



Evaluation of Cleaning and Desalination Techniques for the Conservation of Low-Fired Terracotta Artifacts: A Case Study from Hund Museum, Pakistan

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Abstract

Terracotta artefacts are an important part of the archaeological heritage of Pakistan but low-fired terracotta objects are especially vulnerable to deterioration by the environment and by chemical agents because of their porous structure and their limited mechanical strength. This study is an evaluation of cleaning and desalination methods used on twenty-three low-fired terracotta artefacts from the Hund Museum, Swabi, Pakistan. A systematic approach to conservation was adopted, which included condition assessment, photographic documentation, mechanical cleaning, localized wet cleaning using distilled water, selective chemical treatment using diluted hydrochloric acid and repeated cycle desalination for removing soluble salts. The artefacts showed several phenomena of deterioration such as mud accretions, lime incrustations, salt efflorescence, carbon staining, micro-cracking and surface discolouration. Comparative evaluation of the treatment outcomes suggests treating salt affected objects by controlled distilled water immersion was the most effective and least invasive method for stabilizing samples. Mechanical cleaning was found to be appropriate as a major intervention procedure due to the greater degree of control and chemical hazard and the chemical cleaning procedure required careful application because of surface alteration. The study emphasizes compliance with conservation ethics such as minimum intervention, reversible and preservation of patina and evidential use. The results offer a viable and replicable framework for conservation at regional museums with limited technical facilities and add to sustainable heritage management practices for terracotta collections in Pakistan.

Keywords: Terracotta conservation; Desalination; Mechanical cleaning; Archaeological artifacts; Salt deterioration; Museum preservation



1. Introduction

Terracotta artefacts form a major part of the archaeological heritage of Pakistan, especially of the cultural landscape of Gandhara. These objects, figurines, vessels, oil lamps, lids, and decorative fragments are valuable evidence of the technological practices, domestic life, artistic traditions and ritual activities of societies of the past. Despite their durability, terracotta objects are in themselves vulnerable because of their porous structure and relatively low firing temperatures. As a result, the systematic documentation, conservation and restoration become key for ensuring their long-term preservation (Buys and Oakley 1993; Cronyn 1992).

The district of Swabi, situated in the eastern portion of the Khyber Pakhtunkhwa occupies an important position in the archaeological geography of Khyber Pakhtunkhwa. Historically it served as a cultural pathway between Afghanistan and Gandhara and the Indian subcontinent (Khan, 1995). Numerous archaeological sites have been found in the Swabi including Buddhist establishments, megalithic graves and settlements from Gandharan and Hindu Shahi periods (Dani, 1978; Khan, 1994). Among these, Hund ancient Udabhandapura has a special status from the historical point of view. Hund is located on the right bank of River Indus and is well known for being the last capital of the Hindu Shahi dynasty before their conquest in the eleventh century CE (Rehman, 1979; Mishra, 1972). The site has also historical links with the crossing of the Indus River by Alexander the Great in 326 BCE (Dani, 1992). Archaeological excavations in the area have produced a wide variety of artefacts in the form of Gandharan sculptures, architectural remains, pottery and terracotta objects (Sehrai, 1979; Zarawar Khan & Muhammad, 2012). In recognition to this archaeological importance, the Directorate of Archaeology and Museums, Government of Khyber Pakhtunkhwa established Hund Museum in the year 2010, with the aim of preserving and putting on display these materials.

Terracotta, from the Latin words *terra* (earth) and *cotta* (baked), is used to describe clay objects that have been fired at generally between 6000C and 10000C (Tiller, 1979). Unlike high-fired ceramics, low-fired terracotta is comparatively soft and porous, and is therefore susceptible to deterioration by the environment. Its permeability makes it possible for moisture and soluble salts to penetrate the body of the object which may subsequently lead to cracking, flaking, salt efflorescence and weakening of the structure (Buys and Oakley, 1993; Cronyn, 1992). The mechanical strength of terracotta is especially low when it is hand-moulded and perforated with air pockets that make it more vulnerable to fluctuations in the environment.

