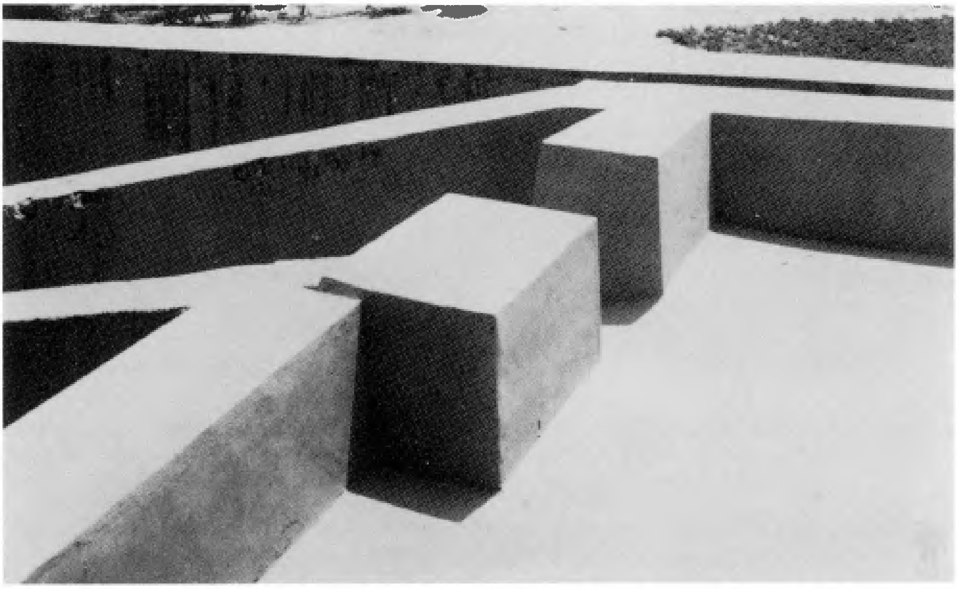

Plate 5. Huaca del Dragón, Trujillo (Peru). Capping of walls with mud mixed with polyvinyl acetate emulsion, resulting in perhaps too hard a surface and excessively smooth. Deterioration of original mudbrick takes place at junction of treated and untreated surfaces.

Plate 6.

Masmak fortress, Riyadh (Saudi Arabia). Area of new mud plaster, 50 cm^2, treated with ethyl silicate. Water sprayed on upper, untreated part is easily absorbed and breaks up surface; then runs down over treated surface until being absorbed again on untreated area at bottom.

Plate 7. Casa Velarde, Chan Chan (Peru). Mud frieze, discovered 1964, then back-filled, but re-excavated several times for display to scholars, with loss of some detail each time. Treated in 1976 with ethyl silicate and immediately backfilled again since not in protected area of site and vulnerable to illicit diggers.

Plate 8. Garagay, Lima (Peru). Painted mud frieze, Chavin culture, ca. 1100 BC. First treated with acrylic emulsion which caused dark colour change (see small section top left). Resin removed with solvent and ethyl silicate applied. Some loss of paint where resin was extracted. Consolidated part anchored to rest of wall with polyvinyl acetate injections inside wall. Frieze is completely enclosed with mudbrick walls, wooden poles, straw roof mats covered with mud plaster. Small windows providing ventilation, and light only when visitors present. Floor, treated with acrylic emulsion in 1973, and rest of structure in perfect condition due to protective roof and absence of humidity.

10

PLANNING AND EXECUTING ANASTYLOSIS OF STONE BUILDINGS

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In contrast to most other archaeological finds, architecture is fundamentally and naturally destined to be preserved at the site, and to be informatively restored. There are therefore certain criteria to be considered, involving:

- technical conservation
- scientific information, and
- aesthetics

Although it is obvious that the technically best conservation should take priority, the other two viewpoints give rise to various considerations.

Special measures, beyond pure conservation interventions, are almost always necessary after the basic decision is made to keep an archaeological excavation open and accessible. (Often the most responsible solution is to backfill the excavation after scientific investigation, because it guarantees the most effective protection of the finds.) In excavations, almost always carried out with public funds and by public authority, the didactic element complements the scientific one. It depends on very diverse conditions of a cultural, ideological, political and economic nature how the two elements bear on the archaeological and architectural remains. The well-equipped and illustrated excavation site, with its urban and architectural monuments, and the museum with its display of movable finds complement each other and create an inseparable whole.

The guiding principle should be one of harmony between scientific objectivity and the didactic and, if possible, even practical role of the site (e.g., new use, such as a museum). The manner, degree and extent of the restoration should be oriented to scientific standards and at the same time make clear the degree of our scientific knowledge about the site as a whole and its monuments. Therefore one will decide between:

a) clearing and conservation of the site and its arrangement for the visitor;

b) display of examples of architecture;

c) anastylosis; or

d) reconstruction.

The measures taken should be appropriate to the significance of the find so that the values of the site will become clear to the visitor. This means as a rule interventions that go far beyond purely technical conservation. They must be consciously and responsibly defined by the archaeologist.

a) Clearing and conservation of the site and its arrangement for the visitor

For architectural monuments this means in general pure conservation, that is the simple preservation of the remains, an intervention which will involve unavoidable and significant decisions. Sometimes a ruined monument is so important, famous or expressive of its monumentality that it is in fact desirable to preserve it as a ruin without any alteration (fig. 23). But in most cases there are visible technical precautions to take, which result from the preservation of a chance state of destruction that generally exists, however, in a certain harmony with the surrounding landscape of ruins. These will become the more decisive, the more restricted the extent of the original remains, that is the less the original form of the ruin is recognizable. So by means of technically necessary interventions, one will aim for an elucidation of the monument.

At the same time, the excavator must protect himself from the illusion and seduction of being able to preserve visibly everything that has been found. Usually he must decide which situation among many (building levels, overlying levels, etc.) he will visibly preserve. Trench sections, excavation of foundations and other deep-lying deposits (groundwater problem) are, if at all, to be preserved in the long run only at considerable expense. As already mentioned, backfilling of certain areas within the excavation after being fully recorded should therefore always be considered in order better to protect and clarify the entire site. The concealed ground plan can easily be depicted schematically on the main level of the site by means of paving, planting, etc.

Obviously among the first tasks is the planning of facilities (protective fences, paths, etc.) to reduce the risk of danger to visitors as well as danger to the monuments caused by visitors. At this stage the didactic element can already be influential, for example by carefully designing pathways instead of leaving naturally beaten tracks.

b) Display of architectural examples (partial anastylosis)

For informative didactic treatment and for the effective protection of building components, architectural elements that form a unit should be correctly assembled and placed in a clear relationship to the monument to which they belong. The presentation should correspond to the extent of scientific knowledge of the monument and make this quite clear (e.g., restoration of foundation features, integration of remains of the original building preserved *in situ*, arrangement of sample sections of preserved architectural elements in the correct position, figs. 1, 2). A reduction in scale (e.g., Memmius' Monument at Ephesus, fig. 3) is not advisable, although many excavators have thought it a good method for presenting the upper part of a building where the lower part is missing. The simple arrangement of architectural fragments on the ancient foundation or on an obviously modern one is often much more satisfactory (fig. 12). Above all, an unpretentious, objective character should be maintained in the presentation of the finds. For explaining the total context to which the architectural fragments belong, the use of information panels is recommended. The extent of these examples naturally depends primarily on the preservation of the original building, but should not be determined only by it. Displays of architecture can also be used to emphasize significant features within the excavation site and to serve indirectly as a guide to visitors (for instance the sequence at Olympia: Heraion (columns) – Treasury of the Sicyonians, Stadium arch – Nike column).

c) Anastylosis

Anastylosis in the strict sense can only be the identical re-erection of a dismembered historical building or one part of it in its original position. In such anastylosis, which is only possible when most of the original building elements are preserved, every element should take up its original position and structural role. As a rule this is possible only with cut stone architecture with its characteristic technique (figs. 4-6).

Such anastylosis represents an ideal case – to be sure only seldom reached – as much in the sense of scientific research as in the actual work of anastylosis of a historical monument. In this ideal case, the knowledge and experience derived from the restoration usually provide such an important contribution to scientific research into the building that anastylosis is to be regarded as an integral part of architectural historiography (e.g., the Library of Celsus at Ephesus and the Treasury of the Athenians at Delphi).

The integrity of the monument is the first goal and its original value the highest criterion. Every modern intervention made to realise it must remain in the background.

d) Reconstruction

Reconstruction is therefore clearly to be distinguished from anastylosis. For ancient stone architecture with its inherent logic of form, it is frequently possible to make scientifically correct reconstructions on paper although comparatively little of the original building survives. But even where a surviving building element can be placed successfully in its original position, the character of the modern reconstruction always remains dominant if too few of the original elements survive. Its erection on the original foundation in a ruined excavation site is always problematical (e.g., Sardis, the Roman baths, fig. 8) and requires a serious justification (e.g., Athens, the Stoa of Attalus – new function as a museum, fig. 7).

More easily justified is reconstruction in the sense of a full-scale model. This then is not bound to the original site (e.g., the Parthenon in Nashville, Tennessee, and the Pergamum Altar in Berlin).

To sum up, one must keep in mind that every intervention represents an opinion and an interpretation which is always the expression of its own time. In the interests of the maximum objectivity, all interventions should therefore be avoided whenever possible or at least be sufficiently recognizable. In all cases, any measure beyond simple safeguarding of the remains must always be alterable and easy to remove (the principle of reversibility) (compare fig. 22).

For every intervention there exist three criteria which must be respected:

- the relationship between the surviving elements and the modern intervention in the single building, determined by the historic significance of the building in absolute terms;
- the relationship between the restored building and the total site, determined by the significance of the building within the (urban) complex; and
- the relationship between the area of the ruins as a whole and the surrounding landscape, determined by the importance of the site in the overall context.

There can be no strict rules, however, despite the procedures recommended or prescribed by the legislation of individual countries. The decisive criterion will probably above all be the historical, that is the scientific meaning of the monument. This is what the archaeologist has the responsibility to define.

On the other hand, there are several concrete rules to follow in the practical treatment of excavated architectural monuments. These concern (1) preparatory work and (2) the actual execution.

