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TRAINING COURSE MANUAL ON CONSERVATION SCIENCE
FOR ARCHAEOLOGICAL OBJECTS:
The Conservation of Archaeological Ceramics

By Estelle Ottenwelter

Funded by UNESCO / SPACH

March 2006
The Society for the Preservation of Afghanistan’s Cultural Heritage, based in Kabul, was formed in 1994. SPACH aims to share information and foster contacts with organizations, institutions and individuals inside and outside Afghanistan.

With the cooperation of its members, SPACH maintains a Photo Catalogue on the Status of Museums, Sites, Monuments, Artifacts and Architecture of Afghanistan. A Newsletter and Website describing SPACH activities is published for its Afghan and international members. It promotes extensive public relations through liaison with the media and public lectures.

As part of its advocacy efforts, the SPACH LIBRARY SERIES is designed to acquaint readers with the diversity of Afghanistan’s cultural heritage. Each volume is devoted to one specific monument, archaeological site, region or, occasionally, other cultural subjects. Articles by experts are selected by an Editorial Board and appear in English, Dari and Pashtu. The intent is to enhance the knowledge of all levels of readers.
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<tr>
<td>TRANSLATOR: Reza Sharifi (Dari), SPACH</td>
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<tr>
<td>EDITORS: Brendan Cassar &amp; Mohammed Zia, SPACH</td>
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<tr>
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</tr>
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* Frontispiece: photograph of ceramic jug (9th-10th Century A.D.) from Balahe Sar, Balkh by the author
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Estelle Ottenwelter,¹
March 2006

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¹ Conservator of archaeological objects, IRRAP, France.
INTRODUCTION

This booklet is addressed in particular to the trainees of the National Museum of Afghanistan and the Institute of Archaeology who participated in the training course, but also to any other institutions and museums in Afghanistan interested in the conservation of ceramics. It provides a basic theoretical knowledge concerning ceramic material, its deterioration and conservation, and also an illustrated section concerned with the different stages of conservation and restoration of archaeological ceramics. This booklet represents the theoretical background to practical work undertaken by trainees during the course.

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CERAMIC MATERIAL

The term “ceramic” refers to objects that have been manufactured from clay and then baked. It includes not only pottery but also all other items made of fired clay, such as, figurines, weights, toys, and architectural elements.

NATURE OF THE MATERIAL

Clay is a material we find in abundance on the Earth’s surface. It is a superficial layer of the Earth made of degraded rock. Clay is constituted by extremely small sized particles that absorb water through a chemical process. When fully wetted, each clay particle becomes covered with a layer of moisture. The moisture causes the particles to adhere and at the same time allows them to be moved over one another in response to pressure. In this way, the whole mass of particles provides a material that is plastic and capable of holding its shape after being deformed by pressure.

The raw clays used to make ceramics are basically aluminium silicates, but they vary greatly in chemical composition and in the nature and quantities of impurities, so it is only natural to find a great diversity in fired pottery as well.

A further difference is introduced by the temper, or filler, which the potter intentionally adds to the clay in order to give it more body and porosity and to minimize shrinkage as the shaped clay dries. In antiquity, quartz sand, pebbles, and calcined flint were common tempers, but small fragments of calcite, ground-shell, crushed pottery or straw were also used. These fillers, added deliberately, can be difficult to distinguish at times from substances already present as natural compounds in clays.
FORMING PROCESSES

There are many techniques that may be employed in making ceramic objects. For archaeological periods the main techniques employed are as follows:

**Pinch Pot:**

The simplest way of making a vessel form is to take a ball of soft clay in one hand and make a series of even pinches outwards from the centre whilst rotating the form. These pots have a crude and irregular finish.

**Coiling:**

In coiling the vessel is made of a series of clay coils linked together. The starting point is usually a flattened pad of clay. The coils are rolled out on a flat board and gradually built up, winding around continuously. Irregularities are scraped away later using a flattened tool. The joints between the different coils can still be distinguished in the finished product.

**Moulding Technique:**

The clay is pressed into moulds made of adsorbent material such as low-fired unglazed clay or wood. In the Iron Age, the lower part of the pot was sometimes made by this technique. The upper part was then made by the 'thrown' technique (see below). The join between the two parts can still be seen in the finished product. These pots are regular in shape with rather thin walls.

**Throwing Clay:**

Throwing clay involves centring a ball of clay on a rotating turntable or wheel and then by applying firm pressure with both hands, pulling up the walls of the vessel, aided by the centrifugal force. It is easy to recognize pots made through this technique as very typical circular traces (striations) are present on the inner surface of the pot in particular. Slides of the tool used to detach the pot from the wheel are also present on the bottom of the vessel. Many other prints are often visible on pottery, including fingerprints and brush marks to name but two.

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**Decoration:**

Different kinds of decoration can be added while the clay is still plastic, such as, incision, carving, or impressing the surface using combs, shells, textiles, or other tools:

- clay shapes may also be moulded and then applied to the surface.
- a slip (a coat of different colour made from diluted fluid clay) can be used to cover a semi-dry pot and add a gloss to the pot (not a glaze).
- the clay particles on the surface of the vessel can be aligned and compacted down mechanically by burnishing when the pot is leather-hard to give it a lustrous finish and an increased impermeability after firing.
- pigments may be added to this layer in the form of graphite or haematite, for example, to give it a black or black/red finish.

**DRYING AND FIRING**

It is important that most of the water content of the clay has evaporated prior to firing otherwise steam trapped in the pores of the body may blow the pot apart. Once heated above a certain temperature, clay particles begin to soften and fuse together, forming a durable, hard material. Depending on the temperature to which the clay is subjected, fired pottery can exhibit a wide range of porosity and hardness. The higher the temperature at which clay is fired, the harder and less porous the pottery will be. Below 1000 °C, only a slight fusing will take place.

Common archaeological pottery, usually made from impure clays and baked between 600-950 °C, produces a porous, light ware. The pots often have different colours ranging from grey to red-brown and dark-brown. Such pots were often used for cooking purposes. Other archaeological, unglazed pottery generally falls within the range of terracotta and earthenware (fired at 1000 - 1200 °C).
As a result of differences in composition and hardness, pottery will react differently to various burial conditions. On the whole, well-fired pottery will survive burial in all types of soil quite well. If the pottery contains a calcareous temper, however, and it has been buried in acidic soil, it may be found in a weakened condition. Inadequate firing will also leave pottery soft and porous, especially if it is damp. If the ground is saline, the pottery can also be weakened by the activity of soluble salts.

**PROPERTIES OF CERAMIC MATERIAL: POROSITY**

Porosity is related to the temperature at which a ceramic object has been fired. The most porous bodies are those which have been fired at a temperature only slightly above that at which the ceramic change occurs (600°C). Porosity decreases with higher temperatures as the spaces between the clay particles shrink and become filled by fluxed silica and feldspars. Bodies fired to the point at which all the spaces have been filled, such as porcelain, are practically non-porous. The porosity of earthenware objects can be compensated by a glaze coating, but if this coat becomes cracked or chipped, moisture can infiltrate the body of the vessel. The more porosity the pottery has the more it will be subject to deterioration.

**PHYSICAL DETERIORATION**

Owing to their fragility, mechanical damage is the most common cause of irreversible deterioration of ceramic objects. It most commonly results from careless handling and packing but may also be the result of major disasters, such as, war, vandalism, frost, drying following the absorption of soluble salts or injudicious treatment during conservation. Such damage includes minor surface abrasions, cracks, chips and breaks, glaze exfoliation and in some cases, complete fragmentation of the body.

**Manufacturing Defects:**

There are a number of different types and causes of manufacturing defects, the majority of which, however, relate either to a poorly formulated body, poor design and construction, careless and inappropriate firing (i.e. cracks and breaks), and flaking, peeling and crazing of glazes.

**Impact Damage:**

Even in the museum environment damage of this sort can occur during handling, packing and storage. Major disasters such as fire, flood, earth-
quake and explosions can result in cracking, chipping and breakage to cer­
amic objects. During conservation, impact damage can be the result of ex­
tensive force or lack of care in the use of tools to remove mortars and plaster. Careless treatment when removing objects from archaeological sites can also result in mechanical damage, not only directly but also indi­
rectly, for example, where dirt or deposits are allowed to dry and shrink.

