The Authentication and Characterization of the Syrian Glass Lamps Dating to the Mamluk Period A Scientific Analysis

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Abstract. *Islamic mosque-glass lamps are considered one of the masterpieces produced by the Muslim glassmakers during the Mamluk period. Syria was the famous country of glassmaking and glass lamp production throughout the Islamic period and exported those glass products to every part of the Islamic world. Authenticating and distinguishing those objects from parallels produced or found in other countries, especially Egypt, appears to be the main problem facing archaeologists and art historians. This paper presents advanced scientific techniques for chemical analysis of ancient glass lamps and will help authenticate those glass lamps. It can be concluded that the use of defined raw materials for glass manufacturing reflects the origin of those glasses. The Syrian mosque-glass lamps from Mamluk period can be authenticated and distinguished from non-Syrian parallels, by the characteristic chemical analysis using non-destructive methods such as, EDX, XRF and AAS, rather than relying on stylistic and aesthetic considerations.*

Introduction

The Mamluks were originally Central Asiatic tribesmen who were slaves and bodyguards to the Ayyubids; a Kurdish dynasty ruling Egypt and the eastern Mediterranean in the 12th and 13th centuries. After the fall of that state in 1250 AD, the Mamluks established a powerful empire, which included Egypt, Syria, Palestine, Southeast Anatolia, and south Arabia, controlling the region for over two hundred and fifty years. They halted the Mongol advance and expelled the last crusaders from the near East. Their piety was reflected in the great religious complexes and beautiful works of art they commissioned. This religious zeal made them generous patrons of architecture and art (Mack et al., 2005).

Mamluk history is divided into two periods based on different dynastic lines: the Bahri Mamluks (1250-1382 AD); of Qipchaq Turkic origin from southern Russia, named after the location of their barracks on the Nile (al-bahr, literally "the sea", a name given to this great river, and the Burji Mamluks (1382-1517 AD), of Caucasian Circassian origin, who were quartered in the citadel (al-burj, literally "the tower"). After receiving instruction in Arabic, the fundamentals of Islam, and the art of warfare, slaves in the royal barracks were manumitted and given responsibilities in the Mamluk hierarchy. Mamluk period has an industrial advantage especially in glassmaking.

Syria was famous for its glass lamps. Remains of glassworks of the highest antiquity has been found at Raqqa/Ar raqqah; Halab/Aleppo; and Dimashq/Damascus, which are well-documented ancient industrial Islamic centers in Syria, especially in the Mamluk period (Mcloughlin et al., 2005) (see Map 1). It was in Syria during the thirteenth and fourteenth centuries that the most glorious glass lamps were produced. In Aleppo and then Damascus glass was produced on a wide scale. Skillfully cut and engraved products, luster-painted glass and spectacular ena-

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Map 1: Showing the main centers of ancient glass making in Syria during Mamluk period.

meled and gilded glasses distinguished the style of Syrian glass in the Mamluk period. This glass was traded all over Euro-Asia, and within Muslim countries (Esther, 1919).

Among the Syrian glass objects, which were decorated and traded, there were sprinklers, globes, footed bowls, beakers, long-necked bottles, and mosque lamps (al-mishkat; literally "the niche" a name given to this great object). Mosque lamps (really lanterns), for use in mosques and schools, were particularly beautiful and important, the nearest equivalent in their symbolism and widespread use is the growth of stained glass in west European Churches. They are really containers for oil lamps, which would have been hung high, suspended from the roof of the mosque by metal wires, or chains, which ran through the loops around the belly. The production of the most beautiful glass lamps in the world continued until about 1400 AD. The decorated glass lamps of Damascus were especially famous and examples of Syrian glass were exported to the Far East and Europe (Tait, 1991).

As the major cities in the Mamluk period were endowed with commercial buildings and religious foundations, these buildings and foundations also were endowed with great collections of glass lamps. These lamps have frequently been endowed for religious foundations such as mosques and schools (madrasas). It was stated that the Umayyad mosque in Damascus was endowed with a great collection of these glass lamps, which are preserved now in the National Museum in Dimashq and in some international museums as masterpieces.

