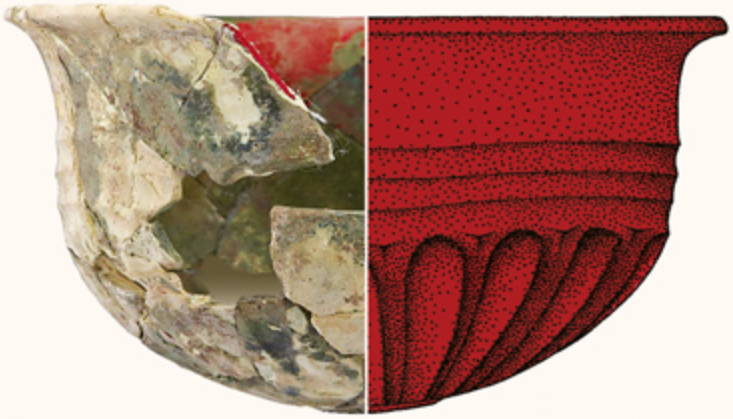
ANNALES



Thessaloniki 2009

du 18e CONGRÈS

de l'ASSOCIATION INTERNATIONALE
pour l'HISTOIRE du VERRE

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Editors
Despina Ignatiadou, Anastassios Antonaras

Thessaloniki 2009

Couverture / Cover illustration

The *haematinon* bowl from Pydna. Height 5.5 cm.

The bowl (skyphos) is discussed in the paper by Despina Ignatiadou 'A *haematinon* bowl from Pydna', p. 69.

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PRÉFACE

Marie-Dominique Nenna

J'ai le grand plaisir de vous présenter les Annales du 18e congrès de l'Association Internationale pour l'Histoire du Verre et je tiens à remercier tous ceux qui ont fait que cette publication paraisse dans les meilleurs délais, les auteurs au premier chef, le comité de lecture et surtout les éditeurs du volume, Despina Ignatiadou, vice-présidente, puis membre du bureau de l'AIHV durant les années 2006-2012 et Anastassios Antonaras.

Le 18e congrès de l'AIHV s'est tenu à Thessalonique du 21 au 25 septembre 2009. Il a été dédié à Clasina Isings qui est venue, via une video, nous offrir ses meilleurs vœux au début des sessions. Tous nos remerciements vont d'abord au Musée archéologique de Thessalonique qui a organisé l'ensemble de cette manifestation et au Musée de la civilisation byzantine qui a accueilli nos sessions dans le tout nouveau auditorium, utilisé pour la première fois pour notre congrès. Remercions aussi les amis du Musée archéologique de Thessalonique qui ont soutenu ce congrès avec entre autres, le beau sac décoré de balsamaires-oiseaux ; la préfecture de Thessalonique qui nous ont accueillis à la fin de ces journées. Et enfin, du fond du coeur, tous nos remerciements vont à Despina Ignatiadou, Anastassios Antonaras et au comité d'organisation pour avoir réuni tous leurs efforts pour organiser ce congrès et nous offrir l'occasion de nous rencontrer une nouvelle fois pour partager nos découvertes et nos réflexions sur ce matériau qui nous passionne tous.

Durant les trente-trois sessions organisées en parallèle, 95 contributions orales et 55 posters ont été présentés, montrant ainsi la vitalité de la recherche sur l'Histoire du Verre dans l'ensemble du monde scientifique. Grâce au dynamisme du comité grec, après une découverte de la ville à l'orée de notre congrès, des promenades thématiques ont été organisées afin de mieux connaître les différents aspects de Thessalonique, ville hellénistique et romaine, ville byzantine, ville ottomane avec son importante communauté juive et ville du xxe siècle. En outre, les excursions post-congrès ont permis aux participants de découvrir le cœur de la Macédoine avec les cités de Vergina et de Dion, ainsi que le lac de Pikrolimni, producteur de natron dans l'Antiquité et encore aujourd'hui, les villes d'Amphipolis et de Philippes ou encore de faire une croisière autour du Mont Athos.

Ce volume réunit 84 contributions qui couvrent un arc chronologique très vaste depuis le deuxième millénaire av. J.-C. jusqu'à nos jours, et touchent à tous les aspects de l'histoire du verre, avec une bonne interconnexion entre l'archéologie, l'histoire de l'art et l'archéométrie. Une part importante est réservée aux débuts de l'histoire du verre au iie millénaire et au début du ier millénaire av. J.-C. et à ses développements

dans le monde hellénistique avec des communications portant sur le Proche-Orient, l'Égypte et le Soudan, la Grèce et la Turquie. Les mondes romain et byzantin sont abordés selon deux axes : étude de la production et de la consommation de la vaisselle et des ornements et étude en fort développement de l'emploi du verre dans les mosaïques pavimentales et pariétales. Les communications sur le monde islamique s'inscrivent dans la lancée inaugurée au 15e congrès et attestent la vitalité de la recherche dans ce domaine. La présentation de découvertes et études portant sur la Grande Bretagne, l'Italie, le Kosovo, le Montenegro, le Portugal, la Pologne, la Roumanie, la Serbie et la Tchéquie alimentent le débat sur le verre à l'époque médiévale et post médiévale en Europe. XVIIIe et XIXe siècles ne sont pas en reste, avec des communications sur le verre dans les toits, les fleurs de verre et le verre mosaïqué et on dispose aussi de communications sur le verre en Chine méridionale et en Afrique subsaharienne.

Lors de l'assemblée générale, le bureau de l'AIHV a été renouvelé. Jan Egbert Kuipers, trésorier et Ian Freestone, que l'on doit remercier pour leur dévouement et leur efficacité, ont présenté leur démissions. De nouveaux membres ont été élus : Irena Lazar, organisatrice du 19e congrès en 2012, comme vice-présidente et Huib Tijssens, comme trésorier. Déjà présents dans le bureau, Despina Ignatiadou a été élue comme membre, Jane Spillman a été réélue comme secrétaire général, David Whitehouse comme membre, et j'ai moi-même été réélue comme présidente. Le comité exécutif réunissant six membres élus ainsi que les représentants des associations ou comités nationaux a été en partie renouvelé, avec l'élection de Fatma Marii et de Yoko Shindo, tandis que Sylvia Fünfschilling, Lisa Pilosi, Marianne Stern et Maria Grazia Diani ont été réélues. Nous avons déploré le décès lors du congrès de deux de nos membres, Sarah Jennings d'Angleterre et Claudia Maccabruni d'Italie.