**Abrasion:**

Abrasion can occur from the soil or abrasive papers during restoration.

**Damage Caused by Soluble Salts:**

One of the most damaging factors, in so far as porous pottery is con­
cerned, is that of water soluble salts once they have been absorbed by the body of the wares and especially salts that tend to deliquesce at high relative humidity (HR) and then re-crystallize. During this process the newly forming crystals occupy a greater volume than the salt solution and exert enormous pressure on the fabric of the pottery. These may be sufficient either to cause the surface to flake off or to effect a disintegration of the body. The speed at which the crystallization occurs will be a factor in the severity of the damage that results.

Soluble salts most commonly associated with this type of deteriora­
tion are chlorides, nitrates and phosphates. The problem may be caused by absorption of salts not only from the soil but also from food or chemi­
cals with which a vessel has been in contact. For example, vessels used to preserve foodstuffs in salt or cooking pots may have absorbed salts during the process of food preparation. The real damage is done by salt infestation when a deliquescing salt re-crystallizes.

It follows then that the least damage will occur if the pottery is maintained in such an environment that the salts contained there are kept either permanently damp or permanently dry. The worst possible case scenario is a state in which the vessel is undergo­ing frequent and violent changes of humidity, such as being placed in a room that is excessively heated and cooled cyclically.

Several types of conservation treatment can introduce soluble salts into a porous ceramic body. These include the use of acids to remove some soluble salts or alkalis for the removal of grease or wax. Such treat­
ments must be followed by very thorough soaking in distilled water.
A further treatment in this category which should be avoided at all costs is the use of chloride bleaches to remove stains. Chloride ions remaining in the body may form salts. The use of Plaster of Paris can introduce sulphate contamination if the edges to which it is applied are not sealed and soaking objects with old plaster restoration in water is also a danger in this respect.

**Frost Damage:**

Another circumstance under which porous bodied wares are put at risk is when they are subjected to frost. When water adsorbed in a porous body freezes, it exerts an enormous pressure on the fabric of the pottery. The cause of damage is due to the formation of ice within the pores of the pottery and the usual effect is to cause the surface, especially if glazed, to spall or splinter away from the body.

**DIRT AND STAINING**

There may be deposits on the surface of the ceramic or, where the nature of the ware allows, intrusions deeper into the interstices of the body of the vessel. These may have arisen from usage, burial, fire, flood, or careless conservation treatments. Burial itself can result in a range of different types of staining and encrustations depending on the circumstances and environment of the burial. Again, earthenware, being porous, is more prone to staining and such invasive encrustation.

**Food Stains:**

Food stains result from food stuffs seeping through fractures in the glaze or being absorbed into a porous body.

**Encrustations:**

Ceramics recovered from archaeological sites may have become covered by concretions which are impossible to remove simply by the process of washing or light scrubbing. These concretions are usually white in appearance but they may have become stained by other materials in the deposit such as iron compounds that will produce an ochreous stain. Generally speaking such concretions will be one of three chemical types: calcite (calcium carbonate), gypsum (hydrated calcium sulphate), and silica. However, a concretion may be composed of varying proportions of any two or three of these compounds.

In the case of vitreous or glazed wares the concretion will form only on the surface of the pottery, but if the pottery is porous the chances are that the deposition will also be found in the interstices of the pottery where its removal may be difficult or even impossible. The removal of
silicate deposits can be even more problematic but is fortunately rather rare in temperate climates, though much more likely in a tropical climate.

The crystallization of carbonates, sulphates and silicates is much slower than the crystallization of the more soluble salts and is unlikely to cause any break up of the fabric of the object.

**Mould Growth:**

Where the humidity is particularly high problems with mould growth can occur on unglazed wares. The spores of moulds are normally present in the atmosphere and where there is any organic residue (including such resins as polyvinyl acetate emulsion) they will start to grow when the humidity reaches a certain level.

**Conservation Material:**

Injudicious use of materials during conservation can be the cause of unnecessary stains to ceramic objects. Some instances are as follows:

- adhesive smeared on either side of a joint
- filling materials spread onto the sound surface surrounding an area of loss
- masking tape discolouring the pottery
- injudicious marking methods can also be a cause of staining

**CHEMICAL DETERIORATION**

Ceramic bodies fired at high temperatures normally have good resistance to chemical attack. Major chemical deterioration is generally found only in those ceramics that have been subjected to extreme conditions, such as, burial in a wet environment particularly highly acid or alkaline, fire, and exposure to sequestering agents or strong acids or alkalis.

**Water:**

Ceramics that are low-fired (e.g.: 600 degrees Celsius) will re-hydrate if subjected to wet conditions. Consequently, objects of this nature can dissolve or deform badly in wet burial conditions. Higher-fired earthenwares may contain mineral particles as body fillers, some of which may be soluble in water. Gypsum and calcite may both dissolve in water if ceramics are allowed to remain in wet environments.
**Acid-Attack:**

When groundwater in contact with a buried ceramic is of an acid nature, any calcareous body fillers will be attacked and will wash away, leaving the object with a porous appearance. Certain glazes will deteriorate in a similar way to glass in acid conditions. Some conservation treatments, such as, the removal of iron stains or calcite, may involve the use of strong acids which can attack calcareous body fillers in the same way.

**Alkaline-Attack:**

Burial in alkaline conditions is more likely to effect the glaze of the ceramic than the body.

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The Conservation of Archaeological Ceramics

CONSERVATION AND RESTORATION TREATMENTS

EXAMINATION

Before starting any treatment the restorer has to examine the object in order to understand the extent and causes of any deterioration, as well as determine the nature of the ceramic body and glaze. Such information will play an important role in deciding if conservation is necessary and in selecting the most appropriate treatment method for the object.

The early stage of any conservation methodology generally involves an examination of the object with the naked eye. As well as assessing the condition of the object and the extent and causes of any deterioration or previous restoration, some observation concerning the colour, texture, density, hardness and porosity must be performed. These qualities relate to the nature of the raw materials used in the body and glazes, the firing temperature, and the method of fabrication. All these characteristics will interact and have implications in the treatment of the object.

A further visual examination can be followed with a hand lens and a binocular microscope. A sharp instrument such as a needle or a scalpel can be used to probe the surface and the body cautiously to determine the qualities of the body and to identify the fillers used in the paste (e.g. calcite, quartz etc.). The conclusion drawn from such observations will have implications in the choice of conservation treatment to be used.

RECORDING CARDS

When any conservation treatment is undertaken, it is imperative to make detailed and accurate records of everything done to the object. The treatment record cards should include three main sections. Firstly, a section has to be devoted to the descriptive information relating to the object. Secondly,

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part of the card should include a space for details about the condition of the object before treatment. The last section should be for detailing the treatment stages, mentioning the processes involved and the materials used, including the full trade name and grade, the solvents used and in what concentrations.

Finally, it may be necessary to mention points particularly relevant to display and storage. It should also include drawings and photographs of the object before and after restoration.

CLEANING

Removal of Soil and Dust:

Cleaning of adhering soil is an issue mainly concerning shards coming from excavations. Unfortunately, much pottery is bonded while it is still dirty and needs to be restored again. Undoing the restoration, the conservator has to carefully clean the shards, especially the broken edges.

Shards from excavations are covered by a layer of soil that hides the paste of the ceramic, the decoration and its state of conservation (presence of salts, shrinkage, chips and breaks). Cleaning is absolutely necessary and has to be done preferably before adhering soils begin to harden and shrink. When the soil is still wet it dissolves more easily in water.

However, it is important to distinguish the robust, well-fired, glazed ceramics that do not generally present problems and the friable pottery with fugitive paint, or poorly glazed surfaces and unbaked clay.

A test should always be performed on the shards to make sure that immersion in water and the drying process does not harm the fabric before using any aqueous cleaning methods.