These objects were used as containers or holders of illumination instruments, and were controlling the distribution of light inside the building. They represented an advanced stage of development of illumination instruments during the Mamluk period in Syria and other Islamic regions. Therefore, because of religious importance, they were carefully made, and professionally decorated with religious inscriptions (Macfarlane and Martin, 2002). They illustrated the words of The Holy Koran as the Verse of Light: "Allah is the light of the heavens and the earth. The likeness of His light is as a niche, in which is a lamp. The lamp in a glass, the glass as it was a shining star". They also were decorated with historical inscriptions, which state that these lamps were ordered for the Sultans and Emirs to endow for religious foundations.

Hypothesis of the research

Under the Mamluks' government, Syria and Egypt were one region; so many vessels of similar quality and decoration were made in Syria in the fourteenth century for the magnificent new mosques of Cairo in Egypt, the centre of Islamic power at that time. Members of a warrior caste, like Emir Shaykhu, rose to positions of great political power, particularly in Egypt. They were generous patrons of architecture, and their mosques and monasteries were decorated with fine wares, many of them produced in Syria. Enameled and gilded glass lamps were a particular specialty of Syrian craftsmen in the Mamluk period. Emir Shaykhu was a powerful figure in mid fourteenth century in Cairo; between 1350 and 1355 AD, he endowed a magnificent mosque and a college in the city. Most likely many of their glass lamps were produced and come from Syria (Tait, 1991).

Several international museums around the world are rich in great collections of mosque-glass lamps. These lamps are, with doubt, dated to the thirteenth and fourteenth centuries AD, and are referred to the Mamluk period. Unfortunately, in most cases, archaeologists are unable to authenticate them and attribute them to their original birthplace or the place of manufacture, especially when they appear completely similar to the Egyptian parallels. So the conjectural authenticating, based on the shared probability, is commonly used for referring them to Syria or Egypt, as a temporal solution for this complicated problem. The following photographs as listed in Figures 1 to 8, along with their attached comments clearly show the confusion that occurs in the documentation process of these objects. This confusion makes the historical information obtained from these archaeological sources suspect and doubtful.

Art historians, archaeologists and conservators are constantly concerned with the questions of where, when and by whom an object was made. Stylistic considerations combined with aesthetic evaluations and comprehensive archive studies can usually provide answers. However, styles were sometimes copied at locations and times completely different from those of their origin, and then investigations of the physical properties and chemical composition of the artifacts are helpful and increasingly applied to allocate an object to a particular historic context, to determine the correctness of the claimed provenance or to explore the technology used for the manufacturing.

Depending on some artistic and technological features, archaeologists used to originate and characterize these glass lamps. From our point of view, this is inadequate means, numerous confusions are occuring because some Egyptian glasses were either fetched from Syria or possibly, manufactured in Egypt by Syrian glassmakers. So it was necessary to put an end to these confusions. The characterestic chemical analysis is the sole means for solving this complicated problem. It is now one of the most important assistant applied sciences for archaeology and history.

According to the Venice Charter (1964), the assistant applied sciences such as conservation and chemical analysis are highly specialized operations; their aims are to preserve and reveal the aesthetic and historic values of the monument and clarify the ambigious evidence. They are based on respect for original material and authentic documents. It must stop where conjucture begins. The process of chemical analysis in any case must be preceded and followed by an archaeological and historical study of the monument.

In recent years, several studies on Syrian glass of analytical interest have been performed. Nevertheless, some questions concerning the origin of the raw materials are still open, and some issues involving their production technology are not yet solved. It was claimed that Mesopotamia (modern dayes Syria) or Egypt was the birtplace of glass production (Newton and Davison, 1989). On the other hand, Yamahana mentioned that glass manufacturing was one of the new technologies that were introduced by Syria to other countries such as Jordan and Egypt. After that, Egyptians began to make their glass products locally using regional raw materials (Yamahana, 2000).

It has been recently suggested that the chemical distinction between Egyptian and Mesopotamian glass reflects the use of Egyptian raw materials for making these glasses which is different from those used for making glass in Syria. It is also possible that those glasses are manufactured by Syrian workmen in Egypt. According to recent studies (Rehren, 2004 and Abd-Alla, 2006), it was assumed that Egyptian glasses were made using local raw materials: sands, lime, and mineral natron from the Wadi Natrun as the main alkali source, whereas Mesopotamian glasses were made using local raw materials also: sands, lime, and plant ash as the main alkali source. In general, the Egyptian glass is identified as soda-lime-silica glass whereas the Syrian glass is identified as potash-lime-silica glass.