Les préparatifs pour le 19e congrès se déroulent sous la houlette d'Irena Lazar. Le congrès se tiendra à Piran en Slovénie du 17 au 21 septembre 2012 (www.aihv.org, www.zrs.upr.si). Après l'accent mis sur la Méditerranée orientale au congrès de Thessalonique, une nouvelle avancée vers les informations et les membres d'Europe Centrale sera effectuée à Piran.

PREFACE

Marie-Dominique Nenna

I have great pleasure in presenting you with the Annales of the l8th congress of the Association Internationale pour l'Histoire du Verre, and I wish to thank all those who have ensured that this publication appears with the least delay: principally the authors, the academic committee, and especially the academic editors of the volume, Despina Ignatiadou, vice-president, and member of the board of the AIHV for the years 2006-2012 and Anastassios Antonaras.

The 18th congress of the AIHV was held in Thessaloniki from September 21st-25th, 2009. It was dedicated to Clasina Isings, who came, via a video, to offer us her best wishes. Here we have to warmly thank the Archaeological Museum of Thessaloniki which has organized the whole manifestation, and the Museum of Byzantine Culture, which has hosted our sessions in the brand new auditorium of the Museum, used for the first time for our congress. All our warm thanks also to The Friends of the Archaeological Museum of Thessaloniki who supported the organization of the congress among the others with the nice bag decorated with bird-balsamaria, and The Prefecture of Thessaloniki, who has hosted us at the end of the congress. Last, but not the least, from the bottom of our heart, our thanks go to Despina Ignatiadou, Anastassios Antonaras and the Organizing committee for their hard work in organizing this congress and for offering us the opportunity to meet once again to share our discoveries and our thoughts on this wonderful material, glass, to which we are all dedicated.

During the 33 parallel sessions, 95 oral communications and 55 posters were presented, displaying the vitality of research on the history of glass in the scientific world. Thanks to the energies of the Greek Committee, after a first glance at Thessaloniki at the beginning of our congress, thematic visits were organised to discover the different aspects of Thessaloniki· Hellenistic and Roman city, Byzantine city, Ottoman city with its important Jewish community, contemporary city. In the post-congress trips, the participants were able to visit the heart of Macedonia, with the cities of Vergina and Dion, and the Pikrolimni Lake, producing natron in Antiquity and still today, the ancient cities of Amphipolis and Philippi, or to make a cruise around Mount Athos.

This volume brings together 84 contributions, which cover a vast chronological span from the second millennium BC up to the present day, touching on all aspects of the history of glass with a good networking between archaeology, history of art and archaeometry. An important part is devoted to the beginnings of the history of glass in the second millennium and the beginning of the first

millennium BC, and the developments in the Hellenistic world with papers covering the Near East, Egypt and Sudan, Greece and Turkey. The Roman and Byzantine worlds are approached from two directions: the study of the production and consumption of vessels and ornaments and the expanding study on the glass in mosaic pavements and walls. The papers on the Islamic world build on the start made at the 15th congress and show the vitality of research in this area. The presentation of discoveries and research coming from the Czech Republic, Great Britain, Italy, Kosovo, Montenegro, Portugal, Poland, Romania and Serbia, fuels the debates about glass during the medieval and post-medieval period in Europe. The 18th and 19th centuries are not ignored, with papers dealing with glass in roofs, glass flowers and mosaic glass and there are also studies dealing with African and Asian glass.

During the General Assembly the board of the AIHV changed. Jan Egbert Kuipers (Treasurer) and Ian Freestone, to whom we extend all thanks for their work, submitted their resignations. The newly elected members were Irena Lazar, organizer of the 19th Congress in 2012, as Vice President, and Huib Tijssens, as Treasurer. Already present in the board, Despina Ignatiadou was elected member, were re-elected Jane Spillman as General Secretary, David Whitehouse as member, and I as President. The executive committee which assembled six elected members as well as the presidents of the national Associations or Committees, was partly renewed, with the election of Fatma Marii and Yoko Shindo; Sylvia Fünfschilling, Lisa Pilosi, Marianne Stern et Maria Grazia Diani were re-elected. We mourned during the congress the recent death of two long time members, Sarah Jennings from England and Claudia Maccabruni from Italy.

The preparations for the 19th congress are progressing under the guidance of Irena Lazar. The congress will be held at Piran (Slovenia) from September 17th to September 21st 2012 (www.aihv.org, www.zrs.upr.si). After the wider opening towards eastern Mediterranean members effectuated during the Thessaloniki Congress, we will receive in Piran more information and members coming from Central Europe.

Fig. 5 : Artémision de Thasos : fragments d'amphorisques (a et c) et d'oenochoé (b).

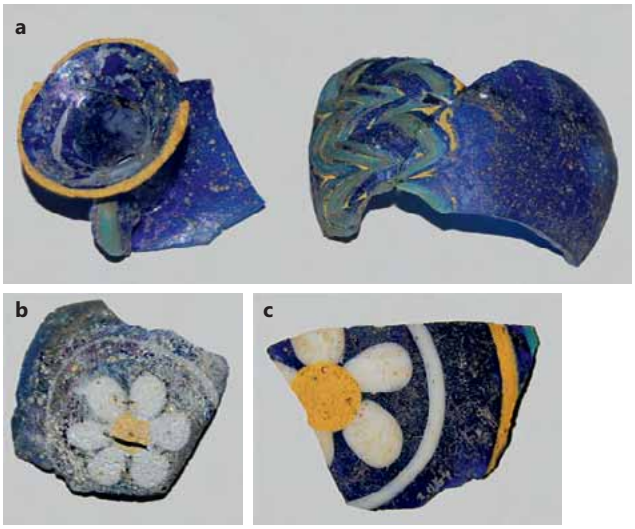

Fig. 6 : Thasos : fragments d'aryballes.

– Groupe 5 : décor jaune et bleu turquoise composé de spirales sur l'épaule et la partie inférieure de la panse et d'une zone de zigzags restreinte sur la zone en dessous de l'épaule (11 ex., McClellan II.C.4)
– Groupe 6 : même type de décor, mais blanc et jaune (fig. 5a : 19 ex., Grose Class I:G ; McClellan II.C.4).