Robust Well-Fired Ceramics:

Water and gentle brushing is normally the best cleaning method for robust ceramics without paint. The shards can be immersed in water and the dirt can be removed by the use of a soft brush without scrubbing too vigorously because the surfaces and edges can be easily abraded, making for bad joins later on. The water should be changed frequently because the dirty water itself can be very abrasive. The shards can be submerged in warm water to which a few drops of non-ionic detergent can be added. Ceramic objects should never be plunged into hot water as the differentials in thermal expansion of the body, glaze and decoration may result in damage. If the dirt is persistent, it may be left to soak for a few minutes before brushing to allow better penetration of the dirt by the water. Objects should be washed singly, never more than one in a sink. After washing, the objects should be thoroughly rinsed in fresh water and then placed on a tray with paper towels. A hair dryer may be used to speed up the drying process.
**Friable, Fragile and Poorly-Fired Ceramics:**

Low-fired pottery, unbaked clay, poorly glazed surfaces, pottery with fugitive paint and unfired decoration should not be cleaned using aqueous methods but can be cleaned using mechanical methods and alternative solvents. A soft brush or swab sticks can be used if the soil is still wet. If the soil is dry, swabbing with alcohol or a mixture of water/alcohol must be chosen. The cotton wool is wrapped around the end of a swab stick, dipped in the water or alcohol and then rolled across the surface of the object. A rolling action is used rather than a wiping one and the swabs are kept damp rather than wet so that the dirt is picked up off the surface rather than being pushed into any surface irregularities, cracks or chips. The swabs should be changed very frequently and the process repeated. Cleaning of ceramics with fugitive paint or pigment must be undertaken under a microscope. It might also be necessary to consolidate the paint during the cleaning.

**Dust:**

Some pottery in museums or storage might be very dusty. As dust is a good environment for insects, it is advisable that it be cleaned regularly. If the dust is not greasy, cleaning can be carried out using a brush, dry cotton-wool swabs or a soft cloth. Water can also be used if the pottery can resist immersion. The use of ethanol which is also suitable for fragile shards should be considered first.

**Removal of Encrustations of Insoluble Salts:**

These encrustations can be removed either mechanically, chemically or a combination of both. Mechanical cleaning can be done by picking, cutting or abrading the encrustations with tools, such as, needles, sharp scalpels or dental drills. There is a danger in the use of all these techniques of causing damage to the object in the form of scratches, cracking or breaking the object if too much pressure is applied in an inappropriate direction. This type of cleaning should be done under a microscope. It is also possible to consolidate the pottery before starting mechanical cleaning.

The encrustation can also be softened or removed by chemicals. Encrustations of calcium carbonate or calcium sulphate can be removed by using acids. Acid cleaning is a very harsh treatment on even the strongest pottery, so it should be used only when absolutely necessary. The most commonly used acids for this purpose are hydrochloric acid, nitric acid and acetic acid.

Concretions of silicates which may also be found can only be removed using hydrofluoric acid, but the use of this acid is extremely hazardous for both the object and the conservator and should be avoided where possible. In any case acid can be extremely dangerous when
handled by inexperienced people and should not be used carelessly.  

Shards with painted decoration or friable surfaces and objects made of unbaked clay with fugitive paint or consolidated pottery should not be subjected to acid cleaning. There is a danger when using acids on pottery if it contains calcium compounds such as chalk or ground shell in its fabrics because these will be attacked. Any pottery with a calcareous temper will be drastically weakened and may disintegrate because acid will attack and dissolve the temper. The ceramic must therefore always be tested before treatment and this can be done by applying a small drop of diluted acid to an insignificant shard or on a sample removed mechanically. If effervescence is observed, there is a form of calcareous filler present. Acid should not be used on glazed pottery either because they often contain iron oxides which are dissolved in the glaze.

The acid bath should be diluted, not exceeding 5%. After testing a shard and finding that acid does not harm the fabric, the shards must be soaked in water for a minimum of one hour to wet the fabric thoroughly. It is necessary to tap or shake the container frequently to release any air bubbles clinging to the pottery to ensure uniform wetting. This soaking prevents the acid from being pulled deep into the fabric of the pottery. When it is thoroughly wet, the pottery must be immersed in diluted hydrochloric or nitric acid until the encrustation has been dissolved or loosened sufficiently to allow it to be removed mechanically. The pottery must be checked frequently while it is in the acid. If it shows any signs of deterioration, it should be removed immediately and rinsed thoroughly in water. The pottery should not stay in acid any longer than is absolutely necessary to remove the encrustation—generally five to ten minutes is enough. It is better to immerse the pottery several times for short periods after mechanically removing loosened dirt and encrustation than to keep it immersed for a long period. Acid can also be applied with cotton wool swabs or applied to the concretion drop by drop. The latter method is preferable as it is more controllable and may be used in the case of a ceramic with calcareous filler if necessary. In such cases, the object is rinsed in running water after the application of each drop of acid.

After treatment the softened concretion is removed using a scalpel and the object must be soaked thoroughly in several changes of water, preferably distilled water, until a neutral pH is reached. This rinsing also removes the soluble salts produced when insoluble salts are dissolved by an acid. Thorough rinsing is extremely important as soluble salts left in the body of the ceramic are potentially far more damaging than insoluble concretions.

**Removal of Soluble Salts:**

Soluble salts commonly found in contaminated ceramics include chlorides, nitrates and phosphates. These salts, when allowed to dry, will crystallize

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6 Appendix II
in the pores of the ceramic or under the glaze. The crystallization will always cause some degree of damage, ranging from exfoliation to complete disintegration of the body. It must be stressed that it is the re-crystallization that causes the damage, not the presence of salts in solution, and for this reason wet excavated pottery must always be tested for salt contamination before drying. If the pottery is dry and contaminated by salts, it might be held together by salt crystal. In this case consolidation will have to be carried out before the salts can be removed.

Removal of salts from within the fabric of an object is usually made by diffusion into wash water. There are several methods used, the main ones being; washing in still water, agitation-dispersion, extraction, and using packs. The method used will depend on the type of ceramic and its condition.

**Washing in Still-Water:**

This method is only suitable if the object is in good condition. As the method involves a long period of soaking in water, it is not suitable for unfired or very low-fired objects. Normal tap water can be used unless it is heavily contaminated. However, it is better to use de-ionized or distilled water for the final rinses.

The object is placed in a clean container and water is added very slowly, allowing time for air in the body to escape gently. If the water is poured in too fast damage can be done through the pressure of air escaping rapidly. The object is then left to soak so that the soluble salts diffuse out of the body into the surrounding water. The water should be changed regularly every day. The salt content should be monitored regularly until it reaches an acceptable level. The use of elevated temperatures improves the effectiveness of the salt removal. The disadvantage of this method is that the salts diffuse relatively slowly through the water.

**Washing in Flowing Water:**

This method employs water running through a sink or bath and hence the object is being continually washed with fresh water. This method is not suitable for objects with any significant degree of deterioration and is very wasteful of water.

**Agitation-Dispersion:**

This method employs apparatus that gently agitates the washing water with the result that there is no build-up of salts in the water immediately surrounding the object, thus facilitating their extraction. This method can be used only on robust ceramics.
**Pack Removal:**

Paper pulp, laponite or sepiolite packs can be used for desalination. Paper pulp is prepared by tearing acid-free blotting paper into pieces about 1 cm square and adding them to a small quantity of de-ionized water or other solvent in a beaker. They are left overnight and stirred to a paste-like consistency in the morning. They are then spread on the surface of the object. The object must be coated all over. The pack is changed when partially dry and the salt content tested with a conductivity meter by soaking a sample in de-ionized or distilled water. Their effect is much slower than the soaking methods as less water is employed. This method can also be dangerous for fugitive paint.

If an object has severely deteriorated, it may be advisable to consolidate the object first and then use one of the above soaking methods. In the case of low-fired ceramics, unbaked clay or pottery with fugitive paint, the salt crystals on the surface should be brushed away and the objects should be stored in stable conditions of humidity.

**ASSEMBLY**

A trial run of a planned re-assembly must be made prior to bonding by fitting the pieces together without adhesive, using masking tape placed perpendicularly to the break. Assembly should preferably be done starting with the base or the rim of the object and building it up from there. The shards must be placed perfectly from the beginning. The slightest misalignment will cause a considerable one to emerge in the final product. Correct location of the shards can be checked by running the tip of a fingernail at right angles back and forth across the joint. It will catch if one edge is proud in relation to the other.

Strips of masking tape should be cut to an appropriate size. They must be positioned at intervals along the back and the front of the break-edge opposing each other. They must not be so long that they cross more than one break and should not cross each other, thus more easily allowing...
corrections to the alignment. Masking tape must not remain on the ceramic for a long period of time because their adhesives stain the fabric of the pottery and become insoluble in time.

