Advanced Research in Conservation Science

Journal homepage: https://arcs.journals.ekb.eg

DOI: 10.21608/arcs.2021.47406.1010

Conservation of an Egyptian Pottery Sarcophagus from Saqqara excavation-A Case Study

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HIGHLIGHTS

- A pottery sarcophagus from Saqqara excavation, Egypt suffered from different deterioration aspects including color change, pitting, and separation of some parts of the body.
- Documentation and conservation treatments were performed including cleaning, joining, and completion.
- The data obtained improved knowledge about the conservation of pottery and led to a detailed protocol for its treatment.

GRAPHICAL ABSTRACT

ARTICLE INFO

Article History:
Received: 22 October 2020
Revised: 11 April 2021
Accepted: 3 May 2021
Available online: 28 June 2021

Keywords:
Pottery, Sarcophagus, Cleaning, Joining, Completion of missed parts

ABSTRACT

This study aims to apply some conservation techniques on an archaeological pottery sarcophagus dating back to the late period in Egypt. It is from the expedition of the Faculty of Archaeology, Cairo University, Egypt (at Saqqara, season 2016/2017). The condition of the sarcophagus was weak and it suffered from many deterioration aspects including the accumulation of dirt and soil remains, cracks, decay, fragility of pottery body and crystallization of salts. Furthermore, many sherds were broken and some were missing. It should be mentioned here that the analysis and investigations for this sarcophagus were done in a previous study. Prior to conservation, documentation was performed using AutoCAD to demonstrate the deterioration aspects and prepare a damage map for the archaeological sarcophagus.

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Conservation techniques included both mechanical and chemical methods, including soft brushes and diluted acetone with distilled water. The joining process for the sarcophagus sherds was performed using paraloid B-72 60% dissolved in acetone. Finally, the completion process was applied with a mixture of dental plaster with grog and primal AC33. The results of the conservation techniques proved that cleaning revealed the aesthetic value of the object, while the joining and completion of missed parts increased the strength of the object studied.

1. Introduction

The excavation mission of the Faculty of Archeology, Cairo University began its work in the south of the ascending road of Ona's pyramid, Saqqara under the supervision of Prof. Dr. Ola El-Aguizy during the period of 2016-2017. During the conservation of (p3. sr) tomb, a burial well was found. In that well, we found several amounts of pottery sherds. Saqqara area is considered one of the most important historical and archaeological sites in Egypt. It is located a few miles north of Dahshur and about eight to ten miles south of Giza. The site of Saqqara is situated on the western bank of the Nile about 20 km to the south of Cairo and 15 km to the north of the Giza plateau .[1]

The exposure of archaeological objects to different weathering factors causes many aspects of deterioration, such as cracks and accumulated dust. Besides, the granular weakness and brittleness cause loss of flexibility to these objects [2]. It should be mentioned that the exposure of archaeological pottery to high temperature in the surrounding environment led to the formation of some micro-cracks, cracks, and deep cracks. Finally, it can lead to the weakness of the body, in addition to the occurrence of separations in the coating layers [3]. The porosity of a material has a strong influence on its physical and mechanical properties. Extremely porous materials such as pottery have high water absorption capacity and less stress-resistant as well as more susceptible to salt attack [4]. Moisture and salts are the basic reason for the deterioration of porous materials. Water is the major force of damage, such as the detachment of the painted layer and the whitening of surfaces because of the crystallization of salts .[5]

The salt crystallization during drying is not spatially homogeneous throughout the sample surface. Where the salt crystals grow faster near the edges of the sample, compared to the center [6]. Salts dissolved in water move to the porous material due to the capillary property and then crystallize in the pores during the stage of drying. The place of salt crystallization depends on the rate of saturation and the rate of drying. When the evaporation rate is low, it results in the formation of salts on the surface. However, when the evaporation rate is considerably higher, the salts crystallize in the pores of the material [7]. The consequence of subflorescence presence is crumbling and the formation of cracks in the materials .[8]

The studied sarcophagus sherds were found approximately in forty-one sherds in large and small parts. The hardness of the sherds is around four on Moh's scale. During the classification of the excavated pottery fragments (fig. 1), it was found that these fragments could complete a sarcophagus, which is divided into two parts؛

Fig. 1: Shows the various sherds of the sarcophagus.

•The main body of the sarcophagus :

Through the initial joining of the main body fragments, we observed different characteristic features that helped in grouping the sherds. It varied from large and small sizes and reached approximately twenty-eight potsherds. The body has the ideal shape for the

deceased. The main body represents the largest part in the sarcophagus size, which has a length of 173 cm and thickness between 1.5-3 cm. It should be stated that the color of the external coating layer differed in different areas between red and white resulting from the use of a wash layer which varied from red to white respectively. Some black spots were noticed on fragments due to insufficient burning.