Deux autres groupes sont constitués d'amphorisques et d'oenochoés de forme différente :

– Groupe 8 : amphores à la panse rebondie, plus petites que les précédentes, avec une rupture nette entre le col et l'épaule (Harden Amphoriskoi 1, Grose Amphoriskoi I:2). Décor de spirales et de zigzags bleu clair et jaune (15 ex., « normal pattern » de Harden, Grose, Class I:B, McClellan II.C.7) Ces pièces sont souvent réalisées dans un verre bleu moyen et sont toujours très bien marbrés. On dispose du fragment d'une oenochoé (fig. 5b) portant la marque circulaire sur le départ de l'anse, signe pour Th. Haevernick d'un atelier rhodien.
– Groupe 9 : amphores et oenochoés à la panse pointue (Grose Amphoriskoi I:3). En verre bleu outremer fin et brillant, ce groupe est à la fois le plus fréquent et le plus homogène avec un décor toujours bleu turquoise et jaune finement peigné (fig. 5c : 38 ex., Grose Class I:H, non distingué par McClellan).

C'est à ce groupe que se rattache la plus grande partie des aryballes au nombre de 27 (fig. 6a). Parmi ces derniers, deux pièces sortent du lot, un aryballe bicolore bleu outremer et blanc, à décor blanc et bleu turquoise finement peigné et un autre dont le fond est décoré d'une fleur (fig. 6b), décor attesté à ma connaissance uniquement par une autre pièce provenant d'un quartier d'habitation de Thasos (fig. 6c)[49].

Quatre points doivent être retenus de cette étude :

– La quantité d'objets exceptionnelle de la première phase de production et la quasi-absence des pièces des deux phases suivantes, qui témoignent à la fois d'une baisse du volume de la production déjà connue, mais aussi des choix des pèlerins qui venaient déposer une offrande à Artémis. En effet, les vases des périodes II et III sont bien attestés dans les nécropoles macédoniennes et thraces[50].
– Le fait que la quasi-totalité des groupes sont aussi présents dans les nécropoles de Rhodes, mais en proportion différente. Si le groupe 8, le « normal pattern » de Harden, domine à Rhodes et plus généralement dans l'ensemble de la Méditerranée, il est peu représenté à l'Artémision. Ceci doit plutôt être mis au compte de la chronologie des dépôts, qu'à un tarissement de l'arrivage, car ce groupe est bien connu dans les nécropoles de Macédoine et de Thrace[51].
– L'intérêt du mobilier de l'Artémision semble donc être que la plus grande partie des pièces appartiennent au début de la première phase de production,

49. Grandjean 1988, 261, Fig. 52.
50. Voir entre autres, Ignatiadou 1990-1995.
51. *Ibidem.*

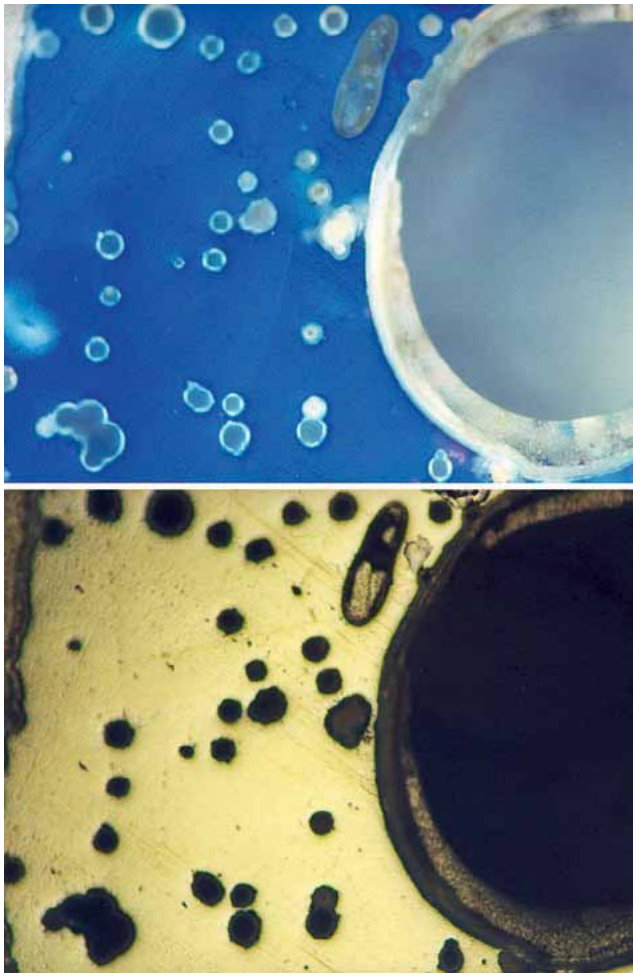

Fig. 4: Bubble holes and altered areas in cross-section viewed in cross (upper) and parallel (lower) Nicols.

Fig. 5: Detail of aqua tubes exhibiting different surface morphologies: fibrous (upper) and smooth surface (lower), due to different forming and finishing techniques.

Tubes of similar coloured tranlucent glass (aqua tint) with a different surface morphology were observed). This variation indicates that either a different forming technique was used or a surface finishing technique was applied (Fig. 5).

Defects enhanced by decay provided evidence of the forming technique since wound beads showed flow lines in the direction of winding, while the drawn tubes and canes had fibrous surfaces due to drawing.

Microscopic examination of the cross- and longitudinal sections of tubes and canes from Kakoula revealed an abundance of bubbles elongated by drawing trapped inside the glass matrix. This feature is well known in the modern glass industry and is described as 'air-lines'[13]. As a result, the external uneven morphology of tubes and canes without a further surface finish could be attributed to the presence of 'air lines' enhanced by decay.

In addition, globular irregularities previously reported as 'knots'[14] were detected on some tubes. 'Knots' are attributed to any refractory matter trapped inside the glass matrix. When the core of the 'knot' was exposed, due to fracture, a white granular material was revealed. Examination with SEM-EDS confirmed the crystalline nature of the core material (Fig. 6), while X-Ray Diffraction detected the presence of natron, quartz, calcite and various oxides of lead, antimony and iron. This is considered to be strong evidence that 'knots' were formed due to the presence of unreacted raw materials, indicating incomplete melting.