The trial reconstruction with masking tape is extremely important and has to be well performed. It allows one to visualize the place of the different shards and to establish an order of joining to make sure that no shard will be locked out. It also gives one an idea of the quality of the alignment that can be achieved. Accurate reconstruction can only be achieved if the broken edges are completely free from soil or salt encrustation.

**BONDING**

Prior to bonding, the broken edges must be coated with a thin layer (especially on porous ceramic) of acrylic resin (Paraloid B-72® at 20% w/v in acetone⁷) to avoid the adhesive used for bonding penetrating deep into the ceramic body.

The most commonly used adhesive in conservation and restoration of archaeological ceramics are acrylic resins. These adhesives are commercialised in droplets which dissolve in acetone. They are reversible, have a good long-term durability, are resistant to high temperature, humidity, light and to biological attack.

The adhesive used for bonding is a solution of Paraloid B-44 at 40% w/v in acetone. This adhesive is particularly well adapted in countries where high temperatures are experienced like Afghanistan, because it has a high glass transition temperature (60°C). The glass transition temperature (temperature above which the adhesive becomes liquid) of Paraloid B-72 is lower (40°C) and is therefore less suitable in this case.

The adhesive must be applied to only one half of the break in a thin coating to avoid the misalignment of pieces, and then the two halves are brought together. When a satisfactory alignment has been achieved, the pieces are pressed firmly together. Strips of masking tape are then positioned across the joins to maintain the shards in their position while the adhesive dries out. The shards can be placed in a sand tray, gravity helping to hold the shard in place until the join is finally dry.

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⁷ Appendix III
Errors can be rectified by dissolving the join using a syringe to inject the solvent into it (see Figure 5). If the joins are not fresh, it is possible to soften them by using cotton wool and acetone on the joins and covering them with aluminium foil in order to avoid the solvent evaporating.\(^8\)

The remaining adhesive on the broken edges must then be removed. Excess adhesive can be removed with a swab of acetone but only when the joints are completely dry.

**GAP-FILLING**

Replacement of lost material is done with Plaster of Paris. Dental wax sheets are used as supports for fillings. Enough wax must be used to ensure that the support will overlap the intact area adequately on either side of the damaged area. The dental wax sheet is then softened by gently heating with a hot air blower and then placed over an intact area of the ceramic that corresponds to the missing area in order to mould it. It is then allowed to cool in position and is removed, carefully wiped dry and repositioned over the damaged area. The support is then taped in place using masking tape.

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\(^8\) For further details see chapter V concerning the removal of previous restoration materials.
Broken edges of ceramics, especially porous body ceramics, must be sealed before the application of Plaster of Paris with a lacquer of Paraloid B-72 at 20% w/v in acetone to avoid the possibility of contamination of the ceramic with soluble salts coming from the plaster and to improve reversibility.

It is also important to seal the surface surrounding the loss with masking tape or latex before applying the Plaster of Paris, especially if the surface is unglazed or porous, in order to avoid filling material lodging in it and causing ‘ghosting’.

The plaster is prepared in a flexible bowl: 1/3 is filled with water to which plaster powder is added little by little until there is no water left on the surface. The plaster should not be mixed so as to avoid forming bubbles of air. When it is ready, it should be poured or applied onto the support using a spatula. Care must be taken to avoid forming air pockets in the bottom of the cavities. After ten minutes excess filling can be cut away with a scalpel. Once the plaster has completely cured the masking tape securing the support is carefully removed and then the support itself.

---

*Figure 10 & 11: the surface is sealed with masking tape or a thin layer of latex*

*Figure 12: the plaster is carefully poured into the lost area*

*Figure 13: excess plaster is cut away with a scalpel or other tool*

---

9 Handle 4 and blade 24 are the most appropriate.
Scalpels and rifflers are then used to make the joint with the original ceramic smooth and to lower the level of the filling to ½ mm below the surface of the original ceramic in order to make the restoration clearly distinguishable.

Abrasive papers of different types and grades cut into small strips are then used to even out any irregularities. Great care must be taken not to continue the abrasive action into the original ceramic surface causing damage. If a further application of plaster is necessary, additions must be made after the first application has cured. The cured plaster should first be wetted in the area in which the addition is to be made.

Incised decoration can be added to fresh plaster. Shapes can be made on cured plaster with a filling containing some glue. If the surface is irregular or if paint does not adhere well on the plaster or filling then another layer of filling (Polyfilla®) without adhesive can be applied.

**COLOUR-MATCHING**

The plaster filling can be tinted with acrylic paints and pigments to match the original surface. However, as the area of the restoration must remain obvious, the general tone of the filling should be made to appear lighter than the background colour of the object.
First, a clear colour similar to the colour of the paste of the ceramic must be found and applied with the help of a sponge. Different tones are then added with a toothbrush. Each layer must be allowed to dry before applying the next one. If the colour matching has to be done again, the removal of the over-paint can be done with cotton swabs and acetone and/or abrasive paper. The tendency of acrylic paint to alter tone upon drying should also be kept in mind.

![Figure 17: a first layer of colour is applied with a sponge](image1)

![Figure 18: each layer is dried out](image2)

**MARKING**

The register number of the object should preferably be placed on the base of the object. Decorated and painted areas must be avoided and equally so, any surface that is flaking or heavily encrusted with dirt or other encrustations.

Before marking, the area to be marked must be thoroughly cleaned and dried. It is possible to use a swab with ethanol to make sure that all the dirt has been removed. A strip of the area to be marked must be coated with a layer of 10% Paraloid B-72. The size of the strip should be commensurate with the quantity and size of the markings. When the lacquer is completely dry, the number must be written on the lacquer with Indian ink. No pressure should be applied when writing the number so as to avoid scratching or penetrating through the sealing layer and damaging the ceramic. When the ink has dried another layer of lacquer is applied on top of the number. If an object is particularly dark in colour, then it can be helpful to use white ink.

************
PREVENTATIVE CONSERVATION\textsuperscript{10}

Ceramics are probably one of the most stable groups of artefacts and for the majority of them there is no need to maintain specific environmental parameters. The most common form of damage to ceramics occurs as a result of mechanical shock upon impact caused by direct or indirect human intervention. Nevertheless, certain objects that have been restored, and those contaminated by salts, should be considered separately and may need to be stored in cases that can be environmentally controlled.

ENVIRONMENTAL REQUIREMENTS FOR CERAMICS

Fluctuation in relative humidity can affect ceramics that contain soluble salts. During cycles of salt crystallisation (low HR) and dissolution (high HR) in conditions of fluctuating relative humidity, the salts will exert physical pressure against the surface of the object, eventually resulting in the complete loss of the surface. Such objects will require stable relative humidity to avoid this type of damage. Old plaster filling can also be sensitive to high humidity. Water soluble adhesives will weaken in high humidity making for bad joins. Fungi, mould and most insects tend to develop if the HR is exceeding 65%. High temperatures can also accelerate the breakdown of joins.

The ideal environmental requirement for restored ceramics, especially for salt contaminated ceramics, would be a storage room with a stable HR around 50\% and a temperature held within the range of 18-25 degrees Celsius. The contaminated ceramics can be placed in hermetic polyethylene bags with some silica gel to maintain a relative humidity within 40-65\%.

STORAGE

Ideally, the store should be dust free. A regular cleaning regime of the floor areas should be established to avoid build-up of dust and dirt. The shelves for storing ceramics should be strong, stable and secure. A thin sheet of high-density polyethylene foam cut to exactly fit the shelf size will guard against the possibility of chipping the base of the ceramic on the hard shelf material.

Objects with irregular bases that may not sit safely on such a surface should be laid down on their side and supported with cushioning, if necessary. Small objects should be stored towards the front of the shelf with larger pieces towards the back. Stacking flat objects such as plates should be avoided, as this will introduce stresses, increasing the possibility of accidents. If the space is very limited, each object must be separated from the one above it using layers of padding in the form of foam discs.

\textsuperscript{10} Buys, Susan & Victoria Oakley, 1993, Conservation and Restoration of Ceramics, Boston, Butterworth-Heinemann, pp.29-73.
When removing objects from shelves great care should be taken to avoid damage to adjacent objects.