The deterioration of terracotta artefacts in museum environment is often caused due to combination of environmental and human factors. Fluctuations of relative humidity and temperature favour the dissolution and recrystallisation of soluble salts such as chlorides, nitrates and phosphates, which causes internal stress and surface damage (Plenderleith & Werner, 1976; Buys & Oakley, 1993). Poor handling and poor storage conditions as well as a lack of routine inspection also hasten deterioration (Ahmed, 2015). In addition, surface incrustations, lime deposits, mud accretions and carbon staining from previous use are commonly observed in excavated pottery objects (Abd-Allah et al, 2020).

Conservation, in its most general form, is all measures intended to halt or slow down the deterioration process while preserving the historical authenticity of materials of the cultural heritage (Coremans, 1969; Sease, 1994). It involves documentation, cleaning, stabilisation and preventive strategies intended to protect objects against further damage.



Restoration by contrast may involve the repair or reintegration of things that are missing, but must always proceed in accordance with conservation principles and with ethical standards (Nardi, 2014). International guidelines for conservation place the emphasis on minimum intervention, reversibility of treatments and respect for original material (Caple, 2003).

Cleaning is one of the commonest and most important procedures in the conservation of terracotta objects (Buys & Oakley, 1993). However, cleaning must be done with great caution in order to prevent removal of original material or historically significant patina. Mechanical cleaning techniques are usually preferred as initial interventions because they have more control and less risk of chemical damage (Sease, 1994). Wet cleaning with distilled water could be useful in elimination of surface material, but extended exposure to moisture can be dangerous for low-fired pottery (Buys & Oakley, 1993). Chemical cleaning which may include the use of diluted acids may be used selectively for removing calcareous deposits, but excessive or inappropriate use can cause irreversible damage (Moncrieff, 1983; Winkler, 1997).

Heavy mud deposits, lime incrustations, soluble salt efflorescence, carbon staining, micro-cracking and discoloration are the phenomena viewed in the terracotta collection at Hund Museum, which show multiple signs of deterioration. Many objects are low-fired and porous, and hence are especially vulnerable to moisture-related decay. Given the regional context of the museum and lack of access to sophisticated laboratory facilities, the choice of the proper, cost-effective and ethical conservation techniques is of critical importance.

This study aims at the documentation, conservation and restoration of selected terracotta objects in the Hund Museum. After a thorough survey done in cooperation with the Directorate of Archaeology and Museums, twenty-three terracotta objects were selected for detailed study and treatment. The research assesses the use of mechanical cleaning, wet cleaning, chemical treatment and desalination techniques, but focuses on decision-making processes based on the condition and material properties of individual objects.

The importance of this research is that it is a contribution to the field of conservation practice in the regional museums of Pakistan. While larger metropolitan institutions may have advanced conservation laboratories, at other museums, smaller museums may have limited technical resources. Developing systematic documentation procedures and treatment approaches with scientific knowledge is thus key to the protection of cultural heritage at the regional level. By combining the theoretical knowledge and practical conservation interventions, this study adds to the sustainable management of heritage, and raises the awareness about the conservation of terracotta artefacts in Pakistan.

2. Literature Review

Abd-Allah et al. (2020) argue that any cleaning process of terracotta objects should consider not only the cleaning procedure efficiency, but also the potential causing damage on the objects. Cleaning is one of the most commonly used public processing methods in the preservation of earthenware. According to Sease (2011), restoration has been done by the restorer especially in dealing with those of cultural heritage because of their instability and degradation and other adverse conditions. Restoration is usually undertaken exhibitionally, to add to the interpreted value of the object, whether by restoring lost parts or by reducing the loss of importance or purpose caused by past changes; is determined by



aesthetic appreciation, historical context and reliable reference points. Such activities often change the presence of the object (Nardi, 2014). Cagiano (1952) considered documentation as an important conservation measure that should be maintained for future direction; if a recovered item should decay or a further conservation is needed, photographic documentation would give essential data about these questions.

Caple (2003) defined cleaning as the removal of contaminants and degradation products from the surface of the artifact. The most suitable method of conservation for terracotta objects is, in his view, cleaning. He defined that the ultimate goal of all preservation methods is to increase the chemical integrity of the preserved item. Cleaning is often an indispensable part of the maintenance practice due to the fact that a dirty coating on an artifact can be a potent catalyst of decomposition (Abd-Allah, 2007).