Beads of opaque and translucent glass, particularly the eye-bead type, often exhibited a network of cracks on the surface (strain cracking). These networks had in some cases developed into wider or deeper cracks due to corrosion that would be described as 'grooves' and 'slots' although they did not extend through the thickness of the bead[15]. Microscopic examination of the surfaces of beads differentiates between 'grooves' and

13. Glossary of Glass Tubing.

14. Francis 1990, 211; Stern 1987, 351.
15. Newton 1985, 33-34; Newton *et al.* 1981, 354-365.

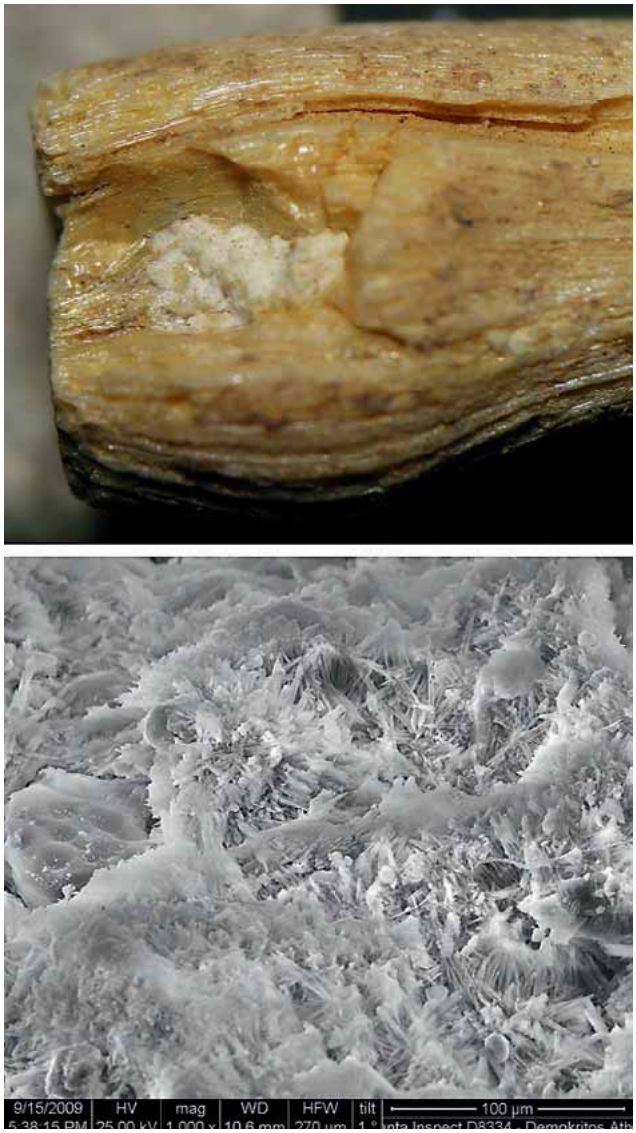

Fig. 6: Detail of knot core morphology under stereomicroscope (upper) and scanning electron microscope (lower).

'slots' on their width, mainly by the presence or not of corrosion layers developed on their side walls. Polished cross- sections of representative samples were examined under optical and scanning electron microscopes coupled with EDX analysis in order to study the microstructure and the composition of these areas. Optical and SEM examination of 'slots' on opaque yellow glass revealed the presence of a solid material in their core usually coupled with circular inclusions. In addition 'slots' were surrounded by corroded areas with a complex laminated structure and convoluted morphological features, while 'grooves' examined on differently coloured glass appeared to be narrow cracks surrounded by leached layers. Compositional data of the solid core detected by EDS analysis indicated the accumulation of Pb and Sb related to the colorant- opacifier (lead antimonate) combined with an enrichment of P, Ca and Cl related to glass corrosion during burial.

Conclusions

The Kakoula glass finds were exposed to similar environmental conditions for the same period of time. Examination of these finds has provided evidence for the influence of manufacture techniques on alteration of the glass. The differences in corrosion morphology are more likely to be connected to composition and forming technique of the individual finds.

The corrosion morphology of the finds exhibited the common phenomena detected on excavated glass like iridescence, translucent to opaque whitish surfaces, blackened external corrosion layers/crust and yellowish discoloration. In addition, the corrosion of crazed surfaces created a network of 'grooves' and 'slots' on both translucent and opaque glass beads.

The defects in the finds clearly enhanced the alteration of the glass. Advanced corrosion due to bubble holes, folding or fissures and cracks were identified. At the same time, information about the manufacturing techniques of glass beads during the Hellenistic period (melting, forming and annealing) were revealed by examination of the altered surfaces. In many cases, defects enhanced by corrosion served as an indication of the forming technique as when wound beads revealed flow lines corresponding to the direction of winding, and tubes and cane showed fibrous surfaces due to drawing.

Finally, detailed examination of the finds supplied evidence for the formation of particular technological features. The fibrous morphology of canes and tubes has been attributed to an abundance of elongated bubbles and 'knots' in opaque glass tubes to the presence of crystalline substances due to incomplete melting of raw materials.

Fig. 2a-c. Pompeii, VII, 4, 56, casa del Granduca di Toscana, the fountain in the garden, decorated with a mosaic revetment (2a). The flanks of the niche are decorated with pumice, shells and glass shards. An opaque red mould pressed dish, Isings form 2, is visible on the left (2b). Some twisted stirring rods are used to draw the borders of the decorative patterns (2c).

3.2 The transitional technique and the success of glass tesserae

From the end of the 1st century BC, wall mosaic techniques changed slightly and the first use of glass tesserae was seen. The technique of this period has been described as the 'transitional technique', because the previous use of multiple materials coexisted with the use of tesserae, with a gradual increase of the use of glass.

In the first years the availability of glass cakes for cutting tesserae seems to have been limited and, when glass occurred, it was used scarcely. A good example of this initial stage is the mosaic from Cremona mentioned above. The mosaic is composed of a large quantity of Egyptian blue, limestone and marble tesserae, with a few green glass tesserae. The mosaicists created several decorative motives, but the green glass tesserae were systematically used only to create ivy leaves on two semi-columns.

The latest examples of the transition technique are datable to the years AD 30-40, as clearly evidenced by the mosaics in the Casa dello Scheletro in Herculaneum, and in the Casa del Granduca di Toscana in Pompeii. In these examples glass tesserae occur in great quantity and a variety of colours. The use of tufa and glass shards was still present, but was relegated to parts of secondary importance as, in the Casa del Granduca di Toscana, the sides of the fountain (Fig. 2). In this stage, glass tesserae are used extensively, but it is important to stress that the colours do not seem to be available in equal amounts. In the fountain of the Casa del Granduca di Toscana, which was characterized by an abundant use of glass, the red glass tesserae were cut from vessels.

Fig. 2: The inside surface of the central bottom part of the dish.