1. Preparatory work

1.1 Excavation phase 1: documentation

The excavation succeeds according to the standard of archaeological methodology applied to it. The first duty is the comprehensive documentation of all archaeological research (section profiles, small finds, etc.). The most important basis is the complete graphic and photographic documentation of the whole find context. (This means as a rule a greater expenditure than is generally required in purely scientific research for publication purposes.) In particular:

a) a site plan must be made of the monument that includes *in situ* finds and the position of disturbed or displaced building elements. The drawings must be complemented by photographs. Polaroid photographs help complete the documentation during the clearance work (figs 9,10).

b) all building elements that are removed from their original position must be numbered individually and recorded on the site plan. The numbering should when possible be firmly secured: punched aluminium labels attached with brass screws in plugs of plastic (∅ 3 mm) on the damaged areas are useful.

1.2 Excavation phase 2: clearing of the ruins, study of the building and its elements

After clarification of the existing state of the destroyed building, the excavation enters its second phase with the clearing of the ruin. The disturbed (numbered) building elements will be clearly and visibly ordered, being placed together in proper relationship to each other and to the building from which they came (figs. 11, 12). For this purpose an adequate place must be created within the site. It is advisable first of all to remove from their excavated position only those elements that (a) must be studied in detail to understand the building or (b) may be needed for its anastylosis or restoration.

It is desirable to preserve in one part at least of the monument an example that illustrates the historical event of its destruction (fallen walls, etc.). Special protection measures (protective roof, chemical consolidation) are therefore necessary.

After clearing the building blocks, their detailed study begins with exact drawing at large scale (usually 1:5 or 1:10). In view of any planned analysis, all building elements are to be recorded, even those that are identical and repetitive. In exceptional cases of especially well-preserved monuments, a simple catalogue with measurements alone should suffice and working with the pieces themselves is the most expedient procedure.

1.3 Scientific study and reconstruction on paper. Preliminary requirements and investigations for anastylosis or restoration

1.3.1 Plans and models

With the material gained in excavation phases 1 and 2, a scientific reconstruction can be achieved. Most important will be its representation in graphic form. The evidence for reconstruction will be in the form of drawings in which all preserved fragments are depicted in their original positions (fig. 13).

These drawings (possibly also photomontages of similar-sized individual photographs) illustrate at the same time the conditions required for anastylosis, giving information on the position, state of preservation and number of preserved fragments in relation to those missing.

Scale models of the excavation site and its buildings are especially helpful:

(a) *reconstruction models* are the final results of scientific research and help to illustrate it for wider audiences. They are found both in museums and on excavation sites, and are all the more helpful, the more destroyed and invisible the monument is (e.g., the city model of Rome and models of individual buildings in the Museo della Civiltà Romana in Rome; city model of Jerusalem in Jerusalem; model of Priene in Berlin, models of Olympia at Olympia and of the Villa Adriana at Tivoli, fig. 14).

(b) *scale models of the existing situation* are recommended as decision-making aids for anastylosis projects (these are easy to construct from paper or cardboard). The models of various suggested options can be subjected to discussion (e.g., the Theatre at Metapontum, fig. 15). This is especially recommended for difficult sites, above all when different overlapping phases are to be made visible.

(c) *full-size scale models* at the site itself are very useful when the overall appearance of the excavation is at stake and when discussion by a wider public is desirable. They can be temporary constructions in light pasteboard or tubular steel (e.g., Metapontum) and can be photographically recorded (fig. 16).

1.3.2 Preliminary investigations

In many cases, special preliminary investigations of a technical nature are necessary, e.g.:

- investigation of the carrying capacity of the building foundation which often has changed since ancient times (through changes in the water table, bradyseism, earthquakes, etc.);
- investigation of the static condition of the ruin; and
- examination of the original materials and those to be used in further work, their static and physical characteristics.

These investigations should always be entrusted to experts.

2. The execution of the work

2.1 Initial protection measures

The first requirement – the protection of the finds *in situ* – involves at first purely technical considerations. Protective roofs and simple shelters, which will be replaced later by aesthetically pleasing and long-term solutions, are usually advisable for a certain time during the excavation and planning phases. Therefore it is important, during the period of excavation, to have readily available the appropriate materials (wooden laths, planks, corrugated roofing sheets) and at the same time to establish suitable transport and work systems.

2.2 Edges of excavated areas

For the long-term safeguarding of the edges of excavations, reinforcement is necessary. Chemical consolidation and reinforcement or stabilizing of embankments with plastic mesh are only practical for large dimensions. The most useful and appropriate solution is generally planting with vegetation, which must correspond to the geographical and climatic conditions and be carefully selected.

2 3 Excavated sections and profiles

Previous experience has shown that the long-term safeguarding of earth profiles is almost impossible. Excavation sections should therefore as a rule be well recorded and then backfilled. In exceptional cases chemical consolidation is advisable, sheltered by a protective roof. Attempts to protect trench sections and at the same time leave them visible by means of glass or plexiglass are to be warned against (problems of water condensation, plant growth). In general, however, sections and any voids (e.g., excavated foundations) are practically unintelligible and confusing for the non-expert.

2.4 Protecting remains of the original building

For the aesthetically and technically satisfactory protection of preserved building remains, there are scarcely any binding rules because there are so many different cases. Nevertheless the difference must be kept in mind between technically necessary measures and additional integration for illustrative purposes. In the first case the intervention should be clearly legible in material and technology. Unequivocal and proven materials and clearly visible construction methods are recommended for this work. The modern intervention should support the ancient monument and interfere as little as possible in its substance.

2.5 Restoration anastylosis and reconstruction

When the wish to interpret and integrate arises, as in most cases, there are two basic positions to consider:

a) illustrative "reconstructions" with clearly modern material and modern technology in continuation of the techniques used for safeguarding (e.g., the Roman villa at Piazza Armerina, Sicily); or, more commonly,

b) the use of techniques and materials that are similar, or should be similar, to the ancient ones. Thus it is important to be aware of the consequences and to use ancient technology and suitable materials as faithfully as possible. That is, a comparable technique should be used both for ashlar masonry (e.g., Athens, the Acropolis; Pella in Greece; Metapontum, the Theatre, figs. 17,18,19) and for brick construction (e.g., Rome, Market of Trajan, fig. 20, but not, however, the restoration of the columns in the Forum of Trajan, fig. 21). It is important, above all, for the new intervention to take into account not only aesthetic considerations but also the static and physical characteristics of the ruin. Interventions that alter the static system (replacement of the structural system in masonry with reinforced concrete skeletal systems, as in the Temple of Hera at Selinunte and at Lindos) and those that misjudge or wrongly evaluate the physical building characteristics (integration of natural stone contexts with brick and concrete, concrete and steel skeletal systems in all cases) are often accompanied by catastrophic results (fig. 22).

The second major problem is at the same time aesthetic and scientific, namely, the degree of approximation of the new to the old material. The legislation of most countries demands clear evidence of the new interventions, if necessary an appropriate marking. But the unity of the whole picture should not be too strongly intruded upon. Judging by experience, the fear is ungrounded that the difference between old and new material could become obliterated with time to the eye of the expert, with only few exceptions (Pella; Agrigento, Temple of the Dioscuri). According to the state of the discussion today, the general principle of the priority of "continuity of form" (Hueber 1978) of ancient buildings is preferred to the one of direct and immediate visibility of modern intervention.

2.6 Stone conservation: restoration of broken and weathered pieces, casts

The most difficult questions arise in ashlar masonry, which represents the most significant monumental architecture of Antiquity. Technical problems are concerned as a rule with:

- joining of broken building blocks and the rehabilitation of badly weathered and brittle elements;

- the integration of damaged architectural elements in order to restore their static characteristics (for re-use in their building contexts) and the restoration of their architectural form; and
- the preparation of new building components needed for anastylosis.

The problems vary according to different materials (marble, limestone, sandstone), but there are some general principles:

a) for gluing broken fragments, epoxy glue has today almost completely replaced the use of cement. For all stone types there are optimal glues which can be obtained commercially. In any case the advice of an expert is necessary, including at least a laboratory analysis of the stone. In general, today, so long as the fragments have first been appropriately treated (for reinforcement), the clamps and pegs that were once required can be avoided completely. In the few cases where they are still necessary, only stainless steel should be used, but there have already been very good results with fibreglass armatures. The problems of weight and differential expansion can be solved in this way.

The rehabilitation ofbrittle stone, especially limestone and sandstone, is possible using injection of epoxy solutions or through treatment with silanes. This can be effective if impregnation is deep, though very expensive for large stone masses. Marble affected by air pollution can also be treated; acrylic resins have been used for this purpose. It is essential in all cases that the stones be cleaned before treatment by experts using non-damaging cleaning methods. Otherwise the best solution is still to dismantle valuable pieces and replace them with artificial stone casts.

b) the integration of missing parts in damaged building blocks is necessary at first only for static reasons. The question of how far the integration should be taken and to what extent it should reproduce the ancient form can only be decided in each individual case. But in recent years there has been general agreement that either any allusion to the original architectural form should be abandoned or that it should be imitated as faithfully as possible. Simplified, crudely reminiscent forms create a third element that is conspicuous and distracting, and generally misleading for the non-specialist.

The integration can be carried out in natural or artificial stone. Although natural stone is aesthetically satisfying, generally there are serious problems. Apart from the difficulty of procuring similar stone, this solution is difficult, costly and lengthy to execute. Since, in accordance with the antiquities legislation of Classical countries, original blocks cannot be altered for restoration purposes, integration of missing parts will require the exacting work of the best-trained stonemasons.

So today, with few and very significant exceptions (Athens, the Acropolis; Pella in Greece), artificial stone is normally used for stone integration. The advantage lies in its fast and simple working, and its application to damaged surfaces. This technique guarantees the optimal adhesion of the old material to the new, which can be chosen to match. The disadvantage consists in general in the too homogeneous and lifeless structure of the stone substitute. The other disadvantages in physical terms (differential expansion and porosity, problems of decay, hairline fractures) that are often produced by artificial stone bonded with cement, can largely be avoided today by the expert use of suitable epoxy binders. Thus what is needed is a very exact matching of materials by means of laboratory tests. The materials can be prepared in the laboratory so that they are produced and delivered in dependable quantities for immediate use at the site (e.g., Metapontum, the Theatre). The desired surface structure will be achieved at the site through reworking by the stonemason.

c) for quite new building components required for anastylosis, the natural stone/artificial stone alternatives are also present. Again, the advantage of artificial stone is that it can often be quickly and easily reproduced in one ready-casting form. But the high cost of the material and its aesthetically lifeless surface are disadvantages. Thus natural stone is used more frequently, if it is obtainable and if suitable stonemasons are available.