**HANDLING CERAMICS**

Before handling objects the hands should first of all be cleaned. An examination of the object should be made prior to handling. Loose, movable parts should be noted and removed before handling. Old bonds should be examined to make sure they are still supporting the joins.

If the object is to be moved more than a few feet within the same building, it is safer to transport it in a padded basket or strong box with bubble wrap or polyethylene foam at the bottom. Each object should be spaced so that it does not touch any other. The object should be lifted with two hands. The weakest and most vulnerable parts of the ceramics are the protuberances, such as, knobs, handles, rims, and restored and damaged areas. Therefore, they should never be handled directly by these parts. Only one object should be lifted at a time and an object should never be lifted over another.

**********
REMOVAL OF PREVIOUS RESTORATION MATERIALS

REMOVAL OF ADHESIVES

Appropriate solvents, in liquid or vapour form, are used to soften and swell the adhesive and separate the joint. The remaining adhesive is removed using further solvent or mechanical methods by picking with a scalpel or needle, preferably under magnification.

The selection of the appropriate solvent for removal of an adhesive is based on the identification of the adhesive. Recorded treatment, colour, hardness and other physical properties, together with their solubility in a range of solvents, will enable identification of most adhesives.

To soften the adhesive, the solvent, in the form of a liquid or a vapour, must be in contact with the adhesive for some time. Small objects may be completely submerged in a solvent. Solvent may be applied to larger objects with cotton wool placed on the joints and covered with aluminium foil. Solvent can also be applied with a syringe.

There are several precautions that should be observed in order to avoid causing damage when removing old adhesives, especially from low-fired ceramics. If the object is low-fired or if there is unfired decoration on the object, spot tests should always be done to ensure that the solvent used will not cause any damage. If the object is sufficiently large or delicate and collapse or damage will occur if the bonds are not supported, then support must be considered and provided. Only gentle pressure should be applied to the joins to try to part them, as stronger pressure, applied before the adhesive has softened sufficiently, will damage the edge.

Cellulose Nitrate Adhesives (UHU Hart®) and Acrylic Resins (Paraloid®):

Cellulose nitrate adhesives range in colour from white to light yellow as they age. They are, together with acrylic resins, soluble in acetone. If unfired decoration is present this should be tested before application of the solvent. Cellulose nitrate adhesive and acrylic resins are sensitive to heat. For this reason, heating the joints in hot water may cause them to part. After the joints have parted the remaining adhesive can either be removed mechanically or using a solvent.

Polyvinyl Acetate (e.g. PVA®):

Polyvinyl acetates will generally appear white, clear or slightly brown in colour. They may be slightly rubbery or slightly brittle, depending on the age and original plasticity. Their solubility will depend on their composition and their age: warm water or acetones are often effective solvents. An ethanol and water mixture may also be effective.

REMOVAL OF PLASTER

Plaster is the most commonly found filling material. It can be softened to a certain degree by water and then removed mechanically with a hammer and a chisel. It must be stressed that soaking a pot in water is very harmful to the fabric, especially in the case of low-fired and porous ceramics because there is also a danger of soluble salts being drawn from the plaster into the body of the ceramic. If the edges of the shards have been isolated by a layer of lacquer it is possible to humidify the filling without any danger.

REMOVAL OF OVER-PAINT

If the nature of over-paint has not been recorded, a test will have to be made using different solvents on cotton wool swabs. Acrylic paint can be removed using acetone applied on cotton wool swabs. A rolling action is used rather than a wiping one, so that the paint is lifted up off the surface rather than pushed into it.
FIELD CONSERVATION

CONSOLIDATION

If the pottery is found in a fragile condition it must be consolidated before it can be safely lifted from the ground. To consolidate a shard or a pot carefully use a brush to clean off the surface to which the consolidant will be applied. Make sure the surface is not scratched or abraded in the process. Use only wooden tools or brushes--metal tools can easily scratch and abrade pottery. Remove as much of the surrounding dirt as is possible to prevent large lumps of dirt from being consolidated to the sides of the object. Using a brush apply the consolidant to the pottery, allowing it to soak in. Continue applying consolidant sparingly until it is no longer adsorbed by the pottery.

In general it is more effective to apply several thin coats of consolidant rather than a single heavy coat. It is important, especially with emulsion, to allow the consolidant to dry after each coat. There should never be a thick, glossy layer of consolidant on the pottery surface. Allow the consolidant to dry thoroughly before attempting to lift the pottery. Any material still wet with consolidant is more fragile than it was before the consolidant was applied. Do not consolidate any shards to be used for analysis because the sample will be contaminated.

If the material to be consolidated is dry, a solution of Paraloid B-72® in acetone can be used. Start with a low 3% to 4% p/v concentration for the first few applications and then increase the concentration to 7% to 10% p/v.

In hot, arid climates, acetone may be too volatile to be used effectively as a solvent because it can evaporate before the consolidant has a chance to penetrate. Under these conditions, toluene is a better choice of solvent because it is less volatile. Ethanol might also be a better choice and it may be necessary to carry out the consolidation process at a time when the temperature is as cool as possible, for example, in the early morning. Loosely covering the object with a piece of aluminium foil after applying the consolidant will also help to slow down the evaporation rate of the solvent. If the pottery is damp, a PVA emulsion diluted at a ratio of 1 to 4 with water should be used.

While the consolidant is drying, try to keep the area around the object as dust-free as is possible. Windy days should be avoided because dust or sand will be blown onto the consolidated surface. A piece of aluminium foil sitting lightly on top of the consolidated object can exclude dust, or alternatively, a box can be placed over the object.

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LIFTING METHODS

Before lifting carefully loosen the surrounding dirt, especially if it is hard and dry. Drops of water or alcohol can be applied on the surrounding soil to soften the dirt and facilitate lifting. However, do not moisten the object when doing this. Always remember that freshly uncovered pottery, especially low-fired pottery, can be very soft and friable while still damp.

Do not pull complete pots out of the ground before undercutting the pot, to make it completely free of the surrounding soil. Then, gently lift it out of the ground, cradling it in both hands. Place it in a well-padded, rigid container. It can also be placed in a bucket filled with sand.

If a pot is intact but has major cracks or breaks, it can be lifted out whole if it is wrapped first firmly with strips of gauze bandage. This procedure can also be helpful for lifting a broken pot when the shards are still held in place by dirt inside the pot. If simple bandaging does not afford sufficient support, a more rigid support can be achieved by further wrapping the pot with plaster bandage. A separating layer of foil or plastic film should be applied first to prevent the surface of the object from absorbing any plaster. Be sure to allow the plaster to dry thoroughly before lifting the object. If ready-made plaster bandage is not available, it can be easily made by mixing a watery Plaster of Paris solution into which strips of gauze bandage are dipped. Remove excess plaster by drawing the strip of bandage lightly through the fingers. If plaster is not available, the same method can be employed using undiluted PVA emulsion.

When pottery comes out of the ground, avoid the temptation to clean it by scraping, brushing, rubbing, or immersing in water. It is very easy to remove delicate decoration and paint in this way and to scratch or abrade the surface.

Do not lift a shard or a pot 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 shard when it is lifted.

When an object is found in pieces, make sure that all the pieces, including the smallest, are lifted and kept together. When a large concentration of shards 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 the shards found in the same deposit.

The content of any vessel should be carefully excavated, and possibly a portion of it set aside as a sample. Intact vessels can contain the remains of their original contents and be extremely valuable in archaeological analyses.

A NOTE ON SAFETY

It must be stressed that no chemical treatment, including acid handling, should be performed without the supervision of an experienced conservator—restorer, and nor without the appropriate clothing, as it can be a
dangerous exercise not only for the objects themselves, but also for the operator.