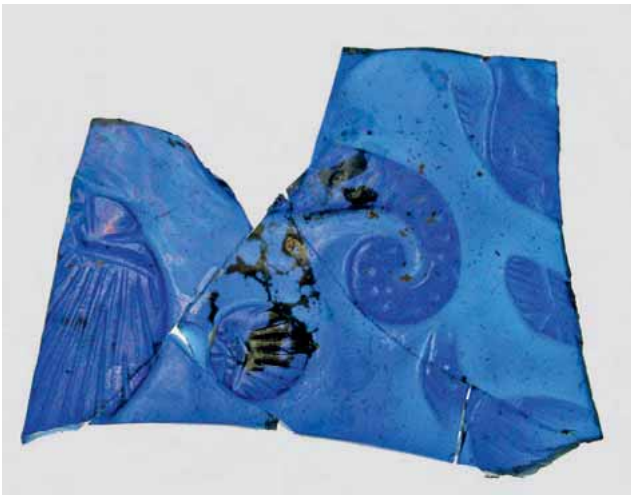

Fig. 3: The central bottom part with the light behind.

Fig. 4: The outside surface of the central bottom part of the dish.

Fig. 5: The rim part with the light behind.

remaining of the mane might indicate it to be a sea-lion or sea-griffin. The part of rolled tail of sea animal Fig. 1.k could have belonged to the same sea animal because we can see similar line decorations both on the tail (Fig. 1.k) and on the body (Fig. 1.j).

The fragment Fig.1.h shows a profiled head with a diamond eye, a pointed ear and a short mane. It is more likely to be a sea-horse, "hippocampus". The three pointed fin of a sea animal could have been either of the sea animal on fragment Fig. 1.j or of the sea –horse, but I have tentatively put it together with the latter on Fig. 1.

Thus, we can assume the decorative scheme of the dish as follows; the big scallop-like shell at the centre was surrounded first by sea animals swimming anticlockwise (perhaps three types of sea animals, such as sea-lion or sea-panther, sea-horse, sea-griffin), secondly by alternate row of fish swimming clockwise accompanied by a shell, thirdly by the missing sea creatures (only trace is remaining on the top of fragment Fig. 1.j), and fourthly, i.e., around the rim, by groups of three fish, shrimp and other missing sea creatures facing anticlockwise.

Manufacture and Decoration of the Dish

The production process of this elaborate dish is assumed as follows; a plain shallow dish was prepared with a thickness of around 4 to 5 mm by mould (the innumerable tiny spherical bubbles around the rim or the bottom are not elongated) and then the decoration was made by cold working, wheel abrasion and engraving. The double raised lines around the rim were made by wheel abrasion. The outside surface of the dish has been cut away round the figures to create the relieves and finally the details of figure itself were made by both engraving and wheel abrasion (Fig. 9). The concentric grinding lines in the in-

terior surface might be the result of wheel abrasion or when the relief cut or polish was done for its exterior.

Comparable Pieces

Mr. Ishiguro cited the early Roman purple and opaque white cameo plate fragment with shells and a crab motif now in the Metropolitan Museum of Art in New York as the only comparable piece[2] because he believed that the dish discussed here was a rare example of the revival of cameo glass around 4th century. However, it has not been possible to find any trace of a double layer of glass on the piece, so this identification is unlikely.

I would rather focus on Late Roman relief-cut vessels with sea creatures for comparisons although they are all smaller and made in colourless glass or in rock crystal and no piece shows the sea animal and fish-mollusc motif together or a group of three fish[3].

The only example in glass is the "Cage cup" from Szekszárd in the National Museum of Budapest, dated to the early 4th century, which has three fish and three molluscs in high relief around the bottom[4].

Examples in rock crystal are the lamp in S. Marco treasury in Venice dated to the 4th century (with a silver-gilt frame of the 10th-12th century)[5], and the shallow dish in the Metropolitan Museum of Art (dated to the 3rd-5th century)[6]. The former has seven fish and molluscs in high relief around the body and three shells around the bottom, while the latter has eleven fish and molluscs around the exterior.

The similarity with the Islamic relief cut glass was also pointed out, however, there is no sea creature motif in relief in Islamic glass, and furthermore Dr. David Whitehouse, the former executive director of the Corning Glass Museum of Art, told me that as far as he is aware the "*hippocampus*" and sea-griffin motif do not occur in Islamic art.

If we focus on just the sea creature motif, Roman and Byzantine mosaic pavements are interesting parallels to be cited because we can find the sea-animal (without the rider on its back) with fish-mollusc motif or a group of three fish motif among them. The former motif is popular so it will be enough to cite the

Fig. 6: All the fragments of the dish.

Fig. 7: A group of three fish (Fig. 1.d).

Fig. 8: A group of three fish (Fig. 1.e).

examples in Ostia Antica, Italy, the black and white figured mosaic pavement such as the one in the "Bath of Neptune" (the early 2nd century), or in the "Bath of Lighthouse"(the mid 3nd century)[7].

On the other hand, the latter motif is rare and we have to ascend to the Byzantine period, around the 6th century. For example, a group of three fish can be seen in one of the panels surrounding the central mosaic at the nave in the church of Sts. Lot and Procopius

2. Goldstein, Rakow and Rakow 1982, fig. 12.
3. Weinberg1992, 112-113, no. 76.
4. Weizel 1999; Donati e Gentili 2005, 316-317, no. 186.
5. Donati e Gentili 2005, 316, no.185.
6. Bühler 1973, 78-79, Tafel. 39, no. 115b.
7. Dunbabin 1999, 61-64, fig. 62-63.

GLASS FINDS FROM ANTINOOPOLIS, EGYPT

Flora Silvano

Antinoopolis is located 286 km S of Cairo on the east bank of the Nile, opposite Hermopolis Magna, in Middle Egypt; it was founded by the emperor Hadrian in AD 130, in memory of his beloved Antinoos, who had drowned in the Nile not far from this site. The emperor intended to build a large wealthy city from which Upper Egypt could be administrated. Archaeological excavations have shown that there was a protodynastic cemetery on the site, on top of which a temple was built by Rameses II. Hadrian's town was built around this temple, complete with triumphal arch, a theatre, a large bath building, a hippodrome and an encircling wall. The new settlement was colonized by Greeks brought from other cities, especially from the Fayum.