According to Mancruff (1983), for a long time it was believed that the nature of the deposits and the strength of their adhesion of the terracotta surface differed widely. Dirt and grease may form loose or weak chemical bonds while deposits like calcium salts may form tighter chemical bonds, especially on low-fired objects. Further specific studies on pottery cleaning have shown that the mechanical techniques are still the most effective way of cleaning pottery. The use of Paraloid B-72 as an adhesive has been evaluated and recommended for use on archaeological pottery (Koob, 1986).

Cleaning seems to be the most known treatment process for terracotta objects, both in the protective works and also in the natural conditions. It has been stated that one of the primary goals of all preservation strategies is to increase the synthetic reliability of the products (Abd 2010, Hovadi 2010). Nardi (2014) mentioned that the mechanical properties of the pottery can be enhanced by adding a coating that fills in the imperfections on the surface and prevents the formation of cracks. Such coatings also improve the overall quality of hard porcelain.

Pottery was the predominant material for construction on account of its cheaper price when compared to stone, a trend that remained from the time when a single artifact could be created from a single component. The reasons for the fragmentation of these objects are often related to the defective assembly of the object, leakage of coatings, water ingress, surface cracks, salination, defects due to corrosion discoloration, defective connections, defects due to stress, as well as substandard repairs (Szerelmey, 2014).

3. Materials and Methods

A group of twenty-three terracotta artefacts was targeted after an initial condition survey. Conservation interventions included mechanical cleaning using brushes and scalpels, specific wet cleaning using distilled water and limited chemical cleaning using a 10% hydrochloric acid solution, in order to eliminate lime incrustations. Desalination was done using a series of immersions in distilled water and controlled drying cycles.

3.1 Research Design

The current research took a pragmatic approach to object centered conservation methodology, focusing on the documentation, examination and treatment of terracotta objects held in the Hund Museum, Swabi. The objective was to test for appropriate conservation strategies on low-fired terracotta objects which had undergone a process of environmental and chemical degradation. The methodology was composed of four main phases: (1) general survey and selection of artefacts, (2) documentation and state of conservation, (3) analytical inspection and (4) conservation treatment.



3.2 General Survey and Selection of Artifacts

An initial thorough-survey was conducted at Hund Museum in association with official representative of the Directorate of Archaeology and Museums, Government Khyber Pakhtunkhwa. The purpose of the survey was to locate objects made of terracotta that require conservation intervention. Selective sampling was used as a method of sampling to maximize the use of time and resources. During the survey, pottery and terracotta items on display at the Hund gallery were visual examined according to:

- Historical importance
- Presence of patina
- Physical stability
- Degree of deterioration
- Surface condition

Following this assessment, a group of twenty-three terracotta artefacts were identified in need of conservation as part of a pilot research initiative. The cohort consisted of figurines, oil lamps, lids, pots, bowls, vases, and pieces of stamped pottery.

3.3 Documentation Procedures

Documentation was performed before any conservation intervention in order to document the original condition of each artefact. This practice is considered vital in the context of conservation, as it makes this a permanent record for future reference. The process involved high resolution digital photography, writing of accession and showcase numbers, written condition reports and detailed descriptions of material, decoration, form and visible deterioration. High resolution cameras, research diaries, and cotton gloves were used to ensure safe handling - each artefact was photographed before treatment to ensure that its condition, surface deposits, cracks, missing bits, salt efflorescence and carbon staining was recorded.

3.4 Condition Assessment and Inspection

A detailed visual examination was carried out with the unaided eye and the magnifying power of the hand lens (x10) to identify deterioration phenomena. The inspection focused on:

- Rim, base, and handle condition
- Surface decoration and color
- Presence of soluble and insoluble salts
- Lime incrustations
- Carbon deposits
- Surface scratches and cracks
- Structural fragility

The artefacts showed signs of considerable mud deposits as well as salt efflorescence, lime incrustation, carbon stains (which can be associated with the artefact's culinary use), micro-cracking and discoloration. Identification of these factors of deterioration informed appropriate treatment of conservation.