**CONCLUSION**

This booklet aims to provide a reference guide to the staff who participated in the training course in the National Museum of Afghanistan during 2004/05. The restoration work performed by trainees during the three month course enabled them to demonstrate their ability to provide a basic treatment and restoration of archaeological ceramics. It is hoped that such additional opportunities for the trainees and other staff involved in the conservation of artefacts in the museums of Afghanistan will emerge in order for them to refine and update their skills further.
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APPENDIX I

NATIONAL MUSEUM OF AFGHANISTAN
RESTORATION DEPARTMENT

TREATMENT REPORT
# APPENDIX I: TREATMENT REPORT

## Treatment Report

### 1- Identification and Description of the Object:

#### A- Object Designation

![Photograph before Conservation](image-url)

#### B- Material:

- Ceramic, Glass, Metal, Stone, else:

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Diam.</th>
<th>Arfaq.</th>
<th>عرض.</th>
<th>طول.</th>
<th>ل.</th>
<th>وزن.</th>
<th>حوزه باستانی</th>
<th>شماره تسجيل</th>
<th>Accession No.</th>
<th>اثر</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>رقم</th>
<th>اسم</th>
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</thead>
</table>

### 1- گزارش وقایع اثر

غیره ترمیم، وقایه و یا کاری اثر

#### A- معین نام اثر

<table>
<thead>
<tr>
<th>رقم</th>
<th>اسم</th>
</tr>
</thead>
</table>
### APPENDIX I: TREATMENT REPORT

<table>
<thead>
<tr>
<th>C- Archaeological Context:</th>
</tr>
</thead>
<tbody>
<tr>
<td>D- Description: (different parts)</td>
</tr>
<tr>
<td>E- Materials and Technology: (Framing Processes, Decoration)</td>
</tr>
</tbody>
</table>

### 2- Assessment of the Conservation of the Object:

**الف- تحليل situación AR (التجزئة وتحليل تحفتي أثر تحت لابتاور).**

**A- Description of the deterioration (detail the different kinds of deterioration, their extent, identify them with a sketch if necessary, identify previous restoration).**

**B- Analysis Observation (observation under magnification)**
3- Causes of Deterioration

What are the causes of the deterioration of the object? What might happen in the future if nothing is done?

4- Objectives of the Conservation and Restoration: Treatment Project

<table>
<thead>
<tr>
<th>A- Treatment asked:</th>
<th>الف- برای وقایع اثر بازه کسی مشورت شده است:</th>
</tr>
</thead>
<tbody>
<tr>
<td>B- Storage:</td>
<td>ب- درکام دنیا حفظ ونوگرداری میشود:</td>
</tr>
<tr>
<td>C- Objectives of the treatment:</td>
<td>ج- نکات قبلی توجه در زمان وقایع اثر:</td>
</tr>
<tr>
<td>D- Treatment Project:</td>
<td>د- پروسه وقایه اثر:</td>
</tr>
</tbody>
</table>

5- Conservation Treatments:

Indicate the type of treatment, the techniques used, the products used:
APPENDIX I: TREATMENT REPORT

6- State after Restoration

6- وضعیت اثر بعد از ترمیم

7- Object exhibited yet?

7- آیا اثر قبلا به نمایش گذاشته شده است؟

8- Can object be exhibited?

8- اثر فعلا قابلیت نمایش را دارد؟

9- Removal of the materials employed.

9- درصورت ضرورت برای چهار سازی دوباره، پارچه های اثرزیره موادی می‌توان استفاده کرد.

10- Other information about object:

10- سایر مطابعات و اطلاعات درمورد اثر:

11- Indication for the Maintenance:

11- نکاتی که باید در زمان نگهداری اثر دردیپویش آنها توجه شود:
APPENDIX II: SAFETY PRECAUTIONS WHEN HANDLING ACIDS

1- Always wear protective clothing; cotton blouse, chemical splash goggles, a dual cartridge respirator and thick rubber gloves when handling acid or shards in acid (see figure 1 below). Avoid getting acid on clothing or skin as serious burns can result.

2- When preparing an acid solution, always add the acid to the water; never add water to the concentrated acid. Large amounts of heat can be produced by adding water to acid which can cause the acid to sputter and spit. Add the acid slowly to the water, stirring continuously to dissipate any heat that may be generated.

3- If acid gets on clothing or skin, flush the area immediately with copious amounts of water. Rinse the area with a diluted solution of bicarbonate of soda. For safety reasons, acid should only be used in close proximity to a source of water.

4- Use acid only in well-ventilated areas. Be careful not to inhale the fumes which can cause serious and irreparable damage to the eyes, nose, throat, and lungs.

5- Clearly label all containers that hold acid solutions.

DISPOSAL OF ACID WASTE

Large quantities of acid should never be disposed of down the drain. For example, when you have small amounts of acid solution (less than a pint or a half a litre), it is possible to thoroughly dilute the acid by adding it to water and then to neutralize it by adding baking soda (sodium bicarbonate). The acid will be neutralized when it ceases to foam and effervescence. The liquid can then be flushed down the drain with copious amounts of water.

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APPENDIX III: MAKING UP SOLUTIONS

A solution is a liquid in which a solid has been homogeneously dissolved. When a liquid dissolves a solid, the liquid is referred to as the solvent, while the solid is called the solute.

- The concentration of a solution is expressed as the amount of solid per unit volume of solution. Thus, a 10% solution means that 10 g (weight) of a solid was dissolved in enough solvent to make 100 ml (volume) of solution: it should be written correctly as 10% weight/volume or w/v.

The simplest and easiest method for making up a solution of 5% p/v Paraloid B-72 in acetone, for example, is as follows:

**STEP 1-** Measure out 100 ml of acetone and place it in a glass jar.

**STEP 2-** Measure out 5 g of Paraloid B-72

**STEP 3-** Place the weighed out resin in the middle bundle of a small piece of gauze bandage. Pull the corners together and tie them securely with a long piece of string to form a small bundle. Suspend the bundle in the solvent, hanging the end of the string over the rim.

**STEP 4-** Put a magnet in the glass jar and place it on a stirring rod until all the resin has dissolved.

**STEP 5-** Write the nature of the solution on the jar, the solvent used and the concentration; Paraloid B-72, 5% w/v in acetone and the date it was made.

---

STEP 6- If the climate is very hot and dry the seal of the jar may be tight enough to prevent the slow evaporation of the solvent. As a result the solution will slowly get thicker. To help prevent this from happening, cover the mouth of the jar with a piece of polyethylene before screwing on the lid. The piece of polyethylene should be considerably larger than the mouth of the jar to ensure that a good seal is achieved.

Diluting a Solution:

To dilute a solution you must add more solvent. The amount needed is inversely proportional to the amount by which you wish to dilute the solution. Thus, if you want to halve the concentration, you must double the amount of solvent; i.e. to dilute the solution by one third, you must triple the amount of solvent. The following formula can be used to dilute a solution;

\[ V = V_a \left( \frac{C_a}{C_b} \right)^{-1} \]

To make from Solution A (of a Ca concentration and a volume Va) a Solution B (with a concentration of Cb) you should add a volume (V) of solvent.

Example:

You want to make from a solution of Paraloid B-72 in acetone a volume (Va = 99 ml), of a concentration (Ca = 16.5%), a solution of Paraloid B-72 in acetone of a concentration Cb = 10%. You must add a volume of acetone, \( V = 99 \cdot \frac{16.5}{10} - 1 \) = 64.35 ml.

Increasing Solution Concentrations:

To increase the concentration of an existing solution more resin must be added to it. The amount of resin needed is directly proportional to the amount by which you wish to increase the concentration. Thus, if you wish to double the concentration, double the amount of resin. For example, suppose you have a 10% solution that you wish to increase to 20%. You have 10g of resin in 100ml of solution. To double the concentration, double the amount of resin: add 10 more grams of resin to the already existing solution. This will give you 100 ml of a 20% solution.
APPENDIX IV: ADHESIVES

All the adhesives used in restoration must be reversible. It is dangerous and unethical to use other materials even where nothing else is available. There are three main types of adhesive that can be used in the restoration of ceramics:

**Cellulose Nitrate (UHU ®):**

Cellulose nitrate is a very convenient adhesive because it is sold in easy to use small tubes. It is soluble in acetone. However, it has a tendency to dry out over time and become brittle. It also tends to become yellow as it gets old and is highly flammable.

**Polyvinyl Acetate Emulsions (PVA®):**

Polyvinyl acetate emulsions are soluble in water. They are commonly used because they are available almost everywhere. The major disadvantage of PVA is its tendency to soften when it becomes hot (30°). It is not a suitable adhesive for use in very hot climates because joins made with it will sag and creep unless storage conditions can remain cool. It has also a tendency to change chemically over time, or cross link, which renders it less readily soluble. It will also turn yellow upon exposure to sunlight and as it gets older. It is thus the best adhesive to bond and consolidate damp objects.

