TECHNICAL NOTE

1

FIELD CONSERVATION OF ARCHAEOLOGICAL OBJECTS

O. P. AGRAWAL

NRLC

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C-257, NIRALA NAGAR,
LUCKNOW

1982

PREFACE

The need for technical notes which could help the curators, museum experts, archaeologists, conservators and other specialists, in their efforts for the preservation of cultural objects has often been felt. With the publication of *Field Conservation of Archaeological Objects*, NRLC is starting a series of technical notes which will be published from time to time. Through these small publications an effort will be made to disseminate information about preservation procedures.

The aim of this first Technical Note is to point out to certain precautions which ought to be taken while excavating and the immediate first aid treatment to be given to objects at site. Quite often, preliminary precautions save much trouble at a later stage when the object is received in the laboratory for full treatment.

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Published by Shri O. P. Agrawal, Project officer, NRLC, Lucknow, and Printed at : Lucknow Publishing House, 37, Cantonment Road, Lucknow - 226 001

Field Conservation of Archaeological Objects

INTRODUCTION

A number of excavations are being held in our country every year by various institutions to unearth thousands and thousands of antiquities belonging to different periods of history. These excavated antiquities are so very important for study, analysis and interpretation, yet concern for the conservation of these objects seems to be singularly absent. The material is dug out, photographed, sketched and is then forgotten, often dumped in boxes or on floor. It is not uncommon also to see that enough precautions are not taken for the conservation of objects while digging, transporting and storing them, before they are treated in the laboratory. It should be the archaeologist's responsibility to ensure that the objects which are excavated are preserved and stored properly so that they remain available for future research. In order that the objects excavated are not damaged, it seems essential that the excavator should have the training to understand the processes of deterioration of materials and conservation procedures applicable in the field. It ought to be compulsory that archaeological expeditions should have with them adequately staffed and equipped field-laboratories. At present these are lacking in our country. It may be emphasized that the field-laboratory should be equipped only for immediate treatment, for prevention of further deterioration of objects. Complicated and prolonged treatment should not be undertaken in the field. A fully equipped conservation laboratory will be required for later treatment.

The aim should be that if any material is excavated, it must necessarily be preserved. For this reason advance planning before the excavations are started is essential. There should be a better interaction between the conservator and the archaeologist. The conservator on his part must understand that in the archaeological context the aim of conservation is not merely to preserve the object. The objective should be to retain the record and the data present on the object. For instance, the objective of treating a rusted object should be to save the shape and the form of the object, even though they may be corroded. Complete removal of corrosion products to reach the metal core, as happens quite often, with a view to stabilization, without taking into consideration whether by doing so the object would lose its archaeological significance, will in fact be anti-conservation. In other words, the problems of conservation should be viewed from the point of view of the archaeologist and the excavator.

This note presents some information on the problems involved.

The ideal situation will be to have a trained conservator available at the site of excavation. It must be emphasized that training of conservator whether in the field-laboratory or in the full laboratory, is absolutely neccessary otherwise more harm than good could accrue to the objects. It is not uncommon to find many a conservator applying a treatment which is sure to damage the objects. It must also be mentioned that costly equipment is not always necessary for treatment. What is required is the understanding of the material, of the processes of deterioration, and of the behaviour of the object when buried under soil, and immediately after excavation. The conservator should be able to identify the materials in the field and he should be able to decide as to in which condition a particular item should be kept. For instance, he could give his opinion that which material needs to be dried out and which should be held in a wet condition. For example, objects made of wood, ivory and bone, if wet, will start disintegrating on drying unless they are properly consolidated, and therefore, wet wooden, ivory, and bone objects should be kept wet until treated in the laboratory.

OBJECTS AND THE SOIL

The behaviour and the condition of any object will depend upon the nature of the material of which the object is made and the environment in which it has remained or is going to remain in future. Archaeological objects differ from other art objects in the sense of their surroundings. Before being excavated, they are found buried in the soil or under water, in the sea or fresh water, or sometimes exposed to the open atmosphere. In order to study the methods of field treatment of objects, it is first of all necessary to understand why do they deteriorate and what changes take place in them during the process of deterioration. The extent and the nature of alteration being the result of environmental surroundings and the nature of the material, it is indispensable that we know about the environmental factors to which the object is exposed, as well as the nature of the object.