•Cover of the sarcophagus :

The initial joining of the cover fragments (about thirty potsherds) revealed that this cover has the shape of a human face with feminine features. It represented the deceased for easily recognizing the soul in the other world. It should be mentioned that this cover has an Ozir shape, which is characterized by the status of hands above with a wig-wearing.

It should be noticed that this study is a continuation of a previous study for this archaeological sarcophagus. Different analytical methods were used for studying the chemical and mineralogical composition and identifying the deterioration aspects of the sarcophagus.[9]

The pressure of the burial environment is considered the worst deterioration factor for pottery in soil, which led to damage of the artifact. Although pottery is highly resistant to chemical damage, it is less resistant to mechanical deterioration, especially when buried in the soil. Therefore, it is necessary to join the damaged sherds to be suitable for museum display [12]. This study aims to apply some conservation techniques to reveal the aesthetic value of the sarcophagus and to increase its strength for storage or exhibition.

2. Materials and Methods

Archaeological pot sherds of the sarcophagus were selected from the excavation of Saqqara to apply the study. These pot sherds suffered from different aspects of damage.

2.1.Documentation

AutoCAD version 2018 was used to precisely document the various types of damage that exist in the pottery jars.

2.2.Cleaning

Soft brushes, needles and scalpels were used to remove dust. In addition to using distilled water, acetone and ethyl alcohol to remove salts and stains.

2.3.Joining

Paraloid B-72 60% dissolved in acetone was used to join the sherds of the sarcophagus.

2.4.Completion (Gap-filling)

The completion (gap-filling) process was applied with a paste consisting of a mixture of dental plaster with grog (powder of new pottery) and primal AC33 15%.

3. Results and Discussion

3.1.Documentation

AutoCAD program was used to document the various types of damage that exist in the pottery sarcophagus accurately, such as missing parts, color change, pitting and separation of some parts of the body (Fig. 2).

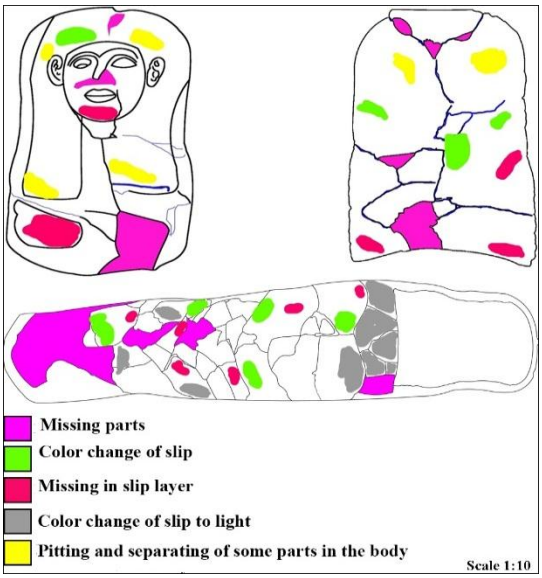

Fig. 2: Shows AutoCAD documentation of the sarcophagus.

3.2.Cleaning

Cleaning means removing dirt and dust from the surface of the object [11]. Cleaning is a very important operation because it takes off encrustations, deposits, and dirt. However, this kind of operation must be accomplished with great care in order to avoid any damage of the surfaces with an irrecoverable loss of material and decoration [10]. Cleaning of break (fractured) edges of friable surfaces, washing of low- fired pottery and abrading of filling material all carry a risk of damage to the original material. So, a great care is

taken when cleaning the fragility pottery objects [11] This was performed done in two stages; mechanical and chemical cleaning.

3.2.1. Mechanical cleaning

This process is considered the first step to clean the object and can be easily controlled compared to chemical cleaning. Choosing of cleaning methods depends on the nature of both the pottery and encrustations. Cleaning is used to remove any foreign matter that is not part of the original fabric of any object [11]. Excavated pottery is usually covered with soil deposits, which can be of similar hardness to the pottery [14]. The main objective is to remove the solids adhering to the surface of the archaeological material or to reduce it to minimize the cleaning materials needed in the case of chemical cleaning. The soft brushes (Fig. 3A) were used to remove the adhered soil from the surrounding environment. Then the scalpels were used to eliminate the solid calcification and various impurities [15]. Mechanical cleaning has been done by brushes of different sizes, spatulas sometimes, scalpels, and a blower to clear the surface accumulation and to remove dust and sand from the surface [16]. Mechanical cleaning implies merely breaking the adhesion of dirt and moving it away.

