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EXPLOSION EFFECTS ON ARCHAEOLOGICAL GLASS, CONSERVATION AND PROTECTION STRATEGY

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Abstract

In 2014, Cairo, the Capital of Egypt waked up on a dramatic explosion in the Cairo Security Directorate building, which is opposite the Museum of Islamic Art; a disaster that damaged many pieces of monuments in the museum especially fragile ones. Many monuments of archaeological glass were broken due to the explosion, and the archaeological glass pieces were mixed up with the non-archaeological pieces of broken windows of the museum. On the other hand, the non-damaged glass monuments were unsafely exposed and needed protection. The first step for the conservation of the non-damaged glass monuments was to pack and move the objects to a safe storage area. Meanwhile, the damaged glass objects were collected carefully, placed in boxes, and moved to the conservation lab to separate the archaeological pieces away from non-archaeological pieces depending on the previous documentation.
The restoration process of the damaged objects started with the documentation, examination by SEM and LM, analysis by EDX and XRF, cleaning, assembling, and completion of the process. This Paper is a case study of the restoration of the museum damaged glass objects.

Key words: *Archaeolog;, Damaged glass; Explosion; Restoration; Protection; Conservation*

Introduction

When wars begin, cultural heritage experts focus on protecting movable or immovable cultural properties from damage, which is an important task to preserve national identity. The cultural heritage concept has expanded considerably in recent decades, and nowadays intangible cultural heritage is also considered relevant in representing the community's identity. In that sense, traditional manifestations and historic buildings [1], archaeological objects and others constitute the essence of the cultural heritage. Therefore, it is worth protecting this new category of cultural heritage during times of conflict [2, 3].

Over the years, cultural heritage is seen as an instrument for peace and reconciliation. Its protection and conservation can play a key role in rebuilding societies and overcoming the sense of loss and displacement caused by conflicts [4].

On 24th of January 2014, an explosion near the museum of Islamic art in Cairo Egypt caused damage of 170 archaeological objects, including 52 glass pieces.

The improper way the pieces were displayed in the museum increased the damage of the obejcts. For example, huge metal lamp was put over a showcase of the glass objects, which caused a crash of the glass objects and the glass showcase when it separated from the ceiling

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[5]. Also, the presence of solid objects with glass objects in one showcase and putting a glass objects showcase in front of the main door of the museum (Fig. 1).

Fig. 1. Problems in the way of the displaying of monuments

Fig. 2. The packing process of the non-damaged object

After the explosion, even undamaged pieces were at risk (Fig. 2a). Therefore, the crew had to pack them by bubble sponge and polyethylene and moved them to the warehouse (Fig. 2b and c) while the damaged objects were transferred to the conservation Lab.

As a result of the explosion, the archaeological glass pieces were mixed with the non-archaeological ones, and therefore, all pieces were sorted in boxes and transferred to the conservation laboratory.

The sorting process were done in steps; firstly, separating every object away from the other based on the type of decoration, thickness, break position and colour of glass pieces (Fig. 3A). Secondly, contacting the museum information centre to identify the numbers of the objects in each showcase and to obtain the pictures of objects before the explosion (Fig. 3B).

While the total number of damaged glass objects were 52 pieces, the restoration steps illustrated in this paper focues on one single case as an example. It is a glass ball dated back to the Mamluk Islamic Age (No. 20083), which was commonly used to decorate mosques. The ball was colored with blue and brown Mina (Fig. 4A), It was 13.5cm in height and 11.2cm in diameter. It was crashed to more than 60 pieces (Fig. 4B).

Fig. 3. Classification of every object separately

Fig. 4. The case before and after the explosion

The cleaning phase was meant to remove dust. The basic stage of the restoration of the object is the assembling step. The pieces were assembled depending on the decoration, thickness, and break position. Firstly, the base of the object was assembled, (Fig. 5A) followed by the body. It was first assembled using transparent tape then Araldite2020.

There were many missing pieces in different parts of the body that made the object weak, and it was completed using Araldite 2020. The assembling step was done with the completion step. The last missing part was made separately then installed in its place. Polishing was done earlier using Araldite 2020 followed by cutting and installing the pieces (Fig. 6A-D).