Archaeological material before being excavated out of the earth or taking out from under water, is surrounded by the soil or by the sea water. It is a well known chemical phenomenon that any material when placed in a new environment, starts altering till it reaches a stable form in relation to its new surroundings. In other words any archaeological object starts changing from the time of its burial, because there is a change in its environment, but in due course of time, the progress of this change is stopped and a stable form of the object is attained. One can say that an equilibrium is reached between the object and its surroundings, be it the soil, the water, or the air. It will remain stable as long as it remains in that condition. However, when the object is excavated there is again a change of surroundings and the equilibrium is disturbed. The object will now have to conform to the conditions of the new surroundings. Most excavators would have experienced this phenomenon quite often in a dramatic manner. A piece of waterlogged wooden object shrinks and crumbles to pieces within a very short time of excavation if proper precautions are not taken. A piece of painted plaster becomes dim when exposed to air. Wet iron objects start corroding and crumbling when excavated and exposed to dry atmosphere.

EFFECT OF SOIL

Soil has a complex composition consisting of mineral and organic matter. The minerals present in the soil are formed by the weathering of the present rock. Organic matter is added in the soil through vegetation, animal remains, remanents of human habitation, agricultural processes, and so on. Furthermore, it is continuously modified by micro-organisms. Through the process of percolation of rain and the effect of sun and air, there is a constant modification in the mineral component of the soil also. As a result, there are different soil types formed and distributed on the earth's surface.

The behaviour of any type of soil and its effect on the objects buried in it are governed by its texture, its composition, its acidity or basicity, salinity, vegetable matter present in it and so many other factors. For example, iron objects will rust more speedily in the presence of chlorides. Presence or absence of water or the rate of its percolation in the soil also has an effect on the deterioration of objects ; for instance, in dry conditions objects are preserved better. Glass deteriorates quickly in alkaline soils ; sometimes the effect is so great that the object becomes entirely powdery. Glazed pottery is also affected in the same manner. Iron dissolves in acid soils. Acidic soils will also damage limestone, sandstone and plaster.

Under water, wood survives very well because of the lack of oxygen and consequent elimination of fungi. On the other hand, aneorobic conditions sustain sulphate-reducing bacteria, responsible for the corrosion of metals.

CONSERVATION

The type of material most likely found in an excavation include pottery, terracotta, unbaked clay materials, metals, stone objects, glass, ivory, bone and wood. While considering conservation of archaeological objects, the problem should be viewed as consisting of :

(i) Treatment in the field.
(ii) Treatment in the laboratory.
(iii) Post treatment care and preservation.

Needless to say, all these aspects are important for the conservation of archaeological materials, but here only treatment in the field will be considered.

FIELD TREATMENT

As a part of planning, the archaeologist, before he embarks upon excavation, should take into account various types of problems he is going to encounter and to prepare for them. Supplies of necessary equipment as well as the required chemicals should be available at the site. First of all, one should be prepared for the type of materials one is likely to come across during excavations. If there is some indication of the type of materials one is going to discover, it will be easier to plan accordingly for chemicals and other equipment. Also needed at site will be running water, and in its absence, other sources of water supply. Appendix II gives a list of some of the important chemicals and equipment needed for field work.

It is observed that some excavators tend to apply solution of polyvinyl acetate or paraffin wax or some other resin on each and every metal and other fragile objects that are excavated. Such a practice creates problem at a later stage. Any treatment should be given after due consideration of the nature of the object as well as its condition.

Also if the object is to be chemically or metallurgically examined later, no coating of whatsoever type should be applied on the objects, otherwise there will be every likelihood of getting a wrong analysis.

The sample for examination should be packed in a polythene bag and sent to the laboratory with full details. Samples for Carbon-14 analysis should not be touched with hand. They should be lifted and packed using a forceps or a polythene bag. Samples of organic nature required for later analysis or identification should not be allowed to dry out because during this process their cellular structure, so very important for identification, will be destroyed. They should be placed in a polythene bag in a wet condition, adding a small quantity of fungicide, like a strip of thymol paper. To save them from drying they can also be put in a preservative solution. The stock solution is prepared by mixing water and ethyl alcohol in equal parts. The composition of the preservative solution is :

Stock solution	..	..	90%
Glycerine	..	..	10%
Formaline	..	..	.5 cc.

CONSERVATION PROCEDURES

It is not the intention to give here a full description of the conservation of objects, but some points, which could be helpful to the archaeologist.

Each type of material presents its own problems and they will be considered one by one.

Metals

In antiquity, the metals normally found are iron, copper and its alloys, silver, gold and lead.

Iron

Normally iron objects are found in advanced state of deterioration. Most iron objects show a tendency of flaking. (Figure 1). The rate of deterioration is fast if salts are present in the soil. The corrosion products are present, often in thick layers on the uncorroded iron core. Sometimes, the entire object is corroded. The important consideration for treatment is that the shape of the object as well as any details which might be present should not be changed. (Figures 2 and 3). Iron chlorides, if present in the object, absorb moisture thereby forming acidic solution. These acids react with fresh metal forming more iron chlorides and in this way the process of deterioration continues.