As emphasized above, the hypothesis of the present study stems from and is based on the latter point. The greatest problem, which hampered and retarded the application of this idea for many years, is that the most available, traditional techniques of chemical analysis such as wet chemical analysis was destructive of glass objects, need substantial amounts of glass as samples, highly trained analysts, and require preliminary dissolution of the glass with hydrofluoric acid or fussion with sodium carbonate. Therefore, it was impossible to apply those, especially on the

Fig. 1.

Lamp, Mosque, ca. 1285;
Mamluk period (1250-1517)
Attributed to Egypt or Syria
Glass; free blown, enameled and gilded;
tooled on the ponytail
H: 10 3/8 in. (26.4 cm) W: 8 1/4 in. (21 cm)
Gift of J. Pierpont Morgan, 1917 (17.190.985)
Metropolitan Museum of Art, NY-USA.

Fig. 2

Mosque lamp Attributed to Egypt or Syri
late 13th century (before 1285)
(Art Museum Images from Cartography AS-sociates)
The AMICA Library
Los Angeles- California - USA.

Fig. 3

Enameled and gilt glass lamp
Egypt or Syria
Fourteenth century AD.
H. 35 cm; Diam. 31 cm (max.)
Inv. no. 1060
Museu Calouste Gulbenkian
Istanbul -Turkey.

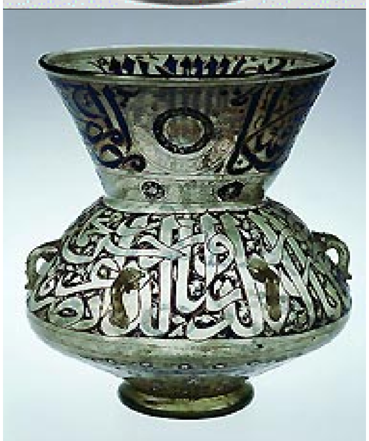

Fig. 4

Lamp
Egypt or Syria
1340-1350 AD
Glass, blown, enameled and gilded
Height: 27.8 cm
Diameter: 25.9 cm
Museum of Islamic Art in Doha- Qatar

Fig. 5

Glass Lamp -Mid-14th century

Glass, enamel and gilt. A typical example of Egyptian articles of the 13th and 14th centuries, this marvelous glass lamp is decorated with multicolored enamel and an inscription including the name of the person who commissioned it. In addition, characteristic of the time is the enamel pattern between the medallions on the body of the lamp. Such lamps were suspended on chains, and a candle or a wick with oil were placed inside it.
Hermitage Museum, Petersburg- Russia.

Fig.6

Glass lamp-holder for a mosque
Syria/Egypt, 1300-1325
This lamp is one of the finest pieces in the Gemeente museum's rich collection of Islamic objects. According to the flowing Arabic inscription, it was made to order for army inspector and head of the Mamluks, Emir Sjams ud-Din. It is no coincidence that the neck is surrounded by a verse from the Koran reading 'Allah is the Light of heaven and earth etcì..'
Gemeente Museum- Holland.

Fig. 7

Mosque Lamp

Syria or Egypt?

15th century (?Ak Koyunlu dynasty, 1402 - 1502)

Glass, polychrome enamel and gold

The William A. Whitaker Foundation Art Fund, 97.13

England .

Fig. 8

Mosque Lamp
Egypt, probably made in Syria
Mid 14th Century AD.
Glass, enameled and gilded
Around the loops on these glass lamps a second inscription identifies the Islamic potentate for whom it was made: "By the order of the noblest authority, the Exalted, the Lordly, the Masterful, holder of the sword, Shaykhu al-Nasir
Museum of Islamic Art in Cairo, Egypt.

complete objects such as those lamps illustrated in the previous figures, only in the case of less valuable glass fragments, can they be allowed and viable.

At the beginning of the 20th century, microchemical techniques and spot tests were developed, which significantly reduced the amount of sample material necessary for the analysis. A specific advantage of the classical micro-chemical analytical tests is that they provide information on both inorganic and organic constituents. The greatest disadvantage of requiring a separate sample for each identification could be overcome by using several separation techniques. Therefore, it is not surprising, that a number of museum and scientific laboratories specializing in the investigation of materials and techniques used for works of art were established in the first decades of the 20th century (Mantler and Schreiner, 2004). Howerver, the invention of such non-destructive instrumental techniques for analysing archaeological materials encourages conducting experiments on the glass lamps as a scientific method for distinguishing and authenticating the Syrian glass lamps according to their characterestic chemical composition which reflects the use of Syrian raw materials for making these glass lamps in the Mamluk period.