2.7 Carrying out the re-erection

For the reassembly of the prepared architectural components, careful planning and building site organization are necessary. The required equipment (crane, scaffolding, etc.), trained workmen and, above all, the continuous presence of supervisory staff are essential. Because of the particular character of ancient ashlar masonry constructed without mortar, every building element has its unique position. Therefore the greatest care is required and many individual decisions must be made actually during the re-erection process. Experience has taught that for the reconstruction of buildings (e.g., Ephesus, the Library of Celsus; Athens, the Acropolis; Olympia, the Treasury of the Sicyonians; Pella; Metapontum, the Theatre) all means of assistance and any device that was used in antiquity (hoisting method, anathyrosis, caulking holes, etc.) must be repeated exactly.

2.8 Maintenance of the re-erected monument

Since in most cases the result of anastylosis retains a ruined or episodic character, the building is rarely covered and the roofing elements seldom survive. Additional protective measures are necessary, usually in the form of waterproofing with an appropriate epoxy solution which must be renewed at regular intervals. This should be part of the normal maintenance of a restored excavation site, as are the control of plant growth, drainage, the regular painting of metal support constructions, the maintenance of footpaths and the replacement of signposting.

Final remarks

From this discussion it has become clear that the responsible restoration of an ancient architectural monument, especially with whole or partial anastylosis, is a very demanding task that should only be carried out by experts, under the best possible conditions and only with the best materials. These remarks can thus serve to make archaeologists familiar with the problems so that they can express their ideas clearly and practically to the specialist.

But if experts, equipment or materials are lacking, then it is better to suggest, in every case, more modest solutions. These solutions must not compromise on clarity, however. A clearly arranged layout, a progressively informative collection of architectural remains in a lapidarium or also at the excavation site (perhaps under a protective roof), explained by reconstruction drawings, is possible for every excavation and is worthwhile in itself.

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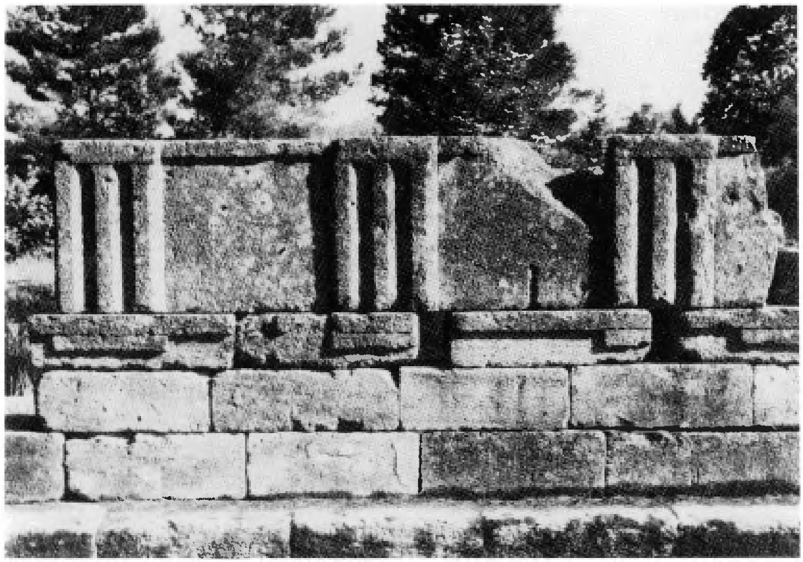

Figure 1. Olympia, Bouleuterion. Simple composition of preserved building elements as general example of the architectural order. Concentration of several preserved fragments, thus false in detail.

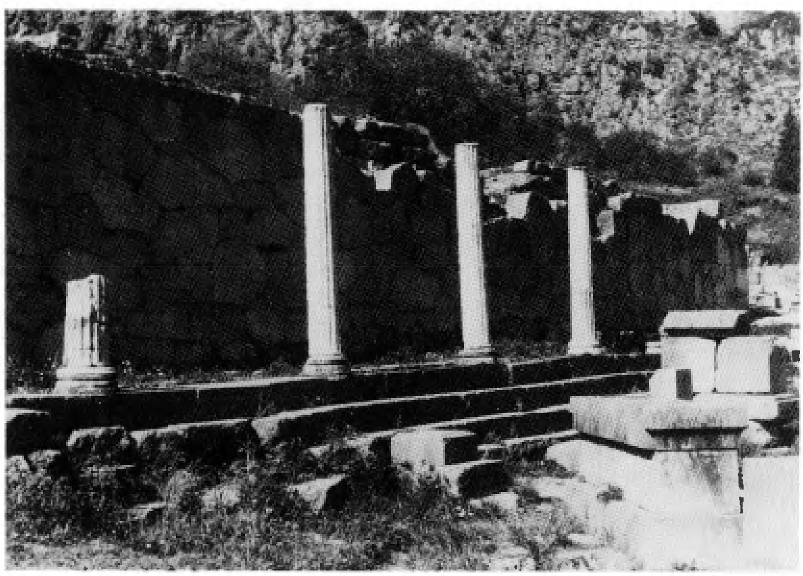

Figure 2. Delphi, Stoa of the Athenians. Columns re-erected in their positions without further restoration. Provides essential information and helps spatial presentation.

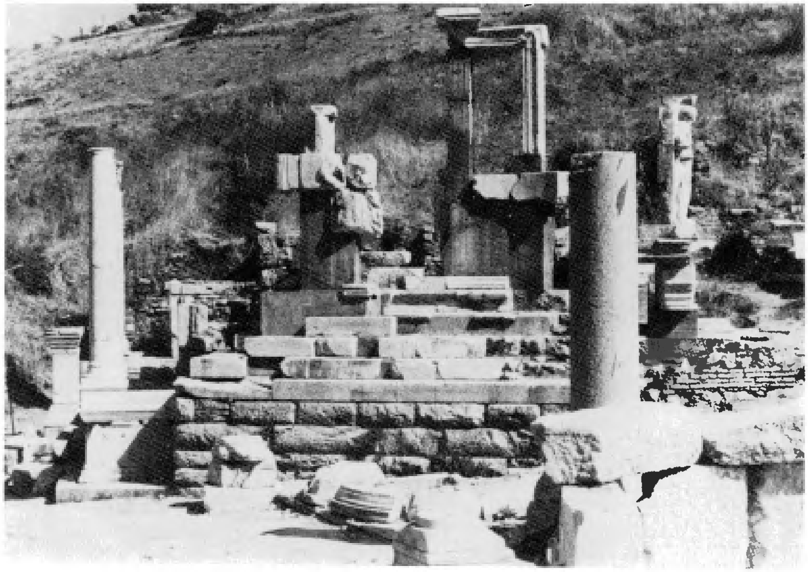

Figure 3. Ephesus, Monument of Memmius. Arrangement correct only in detail. Reduction in height and arbitrary composition of the large components impede presentation of the whole monument.

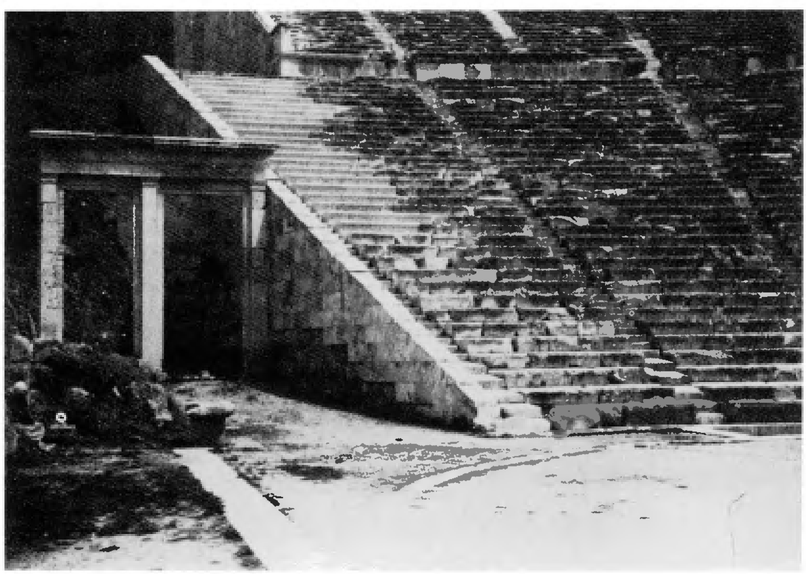

Figure 4. Epidaurus, theatre. Reconstruction of the damaged parts of a monument for the most part well-preserved.

Figure 5. Ephesus, Temple of Hadrian. Anastylosis carried out almost exclusively with original building elements.

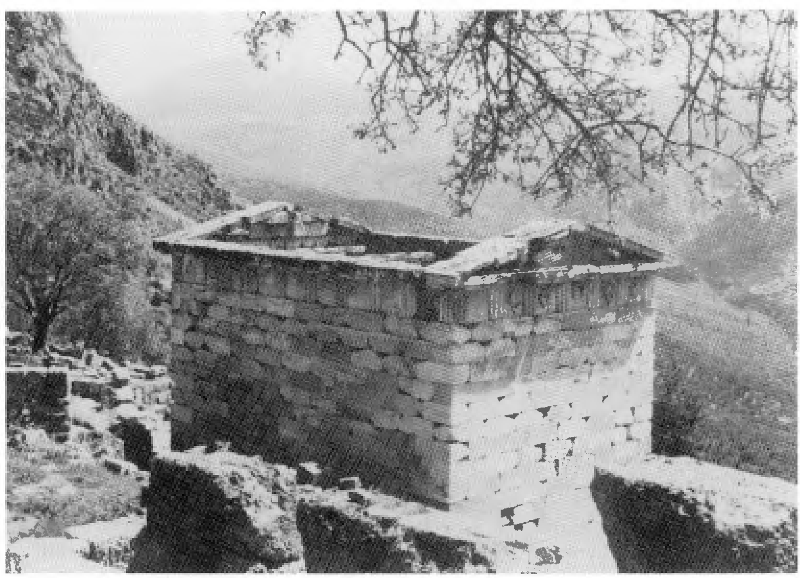

Figure 6. Delphi, Treasury of the Athenians. Anastylosis carried out almost exclusively with original building elements.