Numerous glass fragments were found in the recent and earlier excavations in the northern necropolis of Antinoopolis carried out by the Mission of the Istituto Papirologico "G. Vitelli"[1], now directed by Rosario Pintaudi. In addition to a large number of lamps and other utilitarian vessels the necropolis has also produced a very impressive bowl with cold-painted decoration, a significant number of monochrome and mosaic revetment plaques and a very interesting fragment of *opus sectile* panel. All the glass finds date from the 4th-6th centuries.

Fig. 1: The painted bowl from Antinoopolis © Ist. Papirologico G. Vitelli – Firenze.

Fig. 2: Detail of the painted bowl © Ist. Papirologico G. Vitelli – Firenze.

The Painted Bowl

Of particular interest among the finds is a part of a painted bowl (D. 13.2 cm) in pale bluish-green glass (Fig. 1). The exterior of the bowl is painted in unfired colours on a yellow background. The decorative motifs are reverse painted on the outer surface so that they can be seen through the glass from inside. The decoration consists of a stylized floral frieze below the rim and five roundels in the main part of the body. Each roundel features a bust of an angel, depicted frontally, characterized by wings and halos. In the space between these roundels are four ivy leaves flanked by two dots. The roundels and the busts were painted with black outlines and unfired pigments, including orange, green, white, red and brown. In this technique the normal order of application of the pigments is reversed. The contours of the motifs were applied first, followed by the different colours and finishing with the yellow background imitating gilding.

1. Pintaudi 2008.

Since the black outlines and the colours were not fired, the decoration is particularly fragile, and it was painted on the outside to protect it from damage.

Painting in unfired colours is known on different types of Egyptian glass from the end of the 1st century AD to the 4th century[2]. This kind of decoration is often used on dishes, lids and plates[3]. The resemblance of the decorative scheme to the iconographic repertory of Late Antique and Early Byzantine decorated textiles is noteworthy. The similarities in the type of composition and particularly with regard to the complete frontal presentation of the angels inside the roundels suggests a date in the fifth century. The finding of a papyrus fragment with a staring large-eyed painted figure, probably a cartoon for weavers, in the same necropolis of Antinoopolis, seems to confirm the use of cartoons for the production of decorated textiles and the decorators of the glass bowl probably also sourced their design from this repertoire[4]. The motif of roundels, sometimes present in gold-glasses[5], also depends on the same repertoire as seen in Egyptian textiles.

No other examples of similar Egyptian bowls were known to me but following my paper at the AIHV congress in Thessaloniki I was kindly informed by Daniel Keller of a similar reverse painted bowl from the coptic monastery at Deir el-Bachit near Thebes.

Friezes with rows of painted busts in roundels, including New Testament figures and Egyptian saints[6], are present in the paintings of the monastery building at Bawit[7] and portraits of saints painted on round glass plaques (D 6.5 and 6 cm) were discovered in the central apse of the northern church at Rehovot in the Negev[8]. According to the excavators, the plates of thin colourless glass were affixed to or inlaid into a larger, probably wooden, object.

The Plaques and inlays

A wide assortment of fragmentary revetment plaques of varying thickness, dated to the 4th -5th centuries, was also recovered from the northern necropolis of Antinoopolis[9]. The fragmentary elements, in monochrome and mosaic glass (Fig. 3), are particularly well

Fig. 3: Revetment plaques and inlays from Antinoopolis © Ist. Papirologico G. Vitelli – Firenze.

2. Painter 1987, 259-262.
3. Ryser 1992, 11.
4. Stauffer 2008.
5. Morey 1959, fig. XVIII, 104.
6. Auth 2005, 25-31.
7. Cledat 1906, pls. X, XXXI, LXIII; Cledàt 1916, fig. XVII.
8. Tsafrir 1988, 142-149.
9. Silvano 2008, 419-432.

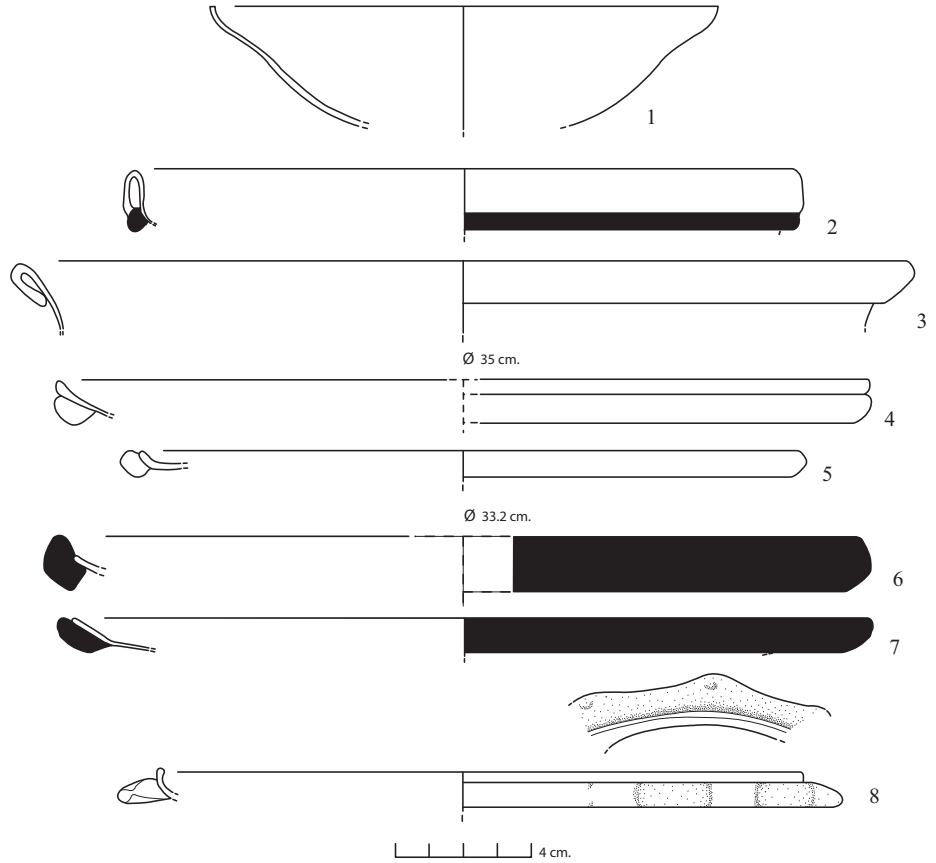

Fig. 1: Plate and bowl fragments of the 5th-6th centuries.