Often it is not possible to do much in the field for the conservation of highly deteriorated iron objects. However, their proper storage, before full treatment in the conservation laboratory, is important. Dry conditions prevent further deterioration of iron. That means that, not only the water contained in the object is removed, but the objects are stored in a dry atmosphere. The object is placed in a sealed container having crystals of dry silica-gel. Silica-gel should be purchased with an indicator. On absorption of moisture, silica-gel changes colour from blue to pink. It can be made again ready for use by drying in an oven. Silica-gel is sold also for thin-layer chromatography, but this grade is very costly and should not be purchased for using as a dessicant.

It is found that water vapour, when present in the atmosphere above a critical humidity level may condense on the objects as small droplets or in the form of a continuous film. In such situations the rate of corrosion is very fast. Electro-chemical corrosion occurs at the site of droplets. Placing of objects in sealed containers will also obviate deposition of dust particles which are active seats of corrosion. Dust or sand particles by themselves are inert but they attract moisture which then reacts with iron.

Iron objects found in waterlogged conditions

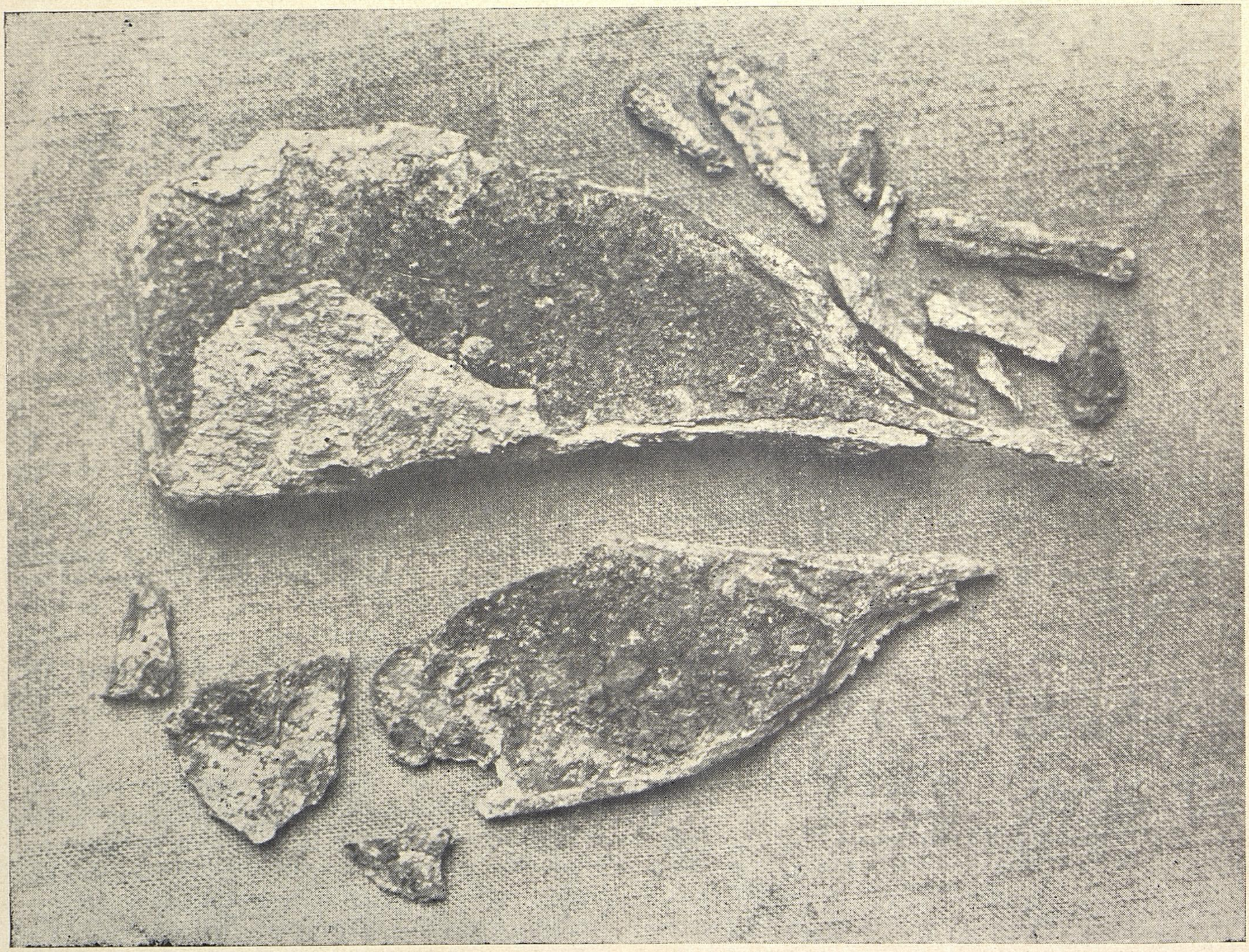

Figure 1. Most iron objects show a tendency of flaking. The rusted layers separate out from the uncorroded metal core.

must be kept wet otherwise they will crack. They, before being transported to the laboratory, can also be stored in a solution of 2% sodium carbonate or 5% sodium bicarbonate or 2% sodium hydroxide.