The most accurate and non-destructive methods used for analysing ancient glass lamps are:

X-ray fluorescence spectrometry (XRF)

XRF is one of the most important and widely used non-destructive techniques in the analysis of works of art and historical materials because it is rapid and accurate, and can be carried out on equipment that is available commercially (Newton and Davison, 1989). Furthermore, this system is used for qualitative and quantitative analysis of a wide range of archaeological, crystalline and amorphous substances. Moreover, XRF instruments are able to detect all elements with an atomic number of about 11 and above (Shugar and Rehren, 2001). The earliest use of XRF in this field dates from the early 1970. During the last 15 years, a great technological effort has been made to develop semiconductor detectors, miniaturized x-ray tubes and electronic equipment, and it now allows one to perform analyses with small and portable equipment. Since some works of art, such as mural paintings or mosaics, statuary, and other large-scale objects, cannot be examined in the laboratory, in addition to those that are valuable and complete objects such as glass lamps in the present study that cannot be sampled, portability has added significantly to the efficacy of the technique. The portable XRF technique gives the best results when used in conjunction with other investigative techniques, and can be used non-destructively on objects directly (Buyes and Oakley, 1999; Moioli and Seccaroni, 2000; Mantler and Schreiner, 2000; and Nishiwaki et al., 2006).

Energy dispersive X-ray Spectroscopy (EDX)

This technique is non-destructively used to determine the elemental compositions of glass, the energies appear as peaks on a video monitor; the positions of the peaks indicate the chemical elements, and the heights of the peaks measure their concentrations. A computer program assists in the interpretations and makes allowance for the mutual interferences of certain elements (Newton and Davison, 1989). This technique has two advantages: its qualitative and quantitative determination, and it just requires a very small glass as a sample, which could be placed back again in its original place without any decay.

Electron Microprobe Analysis (EMPA)

The electron microprobe can either be used with the SEM or separately. It can be used on broken surface, or cut sections, of glass in order to obtain a chemical analysis from a very small area, using principles like that of X-ray flourescence (XRF) except that electrons are used as the exciting radiation instead of X-rays. The disadvantages are that it analyses the surface layer only; lighter elements are harder to measure than heavier ones, and alkali elements can be forced deeper into the glass by the charge of the electron beam. However, the electron beam methods are useful for determination of spot compositions in small glass samples, and provide the type of rapid major and minor element data that are the most useful for answering ancient glass questions (Mass et al., 2001).

Atomic Absorption Spectroscopy (AAS)

The atomic absorption spectroscopy (AAS) was used for quantitative analysis. This method happens to be the most accurate available for determining elemental composition and concentration in the sample. It is also intensive to certain elements, and each element must be analyzed individually. This technique was preferred since it required a small amount of the samples to be taken. A number of features make this particulr method well suited for archaeological specimens; among these are: the method's versatility: it is able to detect over 65 different elements, its sensitivity identifies and determines the percentages of elements concentrated in the sample; its accurancy appears in determining elements in a sample as small as 10 mg; and finally the method is efficient in giving concentration readings for a solution in a relatively short time (Sababha, 2000). The disadvantage of this technique is that it destroys the sample during the analysis; to overcome this problem, unvaluable glass fragments should be used (Buyes and Oakley, 1999).

Experimental work

Glass Samples

It was difficult to obtain samples from complete glass lamps, therefore collecting unvaluable fragments of incomplete glass lamps was the sole means to solve this problem, and to achieve the desired results. Seven archaeological fragments of Syrian mosque-glass lamps have been collected. Three of them (samples 1-3) are stored at the museum of islamic art in Cairo, and conjecturally are decumented as Syrian glasses from Mamluk period (7-8 cent. AH/ 13-14 cent. AD). The other four samples (4-7) have been collected from the archeological finds discovered at ruins of Raqqa; the ancient industrial islamic site situated in northern Syria (see Map 1). They have been excavated with considerable amounts of glass and glassmaking debris as part of the Raqqa Ancient Industry Project. According to the date determined by archaeologists, they are referred to the Mamluk period (8-9 cent. AH/14-15 cent. AD). All these glasses are blowed, transparent, colourless, and enameled. The description of these glasses is given in Table 1.