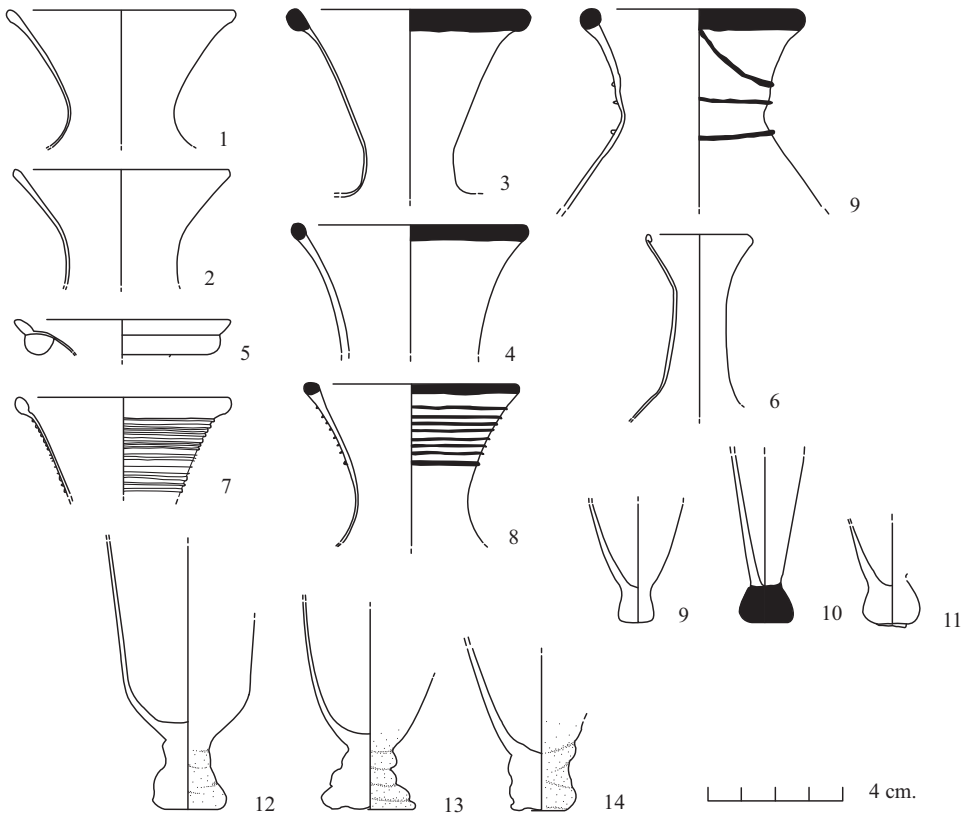

Fig. 2: Bottle, flask and lamp fragments of the 5th-6th centuries.

SPATIAL AND TEMPORAL CONSIDERATIONS OF TECHNOLOGICAL CHANGE: EXAMINING EARLY ISLAMIC GLASS

Carolyn M. Swan

Introduction

One of the most fascinating avenues of archaeometric research deals with questions about the fluxing agents used in the primary production of raw glass. Glassmaking technology changed as craftspeople experimented with different raw ingredients and production processes, and scholars have been working towards defining where and when these changes occurred. Chemical analyses have shown that alkali fluxes changed twice in the Eastern Mediterranean: from plant ash to mineral natron during the first millennium BCE and from natron to plant ash during the first millennium CE. Reade *et al*[1] have observed that there is a dearth of detailed evidence for the emergence of natron glass in the late second to early first millennia BCE primarily due to problems of preservation; in contrast, there has been a greater degree of success in tracing the emergence of plant ash glass in the first millennium CE. This success is fortunate indeed, for not only do such studies improve our knowledge of glass history, this work may also help us to examine larger historical questions. The glassmaking changes that we notice taking place in the 8th-10th centuries CE coincide with a very significant period in history, one in which important political, religious, and socio-cultural changes were taking place as the Near East transitioned from a Greco-Roman to an Arab-Persian sphere of influence.

The purpose of this study is three-fold: first, to present the results of a preliminary chemical analysis of some early Islamic glass artifacts from the site of Ayla in southern Jordan; second, to view this data in light of current scholarship that deals with reasons for the changes in glassmaking technology that took place ca. the 8th-12th centuries; and third, to think critically about current research questions and approaches in order to suggest other theoretical steps forward. What follows are some initial thoughts and reflections that will form the basis of the author's doctoral dissertation; it is believed that scholars must more fully explore and integrate the social realities of the past with the material analyses made in the present, because it is not enough for us to simply show that change occurred—we must think about *why* it occurred and the various processes by which technologies may be shaped and stabilized.

Preliminary Chemical Analyses

The chemical composition of scratch-decorated blue vessel glass fragments (Fig. 1) recovered from 8th-9th century contexts at the site of Ayla in modern Aqaba was determined using electron probe microanalysis (EPMA); the results were then compared to several published studies of first millennium glass in general (Table 1) and scratch-decorated glass in particular (Table 2). It was assumed that the analytical results would fit into the general technological narrative of mineral-natron-based Roman/Byzantine glass and plant-ash-based Islamic glass; however, the Ayla samples proved to be low-magnesium soda-lime-silica glasses made

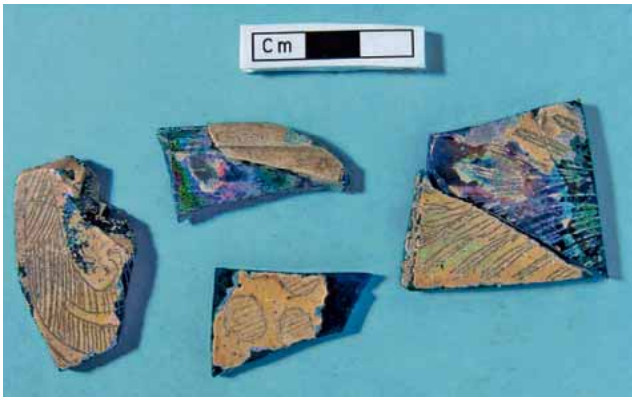

Fig. 1: Scratch-decorated blue vessel glass from Ayla, Jordan, ca. 8th-9th centuries (photo credit: C. Swan 2004)