Copper and its alloys

Copper objects when excavated are covered with copper corrosion products (Figure 4). These are mainly carbonates, chlorides, oxides and sulphates. Copper objects like iron objects also start corroding when exposed to the atmosphere. Presence of 'bronze disease' in copper objects can be harmful. (Figure 5) 'Bronze disease' is because of chlorides present in the corrosion products. Corroded copper objects should also be stored dry. Small objects can be kept in sealed containers with silica-gel crystals. They can also be stored in 5% solution of sodium sesquicarbonate before they are transferred to the laboratory for full treatment.

For full treatment of copper, brass or bronze objects recourse may have to be taken to several methods available for the purpose.

Figure 2. An iron spear almost totally corroded. If all corrosion products were removed, the shape of the object would have completely changed.

Figure 3. The same object after treatment.

Figure 4. Copper objects when excavated are covered with copper corrosion products like carbonates, chlorides, oxides and sulphates of copper.

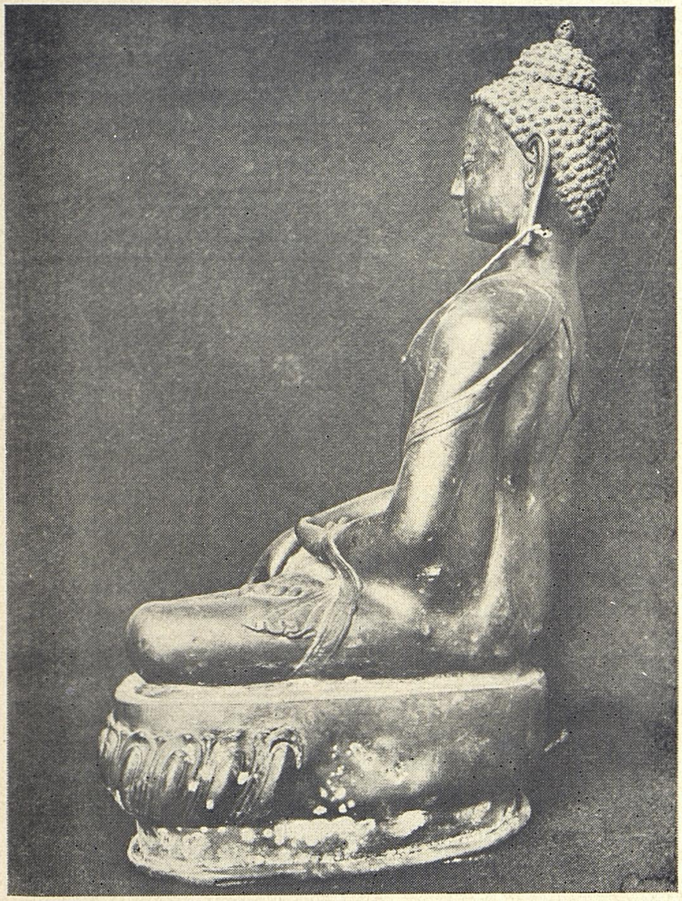

Figure 5. A copper image having spots of "bronze disease" on its pedestal. If the image is not treated, the corrosion will continue.

There might be several types of conditions in which an object is found. Some examples are :

(*a*) Deposition of calcareous or siliceous accretions on the objects.

(*b*) Presence of deposition of calcareous or siliceous accretions on corrosion products.

(*c*) Deposition of copper corrosion products.

(*d*) Highly corroded objects with very little core or no core left.

For removal of soily accretions, a 10% solution of sodium hexametaphosphate in water is found useful. Another cleaning solution consists of 10% citric acid, 4% thiourea and 86% water. The object is brushed slightly to remove corrosion products as well as accretions. Thiourea acts as an inhibitor for prevention of attack on clean metal.

A very popular cleaning solution is alkaline Rochelle salt. The solution is made up as follows :

Sodium hydroxide flakes	1.5%
Sodium potassium tatrate (Rochelle salt)	12.5%
Water	86 %

Rochelle salt treatment gives very satisfactory results for removal of corrosion products as well as of chlorides, mainly responsible for bronze disease. However, treatment with this solution removes also the patina which is considered to be a sign of antiquity. In case the patina is to be retained, but chlorides are to be removed, treatment with sodium sesquicarbonate solution has been recommended. However, this treatment takes a very long time, sometimes several months.