3.2.2. Chemical cleaning

This stage depends on the use of different solvents and solutions, where these solutions interact with the surface-related materials and dissolve them. Distilled water was the first solvent used to remove some dirt deposits that were difficult to remove mechanically. In practice, water is the most important liquid cleaning agent, with the triple advantages of being very cheap, easily available, and without hazard to the conservator. It is rarely used alone as a solvent, and all kinds of additives are used to modify its properties [17]. Acetone was diluted with distilled water to avoid the effect of high concentration on the surface, and ethyl alcohol was used to remove hard stains [18]. On the other hand, chemical cleaning processes were done using a mixture of distilled water and ethyl alcohol in the ratio of 1:1. The treatment has given good results in the cleaning and removal of dust [1] (Fig. 3 B).

3.3.Joining

The joining process of pot sherds from the sarcophagus is considered a difficult stage due to the large number of sherds and size of the sarcophagus. It was difficult to join the sherds with each other because the edges of these fragments were eroded due to the burial environment. The joining process aims to obtain the final shape of the pottery object, as well as to prepare it for the museum display. It is applied to avoid further erosion of the edges and to prevent deterioration of pottery objects during storage. The classification of pottery sherds should be taken into consideration for the success of the treatment process [19]. Many guidelines, such as color, texture, and inner core shape facilitated the joining processes. In addition to numbering these fragments, some distinctive marks were done to simplify the joining of the archaeological pottery by the adhesive material. The purpose of the sorting process is also to exclude the extraneous potsherds from the object .[12]

Paraloid B-72 is suitable for joining pottery and the drying time depends on the ambient temperature and the thickness and porosity of the pottery [20]. 60% wt/v Paraloid B-72 adhesive dissolved in acetone was used to join the pot sherds of the sarcophagus [21]. The joining process was carried out in two stages initial and final joining. Initial joining is done to determine the final shape, as well as to know how to build the fragments and install them one after the other to see which pieces are used at the beginning. The bonding stages began with the reconstruction of the sarcophagus fragments without using adhesive to establish a general idea about its form in the correct position [22]. Therefore, we performed numbering of the fractions of the object to facilitate the joining process (fig. 3C, D).

The adhesive mentioned above was applied for the final joining process to each sherd, one after the other in a specific way that does not allow the adhesive to squeeze out on the surface, while at the same time allowing more penetration of adhesive material within the object. The application is done by drawing an imaginary line in the middle of the edge of the sherds and putting small quanti-

ties (dots) of adhesive on both fractions. The adhesive was sometimes applied on the two opposite edges to ensure greater penetration of the adhesive inside the object. It was left for a period until the adhesive was set and the fractures were cohesive. This was repeated in all the fractures until they were built on top of each other according to the arrangement of the initial assembly of the pieces until the whole piece was finished. Sometimes, if the adhesive squeezed out, it was removed outside the fracture area while the two pieces were attached. In this case, the adhesive was partially set for easy removal with a scalpel. We applied the scalpel in a parallel position to the surface of the object, the adhesive wasn't wiped with cotton, so as not to leave any traces of shiny material distorting the object's surface (fig. 4).

Fig. 3: Shows different cleaning phases and initial joining. (A) Mechanical cleaning with small brushes, (B) chemical cleaning of edges with distilled water, (C) initial joining of the body, and (D) initial joining of the cover parts.

3.4.Completion

The completion process is a manual procedure that needs experience from the restorer. The materials used in filling the gaps and cracks can be considered as filler material mixed with an adhesive [23]. Pottery is characterized as easy to break when extracted from the burial environment [24]. Choosing the material that was used to fill the missing parts depended on the

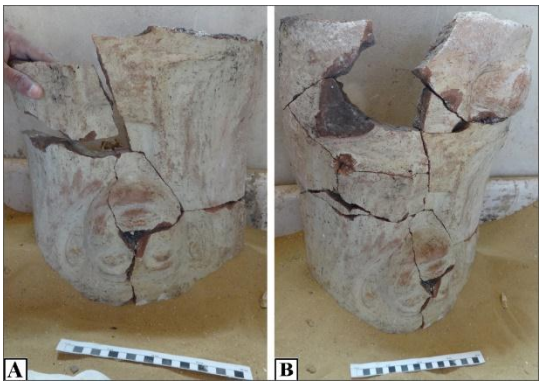

Fig. 4: Shows the final joining of the coffin. (A) The cover in a vertical position fixed in sand and **(B) the final form of the cover after joining.**