1. Reade, Freestone, and Simpson 2005, 23-27.

Date	5th-7th c. Petra Church, Jordan (natron)	6th-7th c. Bet She'an, Israel (natron)	6th-8th c. Bet Eli'ezer, Israel (natron)	8th-9th c. Ayla, Jordan (natron)	8th-9th c. Tell Zujaj, Raqqa, Syria (natron)	8th-9th c. Tell Zujaj, Raqqa, Syria (plant ash)	10th-13th c. Banias, Israel (plant ash)
	Avg. wt%	Avg. wt%	Avg. wt%	Avg. wt%	Avg. wt%	Avg. wt%	Avg. wt%
SiO_2	69.81	69.3	74.9	69.1	71.17	67.55	70.5
Na_2O	15.04	15.6	12.1	14.1	13.82	13.7	12.5
CaO	9.14	9.17	7.16	9.7	9.07	8.51	8.55
K_2O	0.95	0.63	0.46	0.42	0.61	3.47	1.89
MgO	0.52	0.59	0.63	0.68	0.73	3.55	2.72
Al_2O_3	2.86	3.03	3.32	2.31	3.19	1.17	1.06
Fe_2O_3	0.49	–	–	1.21	0.39	0.52	–
FeO	–	0.45	0.52	–	–	–	0.4
P_2O_5	0.15	–	–	0.10	0.1	0.29	–
Cl	0.77	–	–	0.99	0.73	0.79	–
TiO_2	0.09	–	–	0.25	0.05	0.06	–
CoO	–	–	–	0.07	–	–	–
CuO	–	–	–	0.10	–	–	–
MnO	–	<0.1	<0.1	0.19	0.04	1.2	1.0
Source	Schibille *et al.* 2007, 631.	Freestone 2006, 203.	Freestone 2006, 203.	Swan 2004.	Henderson *et al.* 2004, 453.	Henderson *et al.* 2004, 453.	Freestone 2006, 203.

Table 1: Chemical composition of some first millennium glass.

from mineral natron, and are thus more closely associated with the raw materials and technology of the Roman/Byzantine tradition rather than that of the later medieval Islamic tradition. In addition, the Ayla assemblage was colored by adding as little as 0.01 wt% CoO and 0.02 wt% CuO; a small amount of MnO was additionally present, which served to counteract the green effect of FeO impurities and increase the optical absorption of the CoO, thus producing the intense blue color. If the MnO is associated with the CoO, as seems likely, the cobalt may have come from the Great Western Oases in Egypt rather than from other sources like the arsenical ores of Iran.

Scratch-Decorated or Incised Glass

It was found that although the Ayla glasses date to the early Islamic period, they were made using mineral natron as a flux; however, it is unlikely that these glasses are simply Roman or Byzantine products found in later archaeological contexts, as their deep blue color and incised decoration clearly mark them as Umayyad or 'Abbasid period products. Similar glass beakers and bowls of colorless or darkly colored glass—blue, purple, olive, yellow-green, and yellow-brown—with scratch-decorated geometric patterns on the exterior surface have been found in the medieval Near Eastern world, including the following sites:[2]

- al-Mina, Hadir Qinnasrin, and Raqqa (Syria)
- Pella and Aqaba (Jordan)
- Bet She'an, Nessana, and Hammat Gader (Israel and the Palestinian Territories)
- al-Tur (southern Sinai Peninsula)
- Fustat (Egypt)
- Manda (Kenya)
- Gao (Mali)
- Samarra, Tulul al Uhaidir, and Nippur (Iraq)
- Susa and Nishapur (Iran)
- Famensi (China)
- Corinth (Greece)
- Dvin (Armenia)

2. Hadad 2000.

Fig. 1: Examples of Islamic glass analyzed in this study.
Coin weight: (a) A025, (b) M019bis. Disk weight: (c) A077, (d) A102. Ring weight: (e) A113; Vessel stamp: (f) A116, (g) A020; Vessels for daily use and chunk glass from the Fustat site: (h) FG-579a, (i) FG-84, (j) FG-B20-II-35, (a-g, Bouvier collection; h-j, Waseda University).

toko (Director of the Research Institute for Islamic Archaeology and Culture, Tokyo, Japan).

The glass vessels were excavated from the Fustat site by the Japanese mission and analyzed by Mochizuki[5]. In this study, samples were selected on the basis of their decoration, shape, color, *etc*. Selected photographs are shown in Fig. 1. Most of the samples were green, bluish-green, or olive green in color, similar to the stamped glass objects. Typical decorated vessels, such as pinched and enamel-like threaded vessels (Fig. 1-h) were included[6]. One glass vessel fragment (Fig. 1-j) with a similar appearance was also analyzed.

2.2. Analytical methodology

Major and minor elements (Si, Na, K, Mg, Ca, Al, Ti, Mn, Fe) in the glass samples were analyzed using an X-ray fluorescence (XRF) spectrometer (OURSTEX 100FA II-L; OURSTEX Co.). The analytical procedures and conditions are described elsewhere[7].

Trace elemental analysis was performed using an energy-dispersive XRF spectrometer (Epsilon 5; PANalytical) with 3-dimensional polarizing optics and secondary target system. This spectrometer, equipped with a gadolinium (Gd) target tube that can be operated up to 600 W and a germanium solid-state detector (Ge-SSD) allows the detection of K-lines from heavy elements.

We quantified trace elements, such as Cr, Ni, Rb, Sr, Y, Zr, Ba, La, Ce, and Nd, using the following 5 secondary targets: Fe, Zr, Ge, Mo, and Al_2O_3. Standard glass samples (NIST SRM610, 612, 614) and four synthetic glass objects that had been analyzed by inductively coupled plasma-mass spectrometry (ICP-MS) were used to generate calibration curves for quantitative analyses and estimate precision and accuracy. The synthetic glass objects were prepared in concentrations of 10, 100, 500, and 1000 ppm for the trace elements. All calibration curves exhibited high accuracy ranges, with $R^2 = 0.993$-1.000. A cros-check using a reference glass SRM 612 (ca. 50 ppm) or synthetic glass (ca. 500 ppm) showed that the relative standard deviation (RSD) for most elements was below 15%. Detection limits in the ppm range were established through analysis of SRM 612. Calibration curves prepared from standard samples were used to quantify each trace element at concentrations greater than 10 ppm.

3. Results & Discussion

3.1. Analysis of early Islamic glass stamps

3.1.1. Result 1: Appearance of the compositional shift in Islamic glass stamps

The glass weights and vessel stamps analyzed in this study were natron-based glasses, which have low MgO and K_2O contents (less than 1.5 wt%). They can be divided into two primary types based on their aluminum and calcium compositions: the Stamp-1 group

5. In Sakurai and Kawatoko 1992.
6. Shindo 2000.
7. Kato *et al.* 2009a.

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