**Acrylic Resins (Paraloid, Acryloid):**

Acrylic resins are the best type of adhesive to be used in restoration. They are colourless, durable, and chemically stable. They are soluble in acetone and toluene and are fully reversible. Paraloid B-72 is the most commonly used adhesive in restoration. It should be stressed, however, that it has a low glass transition temperature (40°C) and therefore is not suitable for hot climates. Paraloid B-44 is the most appropriate acrylic resin in such cases (Tg 60°C).

************
در این مقاله به برخی از انتقال‌های رایج در سیستم‌های نوری فیوزیک بررسی شد. انتقال‌هایی مانند الکترون انتقال شامل انتقال از مولکول به مولکول می‌باشد. این انتقال با در معماری نوعی تغییرات منحنی می‌باشد که باعث افزایش درریختگی نوری در آنها می‌شود. انتقال‌های الکترون انتقال شامل انتقال از مولکول به مولکول می‌باشد که باعث افزایش درریختگی نوری در آنها می‌شود. انتقال‌های الکترون انتقال شامل انتقال از مولکول به مولکول می‌باشد که باعث افزایش درریختگی نوری در آنها می‌شود. انتقال‌های الکترون انتقال شامل انتقال از مولکول به مولکول می‌باشد که باعث افزایش درریختگی نوری در آنها می‌شود. انتقال‌های الکترون انتقال شامل انتقال از مولکول به مولکول می‌باشد که باعث افزایش درریختگی نوری در آنها می‌شود. انتقال‌های الکترون انتقال شامل انتقال از مولکول به مولکول می‌باشد که باعث افزایش درریختگی نوری در آنها می‌شود. انتقال‌های الکترون انتقال شامل انتقال از مولکول به مولکول می‌باشد که باعث افزایش درریختگی نوری در آنها می‌شود. انتقال‌های الکترون انتقال شامل انتقال از مولکول به مولکول می‌باشد که باعث افزایش درریختگی نوری در آنها می‌شود.
برای رقیق کردن یک محلول، از مقدار بیشتری حلال استفاده می‌نماییم. توجه داشته باشیم که عمل رقیق کردن محلول با مقدار حلال نسبت عکس دارد به این صورت که افزایش مقدار حلال غلظت آن کم می‌گردد. بنابراین اگر شما خواهید علطم آن را به نصف تقسیم دهید، شما پاییز مقدار حلال را به دو پرتاب پرسا. برای رقیق کردن و رساندن به یک سوم شما باید مقدار محلول را به سه برابر افزایش دهید. دراین حالت فرمول زیلی می‌تواند به شرح می‌باشد:

\[ V = V_a ((C_a/C_b)-1) \]

اما فرمول اوردن یک محلول از نوع (V) از تراکم (C_b) و تبدیل کردن به نوع (V_a) حجم و حجم Ca و حجم B از تراکم A از حلال را به آن اضافه می‌نماییم.

مثال:

مقدار محلول دیگری Ca=16/5% با علت 72 ml، به نسبت اوردد از پراید B72 در استنی به حجم V=99 ml باید یک حجم Vاین حالت شما باید یک حجم از استنیون

\[ V = 99((16, 5/10)-1)=64,35 ml \]

افراش تراکم حجم حل شونده:

برای باز تراکم حجم حل شونده در یک حلال، مقدار بیشتری رزین با پایین محلول اضافه شود نهایتاً باشیم که مقدار بیشتری اضافه شده، نسبت مستقیم با تراکم محلول دارد. بنابراین اگر به خواهید غلظت یک محلول را دو پرتاب نمایم مقدار حلال شونده را به حداکثر یکم رسانیم. برای مثال فرض کنید: محلول 10% را به خواهید به محلول 20% تبدیل کنید. اگر به 10 گرم رزین محلول در 100 حلال باشیم: برای دو پرتاب کردن غلظت آن مقدار رزین را به دو پرتاب رسانیم: 10 گرم رزین دیگر را به محلول اضافه می‌کنیم. که حاصل آن حلال کردن 10 گرم در 100 ml شکر که نهایتی محلول 20% می‌باشد.
ضمیمه ۳: طریقه درست کردن محلول‌ها

محلول، مایعی است که اجزای گازی و/یا پریم و دیگر آب‌پذیر آب را در خود کننده مایع، مانند خمیر، نیکل، وسایل پریمی، آبیاری، یا ذرت‌هایی که سطح زیر روی حالت آب مناسبی را دارند در داخل یک لیوان یا ظرف، قرار می‌دهند پس از پختن، حلال‌یابی، و شستن در آب، محلول را در داخل یک لیوان یا ظرف قرار می‌دهند. واکنش‌های ترکیبی برای ساختن محلول است که در اینجا نشان داده شده است.

مثال:

ساده‌ترین روش برای ساخت یک محلول از ۵ تا ۱۰ درصد پراولاً ۷۲ در استون به روش زیر می‌پایند:

۱. ۱۰۰ میلی‌گرم از استون را برداشت و داخل ظرف خود می‌آوریم.
۲. ۵ گرم از جسم مورد نظر که دراین جا پراولاً ۷۲ در استون می‌باشد را وزن دهید و کناری می‌آوریم.
۳. وزن‌گیری شده و جسم را به خوبی داخل شنده را داخل یک لیوان مایع می‌آوریم و بعد از اضافه کردن جسم به آب خودی که درجا نگرش می‌دهد، محلول را قرار می‌دهند.
۴. از افزایش طیف از درصد محلول نمای جسم حل شده و در صورت حلال طیف می‌رود.
۵. به همراه تاریخ درست کردن محلول را حلقه از ۵ درصد وزن پراولاً در نویسنده قرار می‌دهد.

تصویر ۲۱: وزن زنده را در داخل یک لیوان مایع

تصویر ۲۲: نخستین تکان دهنده علت مایع

تصویر ۲۳: لیبل مخصوص را روی ترف می‌نماید
6- State after Restoration

7- Object exhibited yet?

8- Can object be exhibited?

9- Removal of the materials employed.

10- Other information about object:

11- Indication for the Maintenance:
3- Causes of Deterioration

What are the causes of the deterioration of the object? What might happen in the future if nothing is done?

4- Objectives of the Conservation and Restoration: Treatment Project

A- Treatment asked:

الف. برای وقایه اثر بازه کمی مشورت شده است:

B- Storage:

ب. درکدام دیپو حفظ ونگهداری میشود:

C- Objectives of the treatment:

ج. نکات قابل توجه درزمان وقایه اثر:

D- Treatment Project:

د. پروسه وقایه اثر:

5- Conservation Treatments:

نوعیت وقایه، از چه تکنیکی برای وقایه اثر استفاده شده است، مواد استفاده شده در پروسه وقایه اثر درج شود:

Indicate the type of treatment, the techniques used, the products used:
### 2- Assessment of the Conservation of the Object:

A- Description of the deterioration (detail the different kinds of deterioration, their extent, identify them with a sketch if necessary, identify previous restoration).

B- Analysis Observation (observation under magnification)
1- Identification and Description of the Object:

A- Object Designation

B- Material:
Ceramic, Glass, Metal, Stone, else:

| Thickness | Diameter | Height | Width | Length | Weight | Provenance | Accession No. | Object Name |
|-----------|----------|--------|-------|--------|--------|------------|---------------|-------------|-------------|

Photograph before Conservation:
موزیم ملی افغانستان
دیپارتمنت ترمیم
گزارش وقایه
بهادری، مارپیچ، 1990
حفظات آثار باستانی، ماسون، پاریس.

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سی، کاترین، 1994
کتاب راهنمای برای باستان‌شناسان، ابزار واقعیتی در باستان‌شناسی جلد ۴، موسسه باستان‌شناسی,
پهلوان کالیفرنیا، لس انجلس

**************
نتیجه‌گیری

هدف از تنظیم داشره‌های حاضر در اورنجک می‌باشد اگر یک کتاب راهنمای کاری از آموزش موزیم در سال ۲۰۰۵-۲۰۰۶ اشتراک داشته اند. باید گیرنده نامه و اطلاعات بازرگانی و سازمان باستان‌شناسی این امکان برای افراد اورنجک است با بهره‌مندی از اطلاعات پایه‌ای در این علم اگهیم پیدا نمایند و جای امیدواری است که با برگزاری کورس‌های آموزشی برای کارمندان از موزیم که در زمینه بازرگانی و ترمیم آثار تاریخی علاقه‌مند هستند فعالیت مفیدی باشند که باعث ارتقاء اطلاعات و دانش آنان گردد.