Recently, the use of benzotriazole has found wide use. Benzotriazole acts as an inhibitor. By treatment with this chemical, the active corrosion products are stabilized. The object is placed in a 3% solution of benzotriazole in ethyl alcohol. Treatment is quicker under vacuum. The object is taken out of the benzotriazole solution, and rinsed with ethanol before drying.

Silver

Silver objects are usually found covered with silver corrosion products, or quite often with copper corrosion products. The latter is the case when copper objects and silver objects remain buried together, or copper is used to alloy silver. Silver was also used for plating copper, brass or bronze objects.

Normally, silver objects do not continue to corrode after excavation. Therefore, except for safety from physical damage no special precaution for its storage before treatment are required.

In the laboratory, for the removal of copper salts, if found deposited on silver objects, formic acid, ammonia, or alkaline glycerol solution can be used.

Electrolytic reduction or electrochemical reduction can also be used for the treatment of silver objects found in a sound condition.

Gold

Gold by itself does not corrode but is often covered with corrosion products of other metals like silver or copper. These corrosion products can be cleaned by using solution of ammonia or formic acid or alkaline glycerol. Precautions have to be taken against physical damage.

Lead

Lead objects also do not corrode further after excavating. For treatment they have to be sent to the laboratory.

SILICEOUS MATERIALS

Pottery and Terracotta

Pottery and terracotta if fully baked are strong materials. However, soluble salts if present in the pottery give rise to problems sometimes. The surface of the salt-contained pottery becomes weak and powdery. In cases where the pottery is not fully fired, it may even break into pieces because of the crystallization of salts. For removal of soluble salts the pottery should be washed in several changes of water. If the pot has paintings on the surface which are likely to be damaged by water, only mechanical cleaning can be done.

There often is a deposit of thick insoluble incrustations on pottery. At this stage a careful examination is necessary to ensure that the incrustation is actually on the exterior and is not a deteriorated portion of the object. The best way will be to clean these incrustations mechanically. However, that may take too long a time and, therefore, mechanical cleaning is possible only on important objects. For chemical cleaning, the first step is the testing of the incrustation with dilute acids. Drops of dilute hydrochloric acid or nitric acid are dropped on the incrustations. If there is an effervescence, the incrustation consists of calcium carbonate. However, before the use of acid, it should be ensured that the pot itself is not affected by acid, as will happen if there are decorations of lime or other similar materials. It is better not to immerse the pottery or terracotta in the acid bath, but to drop the acid on the pottery incrustation, and washing it away quickly. The incrustation by this treatment often becomes soft and can then be cleaned mechanically. After the use of acid, the pot must be washed in several changes of water to remove all the soluble salts.

The incrustations of calcium sulphate or silicates have to be removed mechanically using needle, pin, sharp knife, etc. Even acids will have no effect.

If there is flaking of the surface, a coating of soluble nylon can be given.

Weak pottery and terracotta can be consolidated by steeping in 3% polyvinyl acetate solution. There is a greater penetration under vacuum. Consolidation is also done with polyethylene glycol 6000.

The chemical, which comes in white flakes, is heated to about 60°C and the pottery is dipped in it. When the bubbles stop coming out the object is removed and cleaned.

Terracotta and pottery are often found in a broken condition (Figure 6). For joining and repair of broken pottery, an adhesive like Quickfix or solution of shellac in spirit is used. The adhesive like Mowicoll has also been used but it gives trouble in humid climates. For joining of pottery, trays full of sand are kept ready for supporting different pieces together.