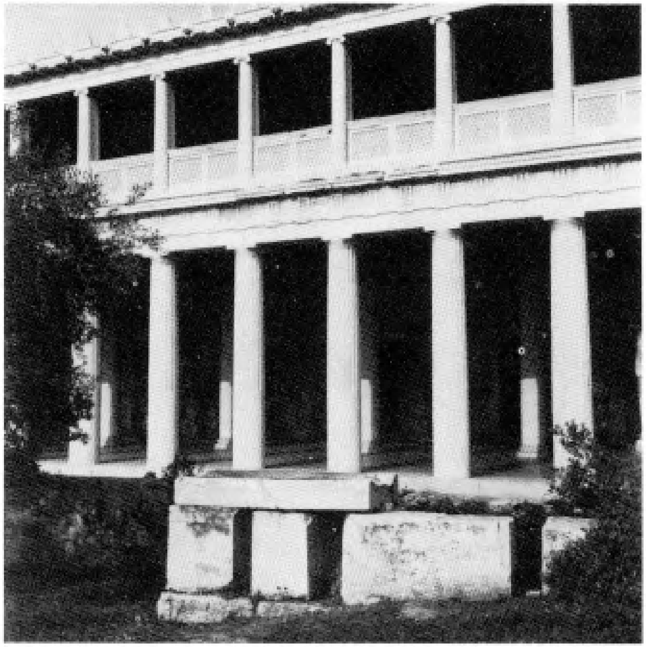

Figure 7. Athens, Stoa of Attalus. Very little original material in the reconstruction. Used as a museum.

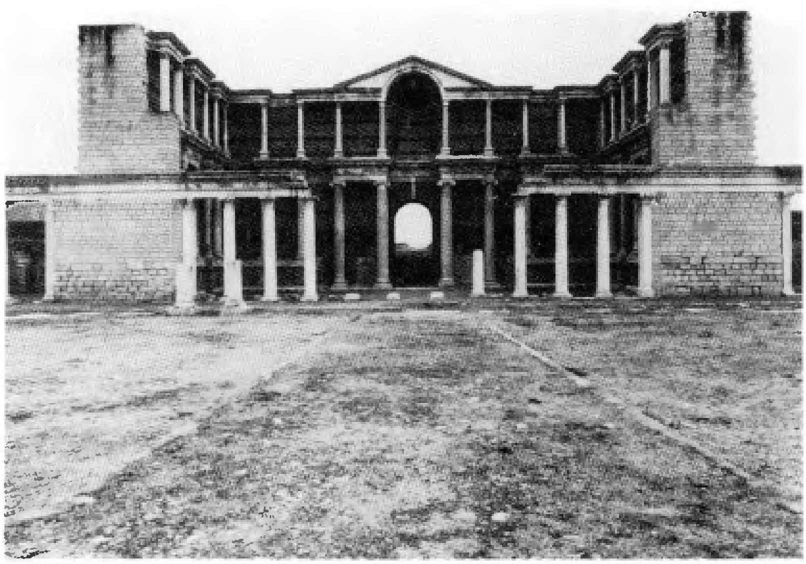

Figure 8. Sardis, Roman baths. Full-scale reconstruction of a large section of a building in an otherwise much ruined environment.

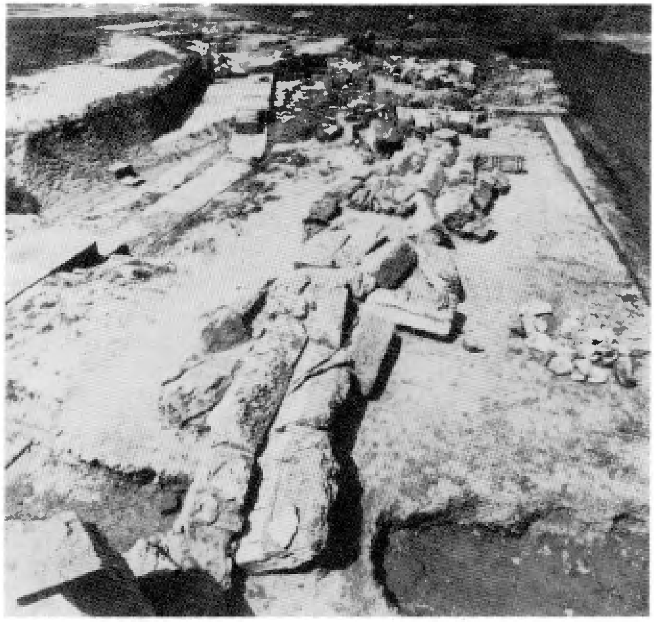

Figure 9. Metapontum, Italy, the theatre. Position of collapsed entablature in Area III.

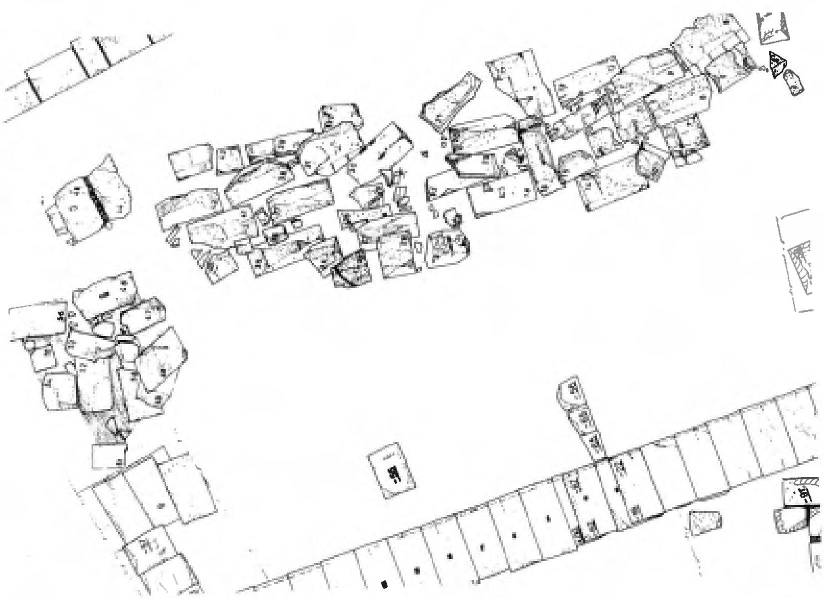

Figure 10. Metapontum, theatre. Plan of finds in Area III.

Figure 11. Metapontum, theatre. The entablature after removal.

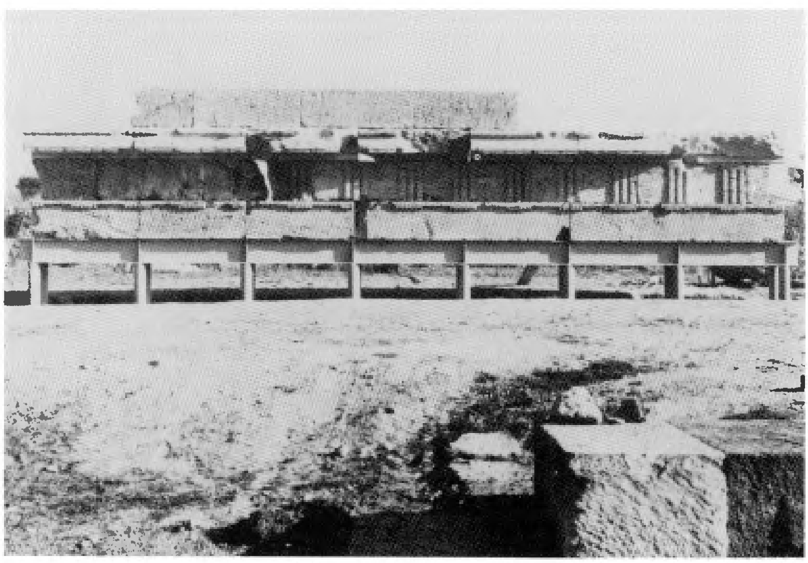

Figure 12. Metapontum, theatre. The entablature put together again as an example of the architecture.

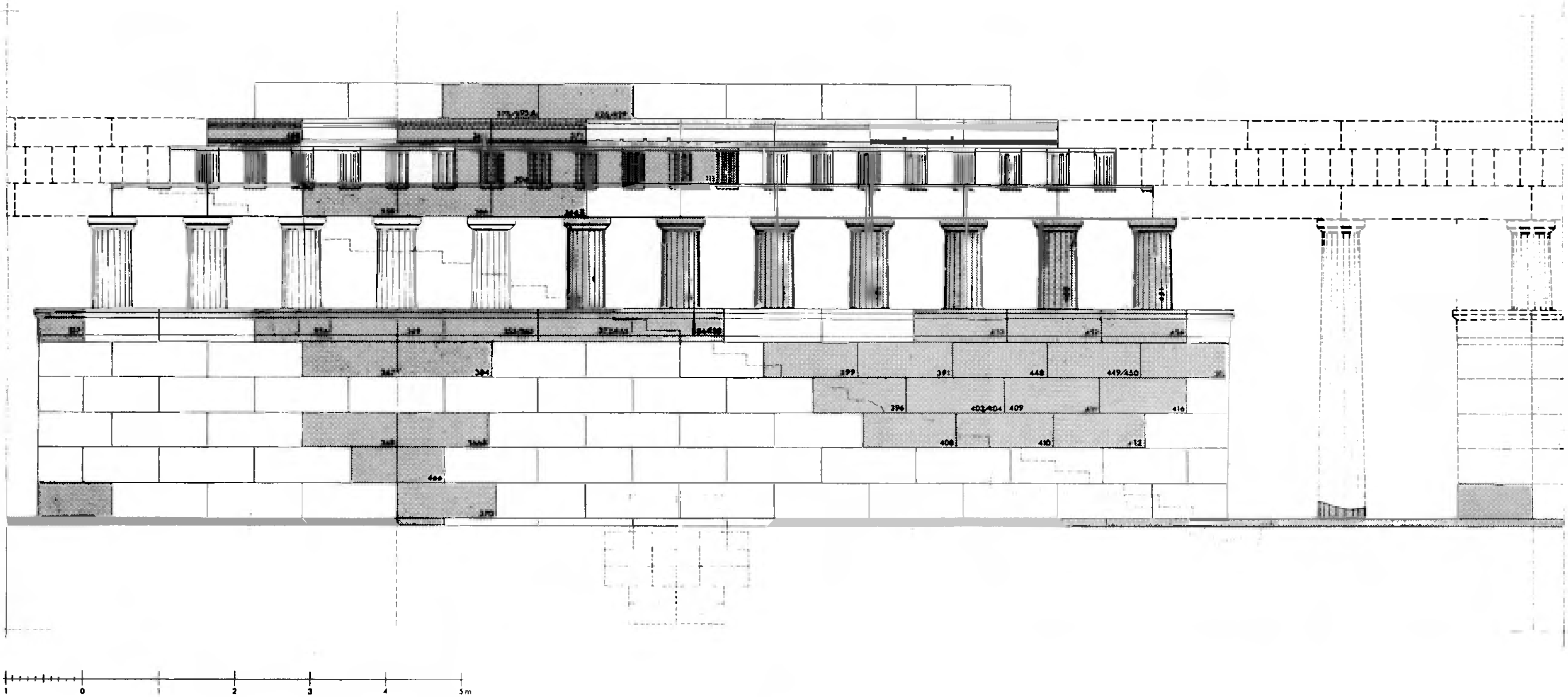

Figure 13. Metapontum, theatre. External architecture in Area XIII/IX, reconstruction drawing.