These samples are prepared for analysis in three forms: for EDX analysis, very small samples were required; for XRF analysis, the samples were finely powdered; and for AAS, the samples were prepared as solutions with standard. It must be noticed that the chemical

Sample No.	*Location (Source)*	*Date/ Cent. AD.*	*Visual description*
1	Islamic Museum in Cairo	13th -14th	Fragment of transparent, colorless and enameled glass lamp
2	Islamic Museum in Cairo	13th -14th	Fragment of transparent, enameled and gilded glass lamp
3	Islamic Museum in Cairo	13th -14th	Fragment of transparent, colorless and enameled glass lamp
4	Raqqa ruins in Syria	14th -15th	Fragment of transparent, colorless, enameled and gilded glass lamp
5	Raqqa ruins in Syria	14th -15th	Fragment of transparent, colorless and enameled glass lamp
6	Raqqa ruins in Syria	14th -15th	Fragment of transparent, colorless, gilded and enameled glass lamp
7	Raqqa ruins in Syria	14th -15th	Fragment of transparent, colorless and enameled glass lamp

Table 1: The visual description of the selected glass samples.

analyses are restricted to only undecorated glass surfaces, enameled and gilded are not included.

Analytical methodology

As the obtained glass samples are varied in their shapes and sizes, three techniques of analysis have been chosen: EDX, XRF and AAS. The choise of these techniques depended on their advantages as non-destructive methods that are appropriate for the case of glass fragments.. An EDX unit (model Philips XL30) with accelerating voltage 30 K.V, at the Department of Earth Sciences, Yarmouk University in Jordan, was used for determining the chemical composition of the samples 1, 2 and 6. An atomic absorption spectroscopy (AAS Perkin-Elmer model 2380) with air-acetaylene flam, at the same department was also used to determine the chemical composition of samples 3 and 7. A portable XRF equipment (model Minipal 2) at Faculty of Archaeology and Anthropology, Yarmouk University in Jordan, was used for microanalysis to determine the chemical compositions of samples 4 and 5.

Results and Disscusion

The results of chemical analyses of the selected glasses, obtained qualitatively and quantitatively by the three techniques mentioned above (EDX, AAS and XRF) are demonstrated in Table 2.

As shown in Table 2, the results of analyses indicate that the major components of these glasses are silica (SiO_2 avg. 71.58%), potash (K_2O avg. 14.82%) and lime (CaO avg. 7.08%). Therefore, these glasses can be classified as potash-lime-silica (K_2O-CaO-SiO_2) glass, the common type of the region of Mesopotamia for more than two thousand years (Shugar and Rehren, 2001).

This composition revealed that the main raw materials from which these glasses were manufactured are quartz sands, which most likely had been fetched from the Syrian coast as a source of silica, lime as a source of calcium, and plant ash as a source of alkali (potash). According to previous studies on Syrian glass, it is further affirmed that the sand of the Syrian coast contains a ratio of lime (CaO avg. 8.7 %), which very proportionally matches the ratio of the analyzed samples of mosque lamps.

The sand at the mouth of the river Byblos on the Syrian coast was reputed over centu-

Sample No.	Analytical method	Oxides (Wt. %)								
		SiO_2	K_2O	CaO	Na_2O	Fe_2O_3	MgO	MnO	Al_2O_3	Cl_2O
1	EDX	71.80	15.17	7.33	-	0.47	3.12	1.37	1.06	0.13
2	EDX	71.26	14.25	8.43	1.46	-	3.33	0.65	0.20	0.42
3	AAS	71.70	16.38	5.69	0.35	1.65	2.42	0.54	0.73	-
4	XRF	72.71	13.52	7.61	0.18	1.13	3.28	0.36	1.21	-
5	XRF	72.15	13.90	6.42	0.73	1.35	2.97	1.12	1.33	-
6	EDX	69.91	15.70	7.02	-	1.36	4.04	0.89	0.99	0.09
7	AAS	71.57	14.83	7.09	0.47	1.65	3.20	0.57	0.53	-

Table 2: The chemical compositions of the glass samples obtained by various analytical methods (EDX, AAS and XRF).