3.5 Conservation Treatment Methods

Depending on the assessment of the condition, three main cleaning methods were used:

1. Mechanical Cleaning
2. Wet Cleaning
3. Chemical Cleaning



In addition, desalination procedures were applied for removal of soluble salts. All treatments were conducted following conservation ethics, emphasizing minimum intervention, reversibility, and preservation of original material and patina.

3.5.1 Mechanical Cleaning

Mechanical cleaning formed the first step of an intervention measure to remove loose dirt and non-coherent deposits. This method means greater control and it reduces the hazard of damage from the chemicals, especially for low-fired porous terracotta.

Tools Used:

- Scalpel (for heavy incrustations)
- Cotton wool
- Brushes of various sizes
- Rubber gloves
- Plastic jars
- Rubber mixing bowls

Soft brushes were used for general dusting. Hard deposits on the surface, like compacted soil, incrustations of lime, were removed carefully with the help of scalpels and wooden tools under controlled pressure. Sharp instruments were used with care in order not to scratch or abrade.

3.5.2 Wet Cleaning

Wet cleaning was used if mechanical cleaning was not sufficient to remove surface deposits. Distilled water was used as the main solvent because we did not want to have any mineral contamination from using tap water.

Tools Used:

- Cotton swabs
- Cotton poultices
- Soft brushes
- Buckets

Cleaning was done by locals with cotton swabs attached to sticks. Care was taken not to absorb too much water with the porous nature of low fired terracotta. For culinary objects with stains of carbon, water was carefully applied to avoid spreading any stains.

3.5.3 Chemical Cleaning

Chemical cleaning was used selectively when physical and wet methods were insufficient. All chemicals were used in diluted form to prevent irreversible damage.

Chemicals Used:

- Hydrochloric Acid (HCl) – 10% diluted solution (for lime incrustations)
- Acetone – for organic stains
- Ethanol – for carbon-based deposits

Hydrochloric acid was applied using cotton swabs in order to clear calcareous deposits. After chemical treatment, the artefacts were properly rinsed with purified water in order to remove residues.

3.5.4 Desalination

Soluble salts were removed by immersion of the artefacts in distilled water several times. The items were placed in plastic containers with distilled water for 24 hr periods, the water was periodically replaced until visible salt efflorescence was reduced. Desalination was considered to be especially important due to the ability of soluble salts to become hygroscopic and cause repeated crystallization and structural damage.



3.6 Drying and Final Stabilization

After cleaning and desalination, the artefacts have been left to dry off slowly under controlled indoor conditions. Sudden environmental changes were avoided in order to avoid the stressing of the ceramic matrix. Each artefact was then carefully packed and put into storage to ensure that they would be protected during display or long term storage.



4. Results & Discussion

4.1 Documentation of Terracotta Objects

S.No	Showcase .No	Accession. No	Description Of Artifacts	Before Conservation	Provenance
1	25	N/A	Broken animal figurine ,deposits of salts, heavy incrustation.		Donated by Mr.Zafir Khan of Hund Swabi.
2	25	N/A	Broken human figurine, deposits of salts incrustation		Donated by Mr.Zafir Khan of Hund Swabi.
3	20	HND 0171	Terracotta small Lid having mud deposits on the surface.		Excavated from Hund by Directorate of Archaeology



4	20	HND 0173	Terracotta small Lid having mud deposits on the surface		Excavated from Hund by Directorate of Archaeology
5	19	HND 0168	Terracotta mercury container black stains, surface dirt and scratches.		Excavated from Hund by Directorate of Archaeology
6	08	HND 0187	Terracotta small size piture having heavy incrustation of salts and dirt on the surface.		Excavated from Hund by Directorate of Archaeology

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7	13	HND o8	Terracotta small size pot covered with heavy dirt.		Excavated from Hund by Directorate of Archaeology
8	16	HND o244	Broken piece of stamped pottery having salts and dirt on the surface.		Excavated from Hund by Directorate of Archaeology
9	21	HND o156	Terracotta animal figurine having heavy dirt on the surface.		Excavated from Hund by Directorate of Archaeology