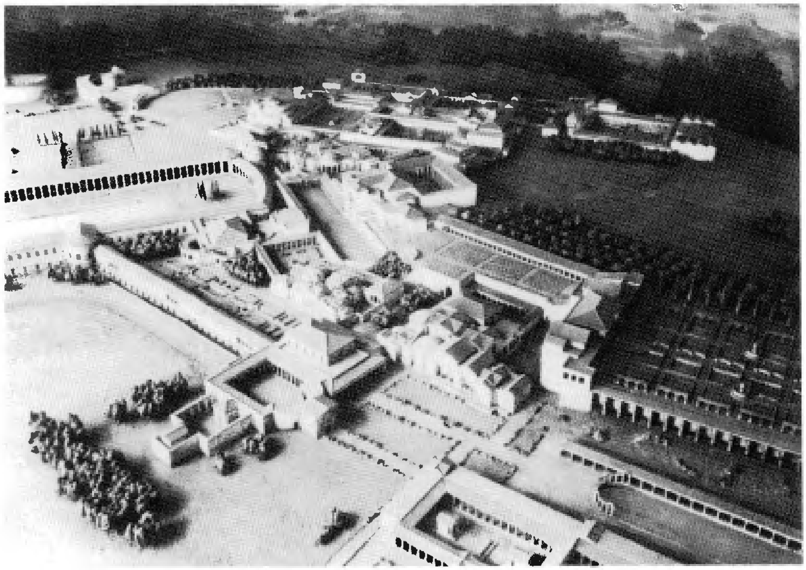

Figure 14. Tivoli, Villa Adriana. Reconstruction model.

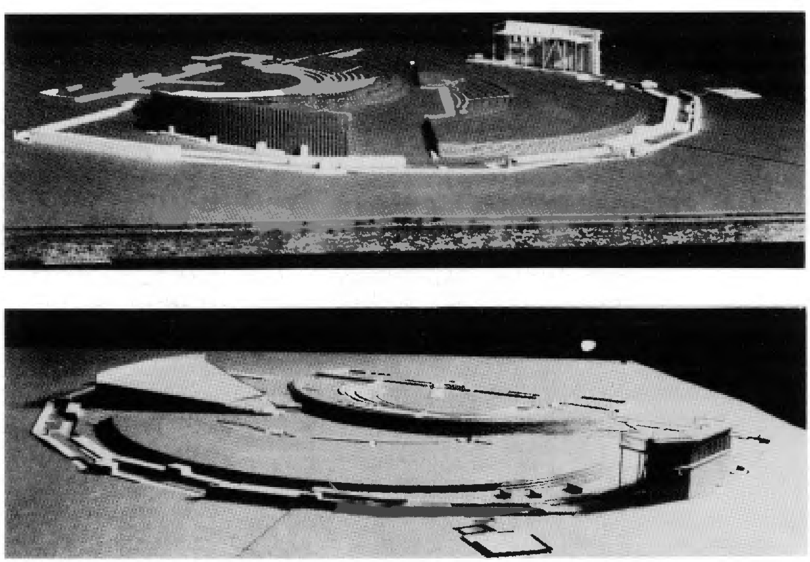

Figure 15. Metapontum, theatre. Model at 1:100 of the proposed restoration.

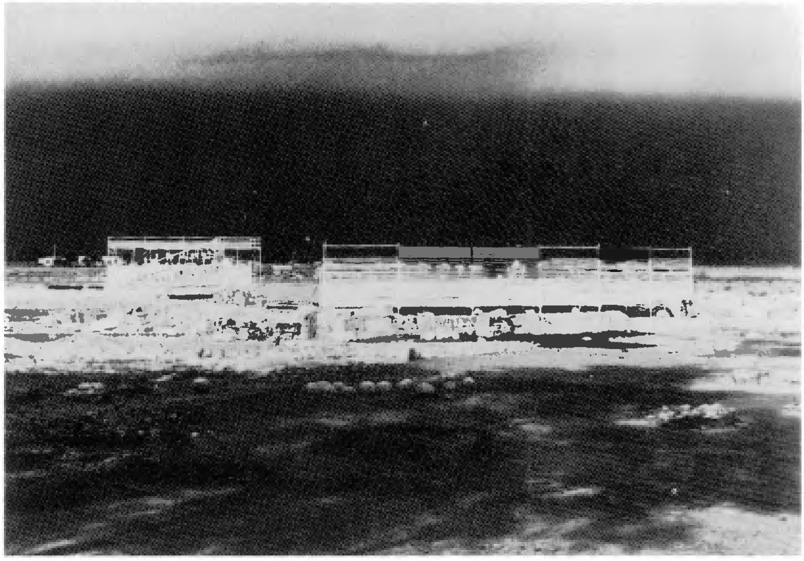

Figure 16. **Metapontum, theatre. 1:1 scale model as an aid to presentation.**

Figure 17. Metapontum, theatre. The completed anastylosis within its site context.

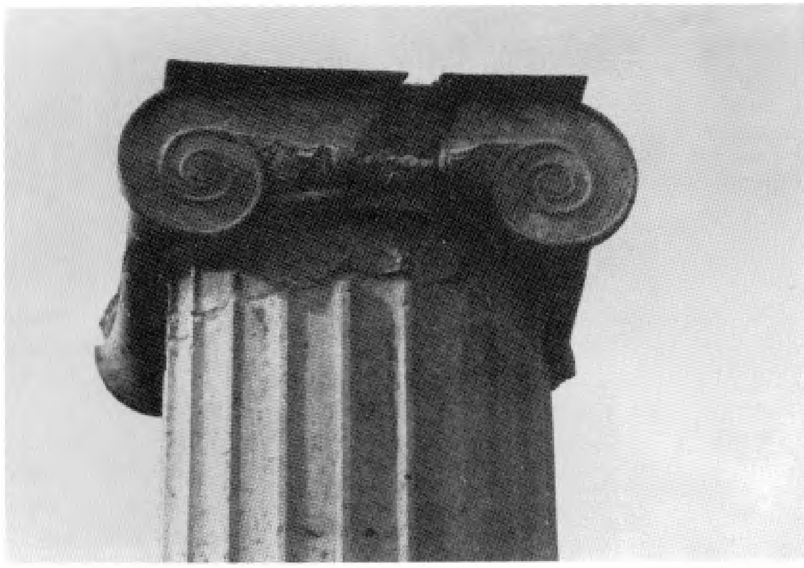

Figure 18. Pella, Greece. Completion of column with natural stone.

Figure 19. Metapontum, theatre. Natural stone used in rebuilding the outer wall, with strict adherence to ancient technique of working.

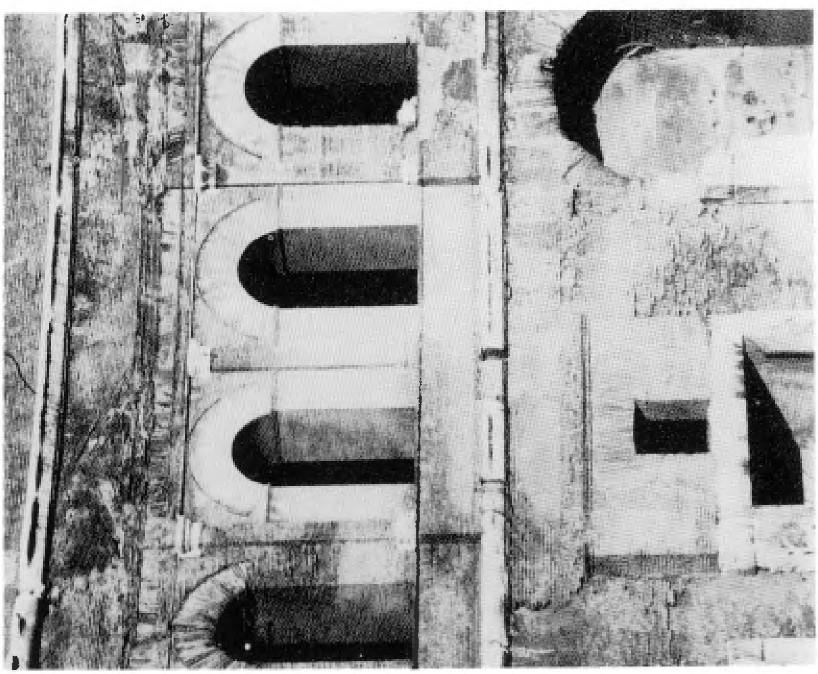

Figure 20. Rome, Market of Trajan. Completion of brickwork of wall. Marking of restored areas by using different working technique.

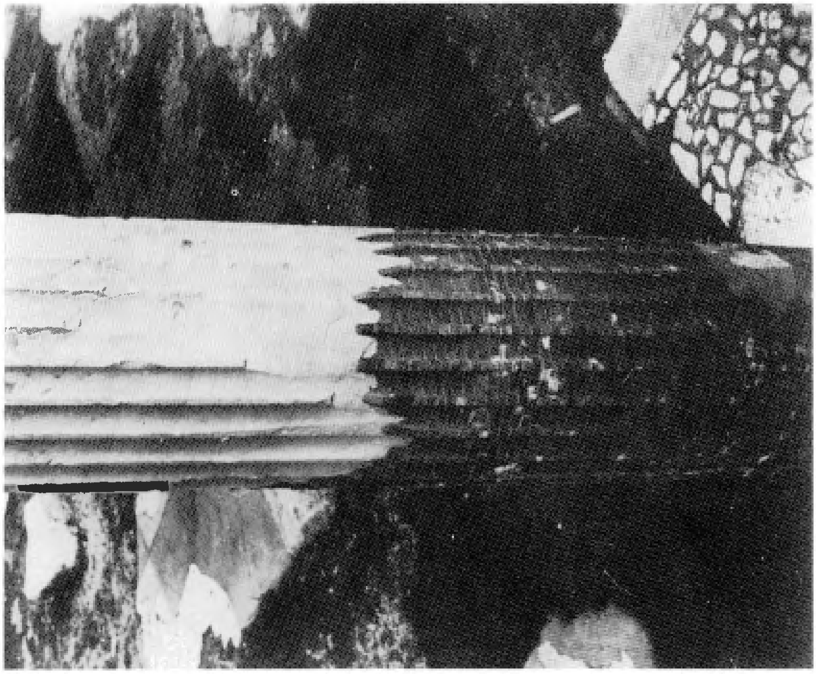

Figure 21. Rome, Market of Trajan. Completion of marble columns with bricks.