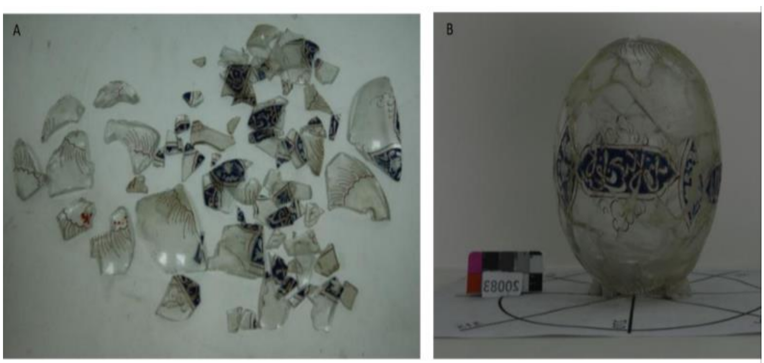

Fig. 5. The object before and after conservation

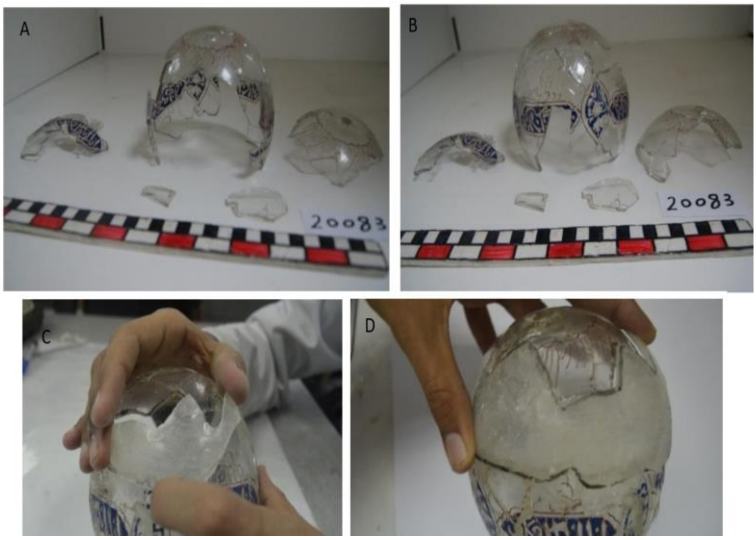

Fig. 6. The assembling and completion steps of the object

Figure 7 shows the image of the object after the restoration interventions, made in AutoCAD.

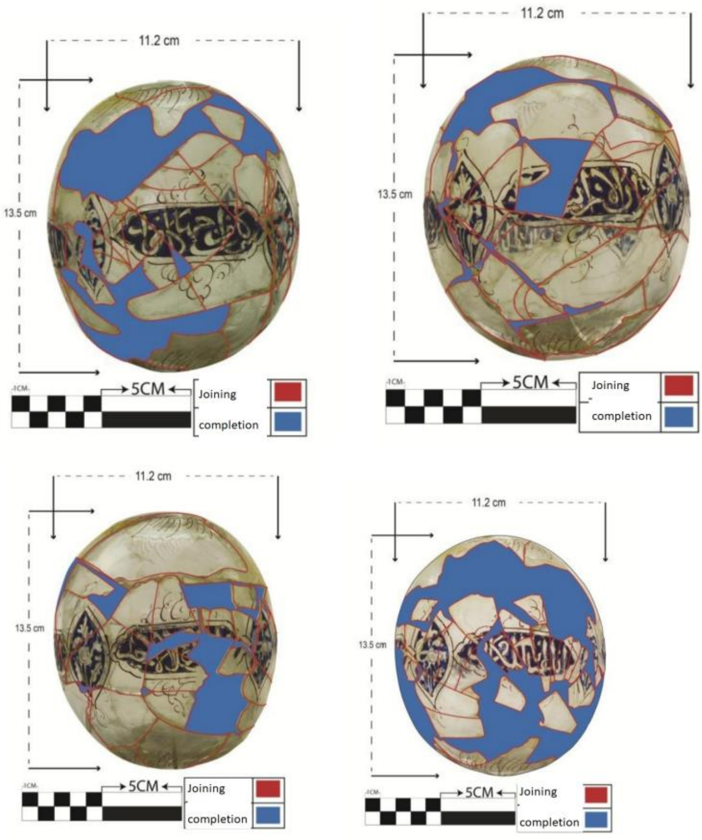

Fig. 7. The object by AutoCAD documentation after restoration

Material and Methods

The examination and analysis were performed on a glass piece with blue and brown Mina.