10	03	HND 066	Terracotta bowl covered with heavy dirt, efflorescence on the outer and inner surface.		Excavated from Hund by Directorate of Archaeology
11	02	HND 058	Terracotta bowl having dirt and mud deposits on inner surface and black stain on the edges.		Excavated from Hund by Directorate of Archaeology
12	23	HND 0189	Terracotta having carbon stain and heavy dirt on the surface.		Excavated from Hund by Directorate of Archaeology



13	23	HND 0190	Terracotta having carbon stain and heavy dirt on the surface		Excavated from Hund by Directorate of Archaeology
14	23	HND 0191	Terracotta having carbon stain and heavy dirt on the surface		Excavated from Hund by Directorate of Archaeology
15	22	HND 215	Terracotta molded human figurine, heavy dirt on the surface.		Excavated from Hund by Directorate of Archaeology



16	18	HND 0119	Terracotta oil lamp, heavy mud and dirt present on the surface.		Excavated from Hund by Directorate of Archaeology
17	18	HND 410	Terracotta oil lamp having deposits of salts and dirt.		Excavated from Hund by Directorate of Archaeology
18	11	HND 082	Terracotta pot, heavy dirt, scratches and mud on inner side.		Excavated from Hund by Directorate of Archaeology



19	07	HND 052	Terracotta pot having heavy mud and dirt present on the surface.		Excavated from Hund by Directorate of Archaeology
20	07	HND 054	Terracotta pot having heavy incrustation and mud on the surface.		Excavated from Hund by Directorate of Archaeology
21	06	HND 0110	Terracotta pot, heavily lime incrustation on the inner and outer surface.		Excavated from Hund by Directorate of Archaeology



22	10	HND 079	Terracotta vase, heavy deposits of mud present on the surface.		Excavated from Hund by Directorate of Archaeology
23	12	HND 095	Terracotta water pot having heavy mud on inner and outer surface.		Excavated from Hund by Directorate of Archaeology



4.2 Inspection of artifacts:

Before any conservation intervention is initiated, a preliminary analysis must be done in order to determine the appropriate conservation methodology for a given object. The following basic points need to be considered before performing any form of intervention:

1. **Parts of vessels (Rim, Handle, Base).**
2. **Function (cooking) storing.**
3. **Shape (round, square)**
4. **Fabric and manufacture.**
5. **Color (brown, red, black)**
6. **Hardness/softness,**
7. **Size (small, medium, large)**
8. **Decoration (flower, birds)**
9. **Types/Color of decoration.**
10. **Condition of decoration (complete/incomplete).**

4.3 Conservation strategies on each objects

The preliminary examination of the terracotta artefacts, with the naked eye and a x10 hand lens, showed that they had been exposed to a variety of deterioration mechanisms and phenomena. During these stages, the layer of dirt, soiling, dust, calcareous residues and foreign matter stuck loosely on the surface of the pottery by weak chemical bonds was accumulated. The fact that these objects were found in conjunction with other tools, fuel ash and pieces of kilns that were used for culinary processing, strongly indicates that they were used as cooking pots in their original form. Furthermore, a number of pots were covered with thick coherent layers of black soot or carbon deposits, that are indicative of use, and these deposits were distributed on the whole object surface, filling cracks and cavities. Obvious dissimilarities in color and texture were noted in examining the section of the body.

4.4 Deteriorating factors

- Soluble/ Insoluble salts.
- Surface Incrustations/dirt.
- Sudden environmental change. (Discoloration, salts crystallization)

4.5 Preservation Methods

- Mechanical cleaning.
- De- salination.
- Wet cleaning
- Chemical methods.

