Conservation of an Archaeologically Human Plastered Skull Displayed in the Jordanian Heritage Museum – Yarmouk University: A Case Study

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Abstract: *The 1988 excavations at the Neolithic site of "'Ain Ghazal» in central Jordan have recovered a well-preserved plastered human skull. This very significant archaeological object offers a striking example illustrating the funerary practice at that well-known site and at several others in Palestine, Syria, and Turkey. The condition of the skull is poor: the plaster and bone were degraded, friable and cracked in some areas. It also has many deterioration forms that need treatment. We have done some tests to determine the best mixture of lime to use in the restoration of the plastered skull. Consequently, the following conservation processes were performed: Removing the bad previous conservation works, cleaning the sedimentation dirt, consolidating the plastered skull, gluing the broken parts, completing the missing parts of the skull plaster, coloring the new plaster with the appropriate color, and displaying the plastered skull in the Museum of Jordanian Heritage.*

1 - Introduction

Bones are considered one of the main types of archaeological remains and a common type of finds; they are also considered a main source of information for archaeologists and anthropologists in any excavation (Hamilton 2010).

Excavations conducted in 1988 by Simmons, Boulton, Butler, Rollefson and Kafafi at Neolithic "'Ain Ghazal» in central Jordan have recovered a well-preserved plastered human skull, and the discovery was significant because this skull offered a striking example illustrating funerary practices at the well-known site of Ain Ghazal (Rollefson 1983; Rollefson and Kafafi 2001) and at several other sites in Palestine, Syria, and Turkey (Butler 1989).

The plastered human skull, coming from Square 2872 in the Central Field of the 'Ain Ghazal excavations, was buried in a small pit dug below a building of the Middle Pre-Pottery Neolithic B-3 period (MPPNB-3), dated ca 7000-6700 BC. The skull was below a painted plaster surface, regarded by the excavators as the floor of a domestic house (Simmons et al 1990).

The skull is currently displayed at the Museum of Jordanian Heritage which is a part of the Faculty of Archaeology and Anthropology at Yarmouk University. Earlier in 1988 it underwent restoration in the laboratory of the Institute of Archaeology and Anthropology, Yarmouk University, and it underwent another again in 1996. At first, it was embedded into a thick plaster. In 1996, after it fell from the exhibit shelf where it was displayed, the 44 bone and plaster fragments were cleaned and anatomically reassembled by Mr. Friedrich Zink, Conservator at the Museum of Jordanian Heritage, Irbid (Simmons et al 1990).

According to Simmons et al, 1990, the sample, belonging to an adult male, consists of a cranium and is represented by the parts of bones of the face, frontal, parietal, temporal and

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Fig. 1. Map showing the location of the archaeological site of Ain Ghazal in Jordan.

occipital bones. The mandible is broken off by force; the upper parts of the cranial vault have been lost due to bulldozing operation. The age of this person is estimated to be about 30 years. In the absence of a more absolute evidence, this age estimation is based on the total loss of the maxillary dentition and the thickening of the braincase.

Had the deterioration processes of the plastered skull been allowed to continue, this unique archaeological object would have disappeared. Therefore, the conservation of the plastered skull will preserve it as a heritage for future generations and as a source of valuable information for archaeologists, conservators, anthropologists and other researchers (Grisson 1996).

Conservation science has played important role in preserving archaeological objects from any further damage and decay, and so scientific approaches should be followed to implement conservation in a scientific way. It depends on the conservator's knowledge and experience in choosing the appropriate materials and methods for conservation (Caple 2000),

2-Applied conservation of the plastered skull

The following processes were applied to the plastered skull:

2.1- Skull description and condition:

The conservator should document scientific examination and treatment by creating permanent records and reports, especially if the object was subject to previous restoration (Berrett, 1994).

The plastered skull takes number 11 in show case No. 2 at the Museum of Jordanian Heritage. It is composed of three separate parts put next to each other without any adhesive power. The skull was installed by iron bars, which were embedded in a thick plaster that was added during earlier conservation (See fig 2).

2.2- condition report:

The plastered skull dimension is ca. 14 cm wide and 12 cm high. There is also a bag with the skull containing broken bones and plasters (Figs 3-6). During the conservation process we used some of them to restore the pieces to their rightful place in the skull.

We noticed that the color of the skull is cream to light brown, and it is very fragile and weak with many micro-cracks in both bone and plaster (Simmons et al 1990).