Scanning Electron Microscopy- Energy dispersive X-ray spectroscopy (SEM-EDX)

The SEM-EDX was used to determine the micro textural and micro chemical features of the glass. The SEM-EDX was performed with K550X scanning electron microscope equipped with an England microanalysis system (kV: 30.0, Tilt: 0.0, Take-off: 39.0, DetTypeSDD Apollo 40, Res: 132, Amp.T: 12.8, FS: 505, Lsec : 10).

X- ray fluorescence (XRF)

X-Ray Fluorescence by NITON XLP 300A/700A series was used to identify the elements of glass, blue and brown Mina. X-Ray Fluorescence was used to identify the elements in glass, blue and red Mina.

Results and Discussion

"Dealing with crises" First Aid to Cultural Heritage in Times of Conflict Specially the archaeological glass aims to create a critical mass of Professionals who can intervene effectively to secure cultural heritage in such times of conflict, and who can work with other actors to integrate this protection into overall planning for peace and recovery [6, 7].

There are currently many problems related to display in muses, who have contributed to the exacerbation of crises, for example: the display of archaeological glass artifacts along with other types of heavy solid archaeological objects, such as archaeological metals. These should be separated in the display [8, 9].

The need for complete documentation of the archaeological artifacts in the museum, which will mainly help in restoration and protection, is necessary [10, 11].

Either Mina samples showed the typical amorphous background of glasses in which no crystalline phase is present. This fact could also indicate that no industrial mistakes were induced in the pyre stage [12, 13].

Scanning Electron Microscopy- Energy dispersive X-ray spectroscopy (SEM-EDX)

Regularly, glass production process involves melting Silica constituent (e.g., quartz, sand, crushed quartz pebbles etc.) with a fluxing agent (e.g., potassium, sodium or alumina oxides) and with additional calcium-rich material, such as limestone, seashells or marble powder [14-16] (Fig. 8).

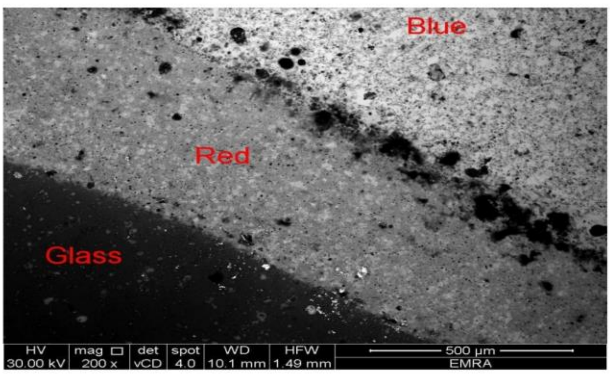

Fig. 8. SEM image for glass, red Mina and blue Mina

The stability is due to the presence of CaO, increasing the coupling of the vibrational modes of the silica no bridging oxygen (Table 1) modifier bonds to the bridging of the Si–O–Si network [17-19].

Table 1. Shows chemical composition of the samples with EDX analysis

Elements-wt%	Na	Mg	Al	Si	Cl	K	Ca	Mn	Fe	Pb	Zn	Cr	P
Glass	9	3.82	1.69	70.24	0.78	4.21	9.51	0.76	-	-	-	-	-
Red Mina	1.05	-	0.35	20.88	-	2.81	3.37	-	18.72	31.99	-	-	2.54
Blue Mina	2.68	-	4.09	22.10	-	0.85	0.52	-	0.35	44.45	4.27	0.70	0.17

The Fluorescence Spectroscopy (XRF)

X-ray flouresence shows the result shows that the main component of the sample is silica and lead component compound and sulfur with a significant presence of chlorine in addition to the presence of other elements in proportions. The biggest simple is calcium, zinc, and potassium. The result of the analysis shows that cobalt is responsible for the blue color in the blue enamel sample [20-22]. It appears that the main component of the sample is silica element and sulfur element in addition to Lead element, noting that the sulfur element in the red enamel sample is present.