***************


این صفحه به زبان فارسی نوشته شده است. متن روی صفحه شامل حروف و علامات فارسی است که به صورت خواندنی قابل دریافت است. با توجه به نمایش صحیح و قابل خواندنی، متن روی صفحه جزئی از مطالعه و بررسی موضوعات مختلفی می‌باشد.
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قراردان جدا کننده:

در این پوشه از خمیش‌هایی که خاصیت آنها جذب نمک می‌باشند استفاده می‌شود به شمول خمیر کاغذ، لیپونایت و غیره. خمیر کاغذ ذکر شده را به توسط ریز کردن "کاغذ خشک کننده" [نوع ماده کمیابی] در مقیاس یک سانتی
متربه و اضافه کردن آنها به مقدار ممکن آب مفطر یا دیگر خالال‌های درک ضرر ازماشگاهی به دست می‌آید. نکتی که منکور را برای مدت زیاد در حال نگهداری به نکته می‌داریم تا به یک حالت خمیری تبدیل شود سپس تمام روبه روی جسم مورد نظر با به توسط خمیری شده‌ش می‌وشانیم. خمیری که در اطراف سرامیک‌ها موردنظر قرار گرفته شده باشد را تا هنگام که خشک شده بر روی جسم حفظ می‌کنیم و به تنوب مقدار نمک موجود در سرامیک را اندیشی می‌گریم.

تأثیر و عملکرد این روش بسیاره از آنتی‌سیستم‌های گیرد و نیز بر استفاده از آن در مورد سرامیک‌های که دارای
رنگ‌های فارامی باشد تاحده تا باید احتیاط به خرج داده شود.

در صورتی که سرامیک مورد نظر دارای استحکام منطقی و مناسبی باشد باشد در مرحله اول اقداماتی در جهت
محک کردن سرامیک استفاده شود و بعد از آن می‌توان از کیک‌آرتیکا (نور و نمک) استفاده کرد.

در صورتی که سرامیک ما نیز مخیت، از گل خام و دارای رنگ‌های فراوان نمای باشد سطح سرامیک‌ها که دارای گل
است به توسط برای هر خوپی‌پاکی‌های کرده و سرامیک مورد نظر با ازدیک مکانی که دارای رطوبت ثابت می‌باشد
نگهداری شود.

جمع اوری و انتقال پارچه‌های اثر

قبل از ایستگاه پارچه‌های اثر توسط سرش به هکتیکری طوری‌اند چسبانده شوند به طور آزمایشی به کمک اسکچ تب
و در گرمای مورد نیاز، به صورت آزمایشی به یکدیگر اتصال داده می‌شوند. عملیه قراردادن پارچه‌های اثری به
یکدیگری طوری معمول از فست تحمل و وابسته آنت شروع می‌شود. دقت شود پارچه‌های اثری از هم از هم
بروی‌یکدیگر قراردادن چسبانده شوند. قسمت‌هایی از پارچه که در آن اثری زبان از آن در آمرفاکاری اتفاق
زد. می‌توان قبل از چسبانده پارچه‌های اثری طوری‌ائی چسباندن با قراردادن قطعات مابین دو انتشیت و قراردادن
آن درمان کننده انتشیت کرد.

دقت شود که انتشیت اسکچ تب ها به طور صحیح و دقیق بریده شود تا اتصال آنها به خوپی انجام شود. در ضمن
سی می‌شود که هریک عدد اسکچ تب فقط یک ترک را پوشش دهد و ارتفاع سکچ تب‌ها به شکلی هم‌می‌رود هم تا چاپ که امکان
دارد جلوگیری شود تا در هنگام تصویب کردن کارکرد مشکل کشید.

تصویر ۲: اسکچ‌های پایدار به خوبی در مکان‌های لازم چسبانده شود.
*************
ন্যান্নি দেবী দে বলিয়া উঠিলেন অর্থ হোক প্রথমেই এই পূর্বাভাস।

সে তাঁর ভ্রাতৃত্বের সম্মানে করিয়াছিল যে, এই পূর্বাভাস হাজারের হাজার পূর্বাভাসের মধ্যে যে একটি হয়েছে তার ভ্রাতৃত্বের সম্মানে।

অর্থ হোক প্রথমেই এই পূর্বাভাস।
रूपक चुँम्प (केन्द्रीय क्विल्टिंग)

यह २ ठाप रहेगा जब उसे संयोग दिया गया है और जब उसे लगा दिया गया है। यह जब संयोग को लगाया जाता है तब संयोग को लगाया जाता है।

मारुत निबन्ध (दिनांकन)

हमें एक ठाप दिनांकन करना होगा। यह तीन ठाप दिनांकन होगा। यह तीन ठाप दिनांकन होगा।

श्लोक (दिनांक)

कोई यहाँ योगदान दिनांकन करना है। तो यहाँ योगदान दिनांकन करना है।
با تشکر و پس از ایجاد این کتاب از افرادی مسئول می‌باشند که با استفاده از این کتاب، موفق به شکستن سیاست‌های کارمندان موزیم که به‌طور می‌باشد در انجام می‌باشد.

_approved_
و: زمینه حفاظتی
وقایه
روش‌های برداشتان آثار
نکته‌های حفاظتی
نتیجه گیری

فهرست منابع
ضمیمه‌ها:
ضمیمه ۱
ضمیمه ۲
ضمیمه ۳
ضمیمه ۴
فهرست

قدردانی

پنجمه

الف: مواد سرامیکی

خواص اجسام سرامیکی
روش‌های کاری
خشک و پخته کردن

ب: امراض و خرابی‌های سرامیک‌ها

خواص اجسام سرامیکی: منفی‌ها
خرابی‌های فیزیکی
چرک و نکه شدن
خرابی‌های کیمیایی

ج: حفاظت و وقایه اثر

آزمایش
کارتهای ثبت و قابلیت
پاک کاری
جمع آوری و اتصال پارچه‌های اثر
پیوست دادن
پره کاری
تکثیر رنگ‌ها
علامت گذاری

د: حفاظت‌های پیشگیری کننده

نیازهای محیطی سرامیک‌ها
نخوره سازی
طریقه برداشتن اصولی اثر سرامیکی

ه: برداشتن مواد استفاده شده در ترمیم‌های سابقه

برداشتن سرشت
برداشتن پلاستر
برداشتن رنگ‌های اضافی
نشر

نشاوالد رسال 2004
توسط اسپیج
انجمن حفظ میراث فرهنگی افغانستان

استل آتن ولتر، 2006

عنوان:
راهنمای حفاظت از آثار باستانی: حفاظت آثار سفالی

نویسنده:
استل آتن ولتر

عکس روی جلد:
عکس روزی چند

ترجمه:
رضا شریفی (دری)، اسپیج

پرانت: ویرایش:
برنده گوی محمد حسین فضی، اسپیج

صفحه بندی:
برنده گوی وحید همدانی، اسپیج

ناشر:
انجمن حفظ میراث فرهنگی افغانستان (اسپیج)

صدوم پستی: نمبر 550

کابل - افغانستان

info@spach.info

www.spach.info

پست الکترونیکی:

وب سایت:

عکس روی جلد: کوزچه سفالین مریبو، قرن 9 میلادی، بالاحصار بلخ
ناجمن حفظ میراث فرهنگی افغانستان

داوغانستان دفرهنگی میراث دسانتی تولنه

اسپجر

ناجمن حفظ میراث فرهنگی افغانستان

راهنمای حفاظت از آثار باستانی:

حفاظت آثار سفالی

تهیه گانده: اسپجر آتن ولتر

با کمک مالی پونسکو/ اسپجر

مارس 2006

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Islamic Republic of Afghanistan
Ministry of Information, Culture, Tourism and Youth
The National Museum of Afghanistan

TRAINING COURSE MANUAL ON CONSERVATION SCIENCE FOR ARCHAEOLOGICAL OBJECTS:
The Conservation of Archaeological Ceramics

By Estelle Ottenwelter

SPACH / Funded by UNESCO