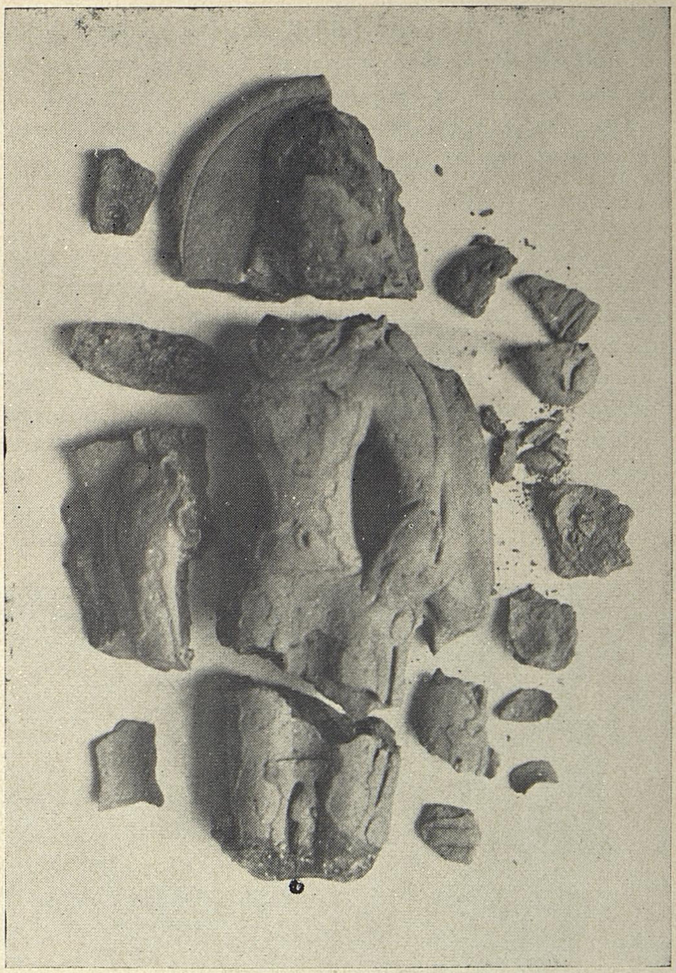

Figure 6. Terracotta and pottery are often found in a broken condition. For joining them adhesives like Quickfix or shellac solution can be used.

Restoration of missing pieces can be done by using plaster of Paris.

Unbaked Clay

During excavations unbaked clay objects are also found. They have to be handled very carefully because they are fragile and affected by water. For cleaning them, water cannot be used except very superficially. Only mechanical cleaning can be done. An attempt should be made to clean off most of the accretions while the object is still wet. For consolidation of objects, soluble nylon or polyvinyl acetate solution in toluene can be used.

Unbaked clay tablets, because of their inscriptions are fired to make them durable. The tablets after air dried are baked in a kiln. Firing is done at about 750°C. The temperature should be raised gradually and in steps. After the tablets have been completely fired, salts contained in them can be removed by washing and soaking in changes of distilled water. For consolidation, a solution of polyvinyl acetate in toluene can be used.

Glass

Glass is mainly composed of acidic and basic oxides. Fusion of these oxides at a high temperature produces a clear transparent viscous liquid which on cooling becomes solid. Normally glass is stable, but when buried under soil, particularly in alkaline conditions it tends to disintegrate. Sodium and potassium oxides used for the manufacture of ancient glasses are leached out to a certain extent by water. The selective solution of the alkaline oxides forms a layer of silica on the surface of the glass. When such a leaching occurs for long periods of time several layers of silica are formed like in an onion.

Such a glass object will have to be consolidated by using dilute soluble nylon. Better consolidation is achieved under vacuum using polyvinyl acetate.

Stone

Generally speaking, stone is a very durable material, but in certain conditions it also deteriorates. Limestone, marble and other similar stones will deteriorate if buried in acid soils. Presence of salts can also be deleterious to stone objects. Stone objects having soluble salts should be dried out slowly so that the salts are not crystallized rapidly. Rapid crystallization of salts may result in damaging the surface and rendering it powder (Figure 7). Salts can be leached by soaking the objects in salt free water. Each change of water

Figure 7. Because of the action of salts contained inside stone, the stone surface is damaged and becomes powdery.

in which the objects are placed, should be tested to see if any more salts are coming out. Salts can also be removed by the application of wet-paper pulp. Well beaten salt-free paper pulp is soaked in water overnight and applied on the object, and allowed to dry. Due to the suction force created by the evaporation of water, salts are driven out of the stone.

For the removal of insoluble accretions, mechanical cleaning is the only safe answer. Sometimes, dilute acid can also be used but with great care and only if it is in contact with the object for very short durations. The object must be washed quickly after each application of acid.

For consolidation of cleaned stone objects 3% polyvinyl acetate solution in toluene may be used. Consolidation of stone objects should be undertaken only if it is certain that they are going to be stored in dry conditions otherwise greater harm may occur.

For cleaning of stone objects hard brushes like the wire brush should never be used.

ORGANIC MATERIAL

Although discovery of objects of organic nature like textile pieces, leather, etc. is not completely ruled out, mostly we come across wood, bone and ivory in the course of excavation.

Wood

If wood is found in wet condition or waterlogged, it must be kept wet till it is consolidated and strengthened. If it is allowed to dry, its cellular structure will break down causing much damage. During the course of drying it may warp or deep cracks may form in the object. Wet wooden objects should better be stored in polythene bags or covered with polythene sheets. A fungicide like 1% solution of pentachlorophenol or orthophenyl phenol may be applied on the object.

Even when the object is transported to the laboratory it must be kept wet unless it has been treated and consolidated.