Figure 22. Selinunte, Temple of Hera. Original building elements embedded in reinforced concrete. Considerable errors, which can no longer be corrected, in the reconstruction from a scientific point of view, and dubious aesthetic decisions: an early Classical Greek temple has been partially destroyed through reconstruction.

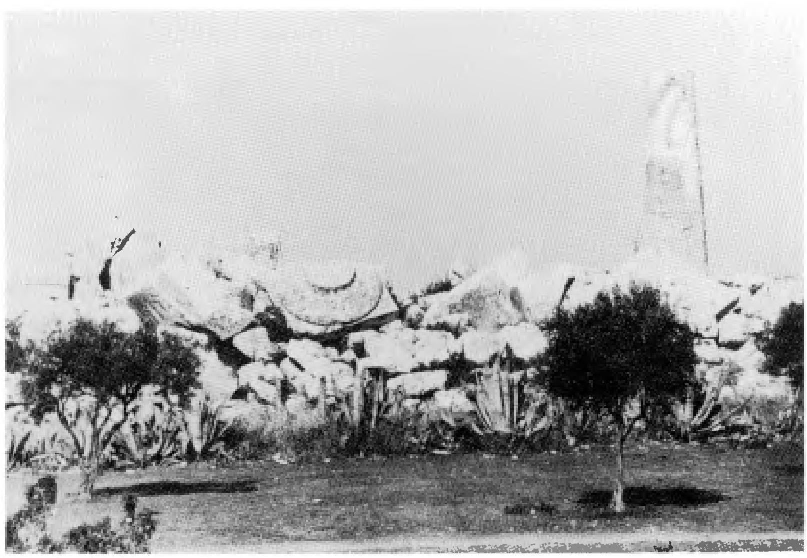

Figure 23. Selinunte, Temple of Zeus. Preservation of the monumentality of a ruin without intervention.

CONSERVATION ON EXCAVATIONS AND THE 1956 UNESCO RECOMMENDATION[1]

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Discussion at the Cyprus Conference made clear that the 1956 UNESCO Recommendation on International Principles applicable to Archaeological Excavations remains an influential document for regulating excavations in the Mediterranean and Middle Eastern region. It also gave rise to suggestions for changes should the Recommendation be revised in the future, a possibility under consideration by UNESCO.

Not only has the nature of archaeological research changed in some respects since the 1950s, but conservation has acquired a better-defined identity in both theoretical and practical terms since the Recommendation was drafted.

The following comments concern those paragraphs of the Recommendation that are especially relevant to conservation on excavations (the text of the Recommendation is reproduced here as Appendix 1). The paragraphs in question come under Section 1 (definitions), 2 (general principles) and 3 (regulations governing excavations and international collaboration).

I. Definitions. Archaeological Excavations. Paragraph 1

" ... by archaeological excavations is meant any research aimed at the discovery of objects of archaeological character ..." The repetition of the word "archaeological" renders the definition unsatisfactory. More seriously, it is out of keeping with contemporary thought in archaeology. Excavation is a technique used to acquire information from archaeological evidence and is not "aimed at the discovery of objects."

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1 Based on statements and discussion at the ICCROM Conference on "Conservation on Archaeological Excavations" held in Nicosia, Cyprus from 22 to 26 August 1983. The following Directors of Antiquities or representatives made statements about policy in their own countries with reference to the 1956 Recommendation: Dr Vassos Karageorghis (Cyprus), Dr Abdullah Saiboub (Libyan Arab Jamahiriya), Mr Ahmed Gabr (Egypt), Dr Adnan Hadidi (Jordan), Dr Avi Eitan (Israel), Mrs Katerina Romiopoulou (Greece), Mrs Licia Vlad Borelli (Italy), Mr Manuel Martin-Bueno (Spain), Dr Antonio Sousa da Silva (Portugal) and Miss G. Saouma-Forero (UNESCO). Others who contributed to the discussions included the authors of the papers in this volume, as well as Dr G. Torraca (ICCROM) and Dr Ian Todd (Brandeis University). None, however, is to be held individually responsible for the opinions expressed here which result from a synthesis of the recorded statements.

Archaeological field survey is another such technique, or variety of techniques, with its own methods and results that are often valid without recourse to excavation. In fact the development of field survey as an end in itself (rather than with the aim of selecting a promising site for excavation) has been one of the growth areas of modern archaeology, not least in the Mediterranean region (Keller and Rupp, eds. 1983). This has been due not only to wider recognition of its intrinsic value but also because of limitations, through official policy and/or through increasing costs placed on major excavations.

Compared to excavation, survey is often viewed as non-destructive; but they share several aspects that are subject to regulation (e.g., storage and temporary loan of material, protection of sites, publication). The 1956 Recommendation includes "systematic exploration of [the ground's] surface" within the definition of "excavations." It may be preferable to distinguish between these two techniques of investigation by specifically adding "and surveys" to the rubric "archaeological excavations."

One survey technique for which the Cyprus Conference proposed that the Recommendation should provide guidelines is the use of metal detectors on archaeological sites (compare the publication of the Council of Europe, 1981). Indeed, several topics peculiar to survey work, for instance the collection of surface material, may justify a separate consideration of survey principles where appropriate.

II. General Principles. Protection of the Archaeological Heritage, Paragraphs 4, 5

Paragraphs 4 and 5(a-f) concerning the protection of a State's archaeological heritage find their expression in national antiquities legislations. These are conveniently being collected and published by UNESCO (1979, 1981, 1984). Elsewhere Prott and O'Keefe (1981) have analysed them with reference to underwater archaeology. It is clear that national legislations share many similarities, based as many of them are on the principles laid down in the 1956 Recommendation, and that they diverge mainly in matters of detail.

The Recommendation continues to be influential in the drafting of new legislations, for example the new Antiquities Laws of Jordan (1976, replacing that of 1968), Israel (1978), Libya (1983, replacing that of 1968) and the new law in Spain shortly to be submitted to Parliament. In Portugal the first central official body, the Portuguese Institute of Cultural Heritage, was established in 1980. The organization and policy of its Archaeology Department has been developed in the light of the 1956 Recommendation and of the experience of other countries in implementing it.

In Israel there has been enacted a special Museums Law, to take effect in April, 1984, in which the principles of the 1956 Recommendation referring to museums have been followed. The Law concerns all museums, not only archaeological; if they meet the requirements laid down in the Law, they become "recognized museums," being thereby entitled to State financial aid.

Protecting Body: Archaeological Excavations. Paragraph 6b

The archaeological service of a country must take steps to ensure "the regular provision of funds ... (iii) to exercise control over accidental discoveries; (iv) to provide for the upkeep of excavation sites and monuments."

The investment required today of an archaeological service "to exercise control over accidental discoveries" could not have been foreseen in 1956. The large number of emergency (rescue or salvage) excavations that is now necessary places a great strain on its staff and resources, for the excavations themselves but especially for conservation, storage and publication needs. The same principles should apply, other things being equal (see Paragraph 9 below), in the regulation of emergency excavations as for non-urgent ones. At the same time, the costs of maintaining excavation sites that are open to the public have also increased substantially.

These additional heavy budgetary demands can be met directly through a larger provision of funds, or indirectly by sharing the responsibility with other bodies, either national or foreign. For excavations this policy has already been adopted both when the emergency is quite unexpected (e.g., in Jordan where the help of local universities and foreign institutes is enlisted), and when there is advance notice of a threat to sites from, for instance, dam construction (e.g., Turkey, Iraq). Part III of the Recommendation concerning international collaboration is relevant here. Indeed, the Recommendation was used as a model in drawing up agreements for foreign participation in the Nubian salvage campaign in Egypt and the Sudan.

For sharing costs of site maintenance and conservation, contributions can be requested in exceptional circumstances from international funds, or they can be made a condition of the granting of an excavation permit (Paragraph 21 below). A more radical solution that is sometimes proposed is the temporary suspension or moratorium on all non-urgent excavation projects. Attention would then be concentrated on rescue excavations and the conservation and publication of the backlog of excavated sites and finds.

Whatever solutions are adopted, some re-drafting of Paragraph 6b may be advisable to take account of the present situation.

Paragraph 7

> "Careful supervision should be exercised by each Member State over the restoration of archaeological remains and objects discovered."

Both here and in Paragraph 21 the Recommendation appears to assume that excavated sites will remain exposed, thereby contributing to the costs of upkeep (Paragraph 6b, iv). There should be mentioned the need to evaluate whether an excavated site is worth presenting to the public or should be consolidated and backfilled instead. Contemporary thinking would also distinguish between the conservation of archaeological remains and objects which is mandatory, and the restoration of them which is an option deserving careful consideration. Subsequent to the 1956 Recommendation the Venice

Charter (Article 15) proposed with regard to the restoration of excavated buildings that only anastylosis (see Mertens, Chapter 10) could be permitted. A closer definition of "restoration" in this paragraph would be advisable, for both objects and buildings.

Paragraph 8

> "Prior approval should be obtained from the competent authority for the removal of any monuments which ought to be preserved *in situ.*"

The meaning of this paragraph is not clear, for which the more restricted sense in English of the work "monument" may be partly responsible. As it stands, it can be interpreted to refer to the removal from a site of, for example, an excavated mosaic pavement or wall painting. But the intent of this paragraph as it appears in the draft document of the Recommendation (UNESCO/CUA/68, Paragraph 36) is to prevent the removal without adequate documentation of those layers on a site that overlie the strata of major interest to the excavator. A more all-embracing phrase such as "cultural remains" would make the paragraph clearer, if it were not to be re-written entirely. The principle has been observed more often in recent years in the meticulous excavation of medieval and Islamic levels overlying the Classical and prehistoric nucleus of a site.

Paragraph 9

The preservation of "witness" areas on large sites, for the benefit of future researchers, is not generally possible in the case of sites threatened with destruction. It will depend as much on the circumstances of the excavation as on the "nature of the land" mentioned in the Recommendation.