shape of the pottery object and the method used to apply the filling material [20]. Gap-filling was undertaken primarily for aesthetic reasons, although it was hoped that it would also provide some additional support for the joined fragments [25]. This process is important for pottery objects due to these reasons: the completed object is ready for museum display and this process strengthens the artifacts [26, 27]. The completion can be applied by using suitable filling material, according to the condition of the pottery.[28]
The process of completion is considered a difficult process and depended on the investigative and analytical results of a previous study of these objects with regards to the method of object formation and use, as well as the thickness of the object and the direction of gap filling. The completion was done in a manner similar to the original object [13]. After the final joining of the pottery sarcophagus, missing parts were found in different areas of the body. The dental plaster was mixed with grog (powder of new pottery) and primal AC33 15% to complete the missing areas of the sarcophagus. This mixture is considered a good filling material that can be used to complete the pottery, as it is chemically inactive. Hence, this paste has similar properties to archaeological pottery [29, 30]. The retouching process with color oxides was used to homogenize the completed areas with the original parts [31] (fig. 5).

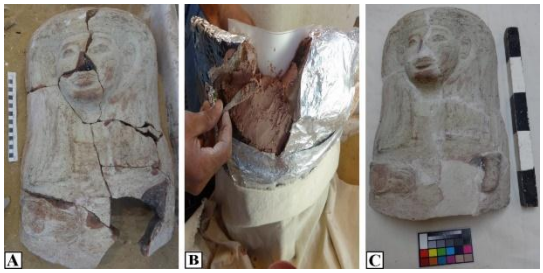

Fig. 5: Shows the different steps of the completion process of the sarcophagus cover. (A) Shows the cover with some missing parts, (B) securing the edges with aluminum foil before applying the completion material and (C) the cover after completion.

At the beginning, a large part of the sarcophagus base was not found. Then, after sorting several pot sherds in the field a very important part of the base was found which contributed to the determination of the edge of the sarcophagus base. Consequently, we managed to complete the missing part until the object's edge. The sarcophagus was placed in a vertical position to facilitate the completion of the missing parts. Some stainless-steel bars (6 mm radius) isolated with Paraloid B-72 (5%wt/v) in acetone were used to support the structure [32]. Before applying the filler, the broken edges were dampened first with water to avoid the rapid absorption of water from the filler. The completion process in this area was carried out with great care and accuracy because the missing area is large and takes a circular shape. Therefore, it was completed in several steps and over several days. Each layer of approximately 7 cm was performed per day to avoid deformation. In general, the polishing process for the completed area was performed before the final drying. The metal bars were intertwined with each other by using a thin stainless-steel wire (2 mm radius) which results in the rise of the mechanical properties of the filling gap material (Figs. 6, 7).

Conclusion

A large number of sarcophagus sherds were discovered at Saqqara archaeological site during the Cairo University excavation mission (2016-2017) and have been found in very bad condition. The sarcophagus suffered from many deterioration aspects such as cracks in several parts of the body, flaking of the slip layer and crystallization of soluble salts within the pores. Additionally, color change in many parts of the sarcophagus body was found. The conservation process was carried out through several stages. It started with mechanical cleaning, with the use of brushes, needles and scalpels to remove the dirt that was accumulated on the surface. Mechanical cleaning tools were used to remove crystallized salt and then cotton poultices immersed in water were used to extract the salt. Different solvents and solutions such as acetone and ethyl alcohol were used to carry out chemical cleaning. Then the stage of joining the sarcophagus fragments using 60% wt/v paraloid B-72 dissolved in acetone. Finally, the mixture of dental plaster with grog and 15% primal AC33 was used to fill the missing areas. After the restoration processes were completed, color oxides were used to homogenize the color of the completed parts.

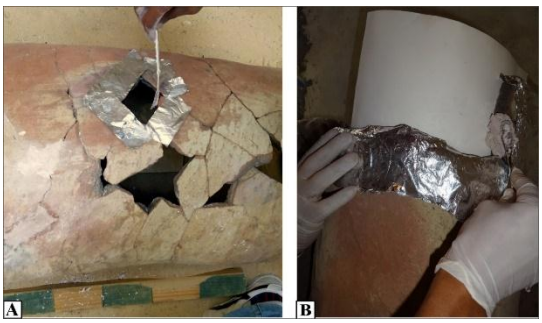

Fig. 6: Shows the different steps of the completion of the sarcophagus body. (A) Securing the edges with aluminum foil before starting the completion process of the body, and (B) Securing the edges and applied the completion mixture.

Fig. 7: Shows the sarcophagus after the conservation process.

Acknowledgments

We wish to thank Prof. Dr. Ola El-Augizi head of the excavation of the Faculty of Archeology, Cairo University at Saqqara site for her encouragement and support in studying and restoring the pottery sarcophagus. The authors would also like to thank Dr. Nader Elhosiny, Mr. Magdi Al-Beheiri, Mr. Montasir Kamal, and Mrs. Weaam Ashour, for their sincere efforts.

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