4.6 Cleaning of Artifacts:

Cleaning is a very important step in conservation. After excavation artefacts need to be cleaned thoroughly with all the dust removed without damage to the artefact. In the case of delicate artefacts, they need to be consolidated. Prior to cleaning it is necessary to determine the type of pottery, the mineralogical composition and the nature of dirt and deposits. It is also vital to understand that cleaning is the removal of soil or deposits and encrustation, but not the removal of original material nor any opaque weathering crust or patina that may possess protective and indicator archaeological attributes. The consensus that removal of original material can be highly undesirable is common to all codes of ethics. Therefore, in the present cases, the total elimination of the black soot remaining on the surfaces of cooking pots, which contains traces of the use these utensils had for cooking,



was avoided, since this would amount to the destruction of these objects by eliminating trace material. The following three cleaning techniques were used to clean with satisfactory results:

1. Mechanical/Physical Cleaning
2. Wet Cleaning
3. Chemical Cleaning

4.6.1 Mechanical/Physical Cleaning:

The first step to perform in the mechanical/physical cleaning method was to remove breakable or non-coherent deposits on all the nominated pottery pots. The merits of mechanical cleaning include the fact that it is better controlled than chemical cleaning and another benefit is that solution incorporation of dirt into the body of the pottery will be avoided. This risk is especially great with low-fired and porous-bodied rather than high-fired ware. For example, if mechanical or physical cleaning methods are used and not carefully executed, there is a threat of scratching, abrasion, partial removal of the artefact, or heavy destruction of the earthenware material. In the case of some terracotta artefacts, where the dirt does not stick too strongly to the outer surface and it is non-oily, a mechanical cleaning has been successfully used to remove the dirt. Dusting was done using suitable sized brushes and dry cotton lint or swabs. When hard surface deposits almost adherent such as excavated dirt or white deposits on vessels had been met, they were eliminated from the surface of the object by sharpened instruments, such as a scalpel, needle or wooden tools. Artefacts were carefully supported on an area of soft supporting material and as little weight was applied as possible, so as not to scratch the earthenware surface. The cleaning of large vessels of insoluble lime deposits that exist on their surface was achieved moderately by chemical and mechanical methods. Hard, medium and soft brushes, high-quality toothbrushes were used effectively, since the aforementioned tools gave satisfactory results in this cleaning method.

Table 01: Name of equipment's used for Mechanical cleaning method

S. No	Tools	Remarks
01	Scalpel	Used for cleaning heavy incrustations.
02	Cotton Wool	Used for removal of moisture.
03	Brushes of various sizes	Used for general dusting & cleaning of surface dirt.
04	Rubber Gloves	Used for working with chemical solutions/ handling of fragile artifacts.
05	Plastic jars	Used for holding solutions & immersion of artifacts into distilled water (24 hours)
06	Rubber mixing bowls	Used for mixing small amount of chemicals.

4.7 Wet cleaning:

In a number of instances the application of mechanical or physical techniques of cleaning was ineffective with regard to the total removal of dirt and stains from the surface of pottery. As a result, the wet cleaning methods were used on terracotta artefacts. Water often is regarded as the most effective, as well as the most economical and safest, solvent for removing surface contaminants and adherent residues. It has been observed that low-fired pottery can have some level of water solubility, and that certain components may be lost when exposed to water for a prolonged period of time during conservation treatment. Clay matrices are prone to rehydration and swelling under extended wet conditions Buys & Oakley (1993).



High-fired earthenware can contain mineral particles as body fillers, some of which are water-soluble. For these reasons, wet cleaning was locally applied to certain low-fired varieties of terracotta, and was used with great circumspection on relatively strong large vessels. Excavated and other non-oily deposits were easily removed by gentle brushing followed by wiping with water.

Distilled water was used instead of tap water which may contain mineral constituents. Cotton cloths were used with good results to soften the solid surface coatings and thus help to remove them. This cleaning protocol was carried out in a systematic order from the top to the bottom of the artefact. Particular care was exercised when the culinary objects were treated as their porous bodies tend to stain with carbon. Water penetrating may increase the stain diffusion, making cotton wool swabs the safest product. The cotton swab was put onto a stick and soaked in water, rolled across the surface. In cases where water was not a good solvent or where mechanical processes were better than wet cleaning, carbon based solvents such as ethanol and acetone were added. Preliminary trials showed that acetone is a highly flammable solvent which can cause white areas on the surface of porous materials. Accordingly, acetone was used on wipes as water was and applied onto all the terra cotta objects until no further debris was detected on the swabs.