Formation of Central and Regional Collections. Paragraph 10

This paragraph contains the only reference (though cf. Paragraph 21) in the Recommendation to the preservation of excavated finds in museums. It recommends that central, regional or local collections "should command, on a permanent basis, the administrative facilities and scientific staff necessary to ensure the preservation of the exhibits."

In the case especially of "local collections" (now often referred to as site museums), security should perhaps be specifically mentioned as a principal consideration; so also should scientific facilities for conservation of the collections. This phrase might replace the more limited "preservation of the exhibits" since it is both the displayed objects and the reserve collections that require continuing conservation. Generally, the conservation of excavated material in museums calls for more detailed guidelines than those contained in the present Recommendation.

III. Regulations Governing Excavations and International Collaboration. Preservation of Archaeological Remains

Paragraph 21

> "The deed of concession should define the obligations of the excavator during and on completion of his work. The deed should, in particular, provide for guarding, maintenance and restoration of the site together with the conservation, during and on completion of his work, of objects and monuments uncovered. The deed should moreover indicate what help if any the excavator might expect from the conceding State in the discharge of his obligations should these prove too onerous."

This paragraph with Paragraphs 23d and 24b (below) provoked the most discussion at the Cyprus Conference. Although drawn up with reference to foreign archaeological missions, these recommendations should, it was agreed, apply also to local institutes and individuals who wish to carry out archaeological work in the country. They are widely implemented nowadays by means of excavation permits or written agreements with the excavator.

Although Paragraph 21 recommends only that the deed of concession (or "permit") should "provide for the guarding, maintenance ... etc.", the last sentence implies that the permit-holder would in general be the one expected to provide for them. For instance, in Israel the permit-holder is responsible for conservation of the site and excavated objects, and also for fencing of the excavated area. Failure to do so results, after a warning, in the Department of Antiquities taking the required measures instead and collecting the expenses from the permit-holder.

More commonly, perhaps, the excavator is responsible for the conservation on-site of all objects and structures discovered, while the State subsequently assumes responsibility for the conservation of the site (including guarding, maintenance and presentation to the public), and for the curation of the objects in a museum. (Restoration of sites should perhaps be omitted from this paragraph since it should be an option, not an obligation, cf. Paragraph 7 above.) This practice is realistic since maintenance and conservation require, if not a permanent presence, at least regular visits.

Nevertheless, some authorities propose that the excavator should be at least *financially* responsible for conservation of the site (including guarding, fencing, consolidation) for the duration of the excavation project. This would be effected by having the excavator deposit a proportion of his operating budget with the permit-granting authority before starting work (as happens at present in Jordan).

Such a scheme would help defray the costs of site maintenance (cf. Paragraph 6b, iv above) during the life of an excavation project. For it to work satisfactorily, it would seem advisable (i) that the budget percentage to be deposited should be variable depending on the nature of the site; (ii) that it should be used for conservation work on that site alone, and (iii) that any funds remaining after the work is completed should be returned to the permit-holder along with an itemized list of expenditures.

Relevant to this same paragraph is the question of whether the granting of a permit should be conditional upon the presence of a qualified conservator in the excavation team. Certain states, for instance the Libyan Arab Jamahiriya, Iraq and Saudi Arabia, require by law the presence in a team of an architect/surveyor, a photographer and draughtsman. In Jordan a team must include a conservator to conserve excavated architectural remains, although this condition has not always been met for shortage of qualified candidates. It is this lack of trained personnel that is the main obstacle to requiring the presence of a conservator in a team, and which makes the more urgent an increase in training opportunities (see Paragraph 23d below).

Assignment of Finds. Paragraph 23d

The paragraph recommends allowing the temporary export of finds for study purposes if there is a lack of bibliographic or scientific facilities in the country concerned or if access is difficult. Although the development of indigenous facilities is obviously the preferred solution, the temporary loan of finds for conservation purposes should also be mentioned, since already permitted in many countries. In this case, the proviso "excluding objects which are exceptionally fragile or of national importance" might no longer apply. However some guidelines concerning the conditions on which such objects are loaned, whether for study or for conservation, should be included in this paragraph in order to guarantee their safe return within the agreed time-limit.

The Cyprus Conference suggested that the export of finds or samples (e.g., soil, slag) for destructive analysis should also be the subject of guidelines.

Moreover, it proposed the establishment of regional conservation centres to which objects requiring treatment could be sent by countries lacking their own facilities. The practical difficulties of such an arrangement are not to be underestimated, including the risks involved in the international transport of fragile objects already needing conservation. The paragraphs of the Recommendation concerning international collaboration are relevant here (especially Paragraphs 15-18); their scope could perhaps be widened to encourage the provision of opportunities for trainee conservators and laboratories accepting excavated material, and listings of training opportunities (though see ICCROM's Directory, 1994), both to be regularly updated.

Scientific rights; rights and obligations of the excavator. Paragraph 24b

> "The conceding State should require the excavator to publish the results of his work within the period stipulated in the deed, or, failing such stipulations, within a reasonable period. This period should not exceed two years for the preliminary report."

These recommendations find frequent expression in current practice. The period within which a final excavation report should be published should definitely be stipulated in the excavation permit since "a reasonable period" is open to ambiguity. The limit of two years for a *published* preliminary report is considered reasonable. Many States require that an internal report be submitted after each campaign to the permit-granting authority as a condition for further permits being issued; this principle could be included in a revised Recommendation.

The principle of final publication of one excavation before a permit for another one may be granted is also widely adopted. Moreover, the number of seasons allowed on one large site may be limited (as now in Cyprus), subject to the completion of a full report on them before excavation is permitted to resume. In this way there is some control over the quantity of information potentially lost if no final excavation reports are forthcoming.

The publication of numerous small excavations by active archaeological services can be seriously delayed unless sufficient staff and funds are devoted to it (cf. Paragraph 6b above). Relevant here is Paragraph 25, recommending that documentation on excavations and reserve collections be made available to other archaeologists.

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APPENDIX I

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION
ORGANIZACIÓN DE LAS NACIONES UNIDAS PARA LA EDUCACIÓN, LA CIENCIA Y LA CULTURA
ORGANISATION DES NATIONS UNIES POUR L'ÉDUCATION, LA SCIENCE ET LA CULTURE
ОРГАНИЗАЦИЯ ОБЪЕДИНЕННЫХ НАЦИЙ ПО ВОПРОСАМ ОБРАЗОВАНИЯ, НАУКИ И КУЛЬТУРЫ

Recommendation on International Principles applicable to Archaeological Excavations, adopted by the General Conference at its Ninth Session, New Delhi, 5 December 1956

Recomendación que define los principios internacionales que deberán aplicarse a las excavaciones arqueológicas, aprobada por la Conferencia General en su novena reunión, Nueva Delhi, 5 de diciembre de 1956

Recommandation définissant les principes internationaux à appliquer en matière de fouilles archéologiques, adoptée par la Conférence générale à sa neuvième session, New Delhi, 5 décembre 1956

Рекомендация, определяющая принципы международной регламентации археологических раскопок, принятая Генеральной конференцией на ее девятой сессии в Нью-Дели, 5 декабря 1956 года

UNESCO

The General Conference of the United Nations Educational, Scientific and Cultural Organization, meeting at New Delhi, from 5 November to 5 December 1956, at its ninth session,

Being of the opinion that the surest guarantee for the preservation of monuments and works of the past rests in the respect and affection felt for them by the peoples themselves, and persuaded that such feelings may be greatly strengthened by adequate measures inspired by the wish of Member States to develop science and international relations,

Convinced that the feelings aroused by the contemplation and study of works of the past do much to foster mutual understanding between nations, and that it is therefore highly desirable to secure international co-operation with regard to them and to further, in every possible way, the fulfilment of their social mission,

Considering that, while individual States are more directly concerned with the archaeological discoveries made on their territory, the international community as a whole is nevertheless the richer for such discoveries,

Considering that the history of man implies the knowledge of all different civilizations; and that it is therefore necessary, in the general interest, that all archaeological remains be studied and, where possible, preserved and taken into safe keeping,

Convinced that it is highly desirable that the national authorities responsible for the protection of the archaeological heritage should be guided by certain common principles which have been tested by experience and put into practice by national archaeological services,

Being of the opinion that, though the regulation of excavations is first and foremost for the domestic jurisdiction of each State, this principle should be brought into harmony with that of a liberally understood and freely accepted international co-operation,

Having before it proposals concerning international principles applicable to archaeological excavations, which constitute item 9.4.3 on the agenda of the session,

Having decided, at its eighth session, that these proposals should be regulated at the international level by way of a recommendation to Member States,

Adopts, this fifth day of December 1956, the following Recommendation:

The General Conference recommends that Member States should apply the following provisions by taking whatever legislative or other steps may be required to give effect, within their respective territories, to the principles and norms formulated in the present Recommendation.

The General Conference recommends that Member States should bring the present Recommendation to the knowledge of authorities and organizations concerned with archaeological excavations and museums.

The General Conference recommends that Member States should report to it, on dates and in a manner to be determined by it, on the action which they have taken to give effect to the present Recommendation.

I. Definitions

Archaeological excavations

1. For the purpose of the present Recommendation, by archaeological excavations is meant any research aimed at the discovery of objects of archaeological character, whether such research involves digging of the ground or systematic exploration of its surface or is carried out on the bed or in the sub-soil of inland or territorial waters of a Member State.

Property protected

2. The provisions of the present Recommendation apply to any remains, whose preservation is in the public interest from the point of view of history or art and architecture, each Member State being free to adopt the most appropriate criterion for assessing the public interest of objects found on its territory. In particular, the provisions of the present Recommendation should apply to any monuments and movable or immovable objects of archaeological interest considered in the widest sense.

3. The criterion adopted for assessing the public interest of archaeological remains might vary according to whether it is a question of the preservation of such property, or of the excavator's or finder's obligation to declare his discoveries.

(a) In the former case, the criterion based on preserving all objects originating before a certain date should be abandoned, and replaced by one whereby protection is extended to all objects belonging to a given period or of a minimum age fixed by law.

(b) In the latter case, each Member State should adopt far wider criteria, compelling the excavator or finder to declare any object, of archaeological character, whether movable or immovable, which he may discover.

II. General **principles**

Protection of the archaeological heritage

4. Each Member State should ensure the protection of its archaeological heritage, taking fully into account problems arising in connexion with excavations, and in conformity with the provisions of the present Recommendation.