2.3-Examination and Results:

Examination is considered the first step the conservator should take for an archaeological object to determine its composition, structure, deterioration forms and, if possible, the causes of the damage. Also, we can determine if object

Fig. 2. the plastered skull in the museum before the third conservation process, also it shows the right places for its parts.

Fig. 3. Part No. 1 of the skull

Fig. 4. Part No. 2 of the skull

Fig. 5: Part No. 3 of the skull.

Fig. 6: Bone and plaster fragments

underwent any previous conservation process. All of these are necessary to determine the best methods and materials for the conservation process. A conservator's trained eye and experience with similar objects are the most important tools at this stage (Buys and Oakley 1993).

2.3.1- XRD Examination and results:

One sample from the bone of the skull (a bone which was in the fragment state) was ground homogeneously to very fine powder. Two powder samples from the old plaster were taken by the scalpel from the back of the plastered skull and also one powder sample from the new plaster was taken and ground homogeneously to fine powder to determine their mineral composition in order to determine the best conservation materials for the conservation and restoration of the plastered skull. Analysis was done by XRD-6000 SHIMADZU X-Ray Diffractometer.

According to XRD analysis the old plaster consists of Calcite ($CaCO_3$) and quartz (SiO_2), Floroapatite (Fig. 7).

According to XRD analysis the new plaster consists of Calcite ($CaCO_3$) and quartz (SiO_2), Calcium Hydroxide Ca (OH_2) (Rollefson, Grissom & Griffin 1998). (Fig. 8).

Bone sample consists of Hydroxyapatite, Floroapatite, Quartz and Calcite

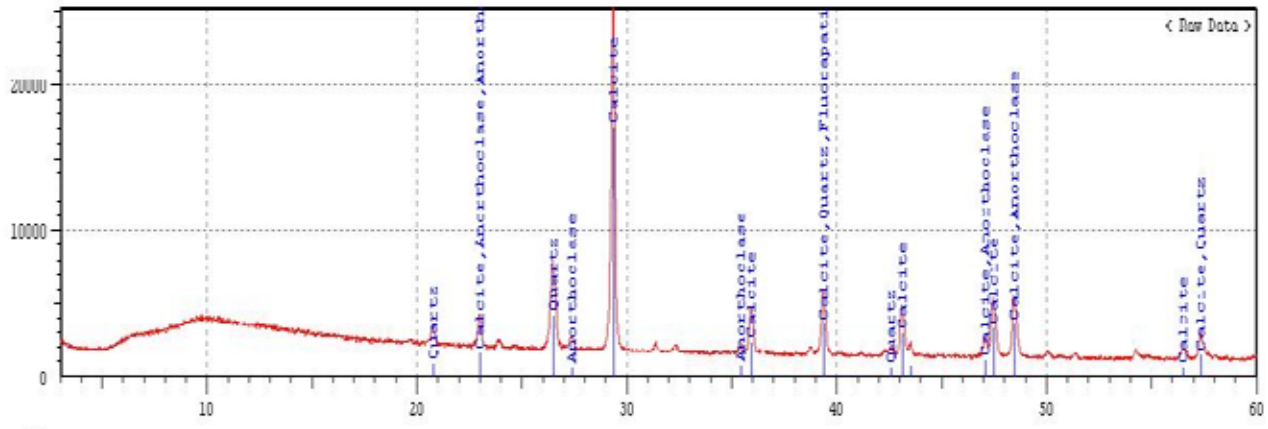

Fig. 7: X-Ray powder diffraction result of old plaster.