4.8 Chemical cleaning:

In this method, chemicals are used to eliminate dirt and incrustations from the artifact. This approach is reserved for cases where physical methods fail in their efforts. The chemicals applied are always in dilute form to reduce any unintended intervention. While the use of chemicals makes it easier to dissolve the stains of different objects, it may also break the artefact integrity under the unsuitable conditions. The efficacy of chemical concentration may be maintained on site by diluting with distilled water and having the chemicals added to the water and not vice versa.

S. No	Chemical	Remarks
01	Hydrochloric Acid (HCl)	10% diluted with distilled water for removal of hard soluble salts incrustations from some artifacts by using cotton swabs.
02	Acetone	For the removal of organic stains.
03	Ethanol	-----do-----

Table: 02 Name of chemicals used in cleaning process.

Although the maximum usage of artifacts was not decorated or glazed, the use of chemical in cleaning has been avoided as much as possible. Further irreversible harm may be done if untried chemicals are taken in excess. It has been observed that high fired pottery tends to have a higher resistance to chemical attack than low fired pieces.

Intelligible deposits of CaCO_3 over the surface of some of the artifacts were removed with cotton pads to which 10 percent hydrochloric acid (HCl) had been added. In all cases power tools and brushes were used to remove soft residue layers. In addition, a process of careful rinsing of the pottery surfaces with purified water was done to remove residuals of chemicals.

4.9 Removal of Soluble Salts:

Pottery recovered from excavation sites commonly contain a range of salts; soluble salts such as chlorides, phosphates and nitrates are the most threatening. These soluble salts are hygroscopic and therefore repeated solubility and recrystallization are reported as a result of changes in relative humidity (RH). The salts migrate to the surface of the vessel where



extensive crystallization takes place, thus damaging the surface of the pottery. Over time, the repeatedly crystalline nature of it can create internal stresses that are enough to cause the pot to fracture. Soluble salts were removed by repeated immersions in distilled water.



Removal of Insoluble salts:

	Showcase	Accession	Description Of artifacts	Before conservation	After conservation	Description of intervention	Remark
<p>In most cases the safest and most appropriate method of removing insoluble salts is manual extraction. Most of the insoluble salts were removed with dental instruments. Chemical removal is also possible, but the pottery then has to be wetted. Nitric acid, hydrochloric acid and oxalic acid are the most</p>	No	No					



commonly used chemicals. While a 10% HCl solution can be used to remove insoluble salts care must be taken because hydrochloric acid can discolor the artifact. Following treatment, the artifacts were well rinsed with tap water.

SR.NO.							
1	25	N/A	Broken animal figurine, deposits of salts, heavy incrustation.			Dusting, mechanical cleaning, desalination and drying.	Legs were missing.



2	25	N/A	Broken human figurine, deposits of salts incrustation			Dusting, mechanical cleaning, desalination and drying.	Head were missing.
3	20	HND 0171	Terracotta small Lid having mud deposits on the surface.			Dusting, mechanical cleaning, wet cleaning, desalination and drying.	Rim was broken.
4	20	HND 0173	Terracotta small Lid having mud deposits on the surface			Dusting, mechanical/ wet cleaning desalination and drying.	N/A



5	19	HND 0168	Terracotta mercury container black stains, surface dirt and scratches.			Dusting, mechanical/ wet cleaning desalination and drying	Decorated on the circumference
6	08	HND 0187	Terracotta small size picture having heavy incrustation of salts and dirt on the surface.			Dusting, mechanical/ wet cleaning desalination and drying	Small area of rim broken patinas on the surface were preserved.
7	13	HND 08	Terracotta small size pot covered with heavy dirt.			Dusting, mechanical/ wet cleaning desalination and drying	Patinas on the surface were preserved.



8	16	HND 0244	Broken piece of stamped pottery having salts and dirt on the surface.			Dusting, mechanical/ wet cleaning desalination and drying	Probably broken, patinas on the surface were preserved.
9	21	HND 0156	Terracotta animal figurine having heavy dirt on the surface.			Dusting, mechanical/ wet cleaning desalination and drying	Object were fragile need consolidation.
10	03	HND 066	Terracotta bowl covered with heavy dirt, efflorescence on the outer and inner surface.			Dusting, mechanical, chemical cleaning desalination and drying.	Patinas on the surface were preserved.