While excavating, if it is found that the wooden object is not strong enough, it should be lifted on some other stronger support like a plank. The object is lifted along with the surrounding soil and stored in polythene bags for later cleaning and treatment.

Once transported to the laboratory, treatment will consist of cleaning, removal of salts and consolidation with a suitable agent. For waterlogged wood, polyethylene glycol solution 4000, in successively increased concentrations, is used. Keeping the object in this solution, the water contained inside the wood is replaced by PEG.

If the object is found in a dry condition, it should not be allowed to become wet. It should be stored in polythene bags along with a dessicant. When brought to the laboratory after cleaning and removal of salts, consolidants like an epoxy resin or a polyster resin can be used. Microcrystalline wax also gives satisfactory results.

In the field, sometimes situations arise where immediate consolidation is required to prevent the effect of sudden change of humidity. Cases are known where dry wooden objects crumbled to pieces when they were exposed to humid conditions. In such cases molten paraffin wax or a solution of polyethylene glycol 4000 can be applied as a temporary measure.

Ivory and Bone

Ivory and bone are very soft materials. On excavation, they are practically always found in a

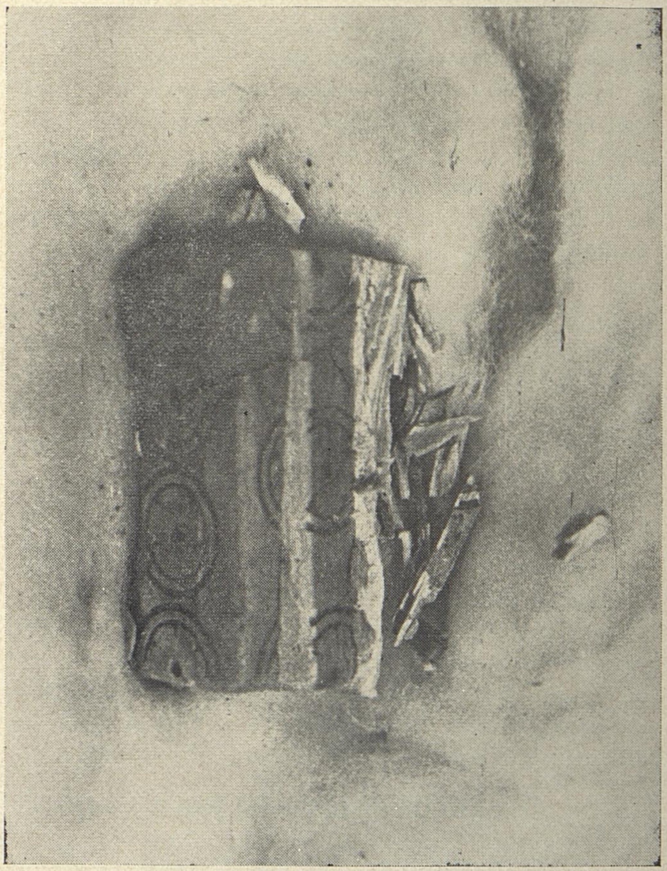

Figure 8. An ivory dice as found on excavation. It was in such a fragile condition that it could not be lifted without the danger of its parts crumbling and falling apart.

fragile and broken condition (Figure 8). The cellular structure of ivory and bone gets disrupted and becomes weak. Both ivory and bone are highly porous and as such readily absorb salts from the soil. Soily and calcareous accretions could also be present on the surface. Quite often, they are so hard that they cannot be removed easily.

As a rule ivory and bone objects should not be cleaned with water. Mechanical cleaning is preferable. For mechanical cleaning also it is better to use wooden sticks, or match sticks, rather than iron needles, which may damage the delicate surface of the object. In the field, weak ivory and bone objects can be strengthened by using a solution of Mowilith (a product of Hoechst). A problem often encountered during excavations is the safe lifting of weak objects. Such objects should be lifted on another support. If strength has to be given *in situ.*, a dilute solution of Mowilith can be applied on the object drop by drop.

If ivory or bone objects contain soluble salts, these must be removed. Prior consolidation with a 5% solution of soluble nylon in alcohol is applied on the object before washing them with water.

For removal of insoluble salts like calcium carbonate or calcium sulphate present on the surface of the objects, a very dilute acid solution (1% hydrochloric acid) can be used locally. This has to be done very carefully and washed off immediately on application, as otherwise the acid solution might affect the object also.

Particular care has to be exercised in packing and transporting ivory and bone materials. They must be wrapped in clean tissue paper before wrapping them in cottonwool. Enough padding all around them should be provided so that they do not get damaged by abrasion.

CONCLUSION

Described above is only a brief account of various techniques of conservation of archaeological objects as applicable in the field. It is hoped that it would provide some idea of the deterioration processes and conservation procedures as well as the precautions an archaeologist should take for better preservation of excavated objects.