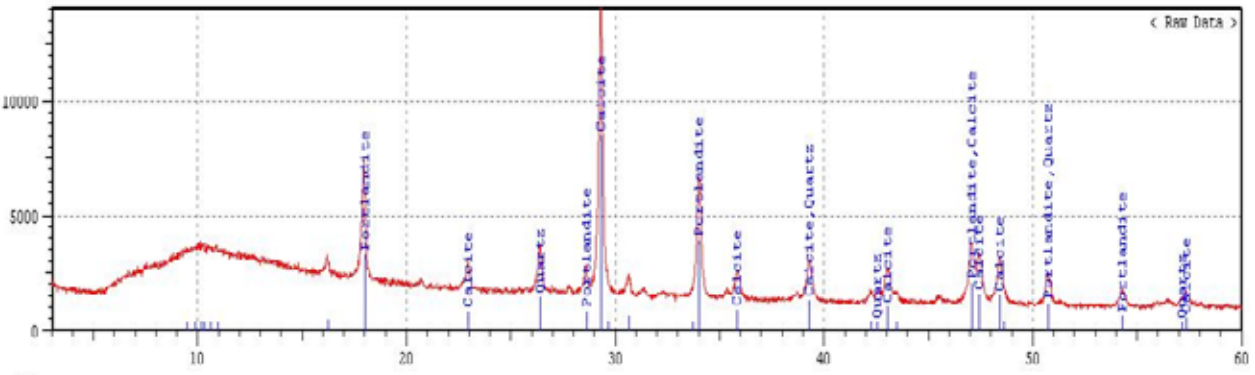

Fig. 8: X-Ray powder diffraction result of new plaster.

2.3.2- polarizing light microscope examination and results:

One sample was taken from the plaster fragment, which was found beside the plastered skull to determine its mineral composition.

To prepare a thin section sample, a slice was cut off from the plaster. One side of the slice is polished until the surface becomes flat and smooth. Then the polished surface is attached with a glass slide using suitable resin (Epoxy). After the resin is hardened, the other side is cut off until the slice reaches suitable thickness (30 micron). The slice is polished until the majority of minerals present are transparent or translucent and able to be studied under the petrological microscope which has a polarizing light source with a rotating stage. (Rollefson Grissom Griffin 1998).

By studying the sample of plaster under the polarizing light microscope, we found that the plaster consists of calcium carbonate and small amount of quartz (SiO2) that were accidentally found in the sample (Fig. 9). Also, we found small amounts of chert (Figs. 11, 12) and a type of microfossils called Foraminifera Globegerina that appeared to be from the upper Cretaceous (Fig 10) (Bender, 1974).

2.3.3- Calcimetry test and results:

Determination of the calcium carbonate content in the old plaster sample was performed using the "Dietrich-Fruhling gas volumetric method" calcimeter that meets the standards DIN 19684.

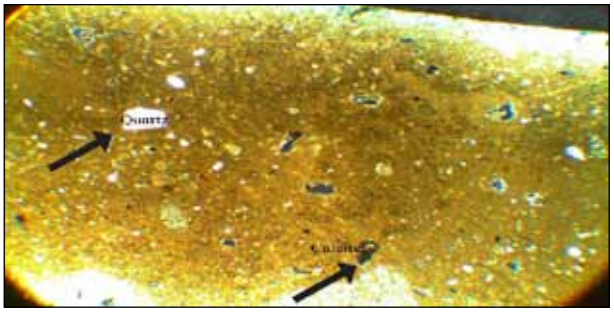

Fig. 9: XPL Polarizing light microscope picture (2.5 x magnifiers) shows calcite lattice (CaCO3) with small amount of quartz (SiO2)

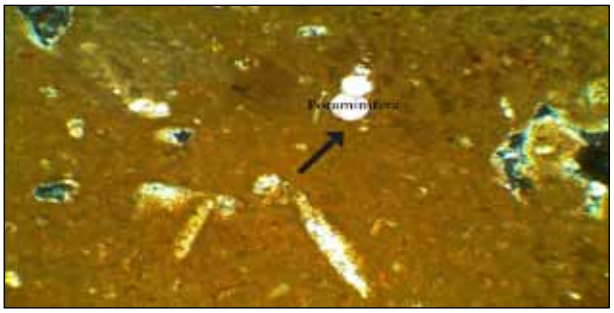

Fig. 10: XPL Polarizing light microscope picture (2.5 x magnifiers) shows a type of microfossils called Foraminifera.

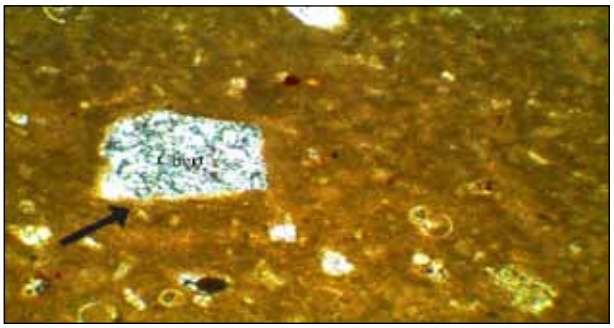

Fig. 11: XPL Polarizing light microscope picture (10 x magnifiers) shows small amounts of chert.