11	02	HND 058	Terracotta bowl having dirt and mud deposits on inner surface and black stain on the edges.			Dusting, mechanical, chemical cleaning desalination and drying.	Micro cracks present on the surface.
12	23	HND 0189	Terracotta having carbon stain and heavy dirt on the surface.			Dusting, mechanical, wet cleaning desalination and drying.	Patinas on the surface were preserved.
13	23	HND 0190	Terracotta having carbon stain and heavy dirt on the surface			Dusting, mechanical, wet cleaning desalination and drying.	Patinas on the surface were preserved.



14	23	HND 0191	Terracotta having carbon stain and heavy dirt on the surface			Dusting, mechanical, wet cleaning desalination and drying.	Patinas on the surface were preserved.
15	22	HND 215	Terracotta molded human figurine, heavy dirt on the surface.			Dusting, mechanical, wet cleaning desalination and drying.	Half piece broken and missing.
16	18	HND 0119	Terracotta oil lamp, heavy mud and dirt present on the surface.			Dusting, mechanical, chemical cleaning desalination and drying.	Patinas on the surface were preserved.



17	18	HND 410	Terracotta oil lamp having deposits of salts and dirt.			Dusting, mechanical, chemical cleaning desalination and drying.	Patinas on the surface were preserved.
18	11	HND 082	Terracotta pot, heavy dirt, scratches and mud on inner side.			Dusting, mechanical, wet cleaning desalination and drying.	Patinas on the surface were preserved.
19	07	HND 052	Terracotta pot having heavy mud and dirt present on the surface.			Dusting, mechanical, wet cleaning desalination and drying.	Patinas on the surface were preserved.



20	07	HND 054	Terracotta pot having heavy incrustation and mud on the surface.			Dusting, mechanical, wet cleaning desalination and drying.	Little piece of rim was broken.
21	06	HND 0110	Terracotta pot, heavily lime incrustation on the inner and outer surface.			Dusting, mechanical / chemical cleaning desalination and drying.	Scratched patinas on the surface was preserved.
22	10	HND 079	Terracotta vase, heavy deposits of mud present on the surface.			Dusting, mechanical, wet cleaning desalination and drying.	Rim was broken. Patinas on the surface was preserved.



23	12	HND 095	Terracotta water pot having heavy mud on inner and outer surface.			Dusting, mechanical, wet cleaning desalination and drying.	Patinas on the surface were preserved.
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5. Conclusion

Contrary to current assumptions, terracotta is not indestructible, although it possesses a great mechanical strength. The strength of terracotta is mostly defined by how much the terracotta material has been fired. In the case of the Hund Museum though the artifacts were made of low-fired clay, which is more permeable and as such more prone to breakage because of the absorption of water. The extent of cleaning and preservation works was determined by detailed on-site surveys of which results were documented in a series of proformas. The artistic value of the conservation of the earthenware needs to match that of the original work. Over the years, the preservation methods for earthenware have evolved, with reversibility and a wider range of materials and methods being introduced. A detailed study of the many different aspects that are required in the restoration of terracotta objects is needed to find out the most appropriate approaches and methodologies - reversibility, clarity of additions, respect for the ancient object, and material stability accepted for restoration, etc. Conservation of these artifacts has to be undertaken by a professional terracotta conservator. Non-destructive test methods should be used for the identification of inherited voids inside the structure. All repair and cleaning procedures are to be tested, in order to establish safe and effective treatments and materials. The results of these tests must be recorded in writing and be augmented by high resolution digital photographs. Among the various methods for protection which have been evaluated, desalination has proven to be the best. This method cleans the terracotta object without harmful effects. In addition, general cleaning instruments, such as tweezers and brushes, did a good job removing surface dirt from the exterior of the object. In conclusion it seems necessary to underline the importance of a closer collaboration between chemists and conservators in studying historical objects for which both disciplines need each other equally.

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