5. Each Member State should in particular:

(a) Make archaeological explorations and excavations subject to prior authorization by the competent authority;

(b) Oblige any person finding archaeological remains to declare them at the earliest possible date to the competent authority;

(c) Impose penalties for the infringement of these regulations;

(d) Make undeclared objects subject to confiscation;

(e) Define the legal status of the archaeological sub-soil and, where State ownership of the said sub-soil is recognized, specifically mention the fact in its legislation;

(f) Consider classifying as historical monuments the essential elements of its archaeological heritage.

Protecting body: archaeological excavations

6. Although differences of tradition and unequal financial resources make it impossible for all Member States to adopt a uniform system of organization in the administrative services responsible for excavations, certain common principles should nevertheless apply to all national archaeological services:

(a) The archaeological service should, so far as possible, be a central State administration—or at any rate an organization provided by law with the necessary means for carrying out any emergency measures that may be required. In addition to the general administration of archaeological work, this service should co-operate with research institutes and universities in the technical training of excavators. This body should also set up a central documentation, including maps, of its movable and immovable monuments and additional documentation for every important museum or ceramic or iconographic collection, etc.

(b) Steps should be taken to ensure in particular the regular provision of funds: (i) to administer the services in a satisfactory manner; (ii) to carry out a programme of work proportionate to the archaeological resources of the country, including scientific publications; (iii) to exercise control over accidental discoveries; (iv) to provide for the upkeep of excavation sites and monuments.

7. Careful supervision should be exercised by each Member State over the restoration of archaeological remains and objects discovered.

8. Prior approval should be obtained from the competent authority for the removal of any monuments which ought to be preserved *in situ*.

9. Each Member State should consider maintaining untouched, partially or totally, a certain number of archaeological sites of different periods in order that their excavation may benefit from improved techniques and more advanced archaeological knowledge. On each of the larger sites now being excavated, in so far as the nature of the land permits, well defined 'witness' areas might be left unexcavated in several places in order to allow for eventual verification of the stratigraphy and archaeological composition of the site.

Formation of central and regional collections

10. Inasmuch as archaeology is a comparative science, account should be taken, in the setting up and organizing of museums and reserve collections, of the need for facilitating the work of comparison as much as possible. For this purpose, central and regional collections might be formed or, in exceptional cases, local collections on particularly important archaeological sites—in preference to small scattered collections, accessible to comparatively few people. These establishments should command, on a permanent basis, the administrative facilities and scientific staff necessary to ensure the preservation of the exhibits.

11. On important archaeological sites, a small exhibit of an educational nature—possibly a museum—should be set up to convey to visitors the interest of the archaeological remains.

Education of the public

12. The competent authority should initiate educational measures in order to arouse and develop respect and affection for the remains of the past by the teaching of history, the participation of students in certain excavations, the publication in the press of archaeological information supplied by recognized specialists, the organization of guided tours, exhibitions and lectures dealing with methods of excavation and results achieved, the clear display of archaeological sites explored and monuments discovered, and the publication of cheap and simply written monographs and guides. In order to encourage the public to visit these sites, Member States should make all necessary arrangements to facilitate access to them.

III. Regulations governing excavations and international collaboration

Authority to excavate granted to foreigners

13. Each Member State on whose territory excavations are to take place should lay down general rules governing the granting of excavation concessions, the conditions to be observed by the excavator, in particular as concerns the supervision exercised by the national authorities, the period of the concession, the reasons which may justify its withdrawal, the suspension of work, or its transfer from the authorized excavator to the national archaeological service.

14. The conditions imposed upon a foreign excavator should be those applicable to nationals. Consequently, the deed of concession should omit special stipulations which are not imperative.

International collaboration

15. In the higher interest of archaeology and of international collaboration, Member States should encourage excavations by a liberal policy. They might allow qualified individuals or learned bodies, irrespective of nationality, to apply on an equal footing for the concession to excavate. Member States should encourage excavations carried out by joint missions of scientists from their own country and of archaeologists representing foreign institutions, or by international missions.

16. When a concession is granted to a foreign mission, the representative of the conceding State—if such be appointed—should, as far as possible, also be an archaeologist capable of helping the mission and collaborating with it.

17. Member States which lack the necessary resources for the organization of archaeological excavations in foreign countries should be accorded facilities for sending archaeologists to sites being worked by other Member States, with the consent of the director of excavations.

18. A Member State whose technical or other resources are insufficient for the scientific carrying out of an excavation should be able to call on the participation of foreign experts or on a foreign mission to undertake it.

Reciprocal guarantees

19. Authority to carry out excavations should be granted only to institutions represented by qualified archaeologists or to persons offering such unimpeachable scientific, moral and financial guarantees as to ensure that any excavations will be completed in accordance with the terms of the deed of concession and within the period laid down.

20. On the other hand, when authority to carry out excavations is granted to foreign archaeologists, it should guarantee them a period of work long enough, and conditions of security sufficient to facilitate their task and protect them from unjustified cancellation of the concession in the event, for instance, of their being obliged, for reasons recognized as valid, to interrupt their work for a given period of time.

Preservation of archaeological remains

21. The deed of concession should define the obligations of the excavator during and on completion of his work. The deed should, in particular, provide for guarding, maintenance and restoration of the site together with the conservation, during and on completion of his work, of objects and monuments uncovered. The deed should moreover indicate what help if any the excavator might expect from the conceding State in the discharge of his obligations should these prove too onerous.

Access to excavation sites

22. Qualified experts of any nationality should be allowed to visit a site before a report of the work is published and with the consent of the director of excavations, even during the work. This privilege should in no case jeopardize the excavator's scientific rights in his finds.

Assignment of finds

23. (a) Each Member State should clearly define the principles which hold good on its territory in regard to the disposal of finds from excavations.

(b) Finds should be used, in the first place, for building up, in the museums of the country in which excavations are carried out, complete collections fully representative of that country's civilization, history, art and architecture.

(c) With the main object of promoting archaeological studies through the distribution of original material, the conceding authority, after scientific publication, might consider allocating to the approved excavator a number of finds from his excavation, consisting of duplicates or, in a more general sense, of objects or groups of objects which can be released in view of their similarity to other objects from the same excavation. The return to the excavator of objects resulting from excavations should always be subject to the condition that they be allocated within a specified period of time to scientific centres open to the public, with the proviso that if these conditions are not put into effect, or cease to be carried out, the released objects will be returned to the conceding authority.

(d) Temporary export of finds, excluding objects which are exceptionally fragile or of national importance, should be authorized on requests emanating from a scientific institution of public or private character if the study of these finds in the conceding State is not possible because of lack of bibliographical or scientific facilities, or is impeded by difficulties of access.

(e) Each Member State should consider ceding to, exchanging with, or depositing in foreign museums objects which are not required in the national collections.

Scientific rights; rights and obligations of the excavator

24. (a) The conceding State should guarantee to the excavator scientific rights in his finds for a reasonable period.

(b) The conceding State should require the excavator to publish the results of his work within the period stipulated in the deed, or, failing such stipulations, within a reasonable period. This period should not exceed two years for the preliminary report. For a period of five years following the discovery, the competent archaeological authorities should undertake not to release the complete collection of finds, nor the relative scientific documentation, for detailed study, without the written authority of the excavator. Subject to the same conditions, these authorities should also prevent photographic or other reproduction of archaeological material still unpublished. In order to allow, should it be so desired, for simultaneous publication of the preliminary report in both countries, the excavator should, on demand, submit a copy of his text to these authorities.

(c) Scientific publications dealing with archaeological research and issued in a language which is not widely used should include a summary and, if possible, a list of contents and captions of illustrations translated into some more widely known language.

Documentation on excavations

25. Subject to the provisions set out in paragraph 24, the national archaeological services should, as far as possible, make their documentation and reserve collections of archaeological material readily available for inspection and study to excavators and qualified experts, especially those who have been granted a concession for a particular site or who wish to obtain one.

Regional meetings and scientific discussions

26. In order to facilitate the study of problems of common interest, Member States might, from time to time, convene regional meetings attended by representatives of the archaeological services of interested States. Similarly, each Member State might encourage excavators working on its soil to meet for scientific discussions.

IV. Trade in antiquities

27. In the higher interests of the common archaeological heritage, each Member State should consider the adoption of regulations to govern the trade in antiquities so as to ensure that this trade does not encourage smuggling of archaeological material or affect adversely the protection of sites and the collecting of material for public exhibit.

28. Foreign museums should, in order to fulfil their scientific and educational aims, be able to acquire objects which have been released from any restrictions due to the laws in force in the country of origin.

V. Repression of clandestine excavations and of the illicit export of archaeological finds

Protection of archaeological sites against clandestine excavations and damage

29. Each Member State should take all necessary measures to prevent clandestine excavations and damage to monunents defined in paragraphs 2 and 3 above, and also to prevent the export of objects thus obtained.

International co-operation in repressive measures

30. All necessary measures should be taken in order that museums to which archaeological objects are offered ascertain that there is no reason to believe that these objects have been procured by clandestine excavation, theft or any other method regarded as illicit by the competent authorities of the country of origin. Any suspicious offer and all details appertaining thereto should be brought to the attention of the services concerned. When archaeological objects have been acquired by museums, adequate details allowing them to be identified and indicating the manner of their acquisition should be published as soon as possible.

Return of objects to their country of origin

31. Excavation services and museums should lend one another assistance in order to ensure or facilitate the recovery of objects derived from clandestine excavations or theft, and of all objects exported in infringement of the legislation of the country of origin. It is desirable that each Member State should take the necessary measures to ensure this recovery. These principles should be applied in the event of temporary exports as mentioned in paragraph 23(c), (d) and (e) above, if the objects are not returned within the stipulated period.

VI. Excavations in occupied territory

32. In the event of armed conflict, any Member State occupying the territory of another State should refrain from carrying out archaeological excavations in the occupied territory. In the event of chance finds being made, particularly during military works, the occupying Power should take all possible measures to protect these finds, which should be handed over, on the termination of hostilities, to the competent authorities of the territory previously occupied, together with all documentation relating thereto.

VII. Bilateral agreements

33. Member States should, whenever necessary or desirable, conclude bilateral agreements to deal with matters of common interest arising out of the application of the present Recommendation.

The foregoing is the authentic text of the Recommendation duly adopted by the General Conference of the United Nations Educational, Scientific and Cultural Organization during its Ninth Session, which was held at New Delhi and declared closed the fifth day of December 1956.

IN FAITH WHEREOF we have appended our signatures this fifth day of December 1956.

The President of the General Conference *The Director-General*

ADDITIONAL REFERENCES

For the re-issue of this volume, the authors were requested to update or amplify their bibliographies if they so desired. The titles below are those suggested for several of the chapters. Other titles in individual chapters have been updated where possible.

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