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APPENDIX I

TEST FOR CHLORIDES

Plenderleith and Werner mention optimum conditions for testing of chlorides. About 10 ml. of the water sample is taken in a tall narrow cylinder. Several drops of dilute nitric acid are added. The solution is well mixed and five drops of 2% silver nitrate solution added to it. The solution is well mixed and viewed against a black surface. Appearance of any opalescence will indicate the presence of chloride. The experiment should always be checked blank, with water alone.

Plenderleith and Werner mention that under these conditions one part of chloride per million of solution may be detected. However, experiments performed by Semczak indicate that minimum 5 p.p.m. of chloride ions give an opalescence.

TEST FOR SULPHATES

The sample is taken in a small test tube and dissolved in dilute analytical grade nitric acid or hydrochloric acid. After the sample is dissolved, a drop of 1% barium chloride solution is added to it. Appearance of a white precipitate will indicate the presence of sulphate.

APPENDIX II

LIST OF MATERIALS

Chemicals

1. Acetic acid (Glacial). Used as a solution in water.
2. Ammonia. Used for cleaning silver and gold objects. Also useful for cleaning of stone, particularly for removal of moss.
3. Barium chloride. Indicator for presence of sulphates.
4. Benzotriazole. For stabilization of copper corrosion products.
5. Citric acid. It is sold as white crystals. Used for cleaning of metals.
6. Formic acid. It is used for removal of corrosion products from copper and silver objects.
7. Glycerine.
8. Hydrochloric acid. Used for removal of calcareous deposits from the surface of a variety of objects.
9. Hydrogen peroxide.
10. Nitric acid.
11. Orthophenyl phenol. Uesd as a fungicide. Trade name Dowicide.
12. Pentachlorophenol. Used as a fungicide. Dissolves in methylated spirit or ethyl alcohol.
13. Polymethylmethacrylate. Solution is made in toluene and ethyl alcohol.
14. Polyvinyl acetate. Sold as white crystals and is a useful resin for conservation purposes. It is dissolved in sulphur free toluene or acetone.
15. Polyvinyl alcohol. Dissolves in water.
16. Rochelle salt (Sodium potassium tatrate). Useful for treating copper objects.
17. 1% Silver Nitrate solution. Indicator for presence of chlorides.
18. Sodium hexametaphosphate. 10% solution used for dissolving calcareous incrustations.
19. Sodium Hydroxide flakes.
20. Sodium pentachlorophenate. Dissolves in water. Used as fungicide.
21. Soluble nylon. Sold under the trade name—Calaton CB.
22. Thymol. Used as a fungicide. Dissolves in alcohol.

Solvents

1. Acetone.
2. Benzene.
3. Chloroform.
4. Ethyl alcohol.
5. Methyl alcohol.
6. Methylated spirit.
7. Toluene.

Manufacturers of Chemicals and Solvents:

1. M/s. Glaxo Laboratories (India) Ltd.
   Dr. Annie Besant Road,
   Bombay-400 025.
2. M/s. Sarabhai M. Chemicals,
   P. O. Box No. 80,
   Baroda-390 001.

Equipment and Small Tools :

1. Scalpels.
2. Sharp knife.
3. Screwdriver set.
4. Pinvice.

5. Pincers.
6. Brushes of assorted sizes.
7. Nylon brush.
8. Tooth brush for cleaning.
9. Cottonwool.
10. A hand spray gun.
11. Polythene bags.
12. Glass bowls.
13. Polythene bowls.
14. Plastic boxes.
15. Polythene sheets.
16. Pair of scissors.
17. Snadpaper.
18. Magnifying glass.
19. Rubber gloves.
20. Adhesive tapes.
21. Blotting-paper.
22. Beakers.
23. Graduated cylinder.
24. Physical balance with weight box.
25. Spirit lamp.
26. Hot air oven.
27. Test tubes.
28. Test tube stand.
29. Bottles for storing of chemicals.
30. Sponge.

Miscellaneous Materials

1. Plaster of Paris.
2. Bandage.
3. Fiberglass .
4. Animal glue.
5. Paraffin wax.
6. Polyethylene glycol. Grades 4000 and 6000.
7. Plasticine.
8. Shellac.
9. Silicagel with indicator.
10. Araldite.
11. Quickfix.
12. Epoxy resins.

Equipment, small tools and miscellaneous materials can be obtained from general merchants, and scientific suppliers.

Manufacturers of glass laboratory-ware:

M/s. Borosil Glass Works Ltd.,
44 Khanna Construction House,
Khan Abdul Gaffar Khan Road,
Worli, Bombay-400 018.