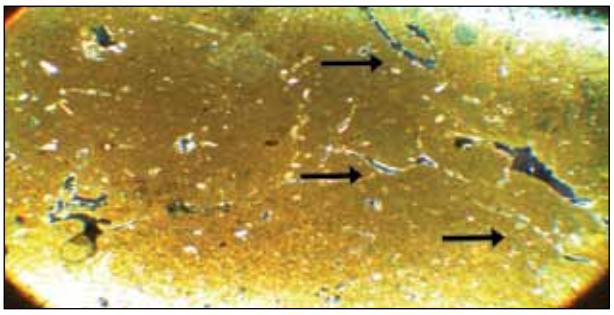

Fig. 12: XPL Polarizing light microscope picture (10 x magnifiers) shows micro-cracks in the sample.

A powder sample from the old plaster was taken from the back of the plastered skull by the scalpel, and then the sample was ground to very fine powder, after that 0.3 g of the sample was dissolved in 10% hydrochloric acid. The method was based on the measurement of CO2 volume developed by HCl reacting with the powdered plaster, the total carbonate present was obtained using formulae that took into account the pressure, temperature, amount of previously weighed sample, and the volume of CO2 developed which was as the follows:

CaCo3 in our sample = Volume of CO2 of the slandered sample / Volume of CO2 of our sample * 100% (Moropoulou, 2003).

After examining the sample we indicated that the concentration of calcium carbonate (CaCO3) is (87%), and non carbonate materials (13%).

2.3.4- soil pH test result:

Samples of soil were collected from the surface of the plastered skull during its cleaning. 2 g of the sample were immersed in a known volume of freshly prepared distilled water (10 ml) for a period of time, after that the pH electrode was immersed in the water, and then the pH value was reported.

pH value for soil sample was (8.9). Hence we concluded that the cause of keeping the plastered skull for a long time in the burial environment is due to its presence in the alkaline soil; it is known that the alkaline soil is more protective for bones and plaster than acidic soils which dissolve calcium carbonate (Abdel-Maksoud and Abdel-Hady, 2011).

3- Conservation processes

3.1- The cleaning process:

We start bone and plaster cleaning mechanically with light brushes and dental

tools. But for very hard dirt, we use chemical methods by using water and alcohol or acetones (the use of alcohol and acetone will facilitate object drying). We also combine mechanical and chemical methods to remove hard dirt (Tubb 1987). We soften the dirt chemically by water and alcohol, and then remove it mechanically by brushes and scalpels (Plenderleith, 1979), (Figs. 13- 17).

After skull and bone fragments were cleaned, they were laid out on a table to dry slowly. After that they were covered with a polyethylene sheet to reduce the evaporation rate and to prevent cracks from developing or other physical changes that may occur.(Abdel-Maksoud, 2009)

3.2- Removing previous Restoration:

Previous conservation work was removed by scalpel and spatula after documentation process by photography. The previous conservation works were wrong in terms of the materials that were used in conservation. Excessive quantities of lime plaster with steel bar were used without any benefit to install and display the skull, although it was possible to use other suitable materials and methods for this purpose (Fig. 18).

Excessive amounts of lime plaster were used incorrectly as an adhesive and as a material to complete the missing parts, but we should remove those (Figs 19-21).

3.3- Consolidation and coating of the plastered skull

After the plastered skull cleaning, we slowly dried it by organic solvents (acetone), then a 3% solution of paraloid B-72 was used for bone and plaster consolidation, (Brierley 2010). We used a brush to apply the resin, and applied a light layer of resin. After the first layer dried, we applied a second layer to get

Fig. 13. Maxilla before cleaning process.

Fig. 14. Maxilla during cleaning process.

Figs. 15a

Fig. 15b

Figs. 15 a, b: Maxilla during cleaning process by dental tools and cotton swap.

Fig. 16. Maxilla during cleaning process by scalpel.

Fig. 17. Maxilla after cleaning.

Fig. 18a.

Fig. 18b.

Figs. 18 a, b: The steel bar and lime plaster before their removal.

Fig. 19. The left part of the skull before removing the excessive amounts of lime.

Fig. 20. The left part of the skull after removing the excessive amounts of lime.