ries (Sababha, 2000 and Rutten et al., 2005). The use of plant ash as a source of alkali instead of soda may be due to the difficulty of obtaining natron salt from Egypt. On the other hand, it was assumed that these regions are rich in marine plants (maritime plants) which, when burned, turned to ash containing a countable amount of potash and magnesia, in a similar way to wooden ash production. Therefore, analyzed glasses have high content of potash (K2O avg. 14.82%) and magnesia (MgO avg. 3.19%). Soda (Na2O avg. 0.45%) in these glasses appears to be an impurity rather than intentional addition. These chemical results indicate that the mineral salts of natron, which have been used in Egypt as alkali, had absolutely not been used here. Furthermore, these glasses were made in Syria by using local raw materials, even though some of them were found in other countries, especially Egypt.

Conclusions

Within the limits of this study, it can be concluded that:

1. The glass lamps considered masterpieces were produced in Syria and Egypt as lighting instruments. They were endowed for religious foundations in the Mamluk period. Now they are regarded as the most imoprtant glassworks of the Islamic period.

2. Authenticating and distinguishing these objects from parallels in other countries such as Egypt, represents the main problem facing the archaeologists and art historians. Much confusion has occurred due to the complete similarity between them and those in other countries, particularly from the artistic and technological features.

3. Chemical analysis of ancient glass can determine the raw materials utilized in the manufactureing of glass, which gives a clue to its origin. This kind of information has the potential to characterize ancient glass technologies in new ways. It could also provide a means of distinguishing between the Syrian glass lamps made in Syria during the Mamluk period and the non-Syrian ones, particulary those parallels made in Egypt during the same period.

4. This study is in agreement with previous studies, which confirm that the K_2O-SiO_2 system glass be regarded as the main composition system of the ancient Syrian glass of any typology and forms, especially during Mamluk period, in which the glass lamps had been widely produced and traded all over the Islamic countries.
5. Chemical analysis, rather than stylistic and aesthetic considerations, appears to be the only means that answers all questions concerning authenticating and dating doubtful Syrian glass lamps, which are still exhibited with conjectural or doubtful registrations in some international museums.

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ملخص: يناقش البحث الدور المهم لطرق التحليل العلمي الكيميائي الحديثة، في كشف الغموض فيما يتعلق بإشكالية تأصيل المشكاوات الزجاجية الإسلامية التي صنعت في سورية في العصر المملوكي وتمييزها عن مثيلاتها غير السورية، في البلدان المجاورة، خاصة مصر؛ نظراً للتشابه التقني والفني بينهما، إلى درجة جعلت من تأصيل هذه المشكاوات وتمييزها أمراً بالغ الصعوبة، نظراً لأنها صنعت في فترة زمنية واحدة، وطبقاً لأصول فنية مماثلة. ومن المحتمل أنها كانت تصنع في مصر من قبَل صُنّاع سوريين ، أو إنها، على الأرجح، كانت تستورد من سورية إلى مصر. وتحتفظ العديد من المتاحف العالمية بمجموعات قيّمة من تلك المشكاوات، غير أن اللغط ما يزال حادثاً في توثيقها؛ وما يزال تأصيلها أمراً بالغ الصعوبة، ما يجعل من الإعتماد عليها بوصفها مصادر تاريخية، أمراً محل شك وخلاف. غير أن هذه الدراسة أسدت منهجاً علمياً تطبيقياً لتأصيل هذه المشكاوات وتمييزها، من خلال الإفادة من معطيات العلوم التطبيقية المساعدة لعلوم الآثار وصيانتها، وذلك باستخدام طرق التحليل العلمي الكيميائي الحديثة، خاصة غير المتلفة منها، مثل: طريقة تشتت الأشعة السينية (EDX)، وطريقة تفلور الأشعة السينية (XRF)، وطريقة الإمتصاص الذري (AAS)، والتي من خلالها يمكن تحديد مجموعات التركيب الكيميائي المميز للزجاج السوري، والذي يعكس طبيعة المواد الخام الأساسية المحلية المستخدمة في صناعة الزجاج في سورية، خلال تلك الفترة التاريخية؛ ومن ثم، يمكن تأصيل تلك القطع الأثرية المهمة والنادرة وتمييزها بأصالتها السورية بما لا يدع مجالاً للشك.

Note:

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