At a rate lower than that of the blue enamel sample [20-23]. The presence of iron oxide indicates the use of ferric oxide, which is given red colour (Fig. 9).

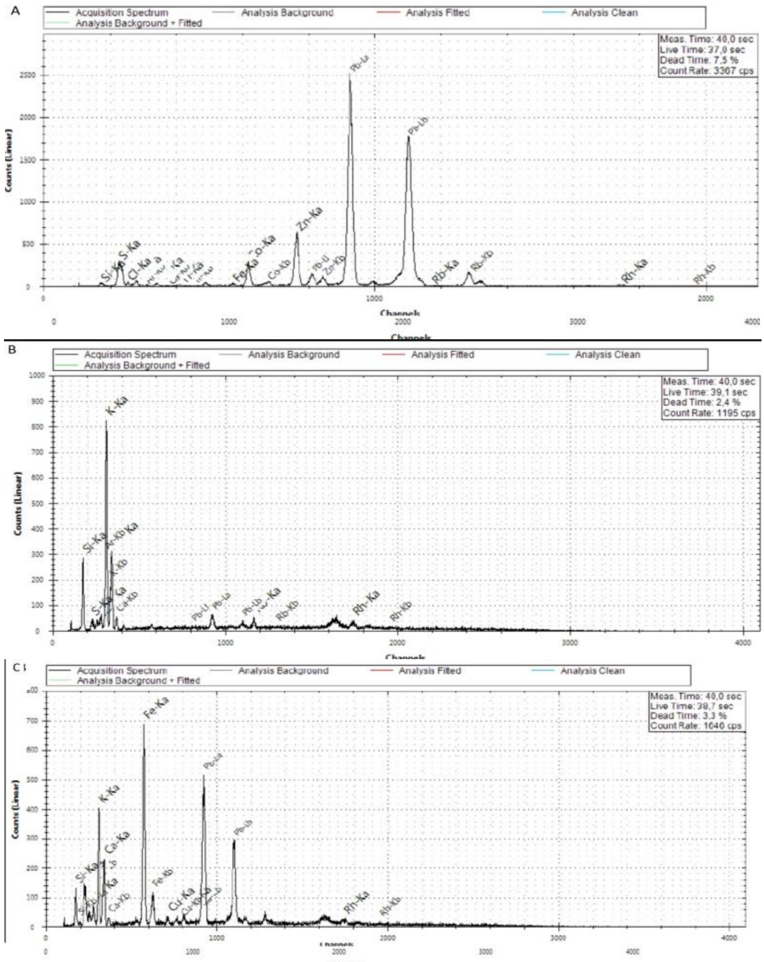

Fig. 9. Chemical composition of the samples obtained by (XRF)

Table 2. Shows chemical composition of the samples obtained by (XRF)

Elements- wt%	Si	Cl	K	Ca	Fe	Pb	S	Cu	Zn	Co	Ti
Glass	72.7	-	16.54	4.02	-	1.78	5.05	-	-	-	-
Red Mina	63.93	-	0.03	0.01	0.65	11.17	24.19	0.02	-	-	-
Blue Mina	41.29	5.77	0.49	1.17	0.07	8.61	40.47	-	0.97	0.7	0.18

Conclusions

Crisis Like explosion may happened in any times around the world, no one can stop or control it. Therefore, the archaeological glass should be displayed in showcase away from the heavy artefacts. The modern digital documentation (MDD) should be used for the documentation process for each archaeological object. The damaged objects moved to conservation lab while the non-damaged one backed and moved to the museum stocks. The archaeological fragment separated from the non-archaeological one due to the previous documentation.

The restoration process illustrated here is for one case as an example; it shows a glass ball (No. 20083), that has been crashed to more than 60 fragments because of the explosion. The cleaning phase was just to remove dust. The basic stage of the restoration of the object is the assembling step, the assembling step was done with the completion step. The examination and analyses were performed on a glass piece with blue and brown Mina and then inserted into the object. The SEM-EDX and XRF were used to study the object. The main component is SiO_2, the glass network-forming oxide, such glass pieces can be classified as (Na_2O-K_2O–CaO–SiO_2) glass. Iron Oxide and Chromium Oxide were used to colour brown Mina, while Cobalt Oxide was used to colour blue Mina.

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