Fig. 21. The second part of the skull after removing the excessive amounts of lime that had been used to complete the missing parts of the nose.

sufficient absorption of the resin by the object to accomplish consolidation.

After that we isolated the skull by a 5% solution of paraloid B-72 before applying the coloring layer, (Tubb 1987).

3.4 - Gluing the broken parts:

After an experimental study on plastered bone samples to choose the best concentration of the adhesive that will be used, and after reviewing previous experimental studies by specialized conservators in the field of bone conservation, we decided on a thick viscous mixture of Paraloid B-72 dissolved in acetone (20 % concentration) to glue the broken parts (Tubb 1995), (Figs 22, 23).

3.5- Completing of missing parts

We used lime mixed with gypsum in a ratio of 1:3 for the completion of missing parts.

Fig. 22. The first and second parts of the skull after the gluing process.

Fig. 23. The second and third parts of the skull after the gluing process.

The missing parts were completed after being matched with the parts that were originally located in the skull. And we used lime mixed with a solution of paraloid B-72 (20%) to adhere and complete the missing parts between the broken pieces (Johnson 1994), (Fig. 24 a, b).

3.6- Coloring of the plaster

We used the acrylic colors dissolved in water for coloring the plaster with the same color as the original plaster but with a little difference that is unnoticed in the color degree. (Brierley 2010)

3.7- Support and display process for the plastered skull

We used plexiglass to support and display the plastered skull, (Fig. 25 a, b).

4- Conclusion and Recommendation:

Conservation of archaeological objects should be applied by a trained conservator, and no conservation processes should be applied unless the conservator is present.

- In showcases, suitable environment conditions must be provided to avoid any further damage and deterioration for archaeological objects, especially those that were subjected to former restoration and treatments.
- For dry bone and plaster consolidation, the best conservation material is to glue and coat them using Paraloid B-72 which is very durable, non-yellowing and has excellent resistance to water, alcohol, alkalis and acid. Paraloid B-72 also has an excellent flexibility, and is resistant to discoloration even at high temperatures. Furthermore, it dries with less gloss than PVA, Dammar and Bee wax.
- The cleaning process of the plastered skull

Figs. 24 a.

Figs. 24 b.

Figs. 24 a, b: These pictures show parts No 2 and 3 from the skull during the gluing process and completing process of missing parts between them.

Figs. 25 a.

Figs. 25 b.

Figs. 25 a, b: These pictures showing the old and new materials and method used to display the plastered skull.

had to start mechanically for the surface accumulated soil and salts, and cleaning by alcohol, acetone and water was used for the hard soil deposit.

- Air pollutant should be controlled by using filters that may be installed on the ventilating system (the fans) in the museum to stop the air particulate entering to the museum. Again, keeping the museum clean and show cases well sealed help minimize dust accumulation on the archaeological objects surface, (Ambrose. A, Paine. G. 2007).

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ملخّص: كشفت أعمال التنقيب التي جرت في العام ١٩٨٨م في موقع عين غزال – وسط الأردن، الذي يعود إلى العصر الحجري الحديث عن جمجمة بشرية مجصّصة، تمثّل قطعة أثرية ذات أهمية كبيرة؛ إذ إنها تقدّم نموذجاً لدراسة الطقوس الجنائزية السائدة في العصور القديمة في عين غزال وعدة مواقع أخرى في فلسطين وسوريا وتركيا. حالة الجمجمة المجصصة سيئة؛ لأن العظام وطبقة القصارة في حالة متدهورة، وهي هشّة، وبها الكثير من التشقّقات، وبعض أشكال التلف الأخرى التي تحتاج إلى علاج. أجريت العديد من التجارب لتحديد أفضل خليط من الجير والجص لاستخدامه في ملء الأجزاء المفقودة. ووفقا للفحوصات والتحاليل التي أُجريت اختيار الباحثون أفضل المواد في الترميم، وأجريت عمليات الصيانة والترميم المناسبة من إزالة أعمال الترميم السابقة غير المناسبة، وتنظيف الترسّبات السطحية، وتقوية العظام وطبقة القصارة، ولصق الأجزاء المكسورة، واستكمال الأجزاء المفقودة من الجمجمة، ولّونت طبقة القصارة الجديدة باللون المناسب. وأخيرا عُرضت الجمجمة في متحف التراث الأردني.

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